undergoing lung resectional surgery. Respir Med 2007;101(7):1572-1578.
4. Barbagallo M, Ortu A, Spadini E, Salvadori A, Ampollini L, Internullo E, et al. Prophylactic use of helmet CPAP after pulmonary obectomy: a prospective randomized controlled study. Respir Care 2012; 57(9):1418-1424.
5. Glossop AJ, Shepherd 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.
6. Lorut C, Rabbat A, Chatelier G, Lefevre A, Roche N, Regnard JF, Huchon G. [The place of routine immediate non-invasive ventilation following pulmonary resection in preventing pulmonay complications in patients with COPD (POPVNI Trial)]. Rev Mal Respir 2005;22(1 Pt 1):127-134. *Article in French.*
7. Kushibe K, Kawaguchi T, Kimura M, Takahama M, Tojo T, Taniguchi S. Influence of the site of lobectomy and chronic obstructive pulmonary disease on pulmonary function: a follow-up analysis. Interact Cardiovasc Thorac Surg 2009;8(5):529-533.
8. Chiumello D, Chevallard G, Gregoretti C. Non-invasive ventilation in postoperative patients: a systematic review. Intensive Care Med 2011;37(6):918-929.

DOI: 10.4187/respcare.02333

The authors respond to: Noninvasive Mechanical Ventilation and Helmet After Lung Resection: Oxygenation Improvement: A Small Step or a Large Step?:

We thank Esquinas and Papadakos for their careful analysis of our paper.[1] The authors of the letter are completely correct that our patient population had favorable features to undergo lung lobectomy. However, we investigated an unselected population that represents the mean standard population of lung cancer patients suitable for surgical resection. Nevertheless, the majority of our patients had mild to moderate COPD according to Global Initiative for Chronic Obstructive Lung Disease classification.[2] Additionally, 86% of them (43/50) were active or former heavy smokers (median of 40 pack/years) and 62% (31/50) had cardiocirculatory diseases.

Regarding the blood gas values, they were collected at admission to ICU and immediately before and after the first helmet CPAP treatment, immediately before and after the second helmet CPAP treatment, and so on, according to time points scheduled. In the paper, Figure 2 nicely showed the evolution and trend of P_{aO_2}/F_{IO_2} during the study period. After the first CPAP course a mild increase of P_{aO_2}/F_{IO_2} was observed; it was also detected after the second course, but the difference was not statistically significant.

Regarding the hospital stay and the transient improvement of P_{aO_2}/F_{IO_2}, on one hand, our study showed that prophylactic use of helmet CPAP can progressively improve P_{aO_2}/F_{IO_2}, reaching a statistically significant higher value after the second course of CPAP, compared to the control group ($P = .004$). On the other hand, the hospital stay was statistically shorter in the helmet CPAP group than in the other group ($P = .042$). In our institution the overall median hospital stay after lobectomy is 7 days, which is in line with our results. The slight but significant difference between the 2 study groups, probably came from the 3 patients in the control group who developed pneumonia, even if that fact did not cause any significant difference in postoperative complications between the groups. So we can't be sure there is a correlation between the 2 variables. Nevertheless, hospital stay might have been influenced by various factors on which helmet CPAP had a positive impact. In any case, it would have been nonambiguous if the P_{aO_2}/F_{IO_2} improvement had been long lasting; in that case, a convincing association could be hypothesized. Further study could focus on the continuation of postoperative CPAP in order to find a relationship between hospital stay and oxygenation improvement.

Thanks again to Esquinas and Papadakos for their important comments, which underline that our data give interesting insights into a prophylactic approach in the management of postoperative period after lung lobectomy.

Luca Ampollini MD
Department of Thoracic Surgery

Maria Barbagallo MD
Department of Anesthesia, Intensive Care, and Pain Therapy
University Hospital of Parma
Parma, Italy

Stefanie Ziegler MD PhD
Andrea Ortu MD
Department of Anesthesia and Intensive Care
Umberto Parini Hospital
Aosta, Italy

The authors have disclosed no conflicts of interest.

REFERENCES

1. Barbagallo M, Ortu A, Spadini E, Salvadori A, Ampollini L, Internullo E, et al. Prophylactic use of helmet CPAP after pulmonary obectomy: a prospective randomized controlled study. Respir Care 2012; 57(9):1418-1424.
2. Vestbo J, Hurd SS, Agusti AG, Jones PW, Vogelmeier C, Anzueto A, et al. Global strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease. GOLD Executive Summary. Am J Respir Crit Care Med 2013;187(4):347-365.

DOI: 10.4187/respcare.02406

High-Flow Nasal Cannula Oxygen Therapy in the Emergency Department: Welcome, But Selection Should Be the First Step

To the Editor:

We read with great interest the observations by Lenglet et al[1] on heated and humidified high-flow nasal cannula (HFNC) oxygen therapy. This technique represents a new alternative to conventional oxygen therapy in the emergency department. The authors' hypothesis was that HFNC is feasible and efficient in patients with acute respiratory failure in the emergency department. This is a potential relevant hypothesis, but, in our view, some concerns must be underlined regarding HFNC in the emergency department.

First, a major factor is the variability in this patient population, which makes it difficult to extrapolate the findings to all patients, and we believe the conclusions should be softened. Although there are some data from pediatric studies,[2,3] information is lacking on HFNC versus noninvasive ventilation in adult patients with acute respiratory failure.[4] Also, there are some concerns about the optimal F_{IO_2} level to use, since F_{IO_2} could be influenced by the type of mask, the amount of leak, the flow, and the breathing pattern. The results from pediatric studies with regards to the level of pressure applied during HFNC cannot be extrapolated to adults, because of differences in, for example, nasopharynx volume, nasal resistance, and respiratory pattern.[5,6]

Second, mouth breathing and the degree of mask-face seal affect the pressure applied, assuming that there is certainly loss of pressure through the nostrils or around the mask. When the mouth is open, we assume there is loss of pressure.[7] We need more clinical studies to understand the correlation with other parameters such as tachypnea.

Third, hypoventilation is the most frequent situation in emergency admissions for acute respiratory failure, so arterial blood gas sampling would be a more objective evaluation and should be performed.[8]

Fourth, it is important to evaluate the work load of the respiratory therapists and nurses. To assess the response to conventional ventilation or HFNC we should use validated questionnaires, as was done in other studies, and assess difficulties in implementation.[9] In the study by Lenglet et al[1] there is no mention of the time required to set up the system.

Fifth, some aspects of hospital organization and healthcare cost deserve attention:

- Some patients need transfer to another department or interventions (radiology or specific procedures), and it is important that the therapy be continued. For instance, we need to know what happens when a patient is transferred to the ICU or other wards for tests or procedures.
- The number of devices required and the oxygen consumption during HFNC are unknown and would be of interest to compare to conventional oxygen therapy.
- Further clinical studies are therefore crucial to rational use of HFNC in the emergency department. Several points should be evaluated, including severity of illness initial HFNC parameters, and whether or not HFNC can decrease ICU admissions or the need for NIV.

Antonio M Esquinas MD PhD
Intensive Care Unit
Hospital Morales Meseguer
Murcia, Spain

Claude Martin MD
Service d'Anesthésie-Réanimation
Hôpital Nord
Marseille, France

The authors have disclosed no conflicts of interest.

REFERENCES

1. Lenglet H, Sztrymf B, Leroy C, Brun P, Dreyfuss D, Ricard JD. Humidified high flow nasal oxygen during respiratory failure in the emergency department: feasibility and efficacy. Respir Care 2012;57(11): 1873-1878.
2. Ritchie JE, Williams AB, Gerard C, Hockey H. Evaluation of a humidified nasal high-flow oxygen system, using oxygraphy, capnography and measurement of upper airway pressures. Anaesth Intensive Care 2011;39(6):1103-1110.
3. Sztrymf B, Messika J, Bertrand F, Hurel D, Leon R, Dreyfuss D, Ricard JD. Beneficial effects of humidified high flow nasal oxygen in critical care patients: a prospective pilot study 2011;37(11):1780-1786.
4. Hess DR. Patient-ventilator interaction during noninvasive ventilation. Respir Care 2011;56(2):153-165; discussion 165-167.
5. Doorly DJ, Taylor DJ, Gambaruto AM, Schroter RC, Tolley N. Nasal architecture: form and flow. Philos Transact A Math Phys Eng Sci 2008;366(1879):3225-3246.
6. Chang GY, Cox CA, Shaffer TH. Nasal cannula, CPAP, and high-flow nasal cannula: effect of flow on temperature, humidity, pressure, and resistance. Biomed Instrum Technol 2011;45(1):69-74.
7. Hasan RA, Habib RH. Effects of flow rate and airleak at the nares and mouth opening on positive distending pressure delivery using commercially available high-flow nasal cannula systems: a lung model study. Pediatr Crit Care Med 2011;12(1):e29–e33.
8. Williams AJ. ABC of oxygen: assessing and interpreting arterial blood gases and acid-base balance. BMJ 1998;317(7167): 1213-1216.
9. Nava S, Evangelisti I, Rampulla C, Compagnoni ML, Fracchia C, Rubini F. Human and financial costs of noninvasive mechanical ventilation in patients affected by COPD and acute respiratory failure. Chest 1997;111(6):1631-1638.

DOI: 10.4187/respcare.02286

The authors respond to: High-Flow Nasal Cannula Oxygen Therapy in the Emergency Department: Welcome, But Selection Should Be the First Step

We thank Drs Esquinas and Martin for their letter regarding high-flow nasal cannula (HFNC) oxygen in the emergency department.[1] They raise several concerns related either directly to our work or more generally to the technique.

Regarding our work, we fully agree that initial arterial blood gases (ABGs) are necessary to explore dyspnea in the emergency department. All our patients had initial ABGs. However, due to the observational design of the study, repetition of ABGs was left to the attending physician's discretion. In addition, in the absence of underlying chronic respiratory insufficiency, and if alleviation of respiratory distress is associated with $S_{pO_2} > 95$–%, we see no reason for immediate and repetitive ABGs, which would not be feasible in emergency departments that admit over 100 patients per day.

The time for set-up of HFNC is approximately 45 seconds longer than for application of a face mask. We do not think that difference has any clinical or practical relevance.

We fully agree with the question regarding hospital organization. However, the most pertinent question is not that of patient transfer to radiology or the ICU, because the HFNC device is easily transported. The relevant question is, can a patient that has been stabilized under HFNC be safely monitored outside the ICU and moved to the ward under HFNC? To the best of our knowledge, there are no data on the subject.

Our bias is that, for a patient admitted for acute hypoxemic respiratory failure, initial monitoring must include continuous respiratory, heart rate, and S_{pO_2} monitoring and regular noninvasive blood pressure measurement. In addition, more aggressive ventilatory support (ie, noninvasive ventilation [NIV] or tracheal intubation) must be readily available. Hence, for these reasons, we believe that patients should be kept under strict surveillance, either in a step-down unit close to the ICU or in the ICU. Obviously, the critical point is the intensity of HFNC support required to stabilize the patient. Once again, there are no data in the literature, but we believe that a requirement of $F_{IO_2} > 0.50$ and flow of 30 L/min should lead to ICU admission.

Simple arithmetic may answer the question regarding the comparison of oxygen consumption between HFNC and conventional oxygen therapy.

Regarding more general comments on HFNC, we disagree with Martin and Esquinas when they ask for caution regarding extrapolation to all patients. The strength of observational studies lies precisely in the fact that they more accurately reflect routine care of patients than do randomized controlled trails, because they have very limited exclusion criteria. As an example, our studies of HFNC in patients with acute respiratory failure[1-3] have included such diverse ARF causes as community-acquired pneumonia, transfusion-related acute lung injury, H1N1 lung infection, drug-induced pneumonitis, COPD exacerbation, cardiogenic pulmonary edema, pulmonary embolism, pneumothorax, sepsis and septic shock, pulmonary contusion, massive pleural effusion, post-extubation respiratory failure, *Pneumocystis jiroveci* pneumonia, aspiration pneumonia, pneumothorax, and pancreatitis-induced ARDS.

Regarding the comparison with NIV, clearly HFNC is much more easily implemented in the emergency department than is NIV. One of the main advantages of HFNC over NIV is patient tolerance. With HFNC the patient retains speech and oral intake.

Martin and Esquinas raise the point of effective (rather than optimal) F_{IO_2} delivery depending on type of mask and breathing pattern. This is typically a major advantage of HFNC; several studies have clearly shown that F_{IO_2} is constant during HFNC, whatever the flow and breathing frequency: a condition never met with other conventional devices.[4,5] In addition, HFNC provides optimal gas conditioning with adequate heat and humidity,[6] which provides better comfort than conventional oxygen.[7,8]

It is inappropriate to extrapolate neonatal data to adults, but that was never our intention. Nonetheless, many of the physiological benefits found in neonates have been reproduced in adults. For example, studies have undisputedly shown that HFNC provides flow-dependent positive airway pressure in adults with mild to moderate respiratory distress.[9,10]

Regarding tachypnea, breathing frequency has consistently been found improved during HFNC, in comparison with conventional oxygen. All the studies have shown that breathing frequency rapidly decreases under HFNC.[11] We have also found that the breathing frequency of patients who required intubation after HFNC initiation was significantly higher than in those who did not, and this difference was observed as early as 15 min.[2] Thus, clinicians should be aware that the absence of reduction in breathing frequency after HFNC initiation may predict or at least alert them to the risk of the need for intubation.

Finally, the true question raised by the considerable differences in effective delivered F_{IO_2}, alleviation of respiratory distress, tolerance, comfort and quality of gas conditioning (heat and humidity) between conventional and HFNC oxygen is whether or not HFNC should now become the new standard of oxygen delivery. Our contention is that it should.

Jean-Damien Ricard MD PhD
Service de Réanimation
Médico-Chirurgicale
Hôpital Louis Mourier
Colombes, France

The author has disclosed a relationship with Fisher & Paykel Healthcare.

REFERENCES

1. Lenglet H, Sztrymf B, Leroy C, Brun P, Dreyfuss D, Ricard JD. Humidified high flow nasal oxygen during respiratory failure in the emergency department: feasibility and efficacy Respir Care 2012;57(11): 1873-1878.
2. Sztrymf B, Messika J, Bertrand F, Hurel D, Leon R, Dreyfuss D, Ricard JD. Beneficial effects of humidified high flow nasal oxygen in critical care patients: a prospective pilot study. Intensive Care Med 2011; 37(11):1780-1786.
3. Sztrymf B, Messika J, Mayot T, Lenglet H, Dreyfuss D, Ricard JD. Impact of high-flow nasal cannula oxygen therapy on intensive care unit patients with acute respiratory failure: a prospective observational study. J Crit Care 2012;27(3):324.e9-e13.
4. Wettstein RB, Shelledy DC, Peters JI. Delivered oxygen concentrations using low-flow and high-flow nasal cannulas Respir Care 2005;50(5):604-609.
5. Wagstaff TA, Soni N. Performance of six types of oxygen delivery devices at varying respiratory rates. Anaesthesia 2007; 62(5):492-503.
6. Ricard JD, Dreyfuss D. Humidification. In: Tobin MJ, editor. Principles and practice of mechanical ventilation, 3rd edition. New York: McGraw-Hill; 2013:1199-1211.
7. Ricard JD, Boyer A. Humidification during oxygen therapy and non-invasive ventilation: do we need some and how much? Intensive Care Med 2009;35(6):963-965.
8. Chanques G, Constantin JM, Sauter M, Jung B, Sebbane M, Verzilli D, et al. Discomfort associated with underhumidified high-flow oxygen therapy in critically ill patients. Intensive Care Med 2009;35(6):996-1003.
9. Parke R, McGuinness S, Eccleston M. Nasal high-flow therapy delivers low level positive airway pressure. Br J Anaesth 2009; 103(6):886-890.
10. Groves N, Tobin A. High flow nasal oxygen generates positive airway pressure in adult volunteers. Aust Crit Care 2007;20(4): 126-131.
11. Ricard JD. The high flow nasal oxygen in acute respiratory failure. Minerva Anestesiol 2012;78(7):836-841.

DOI: 10.4187/respcare.02459