

Non invasive ventilation

Overview

- Definition
- Types
- Advantages & disadvantages
- Indications & contraindications
- Interface
- Modes of NIV
- Guidelines for initiation & termination
- Complications
- Conclusion

Definition

- Non-invasive ventilation (NIV) refers to the delivery of mechanical ventilation to the lungs using techniques that **do not require an invasive artificial airway**(ETT, TT)

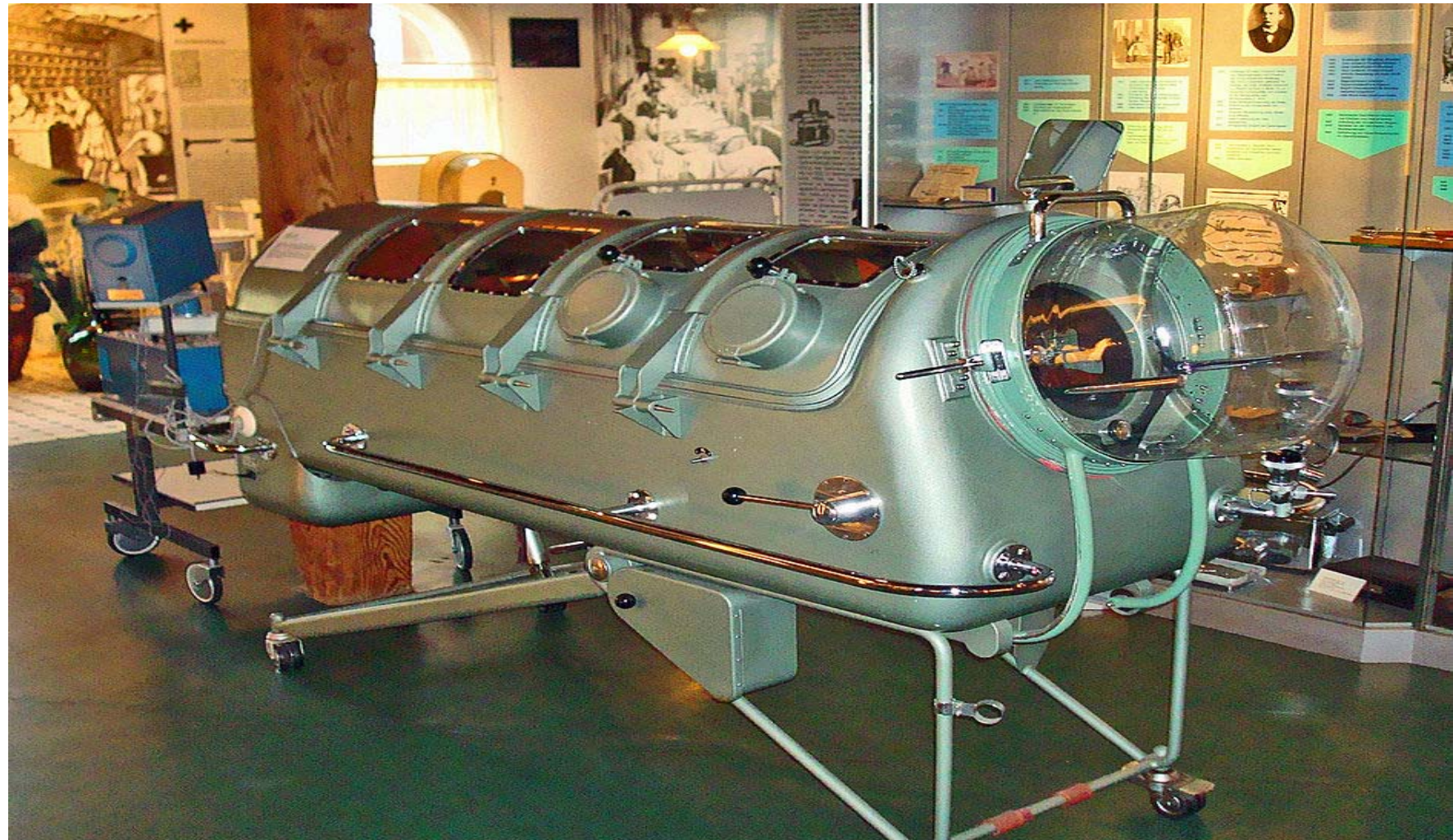
Types of NIV

- Negative pressure NIV
 - Main means of NIV during the 1st half of the 20th century
 - Extensively used during polio epidemics
 - Tank ventilator “iron lung”
 - Cuirass, Jacket ventilator, Hayek oscillator
- Positive pressure NIV
 - Positive pressure delivered through mask case
 - CPAP & BiPAP

Negative Pressure Ventilation (NPV)

- Negative pressure ventilators apply a negative pressure intermittently around the patient's body or chest wall
- The patient's head (upper airway) is exposed to room air
- Negative pressure is applied intermittently to the thoracic area resulting in a pressure drop around the thorax
- This negative pressure is transmitted to the pleural space and alveoli creating a pressure gradient between the inside of the lungs and the mouth

Negative Pressure Ventilation (NPV)



NIV - Advantages

- Non invasiveness
 - Flexibility in initiating and removing mechanical ventilation
 - Allows intermittent application
 - Improves patient comfort
 - Reduces the need for sedation
 - Oral patency
 - Preserves speech, swallowing and **expectoration**, reduces the need for nasogastric tubes

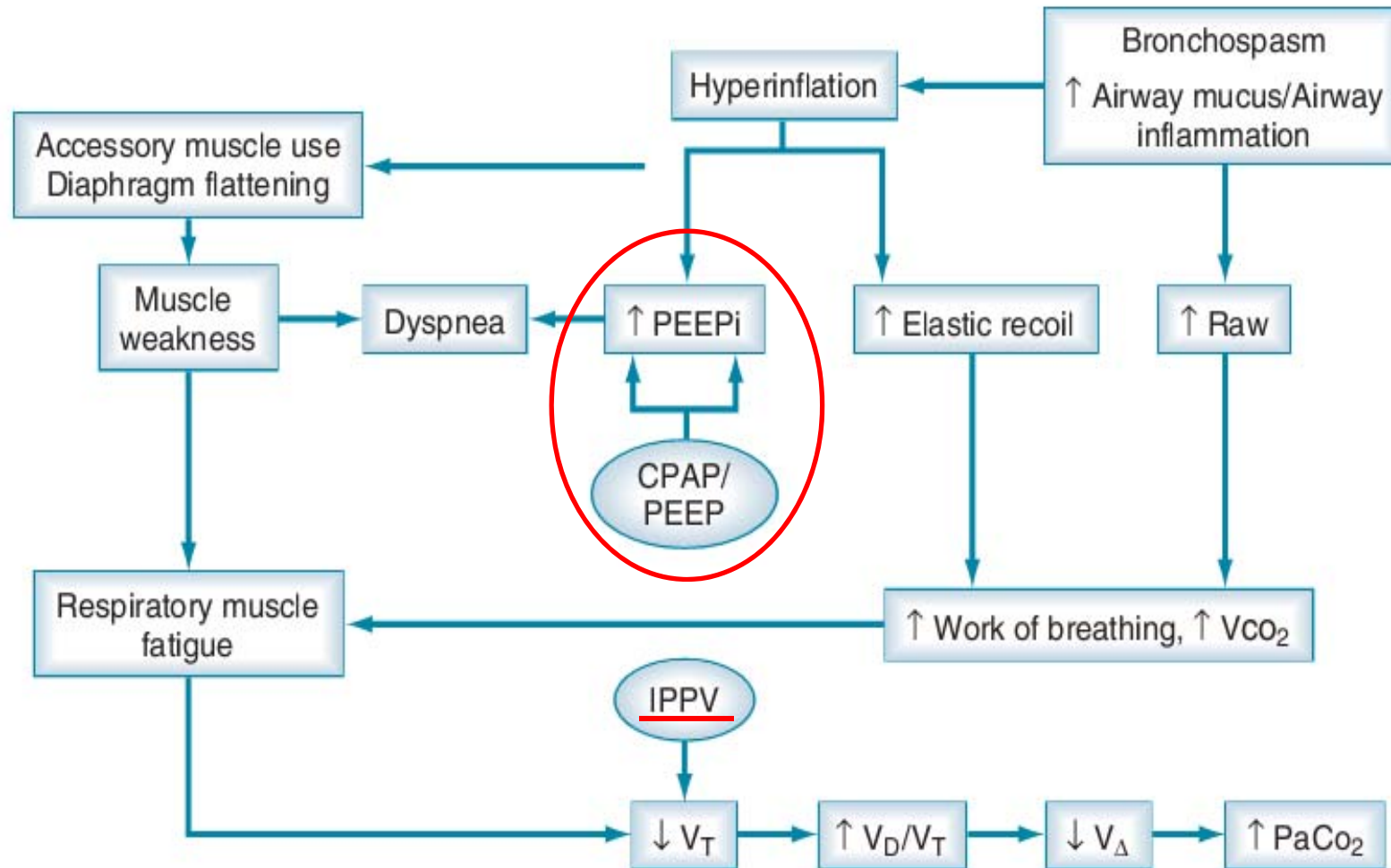
Advantages

- Avoid the resistive work imposed by the endotracheal tube
- Avoids the complications of endotracheal intubation
 - Early (local trauma, aspiration)
 - Late (injury to hypopharynx, larynx, and trachea, nosocomial infections)
- Reduces infectious complications- pneumonia, sinusitis, sepsis
- Less cost

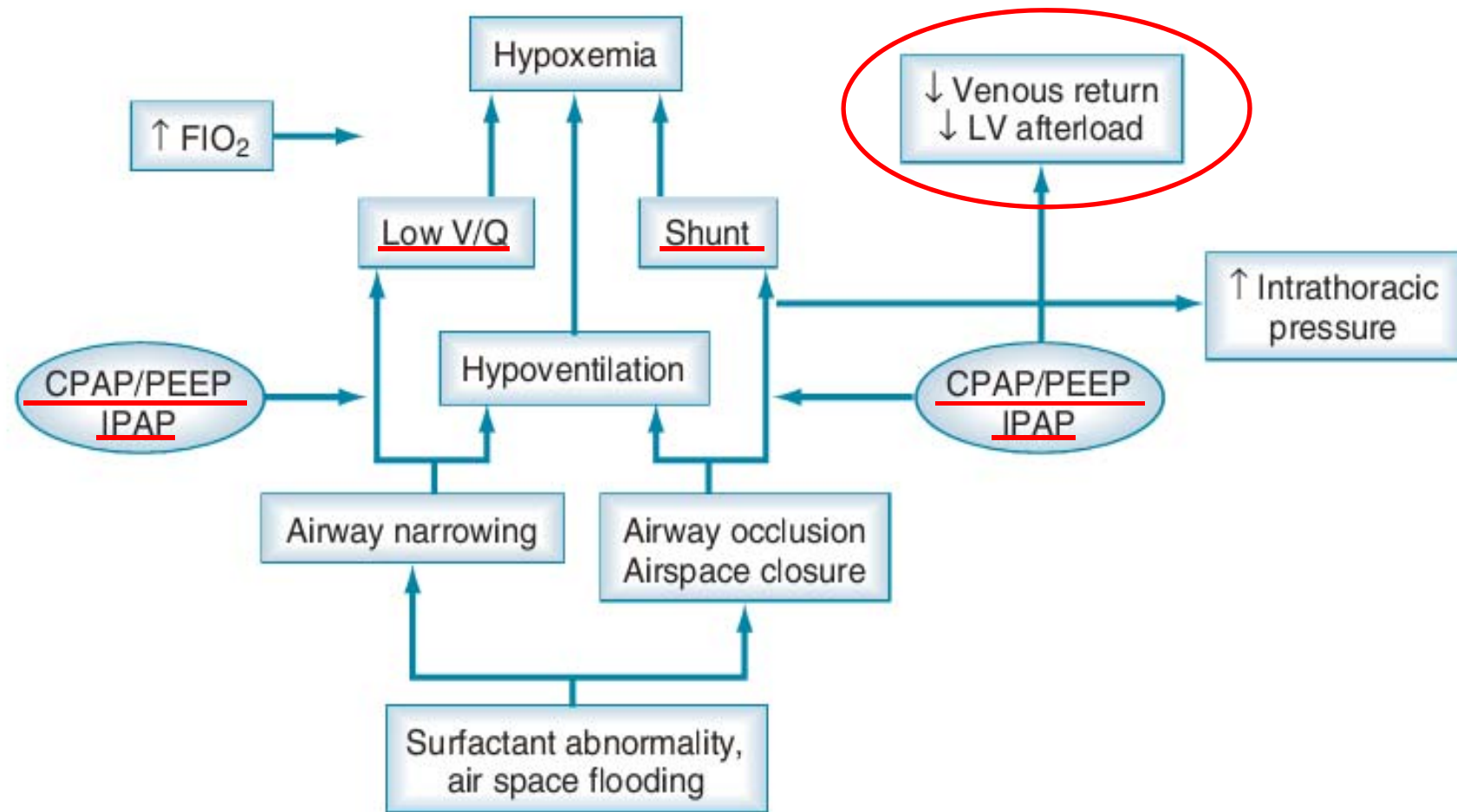
Mechanism of action

- Reduction in inspiratory muscle work and avoidance of respiratory muscle fatigue
- Tidal volume is increased
- CPAP counterbalances the inspiratory threshold work related to intrinsic PEEP.
- NIV improves respiratory system compliance by reversing microatelectasis of the lung
- Enhanced cardiovascular function
 - Afterload reduction d/t increased intrathoracic pressure

Pathophysiology of acute hypercapnia



Pathophysiology of acute hypoxemic respiratory failure



Disadvantages

- System
 - Slower correction of gas exchange abnormalities
 - Increased initial time commitment
 - Gastric distension (occurs in <2% patients)
- Mask
 - Air leakage
 - Transient hypoxemia from accidental removal
 - Eye irritation
 - Facial skin necrosis –most common complication
- Lack of airway access and protection
 - Suctioning of secretions
 - Aspiration

Levels of evidence

- A
 - Multiple RCTs
 - Recommended
- B
 - At least one RCT
 - Weaker evidence
- C
 - Case series/reports
 - Can be tried but with close monitoring

Indications

- **Airway obstruction**
 - COPD (**Evidence A**)
 - Facilitation of weaning in COPD (**Evidence A**)
 - Asthma (B)
 - Extubation failure in COPD (B)
 - Cystic Fibrosis (C)
 - OSA/obesity hypoventilation (C)
 - Upper airway obstruction (C)

NIV & stable COPD

- NIV increasingly used in stable very severe COPD
- NIV+O₂ therapy – in selected patients with pronounced daytime hypercapnia
- Clear benefits in both survival & risk of hospital admission in patients with both COPD & OSA

Global initiative for Chronic Obstructive Lung Disease(GOLD)
update 2013

Non-invasive positive pressure ventilation for treatment of respiratory failure due to exacerbations of chronic obstructive pulmonary disease (Review)

Ram FSF, Picot J, Lightowler J, Wedzicha JA



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Cochrane Database Syst Rev.
2004;(3):CD004104.

Concludes

- Data from good quality RCTs show benefit of NIV as **1st line intervention** in addition to usual medical care to ARF 2° to an acute exacerbation of COPD in **all suitable patients**
- **Use early** in the course of respiratory failure and before severe ensues, as a means of **reducing** the likelihood of endotracheal **intubation, treatment failure** and **mortality**

NIV in COPD exacerbation

- Multiple RCTs support a success rate of **80-85%**
- Has been shown to **improve respiratory acidosis** (\uparrow pH & \downarrow pCO₂)
- \downarrow Respiratory rate, WOB, severity of breathlessness, complications like **VAP**, length of hospital stay (**Evidence A**)
- Mortality & intubation rates are reduced (**Evidence A**)



NIV in COPD exacerbation

- Indications for NIV – **atleast one** of the following
 - Respiratory acidosis ($\text{pH} < 7.35$ &/or PaCO_2)
 - Severe dyspnea with clinical signs s/o respiratory muscle fatigue, increased WOB or both
 - Use of respiratory accessory muscles
 - Paradoxical motion of abdomen
 - Intercostal retraction

Noninvasive positive pressure ventilation as a weaning strategy for intubated adults with respiratory failure (Review)

Burns KEA, Adhikari NKJ, Keenan SP, Meade MO

- 12 trials of moderate to good quality
- Compared to the IPPV strategy, NPPV significantly decreased
 - Mortality(RR 0.55)
 - VAP(RR 0.29)
 - Length of stay in an ICU(WMD* -6.27) & hospital(WMD -7.19 day)
 - Total duration of ventilation(WMD -5.64 day)
 - Duration of endotracheal mechanical ventilation(WMD - 7.81 days)

*Weighted mean difference

Noninvasive positive pressure ventilation as a weaning strategy for intubated adults with respiratory failure (Review)

Burns KEA, Adhikari NKJ, Keenan SP, Meade MO

- Compared to IPPV Noninvasive weaning had no effect on weaning failures or the duration of ventilation related to weaning
- Concluded
 - a consistent, positive effect on mortality and ventilator associated pneumonia

The Role of Noninvasive Ventilation in the Ventilator Discontinuation Process

Dean R Hess PhD RRT FAARC

Introduction

NIV to Shorten the Length of Invasive Ventilation

NIV to Prevent Extubation Failure

NIV to Rescue Failed Extubation

When to Stop

Equipment and Resources

Summary and Recommendations

In recent years, there has been increasing interest in the use of noninvasive ventilation (NIV) in the post-extubation period to shorten the length of invasive ventilation, to prevent extubation failure, and to rescue a failed extubation. The purpose of this review is to summarize the evidence related to the use of NIV in these settings. NIV can be used to allow earlier extubation in selected patients who do not successfully complete a spontaneous breathing trial (SBT). Its use in this setting should be restricted to patients who are intubated during an exacerbation of COPD or patients with neuromuscular disease. This category of patients should be good candidates for NIV and should be extubated directly to NIV. In patients who successfully complete an SBT, but are at risk for extubation failure, NIV can be used to prevent extubation failure. These patients should also be good candidates for NIV and should be extubated directly to NIV. NIV should be used cautiously in patients who successfully complete an SBT, but develop respiratory failure within 48 hours post-extubation. In this setting, NIV is indicated only in patients with hypercapnic respiratory failure. Reintubation should not be delayed if NIV is not immediately successful in reversing the post-extubation respiratory failure. Evidence does not support routine use of NIV post-extubation.

Indications

- **Hypoxemic respiratory failure**
 - Acute pulmonary edema- CPAP (**Evidence A**)
 - Immunocompromised patients (**Evidence A**)
 - Postoperative patients (B)
 - ARDS (C)
 - Pneumonia (C)
 - Trauma or burns (C)
 - Restrictive thoracic disorders (C)
 - Do not intubate patients (C)
 - During bronchoscopy (C)

Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cardiogenic pulmonary oedema (Review)

Vital FMR, Ladeira MT, Atallah ÁN



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Concludes

- Included 32 studies
- NIV is an effective and safe intervention for the treatment of adult patients with acute cardiogenic pulmonary oedema
- Evidence to date on the potential benefit of NIV in reducing mortality is entirely derived from small-trials and further large-scale trials are needed

Indications

- **Immunocompromised patients**
 - Particularly exposed to infectious risk related to invasive ventilation
 - Multiple RCTs support whenever possible, NIV should be tried first in immunocompromised patients with hypoxemic RF

Noninvasive Ventilation for Patients With Acute Lung Injury or Acute Respiratory Distress Syndrome

Stefano Nava MD, Ania Schreiber MD, and Guido Domenighetti MD

Introduction

Physiological Rationale

Meta-analyses and Systematic Reviews

NIV to Prevent Endotracheal Intubation in ALI/ARDS Patients

NIV as an Alternative to Endotracheal Intubation in ALI/ARDS Patients

Summary

Few studies have been performed on noninvasive ventilation (NIV) to treat hypoxic acute respiratory failure in patients with acute lung injury (ALI) or acute respiratory distress syndrome (ARDS). The outcomes of these patients, for whom endotracheal intubation is not mandatory, depend on the degree of hypoxia, the presence of comorbidities and complications, and their illness severity. The use of NIV as an alternative to invasive ventilation in severely hypoxemic patients with ARDS (ie, $P_{aO_2}/F_{IO_2} < 200$) is not generally advisable and should be limited to hemodynamically stable patients who can be closely monitored in an intensive care unit by highly skilled staff. Early NIV application may be extremely helpful in immunocompromised patients with pulmonary infiltrates, in whom intubation dramatically increases the risk of infection, pneumonia, and death. The use of NIV in patients with severe acute respiratory syndrome and other airborne diseases has generated debate, despite encouraging clinical results, mainly because of safety issues. Overall, the high rate of NIV failure suggests a cautious approach to NIV use in patients with ALI/ARDS, including early initiation, intensive monitoring, and prompt intubation if signs of NIV failure emerge. *Key words:*

Indications

- **Postsurgical period**
 - Shown benefits after **lung resectional surgery**, CABG, gastroplasty, high risk procedures like thoracoabdominal aortic procedures
 - Should be considered in selected postoperative patients at high risk of pulmonary complications or with frank respiratory failure especially in the setting of **underlying COPD or pulmonary edema**

Indications

- **Restrictive Lung Disease**
 - Patients with restriction related to an **underlying neuromuscular disease** and superimposed ARF may benefit from a trial of NIV
 - Small case series have reported that using NIPPV in patients with myasthenic crises may avoid intubation



Extubation of Patients With Neuromuscular Weakness

A New Management Paradigm

John Robert Bach, MD; Miguel R. Gonçalves, PT; Irram Hamdani, MD; and Joao Carlos Winck, MD, PhD

Background: Successful extubation conventionally necessitates the passing of spontaneous breathing trials (SBTs) and ventilator weaning parameters. We report successful extubation of patients with neuromuscular disease (NMD) and weakness who could not pass them.

Methods: NMD-specific extubation criteria and a new extubation protocol were developed. Data were collected on 157 consecutive “unweanable” patients, including 83 transferred from other hospitals who refused tracheostomies. They could not pass the SBTs before or after extubation. Once the pulse oxyhemoglobin saturation (SpO_2) was maintained at $\geq 95\%$ in ambient air, patients were extubated to full noninvasive mechanical ventilation (NIV) support and aggressively mechanically assisted coughing (MAC). Rather than oxygen, NIV and MAC were used to maintain or return the SpO_2 to $\geq 95\%$. Extubation success was defined as not requiring reintubation during the hospitalization and was considered as a function of diagnosis, preintubation NIV experience, and vital capacity and assisted cough peak flows (CPF) at extubation.

Results: Before hospitalization 96 (61%) patients had no experience with NIV, 41 (26%) used it < 24 h per day, and 20 (13%) were continuously NIV dependent. The first-attempt protocol extubation success rate was 95% (149 patients). All 98 extubation attempts on patients with assisted CPF ≥ 160 L/m were successful. The dependence on continuous NIV and the duration of dependence prior to intubation correlated with extubation success ($P < .005$). Six of eight patients who initially failed extubation succeeded on subsequent attempts, so only two with no measurable assisted CPF underwent tracheotomy.

Conclusions: Continuous volume-cycled NIV via oral interfaces and masks and MAC with oximetry feedback in ambient air can permit safe extubation of unweanable patients with NMD.

CHEST 2010; 137(5):1033–1039



Noninvasive Ventilation Reduces Intubation in Chest Trauma-Related Hypoxemia

A Randomized Clinical Trial

Gonzalo Hernandez, MD, PhD; Rafael Fernandez, MD, PhD; Pilar Lopez-Reina, MD; Rafael Cuenca, MD; Ana Pedrosa, MD; Ramon Ortiz, MD; and Paloma Hiradier, MD

Background: Guidelines for noninvasive mechanical ventilation (NIMV) recommend continuous positive airway pressure in patients with thoracic trauma who remain hypoxic despite regional anesthesia. This recommendation is rated only by level C evidence because randomized controlled trials in this specific population are lacking. Our aim was to determine whether NIMV reduces intubation in severe trauma-related hypoxemia.

Methods: This was a single-center randomized clinical trial in a nine-bed ICU of a level I trauma hospital. Inclusion criteria were patients with $P_{aO_2}/F_{iO_2} < 200$ for > 8 h while receiving oxygen by high-flow mask within the first 48 h after thoracic trauma. Patients were randomized to remain on high-flow oxygen mask or to receive NIMV. The interface was selected based on the associated injuries. Thoracic anesthesia was universally supplied unless contraindicated. The primary end point was intubation; secondary end points included length of hospital stay and survival. Statistical analysis was based on multivariate analysis.

Results: After 25 patients were enrolled in each group, the trial was prematurely stopped for efficacy because the intubation rate was much higher in controls than in NIMV patients (10 [40%] vs 3 [12%], $P = .02$). Multivariate analysis adjusted for age, gender, chronic heart failure, and Acute Physiology and Chronic Health Evaluation II at admission revealed NIMV as the only variable independently related to intubation (odds ratio, 0.12; 95% CI, 0.02-0.61; $P = .01$). Length of hospital stay was shorter in NIMV patients (14 vs 21 days $P = .001$), but no differences were observed in survival or other secondary end points.

Conclusion: NIMV reduced intubation compared with oxygen therapy in severe thoracic trauma-related hypoxemia.

Trial registration: clinicaltrials.gov; identifier: NCT 00557752.

CHEST 2010; 137(1):74-80

PATIENT SELECTION

- Step 1
 - An **etiology** of respiratory failure **likely to respond** favourably to NIV
- Step 2
 - Identify patients in need of ventilatory assistance by using clinical and blood gas criteria
 - Moderate to severe dyspnea, tachypnea, and impending respiratory muscle fatigue
 - COPD with RR >24 bpm
 - Hypoxemic respiratory failure with RR >30-35 bpm
- Step 3
 - Exclude patients for whom NIV would be unsafe

PREDICTORS OF NIV SUCCESS IN ACUTE

RESPIRATORY FAILURE

- Lower acuity of illness (APACHE score)
- Ability to cooperate; better neurologic score
- Ability to coordinate breathing with ventilator
- Less air leakage; intact dentition
- Hypercarbia, but not too severe (PaCO₂ 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

Exclusion Criteria for NIV

- Respiratory arrest or need for immediate intubation
- Hemodynamic instability
- Inability to protect the airway (impaired cough or swallowing)
- Excessive secretions
- Agitated and confused patient
- Facial deformities or conditions that prevent mask from fitting
- Uncooperative or unmotivated patient
- Brain injury with unstable respiratory drive
- Untreated pneumothorax

Contraindications to NIV

- Cardiac or respiratory arrest
- **Non respiratory organ failure**
- Severe encephalopathy (eg, GCS <10)
- Severe **upper gastrointestinal bleeding**
- **Hemodynamic instability** or unstable cardiac arrhythmia
- Facial or neurological surgery, trauma, or deformity
- Upper airway obstruction
- Inability to cooperate/protect airway
- Inability to clear secretions
- High risk for **aspiration**

Equipment for NIV- Ventilators

- Portable NIV machines
 - Advantages
 - Portability
 - Ease of use
 - Better compensation for leaks
 - Better exhalation
 - Disadvantages
 - Cannot develop pressures $>30\text{cm H}_2\text{O}$
 - Lack O_2 blenders
 - Lack of sophisticated alarm systems, battery backup
- Critical care ventilators

Ventilators for NIV

- Volume controlled home ventilators
 - First machines to be used
 - Limited ability to compensate for leaks
- Bilevel ventilators
 - Most commonly used
 - EPAP & IPAP
 - Single limb circuit
 - Good efficiency & leak compensation
- ICU ventilators
 - Limited leak compensation

Portable BiPAP machines

- RESMED
- RESPIRONICS-philips

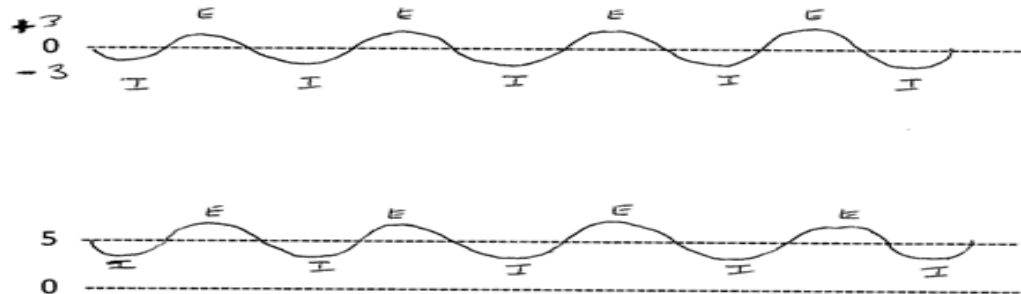


Modes of NIV

- Pressure modes
 - Better tolerated than volume-cycled vents
 - Constant positive airway pressure (CPAP)
 - Bilevel or biphasic positive airway pressure (BiPAP)
 - Pressure support ventilation (PSV)
- Volume modes
 - Initial tidal volumes range from 10 to 15 mL/kg
 - Control
 - Assist control
 - Proportional assist control

CPAP

- A mode for invasive and noninvasive mechanical ventilation
- Provides static positive airway pressure throughout the respiratory cycle- both inspiration & expiration
- Facilitates inhalation by reducing pressure thresholds to initiate airflow



CPAP

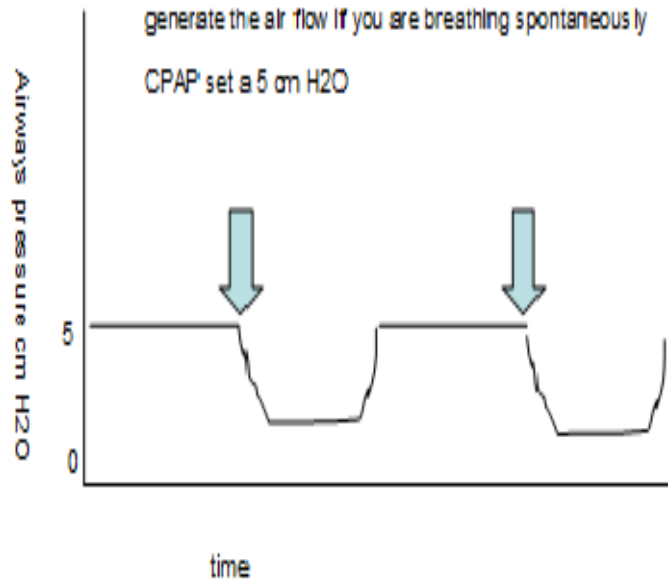
- Creates a "pneumatic splint" for the upper airway, preventing the soft tissues of the upper airway from narrowing and collapsing.
- Increase functional residual capacity
 - Improve lung compliance
 - Open collapsed alveoli
 - Improve oxygenation
 - Decrease work of breathing
- Decrease left ventricular transmural pressure, ↓ afterload and ↑CO

CPAP-ASB

CPAP with no pressure support

There is always positive airways pressure, but this drops on inspiration (arrow) as this requires a negative pressure to generate the air flow if you are breathing spontaneously

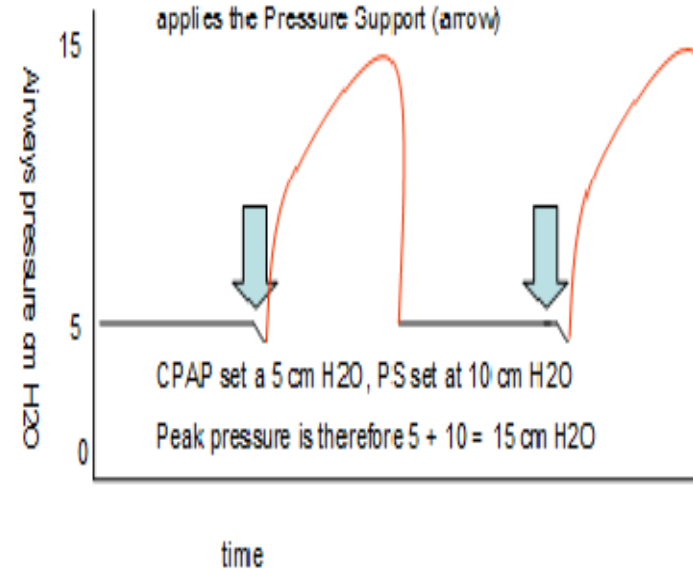
CPAP set at 5 cm H₂O



CPAP with Pressure Support (CPAP ASD)

There is always positive airways pressure

The ventilator senses the inspiratory effort of the patient and applies the Pressure Support (arrow)



Adaptive servo-ventilation

- Specifically to treat central sleep apnea (CSA)
- Designed to vary support according to a patient's individual breathing rate
- Automatically calculates a target ventilation (90% of the patient's recent average ventilation)
- Adjusts the pressure support to achieve it

BiPAP – Spontaneous

- Airway pressure cycles between an inspiratory positive airway pressure (**IPAP**) and an expiratory positive airway pressure (**EPAP**)
- **Patient's inspiratory effort** triggers the switch from EPAP to IPAP
- The limit during inspiration is the set level of IPAP
- The inspiratory phase cycles off, and the machine **switches back to EPAP when it detects a cessation of patient effort**(decrease in inspiratory flow rate, or a maximum inspiratory time reached- typically 2-3 seconds)

BiPAP – Spontaneous

- Vt varies breath to breath and is determined by degree of IPAP, patient effort, and lung compliance
- IPAP is necessarily set higher than EPAP by a minimum of 5cm H₂O
- Difference between the two settings is equivalent to the amount of PS provided
- Spontaneous mode depends on patient effort to trigger inhalation. A patient breathing at a low rate can develop a respiratory acidosis.
- BiPAP can be described as a continuous positive airway pressure system with a time-cycled or flow-cycled change of the applied CPAP level

BiPAP-S

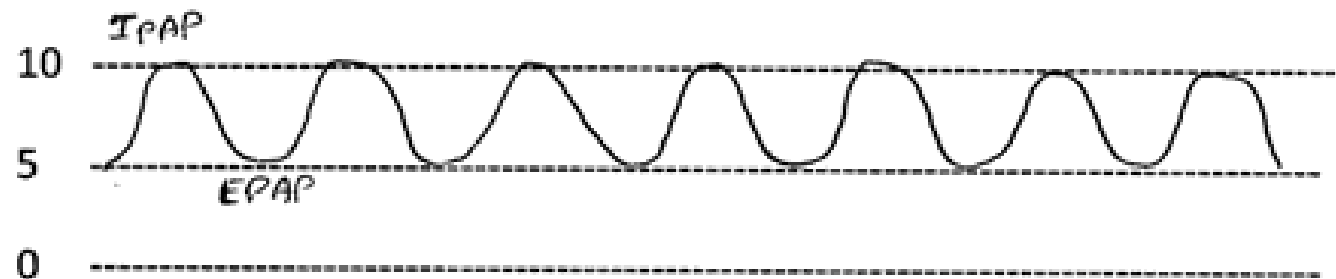


BiPAP

- Spontaneous/timed (ST) mode
 - The trigger in the ST mode can be the patient's effort or an elapsed time interval, predetermined by a set respiratory backup rate.
 - If the **patient does not initiate a breath** in the prescribed interval, then IPAP is triggered. For machine-generated breaths, the ventilator **cycles back to EPAP based on a set inspiratory time**.
 - For patient-initiated breaths, the ventilator cycles as it would in the spontaneous mode.

BiPAP

- Increases in inspiratory pressure are helpful to alleviate dyspnea
- Increases in expiratory pressure are better to improve oxygenation



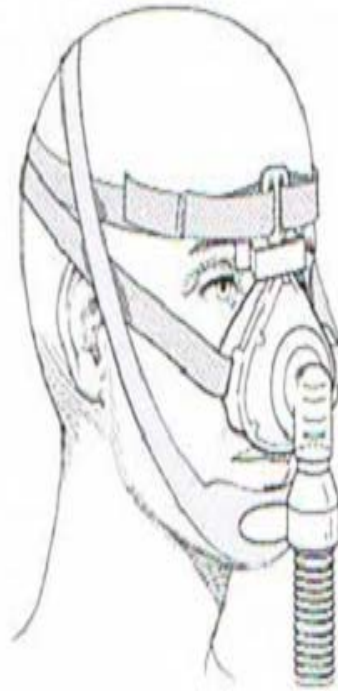
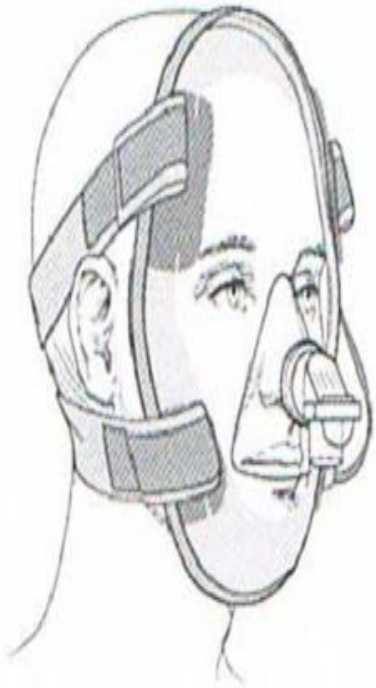
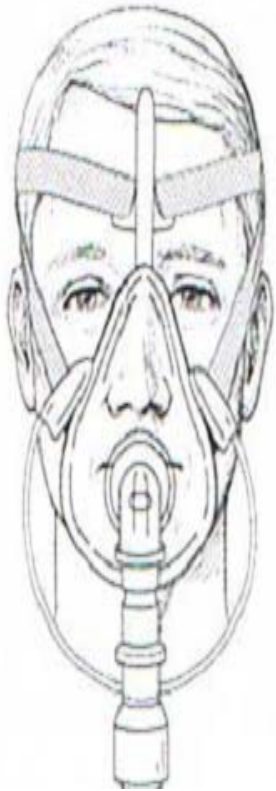
Interface

- The device that makes physical contact between the patient and the ventilator is termed the interface
- Types
 - Nasal mask
 - Nasal pillow
 - Oronasal mask
 - Full face mask
 - Helmet
- Interfaces should be comfortable, offer a good seal, minimize leak, and limit dead space

Interface

- Selection of a comfortable mask that fits properly is key to the success of NIV
- Full facemask should be tried first in the acute setting
- Patient should be allowed to hold the mask in place initially
- Mask straps are then tightened with the least tension necessary to avoid excessive air leakage

Interfaces for delivery of NIV



Oronasal mask interface



Oronasal mask interface

- 1st line for acute care setting
- COPD – mouth breathing



Nasal masks

- Better tolerated than full face masks for long-term & chronic applications
- Less claustrophobia and discomfort and allow eating, conversation, and expectoration



Nasal masks

- Pressure over nasal bridge
 - forehead spacers
 - ultrathin silicon seals or heat-sensitive gels that minimize skin trauma
- Problem- Air leakage through mouth



Nasal pillows



Nasal vs Oronasal mask

Variables	Nasal	Oronasal
Comfort	+++	++
Claustrophobia	+	++
Rebreathing	+	++
Lowers CO2	+	++
Permits expectoration	++	+
Permits speech	++	+
Permits eating	+	-
Function if nose obstructed	-	+

Total face mask

- Equally comfortable
- Similar
 - Application times
 - Early NIV discontinuation rates
 - Improvements in vital signs and gas exchange
 - Intubation and mortality rates



Helmet vs Facemask

- Helmet
 - equally tolerated
 - effective in ameliorating gas exchange
 - decreasing inspiratory effort
 - But less efficient in decreasing inspiratory effort
 - worsened the patient-ventilator interaction



Intensive Care Med. 2007 Jan;33(1):74-81

Protocol for initiation of NIV

- Appropriately monitored location
- Patient in bed or chair sitting at > 30 -degree angle
- A **full-face mask** should be used for the **first 24 hours**, followed by switching to a nasal mask if preferred by the patient (Evidence C)
- Encourage **patient to hold mask**
- Apply harness; **avoid excessive strap tension**
- Connect interface to ventilator tubing and turn on ventilator
- Check for air leaks, readjust straps as needed

Protocol for initiation of NIV

- Check for air leaks, readjust straps as needed
- Consider **mild sedation** (lorazepam 0.5 mg iv) in agitated patients
- Encouragement, reassurance, and frequent checks and adjustments as needed
- Monitor occasional blood gases (within 1 to 2 h and then as needed)

Guidelines for providing NIV

- An initial IPAP of **10 cm H₂O** & EPAP of **4–5 cm H₂O** should be used (**Evidence A**)
- IPAP should be increased by **2–5 cm** increments at a rate of approximately **5 cm H₂O every 10 mins**, with a usual IPAP target of 20 cm H₂O or until a therapeutic response is achieved or patient tolerability has been reached (**Evidence A**)
- O₂ should be entrained into the circuit and the flow adjusted to SpO₂ >88–92% (**Evidence B**)

Guidelines for providing NIV

- Bronchodilators
 - preferably administered off NIV
 - if necessary be **entrained between the expiration port and face mask**
 - Delivery of both oxygen and nebulised solutions is affected by NIV pressure settings (Evidence A)
- If a nasogastric tube is in place, a fine bore tube is preferred to minimise mask leakage(Evidence C)

Guidelines for providing NIV

- **Patient comfort** and **enhanced compliance** are key factors in determining outcome (**Evidence A**)
 - Synchrony of ventilation should be checked frequently.
 - A clinical assessment of mask fit to include skin condition and degree of leak (particularly on to the corneas) should be performed at the same time

OXYGENATION AND HUMIDIFICATION

- Oxygen is titrated to achieve a desired oxygen saturation > 90% to 92%
 - Use of oxygen blenders
 - adjusting litre flow delivered via oxygen tubing connected directly to the mask or ventilator circuit
- Heated blow over vaporiser should be used if longer application intended

Monitoring

- Subjective responses
 - Bed side observation
 - Ask about discomfort related to the mask or airflow
- Physiologic response
 - ↓ RR, ↓ HR, BP, continuous EKG
 - Patient breath in synchrony with the ventilator
 - ↓ accessory muscle activity and abdominal paradox
 - Monitor air leaks and Vt

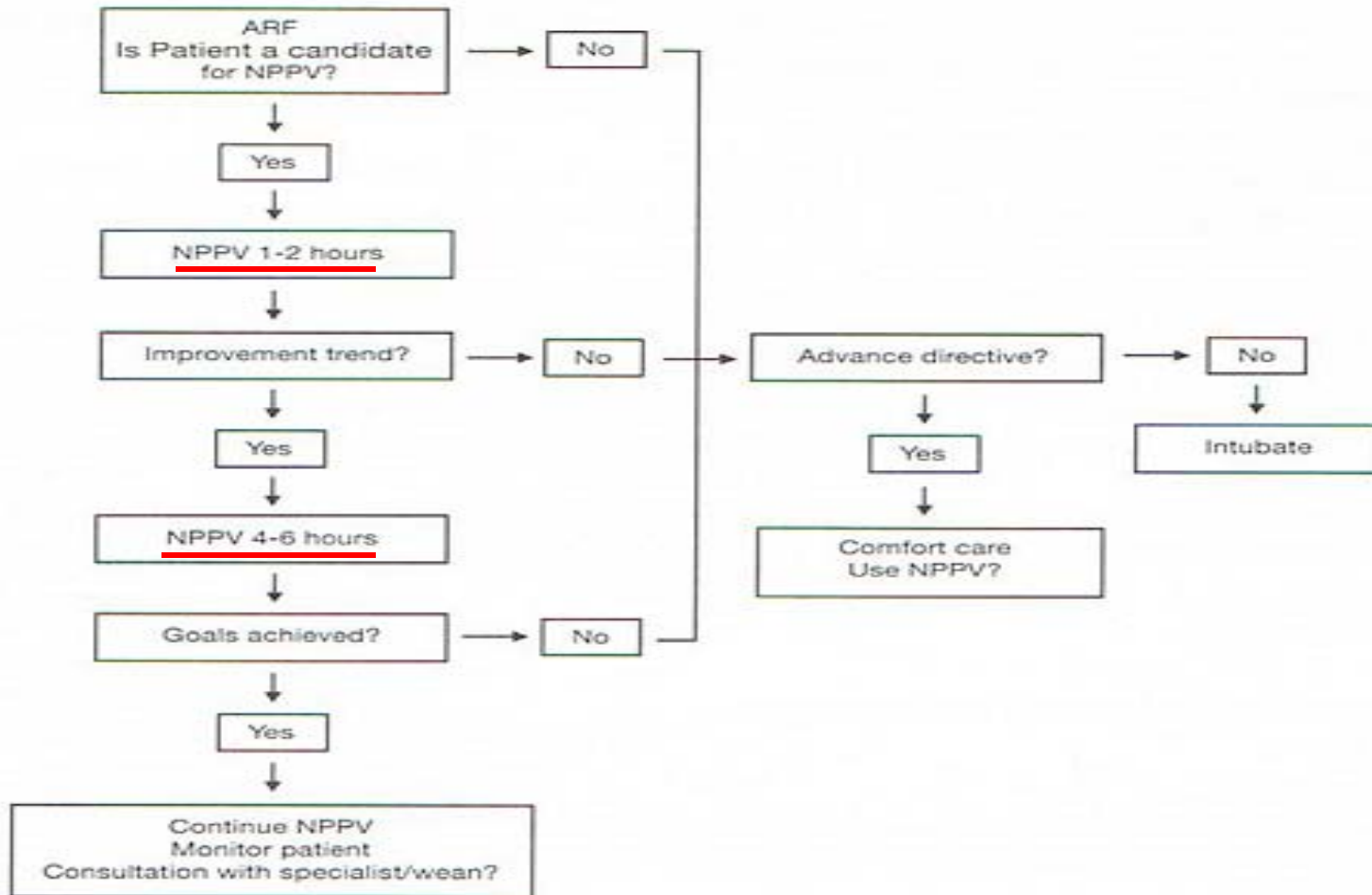
Monitoring

- Gas exchange(Evidence C)
 - Continuous SpO₂ and ECG during the first 12 hours
 - ABG
 - After **1 hour of NIV therapy and 1 hour after every subsequent change in settings**
 - After 4 hours, or earlier in patients who are not improving clinically

Guidelines for providing NIV

- Duration of treatment
 - Patients who **benefit from NIV during the first 4 hours** of treatment should receive NIV for **as long as possible (a minimum of 6 hours) during the first 24 hours** (Evidence A)
- Treatment should last until the acute cause has resolved, commonly after about 3 days
- When NIV is successful (pH>7.35, resolution of cause, normalisation of RR) after 24 hrs/more – plan weaning

Assessment of NIV



Weaning strategy(A)

- Continue NIV for **16 hours on day 2**
- Continue NIV for **12 hours on day 3** including **6–8 hours overnight use**
- Discontinue NIV on day 4, unless continuation is clinically indicate

Criteria for Terminating NIV and Switching to Invasive Mechanical Ventilation

- Worsening pH and PaCO₂
- Tachypnea (over 30 bpm)
- Hemodynamic instability
- SpO₂ < 90%
- Decreased level of consciousness
- Inability to clear secretions
- Inability to tolerate interface

Complications

- Interface related

<u>Carbon dioxide rebreathing</u>	50–100
Claustrophobia	5–10
Discomfort	30–50
Facial skin erythema	20–34
<u>Nasal bridge ulceration</u>	7–100
Arm edema and arm vein thrombosis	<5
Mechanical malfunction	<1
Noise	50–100
Patient ventilator <u>dyssynchrony</u>	50–100

- Air pressure/flow related

Air leaks	18–68
Nasal or oral dryness and congestion	20–50
Gastric Distension	5–50

- Patient related

<u>Aspiration pneumonia</u>	<5
Barotrauma	<5
Hemodynamic effects	<5

Conclusion

- NIV is an important tool to tide over an acute insult in the hands of a experienced operator
- Key factors in success
 - Evidence based application for selected etiologies
 - Careful patient selection/rejection
 - Skilled initiation & application
 - Algorithmic approach in initiation, use, discontinuation
 - Patient comfort & avoiding dyssynchrony
 - Avoiding complications

Conclusion

- Most importantly
 - Decision making on **when** to switch to invasive mechanical ventilation in a setting of failure of NIV

THANKS