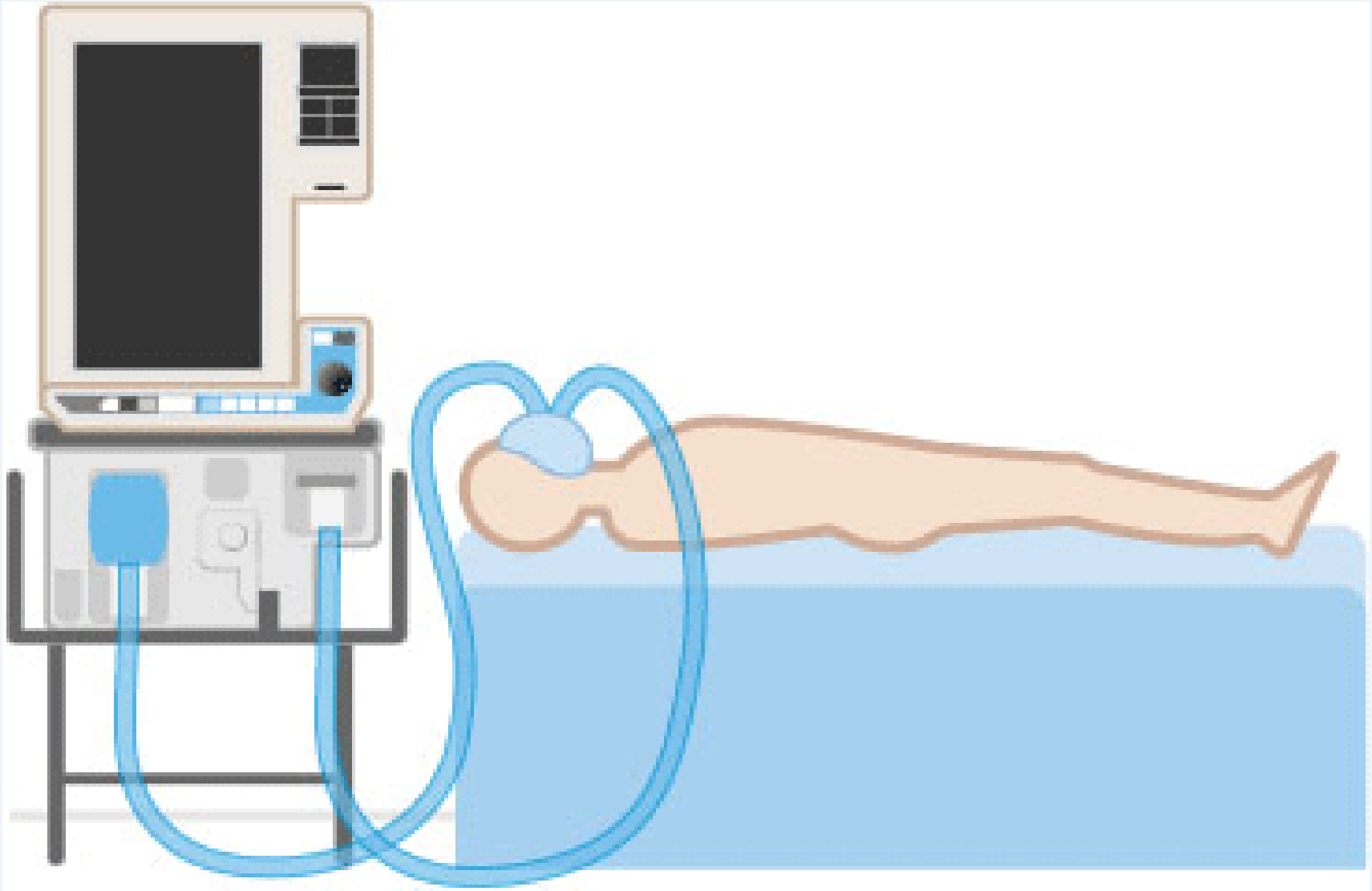
Noninvasive Positive-Pressure Ventilation

Dr. Z. Ostadi
Subspecialist of Critical Care Medicine



✓Noninvasive ventilation is defined as the provision of ventilatory assistance to the lungs without an invasive artificial airway.

✓Over the past 30 years, noninvasive ventilation has spread from the outpatient to the inpatient setting, where it is used to treat acute respiratory failure.

✓The most important advantage of noninvasive ventilation is the avoidance of complications associated with invasive mechanical ventilation.

✓These include upper airway trauma, the bypass of the upper airway defense mechanisms, increased risk of nosocomial pneumonia, and interference with upper airway functions, including the ability to eat and communicate normally.

- ✓The main indication for mechanical ventilatory assistance is to treat respiratory failure, either type 1 (hypoxemic), type 2 (hypercapnic), or both.
- ✓Airspace collapse, surfactant abnormalities, and airway narrowing and closure contribute to ventilation perfusion abnormalities and shunt, which cause hypoxemia.
- ✓By opening the collapsed air spaces and narrowed airways, positive airway pressure reduces shunt and improves ventilation-perfusion relationships, ameliorating hypoxemia.
- ✓In addition, positive airway pressure can reduce the work of breathing by improving lung compliance as a consequence of opening collapsed air spaces.
- ✓Another potential benefit of positive airway pressure is enhanced cardiovascular function via the afterload-reducing effect of increased intrathoracic pressure.

BOX 62-1 Indications for Use of Noninvasive Ventilation in the Acute Care Setting

AIRWAY OBSTRUCTION

COPD (A)*
Asthma (B)
Cystic fibrosis (C)
Obstructive sleep apnea or obesity hypoventilation (B)
Upper airway obstruction (C)
Facilitation of weaning in COPD (A)
Extubation failure in COPD (B)

HYPOXEMIC RESPIRATORY FAILURE

ARDS (C)
Pneumonia (C)
Trauma or burns (B)
Acute pulmonary edema (use of CPAP) (A)
Immunocompromised patients (A)
Restrictive thoracic disorders (C)
Postoperative patients (B)
Do-not-intubate patients (C)
During bronchoscopy (C)

*Letters in parentheses indicate the level of evidence supporting the use of noninvasive ventilation: A, multiple randomized, controlled trials: recommended; B, at least one randomized, controlled trial: weaker recommendation; C, case series or reports: can be attempted, but with close monitoring.

ARDS, acute respiratory distress syndrome; COPD, chronic obstructive pulmonary disease; CPAP, continuous positive airway pressure.

Airway Obstruction

✓Chronic Obstructive Pulmonary Disease

✓NIPPV improves vital signs, gas exchange, and dyspnea scores; reduces the rates of intubation, morbidity, and mortality; and shortens hospital length of stay in patients with moderate to severe exacerbations of COPD.

✓NIPPV is considered the ventilatory mode of choice in selected patients with acute exacerbations of COPD.

Airway Obstruction

✓Asthma

✓Improvements in gas exchange and low rates of intubation after the initiation of NIPPV in patients with severe asthma attacks.

✓Noninvasive ventilation can be combined with continuous nebulization and heliox.

✓Cystic Fibrosis

✓Treatment of acute episodes of respiratory failure in end-stage cystic fibrosis patients and can serve as a bridge to transplantation.

Airway Obstruction

✓Obesity Hypoventilation Syndrome

✓NIV can be safely and efficaciously used in acute hypercapnic respiratory failure related to OHS in the ICU.

✓Upper Airway Obstruction

✓Noninvasive ventilation can be used to treat patients with upper airway obstruction, such as that caused by glottic edema following extubation.

✓Patients should be selected with great caution and monitored closely.

✓The use of noninvasive ventilation in patients with tight, fixed upper-airway obstruction is inappropriate because it delays the institution of definitive therapy.

Hypoxemic Respiratory Failure

- ✓Hypoxemic respiratory failure is defined as severe hypoxemia (arterial oxygen partial pressure-inspired oxygen fraction ratio<200) combined with a respiratory rate above 35 breaths per minute and a nonCOPD diagnosis including acute pneumonia, acute lung injury (ALI), acute respiratory distress syndrome (ARDS), pulmonary edema, or trauma.

- ✓ Patients with a simplified acute physiologic score (SAPS II) less than 35 fare considerably better with NIPPV than do those with higher scores.

Hypoxemic Respiratory Failure

✓Pneumonia

✓No benefit was apparent in the non-COPD patients with severe pneumonia.

✓Immunocompromised States

✓Solid organ transplantation patients and neutropenic patients (most of whom had hematologic malignancies) who developed acute hypoxemic respiratory failure, noninvasive ventilation reduced the rate of intubation, nosocomial infection, and ICU mortality compared with conventional therapy.

Hypoxemic Respiratory Failure

- ✓Acute Respiratory Distress Syndrome
- ✓ARDS patients with severe oxygenation defects and multiple organ system dysfunctions should undergo prompt intubation and invasive ventilation as the preferred modality.
- ✓Simplified acute physiology score of 34 or less and Pao2/ Fio2 above 175 within the first hour predicted the success of noninvasive ventilation.
- ✓Patients must be monitored closely to avoid any delay in intubation if deterioration occurs.

Hypoxemic Respiratory Failure

- ✓Acute Cardiogenic Pulmonary Edema
- ✓CPAP is highly effective at relieving respiratory distress, improving gas exchange, and averting intubation when used to treat patients with acute cardiogenic edema.
- ✓The current recommendation is to use CPAP alone or noninvasive ventilation as an initial therapy.

Hypoxemic Respiratory Failure

- ✓Postoperative Respiratory Failure
- ✓Reduces extravascular lung water and improves lung mechanics and gas exchange following coronary artery bypass surgery.
- ✓Reduces the need for reintubation, lowers the mortality rate after lungresectional surgery, and enhances pulmonary function after gastroplasty.
- ✓Noninvasive ventilation should be considered in selected postoperative patients at a high risk of pulmonary complications or with frank respiratory failure, especially in the setting of underlying COPD or pulmonary edema.

Hypoxemic Respiratory Failure

✓Trauma and Burns

✓chest wall injuries, such as flail chest or mild acute lung injuries that might respond favorably to NIPPV.

✓Restrictive Lung Disease

✓They constitute only a small portion of patients admitted to acute care hospitals.

✓Patients with restrictions related to an underlying neuromuscular disease and superimposed acute respiratory failure may benefit from a trial of NIPPV.

✓Patients with interstitial lung diseases, NIV may play a role in preventing intubation and improving survival.

Hypoxemic Respiratory Failure

✓Do-Not-Intubate Patients

✓Noninvasive ventilation may be a useful tool in patients with acute respiratory failure who do not wish to be intubated.

✓Noninvasive ventilation may also be used as a palliative technique to reduce dyspnea, preserve patient autonomy, and provide time for the finalization of affairs for some terminal patients.

Hypoxemic Respiratory Failure

- ✓Facilitation of Weaning and Extubation
- ✓Patients who require invasive mechanical ventilation initially and fail to wean promptly are potential candidates for noninvasive ventilation to facilitate extubation.
- ✓The benefit of NIV in ventilator weaning seems to be highest in patients intubated for acute exacerbations of COPD.
- ✓Avoid reintubation in patients with extubation failure, a complication of invasive mechanical ventilation associated with a high mortality rate.
- ✓Noninvasive ventilation to facilitate weaning and extubation appears to benefit hypercapnic patients with COPD or congestive heart failure.

Patient Selection

- ✓Noninvasive ventilation should be viewed as a “crutch” that assists patients through a period of acute respiratory failure while reversible factors are being treated, helping them avoid invasive mechanical ventilation and its attendant complications.
- ✓To optimize the chance of success, noninvasive ventilation should be used early, when patients first develop signs of incipient respiratory failure.
- ✓The window opens when the patient first requires ventilatory assistance and closes when the patient becomes too unstable.

- ✓Based on the predictors of success and criteria used in prior controlled trials, we recommend the following three-step selection process: (1) to ensure that the patient has an etiology of respiratory failure likely to respond favorably to noninvasive ventilation; (2) to identify patients in need of ventilatory assistance by using clinical and blood gas criteria. (3) to exclude patients for whom noninvasive ventilation would be unsafe.

- ✓Good candidates are those with moderate to severe dyspnea, tachypnea, and impending respiratory muscle fatigue, as indicated by the use of accessory muscles of breathing or abdominal paradox.

- ✓Patients with mild respiratory distress and only those with mild gas exchange derangement are likely to do well without ventilatory assistance and should not be considered.

- ✓Those with obvious or imminent respiratory arrest should be promptly intubated because the successful initiation of noninvasive ventilation requires some time for adaptation.

- ✓Patients who are medically unstable with hypotensive shock, uncontrolled upper gastrointestinal bleeding, unstable arrhythmias, or life-threatening ischemia are better managed with invasive mechanical ventilation.

- ✓Noninvasive ventilation should not be used for patients who are uncooperative, unable adequately to protect their upper airway or clear secretions, intolerant of masks, or for recipients of recent upper gastrointestinal or airway surgery.

- ✓The level of tachypnea used as a criterion depends on the underlying diagnosis. Those with COPD are considered candidates for noninvasive ventilation when the respiratory rate exceeds 24 breaths per minute; with hypoxemic respiratory failure, higher respiratory rates are used in the range of 30 to 35 breaths per minute

Initiation of Noninvasive Ventilation

- ✓Noninvasive ventilation can be initiated wherever the patient presents with acute respiratory distress, but he or she should be transferred to a location with sufficient monitoring (usually an ICU or step-down unit) until stabilized.

BOX 62-2 Predictors of Noninvasive Ventilation Success in Patients with Acute Respiratory Failure

Lower acuity of illness (Acute Physiology and Chronic Health Evaluation [APACHE] score)
Ability to cooperate; better neurologic score
Ability to coordinate breathing with ventilator
Less air leakage; intact dentition
Hypercarbia, but not too severe ($PaCO_2$ between 45 and 92 mm Hg)
Acidemia but not too severe (pH between 7.1 and 7.35)
Improvements in gas exchange and heart and respiratory rates within first 2 hours

Ventilator Selection

- ✓Selection of a ventilator is based largely on availability, practitioner experience, and patient comfort.

- ✓Pressure-limited modes, including pressure support and pressure control, are available on most critical care ventilators.

- ✓Pressure control ventilation (PCV) delivers timecycled, preset inspiratory and expiratory pressures with adjustable inspiratory/expiratory ratios at a controlled rate.

- ✓The majority of such models also permit patient triggering and the selection of a backup rate. PSV delivers preset inspiratory and expiratory pressures to assist spontaneous breathing efforts

- ✓PSV is a flow-triggered and flow-cycled mode, and patient effort determines tidal volume and duration of inspiration. Pressure-support modes have the potential to match breathing pattern quite closely, and they have been rated by patients as more comfortable for NIPPV than volume-limited ventilation.

- ✓Leaks during noninvasive ventilation can interfere with the detection of reduced inspiratory flow at the termination of inspiration, causing expiratory asynchrony.

- ✓Noninvasive pressure-limited modes of ventilation are usually administered using either standard critical care ventilators or bilevel portable ventilators.

- ✓Initial ventilator pressure settings are usually low to facilitate patient acceptance, but they can be set higher if necessary to alleviate respiratory distress.
- ✓Typical starting pressures are an inspiratory positive airway pressure of 10 to 12 cm H2O and a PEEP (or expiratory positive airway pressure) of 4 to 5 cm H2O.
- ✓Increases in inspiratory pressure are helpful to alleviate dyspnea, whereas increases in expiratory pressure are preferable to improve oxygenation.
- ✓For volume ventilation, initial tidal volumes range from 6 to 7 mL/kg. The ventilator is set in a spontaneously triggered mode, with or without a backup rate. Pressures commonly used to deliver CPAP in patients with acute respiratory distress range from 5 to 12.5 cm H2O.

Interfaces

- ✓The major difference between invasive and noninvasive ventilation is that with the latter, pressurized gas is delivered to the airway via a mask rather than via an invasive conduit

- ✓Commonly used interfaces in the acute setting include nasal and full-face (or oronasal) masks.

- ✓Nasal masks are widely used for the administration of CPAP or NIPPV, particularly for chronic applications.

- ✓Nasal masks are usually better tolerated than full-face masks for long-term applications because they cause less claustrophobia, increased comfort, and allow eating, conversation, and expectoration.

- ✓Full-face masks cover both the nose and the mouth and are preferable to nasal masks in the acute setting.

- ✓The efficacy of both nasal and oronasal masks in lowering Paco2 and avoiding intubation is similar in the acute setting, but a randomized controlled observed better patient tolerance with full-face masks because of reduced air leakage through the mouth.

- ✓More recently, “total” face masks have become available; they seal around the perimeter of the face and resemble a hockey goalie’s mask or a snorkel mask.

- ✓Helmets are clear plastic bucket-shaped devices that fit over the entire head and seal over the shoulders and neck.

- ✓Selection of a comfortable mask that fits properly is the key to the success of noninvasive ventilation

Oxygenation and Humidification

- ✓Bilevel ventilators have limited oxygenation capabilities (maximal inspired oxygen fraction, 0.45-0.5), so ventilators with oxygen blenders should be used for patients with hypoxemic respiratory failure.
- ✓A heated humidifier should be used to prevent drying of the nasal passage and oropharynx when the duration of application is anticipated to be more than a few hours.

Monitoring

- ✓Once noninvasive ventilation is initiated, patients should be closely monitored in a critical care or step-down unit until they are sufficiently stable to be moved to a regular medical floor.
- ✓The aim of monitoring is to determine whether the main goals are being achieved, including the relief of symptoms, reduced work of breathing, improved or stable gas exchange, good patient-ventilator synchrony, and patient comfort.
- ✓A drop in the respiratory rate with improved oxygen saturation or improving pH with a lower Paco2 within the first 1 to 2 hours indicates a successful outcome.

- ✓Abdominal paradox, if present initially, subsides, and the heart rate usually falls. The absence of these propitious signs indicates a poor response to noninvasive ventilation and the need to make further adjustments

- ✓Leaks should be sought and corrected, patient-ventilator synchrony should be optimized, and pressures may need to be adjusted upward to relieve respiratory distress and achieve a reduction in Paco2.

- ✓If these adjustments fail to improve the response within a few hours, noninvasive ventilation should be considered a failure, and the patient should be promptly intubated if it is still clinically indicated.

ADVERSE EFFECTS AND COMPLICATIONS

- ✓Common adverse effects related to the mask include discomfort and erythema or skin ulcers, usually on the nasal bridge, related to pressure from the mask seal.

- ✓Adverse effects related to airflow or pressure include conjunctival irritation caused by air leakage under the mask into the eyes and sinus or ear pain related to excessive pressure.

- ✓Refitting the mask or lowering the inspiratory pressure may ameliorate these problems.

- ✓Nasal congestion and discharge are also frequent complaints and can be treated with topical decongestants or steroids and oral antihistamine decongestant combinations.

- ✓Gastric insufflation occurs commonly, may respond to simethicone, and is usually tolerated.

- ✓The asynchrony may be related to patient agitation, which can be treated with the judicious use of sedatives.

- ✓Failure to synchronize can also result from inadequate ventilator triggering or the inability to sense the onset of patient expiration because of air leakage. This can be corrected by minimizing air leaks and using ventilator modes that permit a limitation of maximal inspiratory duration.

- ✓**Intubation should not be delayed if improvement is not apparent within a few hours.**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спасибо
dank je
thank you
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