Noninvasive Ventilation for Patients with Hypoxemic Acute Respiratory Failure

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Abstract

Noninvasive ventilation (NIV) has an established efficacy to improve gas exchange and reduce the work of breathing in patients with hypoxemic acute respiratory failure. The clinical efficacy in terms of meaningful outcome is less clear and depends very much on patient selection and assessment of the risks of the technique. The potential risks include an insufficient reduction of the oxygen consumption of the respiratory muscles in case of shock, an excessive increase in tidal volume in case of lung injury, and a risk of delayed or emergent intubation. With a careful selection of patients and a rapid decision regarding the need for intubation in case of failure, great benefits can be offered to patients. Emerging indications include its use in patients with treatment limitations, in the postoperative period, and in patients with immunosuppression. This last indication will necessitate reappraisal because the prognosis of the conditions associated with immunosuppression has improved over the years. In all cases, there is both a time window and a severity window for NIV to work, after which delaying endotracheal intubation may worsen outcome. The preventive use of NIV seems promising in this setting but needs more research. An emerging interesting new option is the use of high flow humidified oxygen, which seems to be intermediate between oxygen alone and NIV.

Keywords
- mechanical ventilation
- continuous positive airway pressure
- hypoxemia
- gas exchange
- acute lung injury
- acute respiratory distress syndrome

Noninvasive ventilation (NIV) refers to the application of a mechanical ventilatory support without an invasive access to the lower airway. It generally uses a combination of pressure support ventilation (PS) plus positive end-expiratory pressure (PEEP), or can be simply a continuous positive airway pressure (CPAP). CPAP does not deliver ventilation per se but, through similar effects on respiratory mechanics as other ventilatory support techniques, it can sometimes offer a ventilatory assistance as well as gas exchange improvement. Other modes used for NIV include pressure assist-control ventilation, proportional assist ventilation, and neurally adjusted ventilatory assist.

Expected Benefits of Noninvasive Ventilation in Hypoxemic Acute Respiratory Failure

As is usual in intensive care medicine, this issue can be approached from an evidence-based perspective and by applying known physiological principles. Robust randomized controlled trials are scarce and guidelines often lack specific
recommendations in this area.  

The clinician must reconcile the various studies and the pathophysiological principles to make patient-oriented decisions. A practical approach is therefore required and will be discussed through a concise review of the literature and the principles of physiological concepts.

Unlike exacerbations of chronic obstructive pulmonary disease (COPD) or cardiogenic pulmonary edema, hypoxemic respiratory failure represents a heterogeneous group of diseases with different prognoses and treatments. This heterogeneity explains some of the contradictory results of the literature, suggesting that outcomes vary very much with the study population. The various subgroups of hypoxemic respiratory failure may thus need to be examined separately.

**Pathophysiologic Rationale for Noninvasive Ventilation in Hypoxemic Acute Respiratory Failure**

The hallmark of hypoxemic acute respiratory failure (ARF) is a severe acute hypoxemia (PaO2/FiO2 ratio \(\leq 300\)) that necessitates high levels of oxygen and is accompanied by clinical signs of respiratory distress reflecting a high respiratory drive and an intense work of breathing causing hyperinflation and hypocapnia. The activity of the respiratory muscles is high but there is usually no associated ventilatory failure and respiratory acidosis, except in patients presenting underlying chronic cardiac or respiratory disease. The occurrence of hypocapnia is, however, considered as a serious complication generally indicating impending respiratory muscle fatigue. Although the risk of respiratory muscle fatigue is higher in patients with associated circulatory failure, its occurrence, in general, is probably a late-stage event. The rationale for using NIV in hypoxemic ARF combines the symptomatic treatment of hypoxemia (lung failure) and the support of the high load imposed on the respiratory muscles (latent pump failure). Nevertheless, three crucial points regarding NIV use for this indication should be noted: (1) it does not constitute a treatment for the disease and when interrupted or poorly delivered, the patient immediately returns to the pre-NIV state; (2) the patient may not really need it if he/she can cope with the workload imposed on the respiratory muscles; at the time where the patient becomes completely unable to achieve the required workload, the use of NIV may become insufficient; (3) the usual beneficial effect of NIV on gas exchange and dyspnea may hide an underlying worsening thus resulting in life-threatening respiratory failure in case of NIV interruption. Therefore, there is probably a time window for NIV as a preventive support, beyond which its use may become risky. Moreover, NIV usually increases alveolar ventilation by synchronously increasing the transpulmonary pressure swings with ventilator assistance, generating larger tidal volumes. This increase in tidal volume is usually the price to pay for the work of breathing reduction. This could potentially be involved in the development of ventilator-induced lung injury (VILI) and contribute to the poor outcome sometimes observed in intubated patients who failed NIV. The risk of VILI is, however, still unclear with NIV. Most of the patients with hypoxemic ARF have a high respiratory drive and it has been shown experimentally that even spontaneous breathing could lead to lung injury when coupled with a high respiratory drive.  

It has also been demonstrated that patients who failed NIV had a higher ventilatory demand with larger tidal volumes than those who succeeded.  

Patients with severe acute respiratory distress syndrome (ARDS) will not be favorable candidates for NIV due to the need for delivering lung protective ventilation.

In clinical practice, the total pressure delivered during NIV is limited by the leakage created by high pressures in the mask. To better determine the effects of different combinations of PS and PEEP, the work of breathing and gas exchange were measured in 10 patients with acute lung injury receiving NIV for ARF. As expected, the highest level of PEEP studied (10 cmH2O) resulted in the greatest oxygenation improvement, whereas the PS level had no direct effect on oxygenation. Interestingly, CPAP alone failed to unload the respiratory muscles, which necessitated the provision of PS. Dyspnea was significantly improved with the highest level of PS (15 cmH2O). To adequately handle the lung and pump failure without NIV, clinicians should provide a sufficient level of PEEP to improve oxygenation, while ensuring an optimal PS to unload the respiratory muscles. These two additive but sometimes conflicting pressures generate the peak airway pressure, one of the major determinants of leaks and asynchrony. The clinician must balance PS and PEEP levels, while limiting peak airway pressure below 20 cmH2O. Therefore, patients with very poor respiratory mechanics requiring high airway pressures may not be good candidates for NIV.

**Fig. 1** is a schematic representation of the indication for NIV in hypoxemic respiratory failure: there is both a time window and a severity window beyond which endotracheal intubation (ETI) is required. An early application is sometimes probably useful as a purely preventive measure but it may also be useless in other circumstances and impose an extra burden on the patient and the personnel.

The use of NIV has progressively increased over the years as reflected by repeated large multicenter and international prospective observational studies. Its use has expanded beyond the indications that have the strongest level of evidence.
evidence (severe exacerbation of COPD and cardiogenic pulmonary edema) and the number of patients receiving NIV for hypoxic respiratory failure is at least equivalent to those receiving it for COPD and pulmonary edema.

**Noninvasive Ventilation for Medical Clinical Scenarios**

**Noninvasive Ventilation to Prevent Intubation in De Novo Respiratory Failure**

The use of NIV in patients with mixed causes of hypoxic ARF remains controversial. This is because contrasting results exist between the benefits observed in short-term physiological studies and in a few randomized critical trials (RCTs) on the one hand, and both the high rates of failure described in observational studies and the well-identified risk of delaying intubation on the other hand. Early studies had ambiguous results and the first RCT did not show any benefit. Many factors may have participated in these discrepant results. The mode of support may be one of those. The use of CPAP for this indication has for instance shown to be useless, confirming the results of physiological studies. In a large RCT of patients with diverse hypoxic ARF, Delclaux et al showed that the use of CPAP resulted in a greater subjective response and an increase in the Pao2/Fio2 ratio at 1 hour. Despite this apparent physiological improvement neither the need for ETI nor any clinical outcome improved with CPAP. In addition, a few patients suffered from specific complications only observed in the CPAP group, such as cardiac arrest at the time of intubation or even at the time of mask removal. A study performed in three centers by Ferrer et al also included nonhypercapnic patients with persistent hypoxic ARF but had several important differences. NIV using PS and PEEP was compared with a standard medical treatment with high-concentration oxygen. Patient selection was rigorous, necessitating clinical cooperation of the patient, no alteration in the state of consciousness and the absence of organ dysfunctions, abundant secretions, and cardiac arrhythmias or ischemia. Patients could have pneumonia, cardiogenic pulmonary edema, and 20% were immunocompromised. NIV reduced intubation rate by half and intensive care unit (ICU) mortality from a high value of 39 to 18%. These significant effects were present in the group of patients with pneumonia. Extrapolating these results to individual patients requires the application of the same careful selection process, with the exclusion of all contraindications. Observational studies describing the use of NIV in pneumonia often showed much higher rate of failures, which seems to contradict its beneficial results outside of clinical trials in everyday practice (Fig. 1). Selection of patients, care and experience in the application of NIV and in the decision of intubation, and control group outcomes may all contribute to these differences.

**Noninvasive Ventilation for Acute Respiratory Distress Syndrome**

Observational studies and subgroup analysis of RCTs identified ARDS as a strong predictor of NIV failure. A large prospective observational study of NIV in 147 ARDS patients in experienced centers demonstrated a failure rate around 50%. They found that a higher Simplified Acute Physiology Score (SAPS) II and Pao2/Fio2 ≤ 175 mm Hg 1 hour after initiation of NIV were independently associated with NIV failure. This survey showed that, even in experienced centers, NIV use averted ETI in no more than 50% of patients highlighting that a low number of patients with more severe forms of ARDS can be successfully treated with NIV (31%). A high mortality rate (54%) was observed in patients failing NIV. Close monitoring is crucial when using this technique as a first-line therapy in patients with ARDS. A concern, although not proven, is that delaying intubation may contribute to mortality. In most studies, NIV was used to prevent intubation. Less frequently, it has been used as an alternative to conventional mechanical ventilation (MV). Antonelli et al randomized patients with hypoxic respiratory failure and compared NIV with MV through an endotracheal tube. Ten patients in the noninvasive ventilation group out of 32 subsequently required ETI. There was no significant difference in mortality, but the patients treated with NIV experienced fewer complications and had a shorter ICU length of stay. One issue was whether intubation could have been avoided anyway in the control group. In a comparable study, ETI was avoided in 42% of patients with NIV, but ICU mortality and complications did not differ. In general, however, NIV used lately as an alternative to intubation is associated with a high rate of failure. NIV should not be considered primarily as an alternative to invasive ventilation. A recent small prospective, multicenter, randomized controlled trial included 40 patients whose diagnosis was mild ARDS. Half of patients included had pulmonary infection as the reason for ARDS, and they were allocated either to PSV and PEEP ventilation (NIV group) or high-concentration oxygen therapy (control group). Less patients required intubation and were intubated in the NIV group compared with control group and noninvasive positive pressure ventilation use was associated with a lower number of organ failures. The recent Berlin definition of ARDS indicated that NIV, which remains to be properly evaluated in this indication, could be a possible indication only in mild ARDS, and not in severe and moderate ARDS. NIV failure in ARDS patients seems to be strongly predictable in case of shock, metabolic acidosis, high severity scores of illness, and a greater degree of hypoxemia.

**Noninvasive Ventilation in Community-Acquired Pneumonia**

Pneumonia can respond well to NIV but has also been shown to be associated with a high risk of failure. In one observational study in patients with severe community-acquired pneumonia, NIV was associated with early physiological improvement but, over time, almost two-thirds of the patients required intubation. Patients with severe pneumonia have been shown to fail more often than patients with pulmonary edema despite similar degrees of hypoxemia. One randomized controlled trial in patients with severe pneumonia showed that NIV reduced intubation rate (21
Recent Experience with H1N1-Induced Respiratory Failure

The epidemic wave of H1N1 has brought a large number of patients with severe respiratory failure into ICUs over the world. Many patients developed ARDS requiring intubation and MV and even required techniques of extracorporeal membrane oxygenation. Interestingly, NIV was also used widely in these patients in several parts of the world with relatively favorable results but a high rate of failure. This aspect is interesting since there was a concern about risk of viral transmission that could be associated with NIV that has emerged after the severe acute respiratory syndrome experience. This concern did not seem to be an issue during these epidemic waves, but data are insufficient to properly address this question.

Noninvasive Ventilation to Facilitate Weaning

The use of NIV to facilitate discontinuation of MV in patients with acute hypoxemic ARF has rarely been tested. In a pilot study, the feasibility of early extubation followed by immediate NIV was shown comparable to conventional weaning in 20 patients with resolving hypoxemic ARF. This reduced the number of days under invasive ventilation but not the total days of MV. No real benefit could be demonstrated and a companion editorial suggested that the technique was not ready for prime time.

Noninvasive Ventilation in Immunocompromised Patients

ARF remains the most common cause of ICU admission in immunocompromised patients, including patients with cancer. The prognosis of immunocompromised patients with such a diagnosis has markedly improved in the past 15 years for different categories of patients but invasive MV was repeatedly identified as an independent mortality predictor in this population. The potential to reduce infectious complications, combined with promising early studies, constituted a strong rationale for NIV use in immunocompromised patients. NIV was soon pointed out as a protective factor against death in cancer patients with respiratory failure. The first randomized trial in hypoxemic respiratory failure after solid organ transplantation assessed the role of NIV in 40 patients. NIV reduced intubation rate from 70 to 20%, ICU length of stay in survivors, and ICU mortality (20 vs. 50%), with no difference in hospital mortality. Invasive procedures were kept in place for a shorter period of time in the NIV group. A second randomized trial confirmed the benefit of a sequential use of NIV in 52 mixed immunocompromised patients with respiratory failure and pulmonary infiltrates. Intubation rate (46 vs. 77%) and ICU mortality (38 vs. 69%) were reduced in the NIV group. A delay between admission and first use of NIV was identified as a predictor of NIV failure in patients with hematologic malignancies. Similarly, an early preventive use of CPAP in the hematological ward for neutropenic patients with mild respiratory dysfunction has been shown to prevent a subsequent evolution to frank respiratory failure and ICU admission and the need for intubation.

The generalizability of the results coming from expert centers and their applicability to the real-life practice of other centers have often been discussed. It was therefore interesting to observe in a purely observational study in Italy that NIV was used in 21% of patients with hematologic malignancies requiring ventilatory support. Despite a high failure rate of 46%, NIV was associated with a lower mortality than invasive MV after adjustment using a propensity score. Patients intubated from the beginning had a higher SAPS II score but a lower mortality than patients who failed NIV (50 vs. 61%). This should warn clinicians about a possible harmful delay in intubation by persisting in the administration of NIV until overt failure. A trial of NIV as a first-line intervention in selected immunocompromised patients with hypoxemic respiratory failure appears justified but the caution can be summarized by “don’t push too hard.” As already discussed, the prognosis of these patients submitted to invasive MV has clearly improved and ETI must be considered as a valid option when NIV is not rapidly successful or not well tolerated.

Noninvasive Ventilation in Particular Circumstances

Facilitate Intubation

In all the above-mentioned circumstances, conditions for ETI are frequently nonoptimal and several attempts can sometimes be necessary. Severe hypoxemia during the procedure is frequent and the standard bag-mask preoxygenation procedure can be poorly effective. Preoxygenation with NIV provides higher oxygen saturation and reduces episodes of severe hypoxemia in ICU patients requiring intubation. Preoxygenation of hypoxemic patients with NIV appears to be a useful technique that can be integrated into an intubation management protocol.

Per-Bronchoscopy

While flexible bronchoscopy is usually well tolerated in healthy subjects, it remains an invasive procedure with an increased risk of complications in critically ill patients. Bronchoscopy is associated with an extra work of breathing and a usual decrease in the PaO2 by 10 to 20 mm Hg that can persist, or even worsen, for a few hours after the procedure. Oxygenation can be further worsened by saline instillation for bronchoalveolar lavage and by suctioning with a concomitant reduction in end-expiratory lung volume. Several feasibility studies showed that NIV with different interfaces could be useful during bronchoscopy in at-risk patients. NIV can prevent derecruitment and compensate for the extra work of breathing imposed by the procedure. In a randomized trial of
30 hypoxemic patients, CPAP reduced the per-procedure desaturations and the incidence of respiratory failure necessitating ventilatory support (one vs. seven patients in the oxygen group). In another trial of 26 hypoxemic patients, during bronchoscopy, PaO2/FIO2 ratio increased by 82% in the NIV group and decreased by 10% in the standard oxygen group. NIV can help maintain oxygenation in hypoxemic patients undergoing bronchoscopy. This probably translates into a reduction of procedure-related intubation, although more studies would be needed to answer this question.

Surgical Conditions: Noninvasive Ventilation in Postoperative Period

Respiratory complications constitute a major cause of morbidity after surgery and mortality is often related to reintubation and complications of MV. NIV is becoming increasingly popular for the treatment or prevention of postoperative respiratory complications.50–53

Pathophysiology of Postoperative Respiratory Complications

After thoracic or upper abdominal surgery, residual anesthesia, pain, and worsening of the patient's pulmonary condition can occur. This includes a systematic reduction in lung volume and a transient diaphragmatic dysfunction. On top of this, other conditions can occur such as periprosthetic fluid loading, transfusion-related acute lung injury, inflammation, sepsis, and aspiration. Respiratory modifications are maximal in the 1st hours after surgery and generally recede after 1 or 2 weeks. As it can restore lung volume, CPAP has been used for a long time in postoperative patients.53 As a consequence, some authors advocate the use of postoperative NIV (CPAP or PS plus PEEP) both for prophylactic and curative purposes.52,54

Thoracic Surgery

In the postoperative period following lung resection, pulmonary complications are the leading cause of death. Postoperative invasive ventilation increases the risk of bronchial stump disruption, bronchopleural fistula, persistent air leakage, and pulmonary infection. NIV was proposed to prevent reintubation, infection, and atelectasis in the postoperative period after chest surgery. Despite the theoretical concern of increasing pleural air leaks, a small study of 10 patients suggested the feasibility, efficacy in improving oxygenation, and apparent safety of NIV use after lung resection surgery.55 Prophylactic use of NIV pre- and postoperatively (7 days at home and then 3 days after the surgery) was specifically studied in 32 patients at a higher risk of complications after lung resection surgery and an improvement in spirometric values and oxygenation was found.56 Comparable results have been obtained with prophylactic use of NIV following cardiac surgery and the largest study randomized 500 patients scheduled for elective cardiac surgery between nasal CPAP for at least 6 hours or standard treatment including 10 minutes of intermittent CPAP every 4 hours. The number of pulmonary complications was significantly reduced within the intervention group, but the reintubation rate was low in both groups. Similar results have been obtained after thoracoabdominal aortic aneurysm repair.58 NIV has also been used for the treatment of respiratory failure after thoracic surgery. Auriant et al performed a randomized controlled trial in which 48 patients with ARF after lung resection were randomly assigned to NIV or standard treatment.59 NIV significantly decreased ETI rate (50 vs. 21%) and hospital mortality (13 vs. 38%), probably by preventing intubation-related complications such as tracheobronchial bacterial contamination, bronchopleural fistula, and pyothorax. NIV did not reduce ICU or hospital length of stay which was attributed to the authors to the long duration of their weaning protocol. Similarly, the beneficial effect of NIV was suggested in patients with ARF after esophagectomy and no increase in anastomotic leakage was noted.60 The technique seems very attractive because the risk of surgical complications induced by positive pressure ventilation is high; it is probably wise to keep airway pressures at the lowest effective level.60

Abdominal Surgery

Numerous factors linked to anesthetic and surgical consequences can explain the high incidence of postoperative hypoxemia after abdominal surgery. NIV can address many of these issues, especially by restoring forced vital capacity, preventing atelectasis, improving gas exchange, and decreasing the work of breathing.51–53

NIV, including CPAP, can reduce the incidence of postoperative hypoxemia, but the effect on clinical outcomes is more debatable. Squadrone et al studied the effect of early CPAP delivered by helmet in 209 patients with PaO2/FIO2 < 300 at 1 hour after elective major abdominal surgery.54 Compared with standard oxygen therapy, intubation rate was reduced (1 vs. 10%, p = 0.005), as were pneumonia and sepsis. Despite a positive trend, ICU and hospital length of stay did not significantly differ. NIV was used in this study with the intention to prevent overt deterioration and more serious complications. Available data and general experience with NIV suggest that an early use, as soon as a mild deterioration occurs, is the best timing. Evidence does not justify the routine postoperative use of NIV, but it should be considered in patients at a higher risk of pulmonary complications.

Jaber et al reported that ETI was avoided in 48/72 (67%) patients treated with NIV for ARF after abdominal surgery.51 The PaO2/FIO2 ratio increased and the respiratory rate decreased only in patients who were successfully treated with NIV and avoided ETI. A similar rate of NIV failure had also been reported in other observational studies of respiratory failure in postoperative patients.62 The use of the helmet in this situation has been reported to be associated with a significant decrease in intubation rate compared with face mask, mainly because of a better clinical tolerance.63

Trauma Patients

Trauma patients present a high risk of pulmonary dysfunction with consecutive hypoxemic respiratory failure. In selected patients, NIV may have a good clinical tolerance. Compared with a high-flow oxygen mask, the use of NIV was shown to...
significantly reduce the intubation rate (12 vs. 40%) and hospital length of stay in a single-center RCT of 50 patients with persistent hypoxemia within the first 48 hours after thoracic trauma.\textsuperscript{65–69} NIV is probably a useful adjunct to manage hypoxic patients with predominant chest trauma, but adequate analgesia remains of paramount importance in this situation.

**Noninvasive Ventilation in Patients with Treatment Limitations**

NIV is used more and more frequently in patients in whom intubation is not desirable.\textsuperscript{65–69} An important distinction should be made; however, between a real treatment in patients in whom NIV is considered as a ceiling of therapy and palliative administration of NIV at the end of life for a substantial number of patients improving under NIV with some results suggesting a good quality of life several months after hospital discharge.\textsuperscript{69} Most series report, however, that results are much better in patients with COPD or pulmonary edema than in purely hypoxic patients.\textsuperscript{65,68,71} Therefore, in this group of patients, the same selective criteria than in patients with no limitation, should be applied.

**Alternative Techniques to Noninvasive Ventilation**

Although this is out of the scope of this article, it is important to note that the patient–ventilator interface may play a significant role in the success of the technique. It has been shown for instance that the new interfaces covering all the face may advantageously be used to replace the classical oronasal interfaces, without a risk of CO\textsubscript{2} rebreathing. In the same idea, the helmet has been proposed by several groups as a way to improve long-term tolerance of the technique, which may be useful for severely hypoxic patients.\textsuperscript{63,72–74} The long-term tolerance has not been properly tested, but the helmet has given interesting results for preventive NIV.\textsuperscript{42,54}

Several techniques have also been used noninvasively as techniques of respiratory support. High-frequency percussive ventilation is supposed to have interesting physiotherapeutic effects and is also able to reduce the work of breathing.\textsuperscript{75} High flow oxygen therapy delivers heated and humidified oxygen at relatively high flow (around 40 L/min) through nasal cannulas, generating a low CPAP level and possibly reducing physiologic dead space. It has been shown to be both remarkably well tolerated by patients compared with high flow oxygen therapy and also to be feasible in relatively severe forms of ARF.\textsuperscript{76–79} Whether it will replace NIV in some circumstances is still unknown but is under investigation in several clinical conditions.

**Overview**

The use of NIV is supported by a strong rationale in hypoxic respiratory failure. The literature has yielded sometimes conflicting results that probably reflect, on the one hand, the large heterogeneity of underlying diagnoses, and on the other hand, some pitfalls of the technique in these patients. In a large observational study on the use of NIV in France, Demoule et al. were able to compare the results of NIV in patients with acute exacerbation of chronic cardiac or respiratory failure on the one hand with those with hypoxic de novo respiratory failure on the other hand.\textsuperscript{80} The overall effect of using NIV (taken as an independent variable) on outcome in the two groups was compared. In the “acute on chronic” group, the use of NIV was significantly associated with a better outcome, indicating a positive balance in favor of the use of NIV (adjusted odds ratio [OR], 0.33). In the de novo group, the use of NIV was not significantly associated with a better or worse outcome, indicating that the balance was neutral (adjusted OR, 1.18). This reflected that NIV was indeed associated with a better outcome when successful, but also with a significantly worse independent outcome when failing. This indicates that the use of NIV should be restricted when the risk of failure is very high and that efforts might be provided to avoid any delay in necessary intubation procedures.

Selecting the appropriate patients with pneumonia and without COPD for a trial of NIV will therefore depend on the experience of the team, on patient’s cooperation and on carefully avoiding patients with hemodynamic instability, mental status alteration, and abundant secretions.

**Conclusion**

Uncertainties in the current literature do not allow firm and definitive recommendations concerning the use of NIV in hypoxic ARF. ETI still remains a standard of care for many cases of severe hypoxic ARF. Nonetheless, NIV is part of our armamentarium and some optimally selected patients clearly benefit from its use.

Patient selection is crucial and the focus should be on patients with a favorable risk-benefit ratio, such as immuno-compromised and postoperative patients. NIV must be initiated early on the process of respiratory failure, as illustrated in \textsuperscript{Fig. 1}, and in patients with a reversible underlying condition. Gaining some time with NIV makes sense from a global perspective but failure of NIV must be recognized early to avoid delaying intubation. The delay in ETI is the main hypothesis to explain the mortality excess of hypoxic patients who failed NIV. The use of NIV in hypoxic ARF patients is part of a calculated strategy that must take into account pathophysiology, risks, and limitations of the technique and always ensure patient safety.

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