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Review Article

NIV Partnership with Sedation and Bronchoscopy in High Risk Patients

Raffaele Scala*

Pulmonology and Respiratory Intensive Care Unit, S. Donato Hospital, Arezzo, Italy

***Corresponding Author:** Raffaele Scala, Pulmonology and Respiratory Intensive Care Unit, S. Donato Hospital, Arezzo, Italy.

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Abstract

Sedation during noninvasive ventilation (NIV) to avoid endotracheal intubation (ETI) in poorly compliant subjects and the employ of NIV to support high risk patients undergoing bronchoscopic and gastroscopic procedures in elderly still represents an "unconventional evidence-based" field of application of this popular ventilator technique. However, due to the increasing proportion of fragile elder patients with underlying cardiopulmonary comorbidities and/or immunosuppression associated conditions, in the "real-life" NIV often remains the "ceiling supportive ventilation" for this do-not-intubated (DNI) population and is likely to be push-up forward the evidence-based indications (i.e. COPD exacerbations, cardiogenic pulmonary edema, weaning/postextubation in hypercapnic patients, respiratory distress in immunosuppressive status). Sedation-based strategy to rescue elder patients with poor NIV co-operation and/or adaptation and use of NIV to support elderly during interventional pulmonary procedures are the issues that are reported in this chapter.

Keywords: *Non Invasive Ventilation (NIV); Acute Respiratory Failure (ARF); Chronic Obstructive Pulmonary Disease (COPD); Acute Cardiogenic Pulmonary Edema (ACPE)*

Introduction

The use of non invasive ventilation (NIV) to treat acute respiratory failure (ARF) has been tremendously expanded in the last two decades, and therefore, NIV is now considered the ventilation modality of first choice for a large proportion of patients with ARF, such as exacerbation of chronic obstructive pulmonary disease (COPD), acute cardiogenic pulmonary edema (ACPE), pulmonary infiltrates in immunocompromised status, as well as after endotracheal intubation (ETI) in the transition from invasive ventilation to spontaneous breathing in chronic hypercapnic respiratory failure. The main advantage of NIV is due to the chance of delivering an efficient ventilator support without the life-threatening complications correlated with conventional mechanical ventilation (CMV) delivered via endotracheal intubation (ETI) [1].

In this chapter, the extended applications of NIV together with analgosedation in poorly compliant elder patients and the supportive use of NIV during interventional bronchoscopic and gastroenterologic procedures in high-risk are reported.

Sedation and NIV

Conversely from CMV that requires a pharmacological sedative aid to allow the patient to keep the endo-tracheal tube in site, NIV requires a co-operation of the awake patient to keep the interface well fit outside the airways (i.e. masks, helmet, nasal pillows, mouthpiece). Consistently, the success of NIV is strongly dependent on how good is the degree of tolerance shown by the patient during ventilation. In fact, poor patient's cooperation reduces the effectiveness of NIV to achieve the physiological goals of mechanical ventilation (MV) (unloading respiratory muscles, increasing alveolar ventilation, improving gas exchanges) mainly throughout claustrophobic refusal of the mask, excessive unintentional air leaks and patient-ventilation dys-synchronies [1,2]. Neuro-psychological aspects correlated with both respiratory and metabolic alterations (i.e. hypercapnic encephalopathy, severe hypoxemia, extra-pulmonary organ dysfunctions)

[3] and with hospitalization in ICU, especially for elder patients suffering from comorbidities [4], may contribute to compromise the compliance to NIV. The level of acceptance of NIV is dependent on the curve of adaptation of the patient who has to learn how to breath in synchrony with ventilator-assisted acts. After an initial trial of a length of few hours, adherence to NIV tends to improve quickly depending on the expertise of the staff, the severity and the resolving timing of ARF. Therefore, as the duration of NIV augments, especially if delivered with high levels of pressures, the discomfort of the patient is likely to worsen mainly due to the complications correlated with the ventilator treatment (i.e. skin decubitus, gastro-abdominal distension, eye irritation, nose occlusion, dryness of upper airways, neuropsychological distress) [1]. The attempts of nurses and therapists to reduce air leaks by tightening the security systems of the interfaces are likely to trigger a vicious circle throughout the occurrence of discomfort and decubitus lesions [5]. Even though the rotation strategy of different interfaces is likely to reduce the risk of skin breakdown and to increase patient's tolerance [6], NIV delivered for several hours a day and for several days inevitably provoke devastating skin damage. As a matter of a fact, pain and discomfort are the main determinant of mask intolerance that lead to patient NIV refusal and subsequent requirement of ETI or death [1]. On the other hand, clinicians may experience a different scenario with a premature NIV failure occurring in patients who complaint marked claustrophobia that makes useless all attempts for keeping them to wear any interfaces. The rate of NIV failure due to patient's intolerance was reported in the literature to be variable between 9 and 22% [1,7-11].

After considering other factors that may improve the adherence mask (i.e. changes of ventilator setting, rotation of interfaces, psychological support), sedation may be part of the strategy aimed at improving patient's tolerance in selected cases at a risk of NIV failure. This rationale for sedation during NIV may be evident both within the first hours of ventilation when the patient needs to be adapted to NIV and later on when prolonged ventilation is required. A sedation-based strategy directed to rescue at least a proportion of patients who are failing NIV because of refusal is likely to reduce hospital mortality by means of the prevention of CMV-related complications [1,2].

However, administering sedative in ARF patients during NIV without protection of airways is not free of several caveats: central respiratory drive depression, upper airway obstruction due to tongue replacement, reduced cough reflex and efficacy in removal secretions, vomiting and pulmonary aspiration, class-specific drug side effects (i.e. cardiovascular instability). The incidence and the severity of these sedative-related complications in patients admitted in ICU are variable depending on the dosage, type of drug, severity of ARF, expertise of the team. The large majority of the studies on sedation during MV deals with intubated patients supported with CMV so most of the aforementioned complications could be easily managed: tracheal suction, lack of leaks, protection of airways, hemodynamic monitoring.

A crucial point in the management of critically ill patients submitted to invasive and non-invasive MV is the evaluation of the effectiveness of the dose and type of drug delivered in terms of control of discomfort, pain and distress correlated with MV. Different clinical tools have been used to quantify the depth of sedation (Figure 1) [12]: Richmond Agitation-sedation Scale (RASS) [13], is probably the most sensitive and useful tool applicable for this purpose.

The ideal sedation (i.e. analgo-sedation) should guarantee not only a "pure" reduction of the level of consciousness but only a good control of anxiety, agitation and discomfort induced by NIV without significant respiratory drive depression and prompt arousal. Whatever the drug used, the goal is to achieve the "conscious sedation" while the patients are awake or easily arousable with a sufficient mitigation of NIV-induced discomfort [2,12,14-16].

Drugs available to provide analgosedation in NIV show different pharmacologic profiles so that the choice should be tailored to the features of patients (e.g. failure of non pulmonary organs), duration of NIV and experience of the team. Among all, benzodiazepine are those with a less favorable profile especially in the elderly in consideration of the risk of inducing delirium and of the less predictable offset. Given to its short onset and offset, Remifentanil is a recent opioid that is easy to titrate without concerns about accumulation and unpredictable and/or delayed recovery as compared to morphine.

Dexmedetomidine is an a-2 adrenoreceptor agonist with a unique mechanism of action, providing sedation and anxiolysis via receptors within the locus ceruleus, analgesia via receptors in the spinal cord, and attenuation of the stress response with no significant respiratory depression. As regards safety's profile, a caution should be taken after the initial loading dose as it may cause cardiovascular adverse drug reactions, such as hypertension, hypotension, or bradycardia [2,12].

Richmond Sedation-Agitation-Scale (RSAS)

Score	Term	Description
+4	Combative	Overtly combative or violent; immediate danger to staff
+3	Very agitated	Pulls on or removes tube(s) or catheter(s) or has aggressive behavior toward staff
+2	Agitated	Frequent nonpurposeful movement or patient-ventilator asynchrony
+1	Restless	Anxious or apprehensive but movements not aggressive or vigorous
0	Alert and calm	
−1	Drowsy	Not fully alert, but has sustained (more than 10 s) awakening, with eye contact, in response to voice
−2	Light sedation	Briefly (less than 10 s) awakens with eye contact in response to voice
−3	Moderate sedation	Any movement (but no eye contact) in response to voice
−4	Deep sedation	No response to voice, but any movement to physical stimulation
−5	Unarousable	No response to voice or physical stimulation

Riker Sedation-Agitation Scale (RASS)

1. Unarousable: Minimal or no response to noxious stimuli; does not communicate or follow commands
2. Very sedated: Arouses to physical stimuli but does not communicate or follow commands; may move spontaneously
3. Sedated: Difficult to arouse; awakens to verbal stimuli or gentle shaking but drifts off again; follows simple commands
4. Calm and cooperative: Calm, awakens easily, follows commands
5. Agitated: Anxious or mildly agitated, attempts to sit up, calms down to verbal instructions
6. Very agitated: Does not calm despite frequent verbal reminding of limits, requires physical restraints, biting endotracheal tube (ETT)
7. Dangerous agitation: Pulling at ETT, trying to remove catheters, climbing over bed rail, striking at staff, thrashing side-to-side

Observer's Assessment of Alertness/Sedation Scale (OASA/S)

Score	Responsiveness	Speech	Facial expression	Eyes
5	Responds readily to name spoken in normal tone	Normal	Normal	Clear, no ptosis
4	Lethargic response to name spoken in normal tone	Mild slowing or thickening	Mild relaxation	Glazed or mild ptosis (less than half of the eye)
3	Responds only after name is called loudly and/or repeatedly	Slurring or prominent slowing	Marked relaxation (slack jaw)	Glazed and marked ptosis (half of the eye or more)
2	Responds only after mild prodding or shaking	Few recognizable words	-	-
1	Does not respond to mild prodding or shaking	-	-	-

Ramsay Sedation Scale (RSS)

1. Anxious and agitated or restless or both
2. Cooperative, oriented, and tranquil
3. Responding to commands only
4. Brisk response to light glabellar tap
5. Sluggish response to light glabellar tap
6. No response to light glabellar tap

Bispectral Index (BI)

0–40: Deep hypnotic state
41–60: Moderate hypnotic state
61–70: Light hypnotic state
71–100: Awake/light to moderate sedation

Figure 1: *Neurological scales used to assess the sedative drug effects during noninvasive ventilation (NIV).*

Clinical studies investigating the feasibility, safety and effectiveness of sedation during NIV to treat ARF are reported in table 1 [17-25]. These trials are heterogeneous in terms of design (most of them lack of a controlled arm), type and doses of drugs, characteristic of population (mostly < 60 yrs old), duration of NIV and environment. No studies investigated the impact of sedation in elderly NIV poorly tolerant patients. In a larger following observational uncontrolled study, Rocco., *et al.* [19] assessed the effectiveness and safety of remifentanil-based analogo-sedation in 36 patients with hypoxemic ARF who complained of discomfort and intolerance to two different interfaces (helmet and total face mask) and were candidates for ETI. Sixty one percent of the patients continued NIV after remifentanil infusion. Non patient had respiratory drive or hemodynamic alterations during the study period. In addition, arterial blood gases and respiratory rate improved after 1 hour of NIV with remifentanil-analgosedation either with helmet or total face mask. ICU mortality rate in the failure group was 50% versus 14% in the success group ($p < 0.05$). Two recent RCTs compared the effectiveness and safety of sedation with dexmedetomidine vs midazolam in patients at risk of NIV failure due to refusal of treatment for discomfort and agitation. However, these two small studies differs from the underlying disease (COPD vs ACPE), timing of sedation (at the beginning of treatment vs during treatment) and design (different primary end-points) [22,23].

A new technology, the target-controlled infusion (TCI), was implemented in a recent study with the aim of better optimizing the loading dose and the maintenance infusion rate of a drug according to the level of desired sedative effect [24].

It's important to highlight that all the reported studies were performed in high-intensity settings, such as ICU or RICU, with a long experience in NIV therapy and in handing sedative drugs and where the patient is closely monitored and adequately cared and, last but not least, ETI was promptly available if NIV fails [6]. According to the recent survey [26], not unexpectedly, nurses (67%) and, less often, physicians (28%) were the healthcare professionals most responsible for monitoring sedation. Consistently, even if the use of NIV for the

Author, study (reference)	Patients (type of disease)	Interface	Baseline physiologic data	Type of sedative drug	Timing of sedation	Length of sedation	Side-effects of sedation	Main outcome results
Rocker, NCT [36]	10 (12 ARF)	FFM	P/F 102; APACHE II 16	Mo (9), M (6)	At NIV starting	64.5 hrs	None	Improved P/F in 9/12; ETI 20%; Mortality 30%
Constantin, NCT [37]	13 (10 ARF; 3 AHRF)	FFM	pH 7.38; P/F 134; RR 32; SAPS II 32	RM (3 Pr)	Poor NIV acceptance	90 hrs	None	Improved ABG/RR; ETI 31%; Mortality 7.7%
Rocco, NCT [38]	36 (ARF)	FFM, Helmet	P/F 157; RR 34; SAPS II 36	RM;	Poor NIV acceptance	2.5 hrs (F), 52 hrs (S)	None	Improved ABG/RR; ETI 39%; Mortality 28%
Akada, NCT [39]	10 (ARF)	FFM	pH 7.38; P/F 219; $PaCO_2$ 45.8; RR 29	D plus Mo (1) and Pr (1)	Poor NIV acceptance	16.5 hrs	None	Improved ABG/RR; None intubated or died
Takasaki, NCT [40]	2 (SAA)	TFM	pH 7.38; PaO2 56; $PaCO_2$ 45 (O_2 7 lpm) pH 7.25; PaO2 66, $PaCO_2$ 48 (O_2 5 lpm)	D	Poor NIV acceptance	8 hrs (case 1) ND (case 2)	None	Improved ABG/RR; None intubated and died
Senoglu, RCT [41]	40 (COPD)	FFM	RR 25 (D) 25 (M); pH 7.29 (D) 7,30 (M); PaO_2 59 (D) 59 (M); $PaCO_2$ 70 (D), 70 (M); APACHE II 21.5 (D), 21.4 (M)	D (20) vs M (20)	At NIV starting	24 hrs	None	Improved ABG/RR in both groups; lower HR and BP in D, fewer adjustment of doses in D; None intubated or died
Huang, RCT [42]	62 (ACPE)	TFM, Helmet	RR 36 (M), 35 (D); pH 7.22 (M), 7.23 (D); P/F 183.3(M), 176.6 (D); APACHE II 21.4 (M), 22.6 (D)	D (=33) vs M (29)	Poor NIV acceptance	57.5 (D) vs 93.4 hrs (M)	Bradycardia (D); Respiratory infections/ vomiting (M)	Improved ABG/RR in both groups; Lower ETI, LOS and Mortality in D vs M
Clouzeau, NCT [43]	10 (7 ARF, 3 AHRF)	FFM	pH 7.32; P/F 144; $PaCO_2$ 57.8; SAPS II 37	Pr	Poor NIV acceptance	2 hrs	Transient low SpO_2 (n = 1)	Improved ABG; ETI 30%; Mortality 20%
Devlin, RCT [48]	23 (mostly COPD, asthma, Pneumonia)	FFN (mostly)	pH 7,40, PaO_2 94-100, $PaCO_2$ 48-50	D (16) vs placebo (17)	Intolerance 28-39%	72 hrs	Requirement of midazolam and bradycardia similar	No difference in NIV tolerance, ETI and length of ventilation

Table 1. *Main findings of the published studies on the use of sedation during noninvasive ventilation (NIV).*

ABG: Arterial Blood Gases; ACPE: Acute Cardiogenic Pulmonary Edema; APACHE: Acute Physiology and Chronic Health Evaluation; ARF: Acute Hypoxemic Respiratory Failure; AHRF: Acute Hypercapnic Respiratory Failure; BP: Blood Pressure; D: Dexmedetomidine; ETI: Endotracheal Intubation; FFM: Full-Face Mask; HR: Heart Rate; LOS: Length of Stay in Hospital; M: Midazolam; Mo: Morphine; ND: Non Defined; NCT: Non-Controlled Trial; P/F: PaO_2 to FiO_2 Ratio; Pr: Propofol; R: Remifentanil; RCT: Randomized Controlled Trial; RR: Respiratory Rate; SAA: Severe Asthmatic Attack; SAPS: Simplified Acute Physiology Score; TFM: Total-Face Mask.

All numeric values are reported as mean or median unless otherwise stated; PaO_2 and $PaCO_2$ are expressed in mmHg.

treatment of ARF is increasing outside ICU in low-intensity of care setting [27], it's highly recommended that sedation during NIV should be restricted to ICU or expert RICUs [28].

NIV and bronchoscopy

There is a strong patho-physiologic rationale in combining FBO and NIV in critically ill patients because the limitations of one of the two techniques may be counterbalanced by the properties of the other one [29]. NIV prevents FBO-induced cardiopulmonary alterations by means of unloading respiratory muscles, improving gas exchange and heart performance. Moreover, keeping the patient on NIV after FBO may prevent the risk of post-procedural pulmonary complications. Conversely, thanks to the possibility of clearing the airways under NIV, FBO may improve gas exchange and, potentially, reduce the need of ETI [29]. This is particularly true for elder fragile patients who are at greater risk of developing FBO-related complications.

Literature [30-44] reported different acute scenarios of synergistic interaction between FBO and NIV**.** The majority of the published studies used NIV (with the inclusion of CPAP) to prevent respiratory deterioration in spontaneously breathing ARF patients undergoing diagnostic FBO (Table 2) [29]. Most of them are uncontrolled and heterogeneous studies in terms of severity and type of ARF, age, underlying diseases, setting of treatment, modes of ventilation, NIV interface, way of performing FBO during NIV, FBO procedures. Rates of success in avoiding intubation varied from 89 to 100%. Two RCTs compared efficacy and safety of NIV versus oxygen in "assisting" non-ventilated patients receiving FBO. In the first RCT conducted on 30 patients (PaO_2 ≤ 125 mmHg under oxygen-mask) with suspected pneumonia, Maitre., *et al.* [32] showed significantly higher SpO_2 values during and 30 minutes after FBO with CPAP compared to oxygen-therapy. Not only did the patients in the oxygen-group develop hypoxemia during FBO, but also 5 patients in the oxygen-group (compared to none in the CPAP-group) required ventilatory assistance within 6 hours following the procedure. In another RCT involving 26 patients with HAP (PaO_2/FiO_2 ≤ 200 mmHg), Antonelli., *et al.* [33] reported that compared to oxygen-group, NIV-group showed higher PaO_2/FiO_2 values during and 60 minutes after FBO, as well as lower heart rate and mean arterial pressure values after FBO. One patient in NIV-group and two patients in oxygen-group required non-emergent intubation. Accordingly, the Author concluded that prophylactic NIV is able to ensure adequate gas exchange during FBO in spontaneously breathing hypoxemic patients, thus preventing intubation [29].

Two uncontrolled studies [37,38] investigated feasibility, effectiveness and safety of FBO with BAL in hypoxemic patients (PaO_2/FiO_2 < 200 mmHg) requiring NIV before the procedure. The rate of intubation at 48 hours after FBO was much higher (39 - 45%) than that reported in studies dealing with prophylactic NIV during FBO (0 - 11%). According to these limited data, patients requiring NIV prior to FBO are at high-risk for intubation, and therefore FBO should be considered only in selected cases if intubation is promptly available [29].

One case-control study [39] reported the effectiveness of early therapeutic FBO to avoid NIV failure for excessive secretions as compared to FBO after IMV in 30 acidotic COPD patients with hypercapnic encephalopathy. Two hours of NIV plus FBO significantly improved gas exchange, sensorium and cough efficiency without major complications. Improvement in acidosis, as well as hospital mortality, and durations of hospitalisation and ventilation were similar in NIV-FBO versus IMV-FBO group. NIV-FBO strategy significantly reduced infectious complications and tracheostomy requirement. Even if this strategy may be a successful alternative to IMV in selected COPD patients, larger RCTs are necessary to confirm this result.

The combined use of FBO and NIV may be useful also to perform intubation in two contexts, difficult airways and NIV failure. *First, according to* an RCT performed on 32 patients with an anticipated difficult intubation in ear-nose-throat surgery [40], NIV was more effective than spontaneous breathing to improve ventilation during Fiberoptic intubation (FOI) performed under propofol. This issue may be particularly critical in obstructive sleep apnea syndrome for the risk of severe hypoxemia due to upper airways collapse under sedation; working as "functional airways stenting", NIV/CPAP may facilitate FOI [41]. Second, intubation is challenging in severely hypoxemic patients who deteriorate under NIV for risk of major cardiovascular complications when the mask is removed [42]. Two small pilot studies [41,42] reported the feasibility and safety of FOI under sedation during NIV in patients with either hypercapnic and/or hypoxemic ARF who had developed NIV failure. These preliminary findings requires the confirm by large RCTs comparing conventional versus FBO-guided intubation under NIV in patients with either predicted or proven difficult direct laryngoscopy or with NIV failure due severe hypoxemia.

Author, year	Study	Patients (number)	Type of ARF, Population	Support pre-FBO	Indication for FBO	FBO procedures	ETI (%) at 48 hours
Antonelli, 1996 [30]	P/Obs	NIV:8	Hypoxemic, suspected pneumonia	Oxygen	Diagnostic	BAL	NIV:0
Da Conceicao, 2000 [31]	P/Obs	NIV:10	Hypoxemic -Hypercapnic, COPD	Oxygen	Diagnostic	BAL	NIV:0
Maitre, 2000 [32]	RCT	Oxygen: 15; CPAP: 15	Hypoxemic, suspected pneumonia	Oxygen	Diagnostic	BAL, BB	Oxygen: 46,7; CPAP: 6,7
Antonelli, 2002 [33]	RCT	Oxygen: 13; NIV:13	Hypoxemic, suspected pneumonia	Oxygen	Diagnostic	BAL	Oxygen: 15,4; NIV: 7,7
Bourgain, 2007 [40]	RCT	Oxygen: 16; NIV: 16	ENT surgery	None	Difficult ETI	FBO-assisted ETI	NA
Criner, 2010 [35]	P/Obs	NIV: 35	Hypoxemic, miscellanea	Oxygen	Diagnostic	BW, PSB, BAL, BB	NIV: 0
Heunks, 2010 [36]	P/Obs	NIV: 12	Hypoxemic, miscellanea	Oxygen	Diagnostic	BAL	NIV: 8,3
Scala, 2010 [39]	P/CC	NIV: 15; IMV: 15	Hypoxemic -Hypercapnic, COPD	NIV	Diagnostic/ therapeutic	BAL	NIV: 20
Baumann, 2011 [37]	P/Obs	NIV: 40	Hypoxemic, miscellanea	NIV	Diagnostic	BAL	NIV: 10
Clouzeau, 2011 [24]	P/Obs	NIV: 23	Hypoxemic, miscellanea	NIV	Diagnostic	BAL	NIV: 17,4
Agarwall, 2012 [43]	P/Obs	NIV: 6	Hypoxemic, acute ILDs	Oxygen	Diagnostic	BAL, TBLB	NIV: 1,7
Cracco, 2013 [44]	P/Obs	Oxygen and NIV: 169	Hypoxemic, miscellanea	Oxygen and NIV	Diagnostic	BAL	NIV and Oxygen: 15
Barjaktarevic, 2015 [42]	P/Obs	NIV: 10	Hyoxemic, NA	NIV	ETI in NIV failure	FBO-assisted ETI	NA
Korkmaz Ekren, 2016 [38]	P/Obs	NIV: 28	Hypoxemic, miscellanea	NIV	Diagnostic	BAL	NIV: 39,3

Table 2: *Studies evaluating the combined use of flexible bronchoscopy and noninvasive ventilation in different acute scenarios. BAL: Broncho-Alveolar Lavage; BB: Bronchial Biopsy; BW: Bronchial Washing; CC: Case-Control; CPAP: Continuous Positive Airway Pressure; FBO: Flexible Bronchoscopy; ENT: Ear, Nose and Throat; ETI: Endotracheal Intubation; ILDs: Interstitial Lung Diseases; IMV: Invasive Mechanical Ventilation; NA: Not Available; NIV: Noninvasive Ventilation; Obs: Observational; P: Prospective; PSB: Protected -Specimen Brush; RCT: Randomized Controlled Trial; TBLB: Transbronchial Lung Biopsy.*

Risks of the NIV-FBO approach are related to both NIV (gastro-distension, pulmonary aspiration, hypoventilation, skin breakdown) and FBO procedures (cardiovascular events, hypoxemia, bleeding, pneumothorax), as well to analogo-sedation [29].

Conclusion

Strategy of NIV combined with analgosedation in poorly compliant patients and NIV-FOB synergistic use of NIV during interventional bronchoscopic procedures in high-risk are largely applied in the clinical practice with favorable results even if most of these scenarios have not been proved by the evidence based medicine.

Bibliography

1. Rochwerg B., *et al*. "Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure". *European Respiratory Journal* 50.2 (2017): 1602426.
2. Hilbert G., *et al*. "Sedation during non-invasive ventilation". *Minerva Anestesiologica* 78 (2012): 842-846.
3. Scala R. "Hypercapnic encephalopathy syndrome: A new frontier for non-invasive ventilation?" *Respiratory Medicine* 105 (2011): 1109-1117.
4. Schortgen F., *et al*. "Results of noninvasive ventilation in very old patients". *Annals of Intensive Care* 21.2 (2012): 5.
5. Schettino GP., *et al*. "Mask mechanics and leak dynamics during noninvasive pressure support ventilation: a bench study". *Intensive Care Medicine* 27 (2001): 1887-1891.
6. Girault C., *et al*. "Interface strategy during noninvasive positive pressure ventilation for hypercapnic acute respiratory failure". *Critical Care Medicine* 37 (2009): 124-131.
7. Masip J., *et al*. "Non-invasive pressure support ventilation versus conventional oxygen therapy in acute cardiogenic pulmonary oedema: a randomised trial". *Lancet* 356 (2000): 2126-2132.
8. Delclaux C., *et al*. "Treatment of acute hypoxemic nonhypercapnic respiratory insufficiency with continuous positive airway pressure delivered by a face mask: A randomized controlled trial". *The American Journal of Medicine Association* 284 (2000): 2352-2360.
9. Rocco M., *et al*. "Noninvasive ventilation by helmet or face mask in immunocompromised patients: a case-control study". *Chest* 126 (2004): 1508-1515.
10. Scala R and Naldi M. "Non-invasive positive pressure ventilation in acute hypercapnic respiratory failure: ten-years' clinical experience of a Respiratory Semi-Intensive Care Unit". *Revista Ciencias de la Salud* 5 (2007): 7-23.
11. Rocco M., *et al*. "Rescue treatment for noninvasive ventilation failure due to interface intolerance with remifentanil analgosedation: a pilot study". *Intensive Care Medicine* 3 (2010): 2060-2065.
12. Scala R. "Sedation during noninvasive ventilation to treat acute respiratory failure". *Shortness of Breath* 2 (2013): 35-43.
13. Sessler CN., *et al*. "The Richmond Agitation-Sedation Scale: validity and reliability in adult intensive care unit patients". *American Journal of Respiratory and Critical Care Medicine* 166 (2002): 1338-1344.
14. Martin J., *et al*. "Sedation and analgesia in German intensive care units: how is it done in reality? Results of a patient-based survey of analgesia and sedation". *Intensive Care Medicine* 32 (2006): 1137-1142.
15. Jacobi J., *et al*. "Task Force of the American College of Critical Care Medicine (ACCM), of the Society of Critical Care Medicine (SCCM), American Society of Health-System Pharmacists (ASHP), American College of Chest Physicians. Clinical practice guidelines for the sustained use of sedatives and analgesics in the critically ill adult". *Critical Care Medicine* 30 (2002): 119-141.
16. Devabhakthuni S., *et al*. "Analgosedation: a paradigm shift in intensive care unit sedation practice". *Annals of Pharmacotherapy* 46 (2012): 530-540.
17. Rocker GM., *et al*. "Noninvasive positive pressure ventilation: successful outcome in patients with acute lung injury/ARDS". *Chest* 115 (1999): 173-177.

18. Constantin JM., *et al*. "Remifentanil-based sedation to treat noninvasive ventilation failure: a preliminary study". *Intensive Care Medicine* 33 (2007): 82-87.

19. Rocco M., *et al*. "Rescue treatment for noninvasive ventilation failure due to interface intolerance with remifentanil analgosedation: a pilot study". *Intensive Care Medicine* 3 (2010): 2060-2065.

20. Akada S., *et al*. "The efficacy of dexmedetomidine in patients with noninvasive ventilation: a preliminary study". *Anesthesia and Analgesia* 107 (2008): 167-170.

21. Takasaki Y., *et al*. "Dexmedetomidine facilitates induction of noninvasive positive pressure ventilation for acute respiratory failure in patients with severe asthma". *Journal of Anesthesia* 23 (2009): 147-150.

22. Senoglu, N., *et al*. "Sedation during noninvasive mechanical ventilation with dexmedetomidine or midazolam: A randomized, double-blind, prospective study". *Current Therapeutic Research* 71 (2010): 141-153.

23. Huang Z., *et al*. "Dexmedetomidine versus midazolam for the sedation of patients with non-invasive ventilation failure". *Internal Medicine* 51 (2012): 2299-2305.

24. Clouzeau B., *et al*. "Target-controlled infusion of propofol for sedation in patients with non-invasive ventilation failure due to low tolerance: a preliminary study". *Intensive Care Medicine* 36 (2010): 1675-1680.

25. Devlin JW., *et al*. "Efficacy and safety of early dexmedetomidine during noninvasive ventilation for patients with acute respiratory failure: a randomized, double-blind, placebo-controlled pilot study". *Chest* 145.6 (2014): 1204-1212.

26. Devlin JW., *et al*. "Survey of sedation practices during noninvasive positive-pressure ventilation to treat acute respiratory failure". *Critical Care Medicine* 35 (2007): 2298-2302.

27. Chiumello D., *et al*. "Non-invasive ventilation outside the Intensive Care Unit for acute respiratory failure". *Minerva Anestesiologica* 75 (2009): 459-466.

28. Scala R., *et al*. Scientific Group on Respiratory Intensive Care of the Italian Association of Hospital Pneumologists. "Increased number and expertise of Italian respiratory high-dependency care units: the second national survey". *Respiratory Care* 56 (2011): 1100-1107.

29. Scala R. "Flexible bronchoscopy during noninvasive positive pressure mechanical ventilation: two are better than one?". *Panminerva Medica* (2016).

30. Antonelli M., *et al*. "Noninvasive positive-pressure ventilation via face mask during bronchoscopy with BAL in high-risk hypoxemic patients". *Chest* 110 (1996): 724-728.

31. Da Conceiçao M., *et al*. "Fiberoptic bronchoscopy during noninvasive positive-pressure ventilation in patients with chronic obstructive lung disease with hypoxemia and hypercapnia". *Annales Françaises d'Anesthésie et de Réanimation* 19 (2000): 231-236.

32. Maitre B., *et al*. "Continuous positive airway pressure during fiberoptic bronchoscopy in hypoxemic patients. A randomized double-blind study using a new device". *American Journal of Respiratory and Critical Care Medicine* 162 (2000): 1063-1067.

33. Antonelli M., *et al*. "Noninvasive positive-pressure ventilation vs conventional oxygen supplementation in hypoxemic patients undergoing diagnostic bronchoscopy". *Chest* 121 (2002): 1149-1154.

34. Antonelli M., *et al*. "Fiberoptic bronchoscopy during noninvasive positive pressure ventilation delivered by helmet". *Intensive Care Medicine* 29 (2003): 126-129.

35. Chiner E., *et al*. "Fiberoptic bronchoscopy during nasal non-invasive ventilation in acute respiratory failure". *Respiration* 80 (2010): 321-326.

36. Heunks LM., *et al*. "Noninvasive mechanical ventilation for diagnostic bronchoscopy using a new face mask: an observational feasibility study". *Intensive Care Medicine* 36 (2010): 143-147.

37. Baumann HJ., *et al*. "Fiberoptic bronchoscopy in patients with acute hypoxemic respiratory failure requiring noninvasive ventilation- a feasibility study". *Critical Care* 15 (2011): R179.

38. Korkmaz Ekren P., *et al*. "Can fiberoptic bronchoscopy be applied to critically ill patients treated with noninvasive ventilation for acute respiratory distress syndrome? Prospective observational study". *BMC Pulmonary Medicine* 16 (2016): 89.

39. Scala R., *et al*. "Early fiberoptic bronchoscopy during noninvasive ventilation in patients with decompensated chronic obstructive pulmonary disease due to community acquired pneumonia". *Critical Care* 14 (2010): R80.

40. Bourgain JL., *et al*. "Pressure support ventilation during fibreoptic intubation under propofol anaesthesia". *British Journal of Anaesthesia* 98 (2007): 136-140.

41. Da Conceiçao M., *et al*. "Fiberoptic intubation with non-invasive ventilation with an endoscopic facial mask". *Annales Françaises d'Anesthésie et de Réanimation* 21 (2002): 256-262.

42. Barjaktarevic I and Berlin D. "Bronchoscopic intubation during continuous nasal positive pressure ventilation in the treatment of hypoxemic respiratory failure". *Journal of Intensive Care Medicine* 30 (2015): 161-166.

43. Agarwal R., *et al*. "Bronchoscopic lung biopsy using noninvasive ventilatory support: case series and review of literature of NIV-assisted bronchoscopy". *Respiratory Care* 57 (2012): 1927-1936.

44. Cracco C., *et al*. "Safety of performing fiberoptic bronchoscopy in critically ill hypoxemic patients with acute respiratory failure". *Intensive Care Medicine* 39 (2013): 45-52.

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