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High-flow nasal oxygen for bronchoalveolar lavage in acute respiratory failure patients

To the Editor:

Fiberoptic bronchoscopy with bronchoalveolar lavage (BAL) holds significant risks of oxygenation deterioration [1]. Among various means to improve oxygenation during BAL, noninvasive positive pressure ventilation (NPPV) has received the greatest attention [2, 3]. However, NPPV is a time-consuming and very demanding technique. High-flow nasal cannula oxygen therapy (HFNC) has emerged as a technique for noninvasive respiratory management of hypoxaemic patients [4]. In patients with acute respiratory failure (ARF), its beneficial effects have been shown in various populations [5], and its effectiveness and superiority over NPPV and conventional oxygenation recently demonstrated [6]. Its use has also been described during bronchoscopy in non-hypoxaemic [7] and in hypoxaemic patients in comparison with NPPV [8]. However, bronchoscopy was performed with an open mouth in both studies, which considerably reduces HFNC efficacy [9]. Thus, we aimed to determine HFNC's effectiveness during nasal bronchoscopy with BAL in patients with ARF along with BAL's feasibility and yield.

We conducted a prospective, observational, multicentre, open study in critically ill patients with ARF. Intensive care unit (ICU) patients from four university hospitals, with ARF and requiring a bronchoscopy with BAL were included in the study. ARF was defined as a respiratory rate >25 breaths·min^{-1} (or >20 breaths·min^{-1} if use of accessory respiratory muscles was present) in patients requiring oxygen at $\geqslant$6 L·min^{-1} to attain a pulse oximetry measurement of >92%. Patients were not included if they had contraindications to bronchoscopy with BAL (including respiratory acidosis).

The Ethics Committee of the French Society of Intensive Care (SRLF, Société de Réanimation de Langue Française, Paris, France) approved the study (approval number: 12-374).

HFNC was delivered *via* a dedicated high-flow delivery system (Optiflow; Fisher & Paykel, Auckland, New Zealand). Oxygen flow and inspiratory oxygen fraction (F_{IO_2}) were adjusted to obtain a pulse oximetry measurement >92%. Bronchoscopy with BAL was performed under local anaesthesia and with careful monitoring. Patients were asked to rate their dyspnoea according to a visual analogue scale, and after each BAL, the operator rated the eventual discomfort related to HFNC. Baseline and subsequent arterial blood gases were collected. Failure of the oxygenation strategy was considered if NPPV or invasive ventilation were needed within 24 h of the procedure. The study centres followed similar classical intubation criteria [10].

Data were compared according to failure or success of HFNC using the Mann–Whitney U-test, the paired t-test and Fisher's exact test, as appropriate. Changes in physiological measures over time were assessed using one-way ANOVA for repeated measures.

30 ICU patients (median (interquartile range (IQR)) age 54 (46–68) years) were included in the study. Demographics, physiological data and patient outcomes are detailed in table 1. Within 24 h, five (16.7%)

TABLE 1 Demographics, physiological data and patient outcomes

	Total	Procedure success	Procedure failure	p-value
Subjects n	30	25	5	
Age years	54 (46–68)	54 (46–61)	70 (38–76)	0.94
Male sex	18 (60)	15 (60)	3 (60)	1
SAPSII score	36 (27–43)	36 (27–43)	35 (24–66)	0.66
ODIN score	1 (1–2)	1 (1–2)	1 (1–1)	1
Prior HFNC	18 (60)	16 (64)	2 (40)	0.36
Baseline physiological data				
Respiratory rate breaths·min^{-1}	28 (23–34)	28 (22–35)	25 (25–32)	0.37
Heart rate beats·min^{-1}	95 (88–113)	95 (89–111)	96 (71–113)	0.72
Systolic blood pressure mmHg	131 (119–141)	129 (119–141)	135 (116–157)	0.37
Baseline arterial blood gases				
Administered flow L·min^{-1}	15 (9–50)	15 (9–60)	9 (5–50)	
P_{aO_2}/F_{IO_2}	169 (145–196)	169 (148–200)	135 (113–197)	0.31
P_{aO_2} mmHg	90 (74–123)	97 (82–140)	68 (57–90)	0.47
F_{IO_2}	0.59 (0.46–0.7)	0.6 (0.47–0.85)	0.48 (0.36–0.65)	0.82
P_{aCO_2} mmHg	36 (33–40)	36 (31–40)	40 (37–51)	0.04
Arterial blood gases after procedure				
P_{aO_2}/F_{IO_2}	99 (98–126)	99 (98–113)	122 (91–186)	0.12
P_{aO_2} mmHg	116 (86–165)	122 (91–165)	77 (67–108)	0.27
F_{IO_2}	1 (0.8–1)	1 (0.9–1)	0.8 (0.6–1)	0.13
P_{aCO_2} mmHg	36 (33–40)	36 (32–40)	38 (36–43)	0.18
Duration of HFNC h	61 (31–95)	64 (43–94)	14 (6–123)	0.11
Post-bronchoscopy length of hospital stay days	5 (3–9)	5 (3–7)	10 (5–18)	0.66
Survival	25 (83.3)	21 (84)	4 (80)	1

Data are presented as median (interquartile range) or n (%), unless otherwise stated. SAPSII: Simplified Acute Physiology Score II; ODIN: Organ Dysfunctions and/or Infection; HFNC: high-flow nasal cannula oxygen therapy; P_{aO_2}: arterial oxygen tension; F_{IO_2}: inspiratory oxygen fraction; P_{aCO_2}: arterial carbon dioxide tension.

patients experienced failure of the oxygenation strategy, between 2.5 and 14 h after BAL (four required NPPV, one of whom further required endotracheal intubation (ETI), and one was directly intubated). Reasons were onset of hypercapnia after the procedure (two patients) and worsening hypoxaemia (three patients). There was no significant difference in the patients' baseline characteristics when comparing success and failure.

During bronchoscopy, median (IQR) HFNC flow was 50 (50–60) L·min^{-1} with an F_{IO_2} of 1 (0.8–1). Median volume instilled was 150 (140–150) mL, with a median recovered volume of 41 (27–53)%. Tolerance was remarkable since no procedure was interrupted because of discomfort or respiratory failure. Variations in arterial oxygen saturation measured by pulse oximetry were minute, from a median of −1% 10 min after BAL to +2% 30 min after. Transient desaturation below 88% only occurred in two patients without compromising their respiratory status and they rapidly recovered. No other per procedure adverse events were reported. Dyspnoea was evaluated in all but four patients (because of a language barrier). Although it increased immediately after bronchoscopy (from a median (IQR) of 4.2 (2.5–6.8) to 6.1 (4.2–8.9)), dyspnoea returned to baseline level within the first hour post-procedure (4.5 (2.7–6.3); p=0.007). Operators reported no discomfort linked to the device (median (IQR) score 10 (7–10)).

BAL enabled a diagnosis to be reached in 21 patients (70%), mainly pneumonia in 14 patients, including eight cases of pneumocystis pneumonia. As a result, treatment was modified in 19 (63.3%) patients, either de-escalation (n=7, 23.3%), initiation of antimicrobial therapy (n=7), or initiation of an immunosuppressive therapy (n=7).

Eight patients required HFNC for more than 4 days of continuous use. A total of six (20%) patients underwent ETI during their stay, two of them in the first 24 h (included among the patients mentioned as experiencing failure of the oxygenation strategy), the others underwent ETI after a median (IQR) of 135 (111–222) h post-bronchoscopy, because of worsening of their respiratory disease.

ICU mortality was 16.7%, as four patients died in the ICU within a median (IQR) of 20 (15–25) days after the procedure. All deaths followed withdrawal of life support therapy. Median (IQR) ICU stay was 5 (3–9) days.

Here, we showed that HFNC enabled all BAL procedures to be completed uneventfully. BAL was remarkably well tolerated, with dyspnoea score returning to the baseline value only 1 h after the procedure.

Although effectively improving oxygenation [2], NPPV is associated with a number of drawbacks [11]: patient intolerance that may lead to ETI [12]; and difficult access of the bronchoscope to the nares due to the facemask. Only two studies have previously evaluated HFNC during bronchoscopy, both with significant limitations. In a randomised control study, Lucangelo *et al.* [7] showed that use of HFNC enabled maintenance of arterial oxygen tension/F_{IO_2} during the procedure, with significantly better oxygenation with a 60 L·min^{-1} flow rate (*versus* 40 L·min^{-1}). However, their population included non-hypoxaemic patients. A second randomised study compared HFNC to NPPV in hypoxaemic patients requiring bronchoscopy. Although Simon *et al.* [8] found that application of NPPV was superior to HFNC with regard to oxygenation before, during and after bronchoscopy, the need for subsequent intubation was similar in the two groups. Moreover, HFNC may have been disadvantaged in their study. First, patients randomised to HFNC were possibly sicker in terms of respiratory failure. Second, bronchoscopy was performed through the mouth, which was maintained open using a bite-block. Hence, positive pressure was substantially reduced [9, 13].

In our series, an increase in respiratory support within the first 24 h was necessary in only 16.7% of patients (with NPPV for four out of five and ETI for two out of five). This figure compares fairly well with the 25% reported by Cracco *et al.* [14]. In terms of immediate outcome, the increase in respiratory support was not different between HFNC and NPPV in the study by Simon *et al.* [8] and was in the same range as our study (10% and 16.7%, respectively). Simon *et al.* [8] limited the time frame of HFNC failure to 8 h after BAL. We were stricter, considering it up to 24 h. With the definition used by Simon *et al.* [8], our number of failures drops to two. HFNC efficacy can be explained by several mechanisms, as it relieves respiratory distress symptoms and improves oxygenation by washing the dead space, reducing inspiratory nasopharyngeal resistance, and creating a moderate positive airway pressure effect [4].

Despite its prospective and multicentre design, our study has limitations. The limited number of patients is explained by the availability of noninvasive diagnostic strategies [15], but remains similar to other studies [2, 8]. Our study is not a randomised trial, as our interest was focused on the assessment of HFNC feasibility and safety in view of its potential use outside the ICU. Whereas NPPV is less commonly performed outside the ICU, HFNC is a much simpler device to implement. Further studies are required to evaluate its use outside the ICU and in which patients. NPPV would obviously be too costly and binding for every patient undergoing BAL. HFNC offers the advantage of being easily implemented in all patients.

To conclude, HFNC is a simple, effective, well-tolerated and safe technique to ensure oxygenation during nasal bronchoscopy with BAL in patients with hypoxaemic ARF.

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HFNC is an effective and safe method of oxygenation during nasal bronchoscopy with BAL in hypoxaemic ARF patients http://ow.ly/XAmtZ

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