Intensive Care Med (2009) 35:192–194
DOI 10.1007/s00134-008-1351-x

EDITORIAL

Alexandre Demoule

Non-invasive ventilation: how far away from the ICU?

Received: 22 September 2008
Accepted: 22 October 2008
Published online: 19 November 2008

This editorial refers to the article available at:
doi:10.1007/s00134-008-1350-y.

A. Demoule
Service de Pneumologie et Réanimation,
Groupe Hospitalier Pitié-Salpêtrière,
Assistance Publique, Hopitaux de Paris and EA2397,
Université Paris 6 Pierre et Marie Curie, Paris, France

A. Demoule (✉)
Service de Pneumologie et Réanimation,
Groupe Hospitalier Pitié-Salpêtrière,
47-83 boulevard de l'Hôpital,
75651 Paris cedex 13, France
e-mail: alexandre.demoule@psl.aphp.fr
Tel.: +33-1-42167761
Fax: +33-1-42167843

In less than 15 years, non-invasive mechanical ventilation (NIV) has become a major therapy of acute respiratory failure. The benefit of NIV is very well established in ventilatory failure resulting from acute exacerbations of chronic obstructive pulmonary disease (COPD) [1, 2] as well as in acute cardiogenic pulmonary edema [3]. Although the benefit of NIV in "*de novo*" acute respiratory failure is less clear [4], it is well demonstrated that NIV is an effective treatment of hypoxemic respiratory failure in immunocompromised patients [5] [6]. Indications for NIV are still increasing, especially in ventilator weaning [7] and in the post-operative setting [8]. Consequently, growing evidence of the benefits of NIV in multiple indications has led to a major increase in NIV use [9, 10].

For safety reasons, as well as to improve the chances of success, NIV requires an appropriate environment. Elliott et al. [11] have defined this environment as follows: the presence of staff with training and expertise in NIV, and in adequate numbers for 24/24 cover, facilities for monitoring, and rapid access to endotracheal intubation and invasive ventilation. Obviously, the ICU setting fits all these criteria. Unfortunately, there is clearly an imbalance between ICU beds and the number of patients that need NIV. According to forecasts, this imbalance should increase in the future. Indeed, the number of patients requiring mechanical ventilation will grow continuously [12], while work force shortage currently forces ICU bed closure. The strong pressure on ICU beds combined with their high cost have both made NIV outside the ICU an attractive option.

What is meant by outside the ICU? The model of hospital care differs from country to country and the type of treatment undertaken in a given department differs from hospital to hospital. It is thus difficult to make close comparisons. The benefit of NIV in the emergency department has been demonstrated in acute cardiogenic pulmonary edema [13] but remains disputed in acute exacerbations of COPD [14]. Achieving safe and successful NIV in the ward is another challenge. However, the study by Plant et al. suggested that, with adequate staff training, NIV can be applied with benefit in the general respiratory ward with the usual ward staff [15]. The proximity of a respiratory ICU obviously facilitates the feasibility of NIV in the ward [16]. Furthermore, recent North-American surveys have shown that NIV outside the ICU was becoming a widespread practice [17–19]. This observation raises the issues of staffing and training in a general ward where nurse to patient ratio is commonly modest.

The study by Cabrini et al. published in this issue of Intensive Care Medicine [20] provides new interesting data on the management of NIV outside the ICU by a medical emergency team (MET). A MET is the efferent arm of a rapid response system [21]. Their role is to identify and treat hospitalized patients with physiological instability and, therefore, prevent further adverse events. Although acute respiratory failure is one of the situations prompting a MET call, application of NIV by a MET had never been described previously. The objective of the observational study by Cabrini et al. was to describe organizational aspects, safety and short-term outcome of patients treated with NIV for acute respiratory failure outside the ICU [20]. Patients received NIV (43% CPAP) if ventilatory support was indicated but tracheal intubation was not appropriated or immediately needed. NIV was instituted in a large variety of departments, mostly in the emergency department and in the general medicine ward, but also in various medical and surgical wards.

Their results are quite encouraging since 77% of patients avoided intubation, which is close to or better than rates reported in studies of NIV in ICUs [4]. Obviously, the observational design of the study does not allow for confirmation that all patients who received NIV really needed NIV. Unfortunately, PaO_2/FiO_2 ratios are not provided which does not permit the evaluation of the severity of hypoxemia. However, patients ventilated for hypercapnic respiratory failure including acute cardiogenic pulmonary edema exhibited a high level of hypercapnia and subsequent acidosis, which suggest a deep level of hypoventilation. Unsurprisingly, NIV success rate was high in acute exacerbation of COPD and pulmonary edema, and low in pneumonia and in patients with hematological diseases.

Apart from the success rate, safety, a crucial issue for such a study, must be considered. In that respect, Cabrini et al. report very few adverse events. The 16 patients who died had all been judged as "do not attempt resuscitation". No patient was transferred to the ICU for better monitoring and care (which, of note, might also suggest that patients were not so severe). Eventually, complications were limited to failure to accomplished the NIV program or complications related to the mask.

The study presented herein has some limitations that need to be underlined. First of all, the MET had been introduced 18 years ago in the hospital where the study was conducted. Moreover, the MET had 10 years experience in NIV outside of the ICU. Therefore, the quite encouraging results of Cabrini et al. are the fruit of a very long process. Adoption of this strategy cannot be recommended without a strong educational program. As Cabrini et al. wrote very clearly "what is effective in a hospital, can even be dangerous elsewhere". The results of this single center study conducted by highly experienced investigators cannot be translated elsewhere without caution. The workload is another issue of this study. Indeed, the workload related to NIV has not been precisely evaluated. It is obvious that managing NIV in various wards is highly time consuming, and one would like to know more about this workload before implementing such strategy in a given hospital. The observational design of the study is a limitation that has been discussed previously. This issue might be addressed by future trials with inclusion criteria that ascertain the need for NIV. The occurrence of complications of NIV also needs to be evaluated more rigorously.

In conclusion, this pilot observational study provides valuable new data regarding the efficiency and safety of NIV management outside the ICU by a MET. Nevertheless, such strategy needs training and expertise and is not easy to translate quickly to another hospital. In a period of high pressure on ICU beds, initiation and continuation of NIV outside the ICU under the supervision of a MET is an interesting alternative. Until the benefit of this strategy has been evidenced by randomized controlled trials, we should not forget that ICU, high dependency or intermediate care units remain the best places to administer NIV. Subsequently, our duty will also be to insist on obtaining the resources required to provide the best care for our patients.

References

1. Keenan SP, Sinuff T, Cook DJ, Hill NS (2003) Which patients with acute exacerbation of chronic obstructive pulmonary disease benefit from noninvasive positive-pressure ventilation? A systematic review of the literature. Ann Intern Med 138:861–870
2. Scala R, Nava S, Conti G, Antonelli M, Naldi M, Archinucci I, Coniglio G, Hill NS (2007) Noninvasive versus conventional ventilation to treat hypercapnic encephalopathy in chronic obstructive pulmonary disease. Intensive Care Med 33:2101–2108
3. Masip J, Roque M, Sanchez B, Fernandez R, Subirana M, Exposito JA (2005) Noninvasive ventilation in acute cardiogenic pulmonary edema: systematic review and meta-analysis. JAMA 294:3124–3130
4. Demoule A, Girou E, Richard JC, Taille S, Brochard L (2006) Benefits and risks of success or failure of noninvasive ventilation. Intensive Care Med 32:1756–1765
5. Hilbert G, Gruson D, Vargas F, Valentino R, Gbikpi-Benissan G, Dupon M, Reiffers J, Cardinaud JP (2001) Noninvasive ventilation in immunosuppressed patients with pulmonary infiltrates, fever, and acute respiratory failure. N Engl J Med 344:481–487

6. Antonelli M, Conti G, Bufi M, Costa MG, Lappa A, Rocco M, Gasparetto A, Meduri GU (2000) Noninvasive ventilation for treatment of acute respiratory failure in patients undergoing solid organ transplantation: a randomized trial. JAMA 283:235–241
7. Nava S, Gregoretti C, Fanfulla F, Squadrone E, Grassi M, Carlucci A, Beltrame F, Navalesi P (2005) Noninvasive ventilation to prevent respiratory failure after extubation in high-risk patients. Crit Care Med 33:2465–2470
8. Squadrone V, Coha M, Cerutti E, Schellino MM, Biolino P, Occella P, Belloni G, Vilianis G, Fiore G, Cavallo F, Ranieri VM (2005) Continuous positive airway pressure for treatment of postoperative hypoxemia: a randomized controlled trial. JAMA 293:589–595
9. Demoule A, Girou E, Richard JC, Taille S, Brochard L (2006) Increased use of noninvasive ventilation in French intensive care units. Intensive Care Med 32:1747–1755
10. 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 (2008) Evolution of mechanical ventilation in response to clinical research. Am J Respir Crit Care Med 177:170–177
11. Elliott MW, Confalonieri M, Nava S (2002) Where to perform noninvasive ventilation? Eur Respir J 19:1159–1166
12. Needham DM, Bronskill SE, Calinawan JR, Sibbald WJ, Pronovost PJ, Laupacis A (2005) Projected incidence of mechanical ventilation in Ontario to 2026: preparing for the aging baby boomers. Crit Care Med 33:574–579
13. Park M, Sangean MC, Volpe Mde S, Feltrim MI, Nozawa E, Leite PF, Passos Amato MB, Lorenzi-Filho G (2004) Randomized, prospective trial of oxygen, continuous positive airway pressure, and bilevel positive airway pressure by face mask in acute cardiogenic pulmonary edema. Crit Care Med 32:2407–2415
14. Wood KA, Lewis L, Von Harz B, Kollef MH (1998) The use of noninvasive positive pressure ventilation in the emergency department: results of a randomized clinical trial. Chest 113:1339–1346
15. Plant PK, Owen JL, Elliott MW (2000) Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. Lancet 355:1931–1935
16. Carlucci A, Delmastro M, Rubini F, Fracchia C, Nava S (2003) Changes in the practice of non-invasive ventilation in treating COPD patients over 8 years. Intensive Care Med 29:419–425
17. Burns KE, Sinuff T, Adhikari NK, Meade MO, Heels-Ansdell D, Martin CM, Cook DJ (2005) Bilevel noninvasive positive pressure ventilation for acute respiratory failure: survey of Ontario practice. Crit Care Med 33:1477–1483
18. Paus-Jenssen ES, Reid JK, Cockcroft DW, Laframboise K, Ward HA (2004) The use of noninvasive ventilation in acute respiratory failure at a tertiary care center. Chest 126:165–172
19. Maheshwari V, Paioli D, Rothaar R, Hill NS (2006) Utilization of noninvasive ventilation in acute care hospitals: a regional survey. Chest 129:1226–1233
20. Cabrini L, Idone C, Colombo S, Monti G, Bergonzi PC, Landoni G, Salaris D, Leggieri C, Torri G (2008) Medical emergency team and non-invasive ventilation outside ICU for acute respiratory failure. Intensive Care Med. doi: 10.1007/s00134-008-1350-y
21. Devita MA, Bellomo R, Hillman K, Kellum J, Rotondi A, Teres D, Auerbach A, Chen WJ, Duncan K, Kenward G, Bell M, Buist M, Chen J, Bion J, Kirby A, Lighthall G, Ovreveit J, Braithwaite RS, Gosbee J, Milbrandt E, Peberdy M, Savitz L, Young L, Harvey M, Galhotra S (2006) Findings of the first consensus conference on medical emergency teams. Crit Care Med 34:2463–2478