Essences From ERS Congress 2021

COBEL DAROU

Noninvasive respiratory support in the hypoxemic peri-operative/periprocedural patient: joint ESA/ESICM guideline

Dr. Hamidreza Jamaati

COBEL DAROU

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Intensive Care Med (2020) 46:697–713

CONFERENCE REPORT AND EXPERT PANEL

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Marc Leone[1*], Sharon Einav[2], Davide Chiumello[3,4,5], Jean-Michel Constantin[6], Edoardo De Robertis[7], Marcelo Gama De Abreu[8], Cesare Gregoretti[9], Samir Jaber[10], Salvatore Maurizio Maggiore[11,12], Paolo Pelosi[13,14], Massimiliano Sorbello[15], Arash Afshari[16] and Guideline contributors

- Hypoxemia = common complication in the peri-operative and periprocedural period
- Hypoxemia can be life-threatening
- Few data available on respiratory support in this setting

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GUIDELINE

- 5 clinical questions, 19 recommendations
- No grade 1A and only two grade 1B recommendations

MCQ 1
What is true regarding a grade 1B recommendation?

1. It means strong recommendation from the experts, low quality of evidence
2. It means weak recommendation, high quality of evidence
3. It is a recommendation that should not be followed
4. It only applies to very specific patients
5. It should be followed unless a clear and compelling rationale for an alternative approach is present

MCQ 1
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GRADE for this guideline

Grade of Recommendation	Quality of supporting evidence	Implications
1A. Strong recommendation, high quality evidence	Consistent evidence from well performed randomized, controlled trials or overwhelming evidence of some other form. Further research is unlikely to change our confidence in the estimate of benefit and risk.	Strong recommendations, can apply to most patients in most circumstances. Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present.
1B. **Strong recommendation, moderate quality evidence**	Evidence from randomized, controlled trials with important limitations or very strong evidence of some other research design. Further research (if performed) is likely to have an impact on our confidence in the estimate of benefit and risk and may change the estimate.	**Strong recommendation and applies to most patients. Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present.**
1C. Strong recommendation, low quality evidence	Evidence from observational studies, unsystematic clinical experience, or from randomized, controlled trials with serious flaws. Any estimate of effect is uncertain.	Strong recommendation, and applies to most patients. Some of the evidence base supporting the recommendation is, however, of low quality.

GRADE for this guideline

Grade of Recommendation	Quality of supporting evidence	Implications
2A. Weak recommendation, high quality evidence	Consistent evidence from well performed randomized, controlled trials or overwhelming evidence of some other form. Further research is unlikely to change our confidence in the estimate of benefit and risk.	Weak recommendation, best action may differ depending on circumstances or patients or societal values.
2B. Weak recommendation, moderate quality evidence	Evidence from randomized, controlled trials with important limitations or very strong evidence of some other research design. Further research (if performed) is likely to have an impact on our confidence in the estimate of benefit and risk and may change the estimate.	Weak recommendation, alternative approaches likely to be better for some patients under some circumstances.
2C. Weak recommendation, low quality evidence	Evidence from observational studies, unsystematic clinical experience, or from randomized, controlled trials with serious flaws. Any estimate of effect is uncertain.	Very weak recommendation; other alternatives may be equally reasonable.

MCQ 2
Which respiratory support should be used to improve oxygenation in an hypoxemic patient after surgery?

1. Conventional oxygen therapy (COT)
2. Non invasive pressure support ventilation (NIPPV) or CPAP (continuous positive airway pressure
3. Endotracheal intubation
4. High flow nasal cannula (HFNT)
5. HFNT and COT in alternance

Guidelines question 1:
What goals of therapy can be achieved with each noninvasive respiratory support technique in the postoperative/periprocedural hypoxaemic patient with acute respiratory failure?

Nb	Recommendation	Grade
R1	Use of **NIPPV or CPAP** (based on local expertise) **is preferred to COT to improve oxygenation**	**1B**
R2	If hypoxaemia **after cardiac surgery**, use **NIPPV rather than CPAP to ↓ risk of atelectasis**	2C
R3	If hypoxaemia **after upper abdominal surgery**, use **CPAP or NIPPV rather than COT to ↓ risk of nosocomial pneumonia**	2A
R4	In the peri-operative/periprocedural hypoxaemic patient **prefer CPAP or NIPPV over COT to prevent reintubation**	2B
R5	In the peri-operative/periprocedural hypoxaemic patient **use NIPPV rather than COT to ↓ mortality**	2C

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R4	In the peri-operative/periprocedural hypoxaemic patient **prefer CPAP or NIPPV over COT to prevent reintubation**	2B
R5	In the peri-operative/periprocedural hypoxaemic patient **use NIPPV rather than COT to ↓ mortality**	2C

➔ **Overall, the experts suggest using positive pressure as a first choice in hxpoxemic peri-operative/periprocedural patients**

MCQ 3

NIPPV or CPAP can be considered as indicated in case of hypoxemia after surgery except in …

1. Patients after cardiac surgery
2. Patients after abdominal surgery
3. Patients after lung resection
4. Patients after neurosurgery
5. Patients after solid organ transplantation

Guidelines question 2:
Which patient populations may benefit from the use of noninvasive respiratory support techniques for hypoxaemic patients with acute respiratory failure?

Nb	Recommendation	Grade
R6	**Use NIPPV or CPAP immediately post extubation for hypoxaemic patients at risk of developing acute respiratory failure after abdominal surgery**	**1B**
R7	**NIPPV or CPAP** may be considered **to prevent further** respiratory **deterioration in hypoaxemic patients after cardiac surgery**	2B
R8	**HFNC may be considered** for hypoxaemic patients **after cardiac surgery**	2C
R9	**NIPPV may be considered to prevent atelectasis after lung resection**	2C
R10	**NIPPV may be considered after solid organ transplantation**	2C
R11	**If hypoxemia + bronchoscopy required, use non invasive respiratory support techniques (positive pressure or HFNT) instead of COT**	2B

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Which patient populations may benefit from the use of noninvasive respiratory support techniques for hypoxaemic patients with acute respiratory failure?

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R7	**NIPPV or CPAP** may be considered **to prevent further** respiratory **deterioration in hypoaxemic patients after cardiac surgery**	2B
R8	**HFNC may be considered** for hypoxaemic patients **after cardiac surgery**	2C
R9	**NIPPV may be considered to prevent atelectasis after lung resection**	2C
R10	**NIPPV may be considered after solid organ transplantation**	2C
R11	**If hypoxemia + bronchoscopy required, use non invasive respiratory support techniques (positive pressure or HFNT) instead of COT**	2B

➔ **Again, the experts consider that using positive pressure is of interest in hyoaxemic peri-operative/periprocedural patients**

MCQ 4

The following points can be considered as important to manage respiratory support in hypoxemic post operative patients except…

1. Periodic clinical examination (signs of respiratory distress, neurological status, interface intolerance)
2. Continuous monitoring (pulsoximetry, blood pressure, ECG)
3. Daily chest X-ray
4. BGA 1 hour after treatment initiation, every 6 hours during the first 24 hours and then1x/day
5. Treatment supervision by a health care professional with recognized competence and skill in airway management and ventilation

Guidelines question 3:
What minimal standards of haemodynamic and respiratory monitoring and what laboratory and radiological tests are required during the support period?

Nb	Recommendation	Grade
R12	**Recognised competence and skill in airway management and ventilation** of patients with lung injury is required for clinicians applying NIPPV in this setting	2C
R13	Patients receiving noninvasive respiratory support must be **examined periodically** (signs of respiratory distress, neurological status, interface intolerance) by a clinician with recognised competences	2C
R14	Patients treated with NIPPV must be **monitored on a continous basis** (pulse oxymetry, blood pressure, ECG)	2C
R15	Periodic **arterial blood gas after the 1st hour of treatment**, at least **every 6h during the first 24h** and then 1x per day.	2C
R16	No possible recommendantions for routine imaging	-

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R15	Periodic **arterial blood gas after the 1st hour of treatment**, at least **every 6h during the first 24h** and then 1x per day.	2C
R16	No possible recommendantions for routine imaging	-

➔ **The experts consider that close monitoring is mandatory in this setting**

Guidelines question 4:
What are the ways to prevent avoidable complications in patients receiving various types of noninvasive respiratory support?

Nb	Recommendation	Grade
R17	No studies were found addressing means of prevention of complications of the respiratory supports techniques ➔ no recommendations	-
R18	Use **HFNC** rather than COT **in peri-operative/periprocedural hypoxaemic patients with low tolerance to other respiratory supports**	2B

Guidelines question 4:
What are the ways to prevent avoidable complications in patients receiving various types of noninvasive respiratory support?

Nb	Recommendation	Grade
R17	No studies were found addressing means of prevention of complications of the respiratory supports techniques ➔ no recommendations	-
R18	Use **HFNC** rather than COT **in peri-operative/periprocedural hypoxaemic patients with low tolerance to other respiratory supports**	2B

Guidelines question 5:
How and where to initiate noninvasive respiratory support?

Nb	Recommendation	Grade
R19	No studies were found addressing this query ➔ no recommendations	-

GUIDELINES SUMMARY

➔ NO GRADE 1A RECOMMENDATIONS

➔ ONLY TWO GRADE 1B RECOMMENDATIONS

1B.
Strong recommendation, moderate quality evidence

Strong recommendation and applies to most patients. <u>Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present.</u>

R1	Use of NIPPV or CPAP (based on local expertise) is preferred to COT to improve oxygenation	1B
R6	Use NIPPV or CPAP immediately post extubation for hypoxaemic patients at risk of developing acute respiratory failure after abdominal surgery	1B

Rational related to the 1st 1B recommendation

R1	Use of NIPPV or CPAP (based on local expertise) is preferred to COT to improve oxygenation	1B

- 4 RCTs
  - 3 single-center RCTs showed better oxygenation with NIPPV vs COT
    - After lung resection
    - After solid organ transplant
    - During and after major vascular surgery
  - 1 multicenter RCT showed no differences after abdominal surgery

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  - 3 single-center RCTs showed better oxygenation with NIPPV vs COT
    - After lung resection
    - After solid organ transplant
    - During and after major vascular surgery
  - 1 multicenter RCT showed no differences after abdominal surgery

→ RCTs but very specific patients and small studies

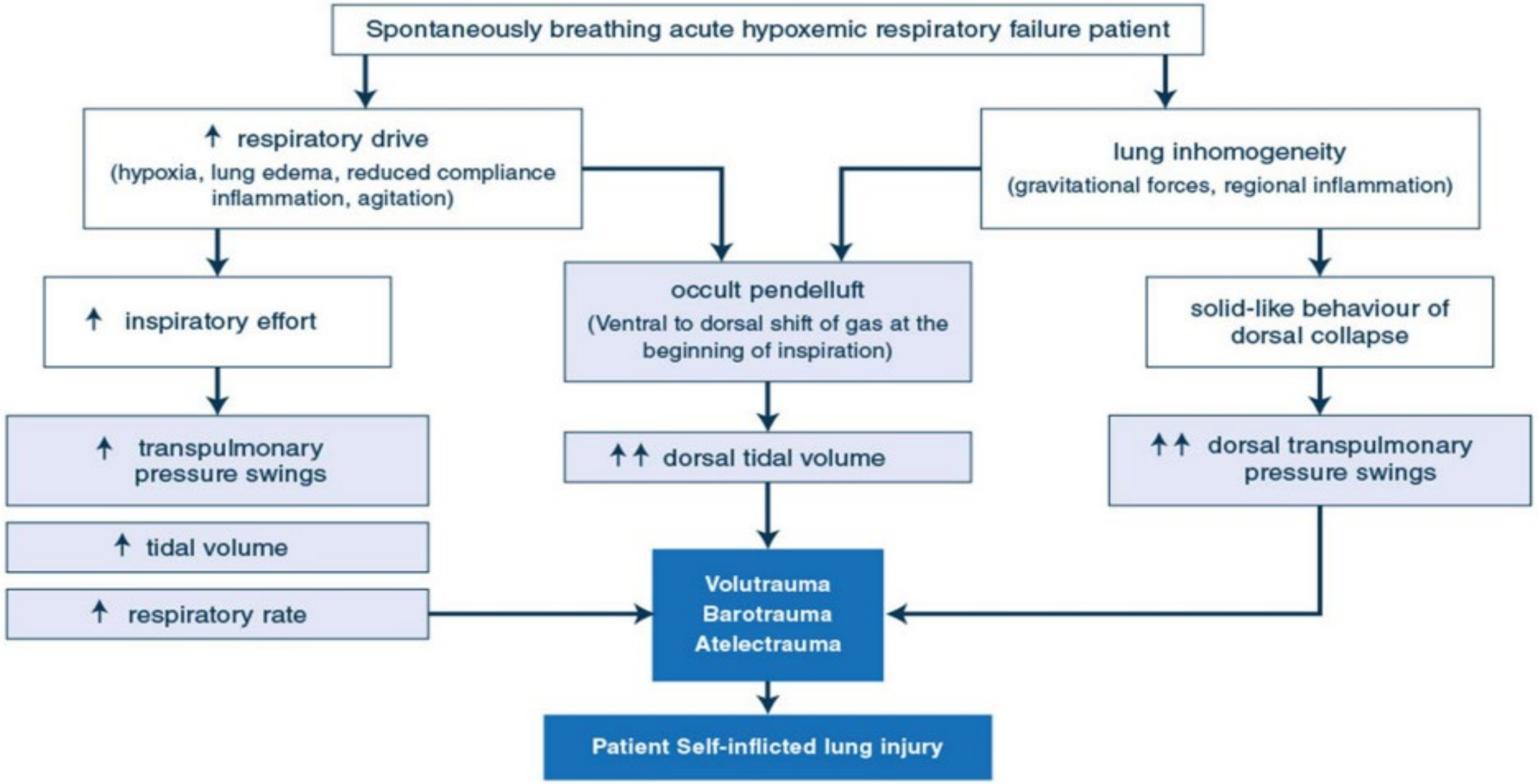
Rational related to the 2nd 1B recommendation

R6	Use NIPPV or CPAP immediately post extubation for hypoxaemic patients at risk of developing acute respiratory failure after abdominal surgery	1B

- 2 RCTs
  - 1 multicenter study in patients after upper abdominal surgery (Helmet CPAP vs COT)
    - ↓ reintubation at day7
    - ↓ ICU length of stay
    - ↓ infection rate
  - 1 multicenter study in hypoxaemic patients after major elective abdominal surgery (NIPPV vs COT)
    - ↓ reintubation at day7
    - ↑ ventilator free days
    - ↓ infections
    - ↓ 90 day mortality

Overall, very few data available to establish the guideline…
and no definitive answer

➔ Interest for a physiology based approach?


Spontaneously breathing acute hypoxemic respiratory failure patient
↑ respiratory drive
(hypoxia, lung edema, reduced compliance inflammation, agitation)
lung inhomogeneity
(gravitational forces, regional inflammation)
↑ inspiratory effort
occult pendelluft
(Ventral to dorsal shift of gas at the beginning of inspiration)
solid-like behaviour of dorsal collapse
↑ transpulmonary pressure swings
↑↑ dorsal tidal volume
↑↑ dorsal transpulmonary pressure swings
↑ tidal volume
↑ respiratory rate
Volutrauma
Barotrauma
Atelectrauma
Patient Self-inflicted lung injury

Relevant physiological measures for monitoring of hypoxemic patients on noninvasive respiratory support

Parameter	Monitoring technique/score calculation	Clinical thresholds associated with risk of failure	Limitations
SpO_2/FiO_2	Pulse oximetry	< 120 and/or worsening trend	Underestimation of severity with low $PaCO_2$
PaO_2/FiO_2	Arterial blood gas analysis	< 150–200 mmHg and/or worsening trend	Intermittent
Respiratory Rate	Clinical examination	> 25–30 and/or not decreasing with support	Poorly correlated with effort
Expired tidal volume	Ventilator	> 9–9.5 ml/kg PBW	Not feasible during HFNO, standard helmet NIV
ΔP_{ES}	Esophageal balloon catheter	> 15 cmH_2O and/or reduction < 10 cmH_2O during NIV	Needs some expertise
ROX	(SpO_2/FiO_2)/Respiratory Rate	< 2.85 at 2 h of HFNO initiation < 3.47 at 6 h of HFNO initiation < 3.85 at 12 h of HFNO initiation	Validated only for HFNO

High Flow Nasal Oxygen Therapy

Settings

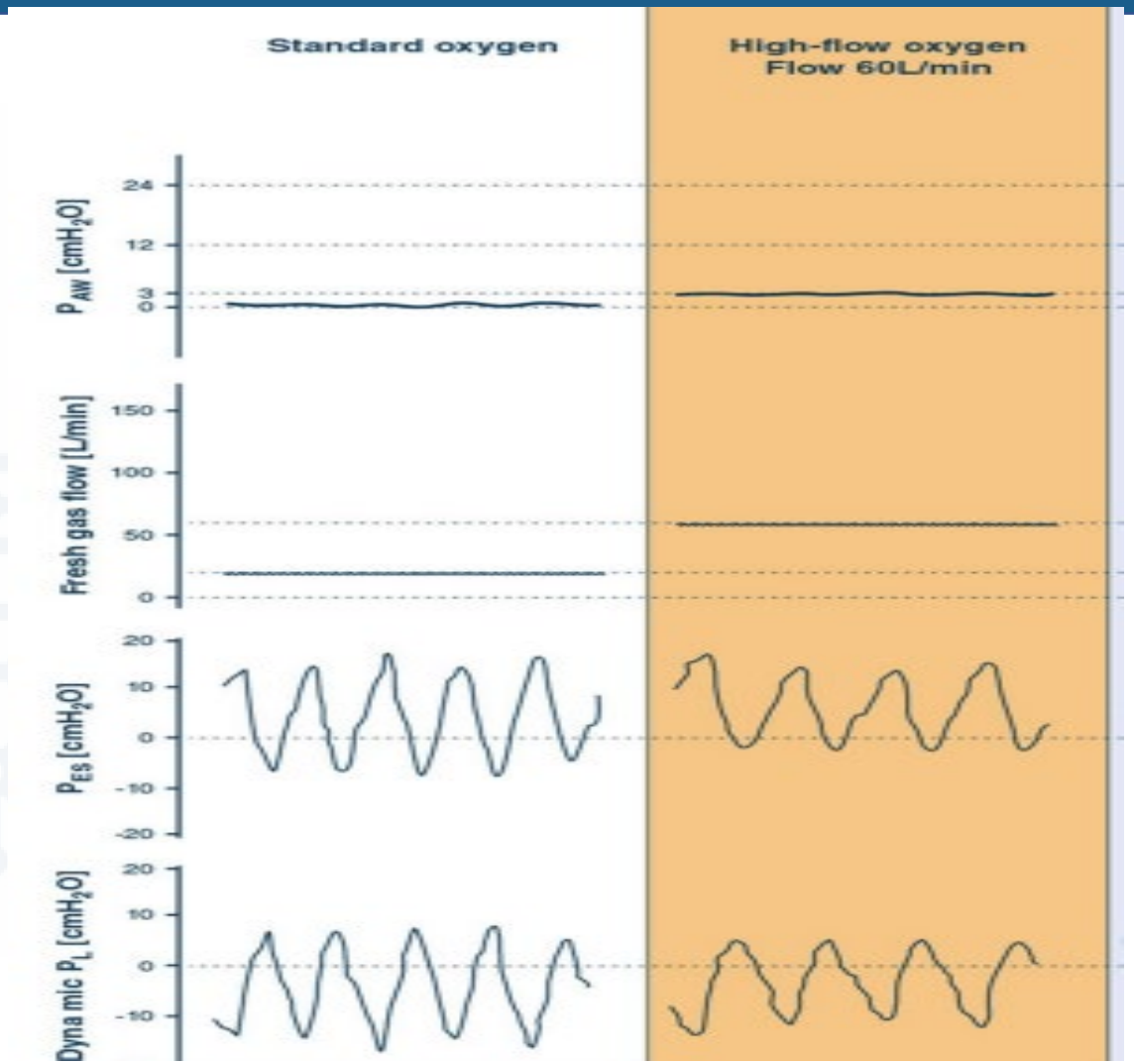
- FiO_2: 0.21-1
- Gas flow: 40-60 lpm
- Temperature: 31-37°C

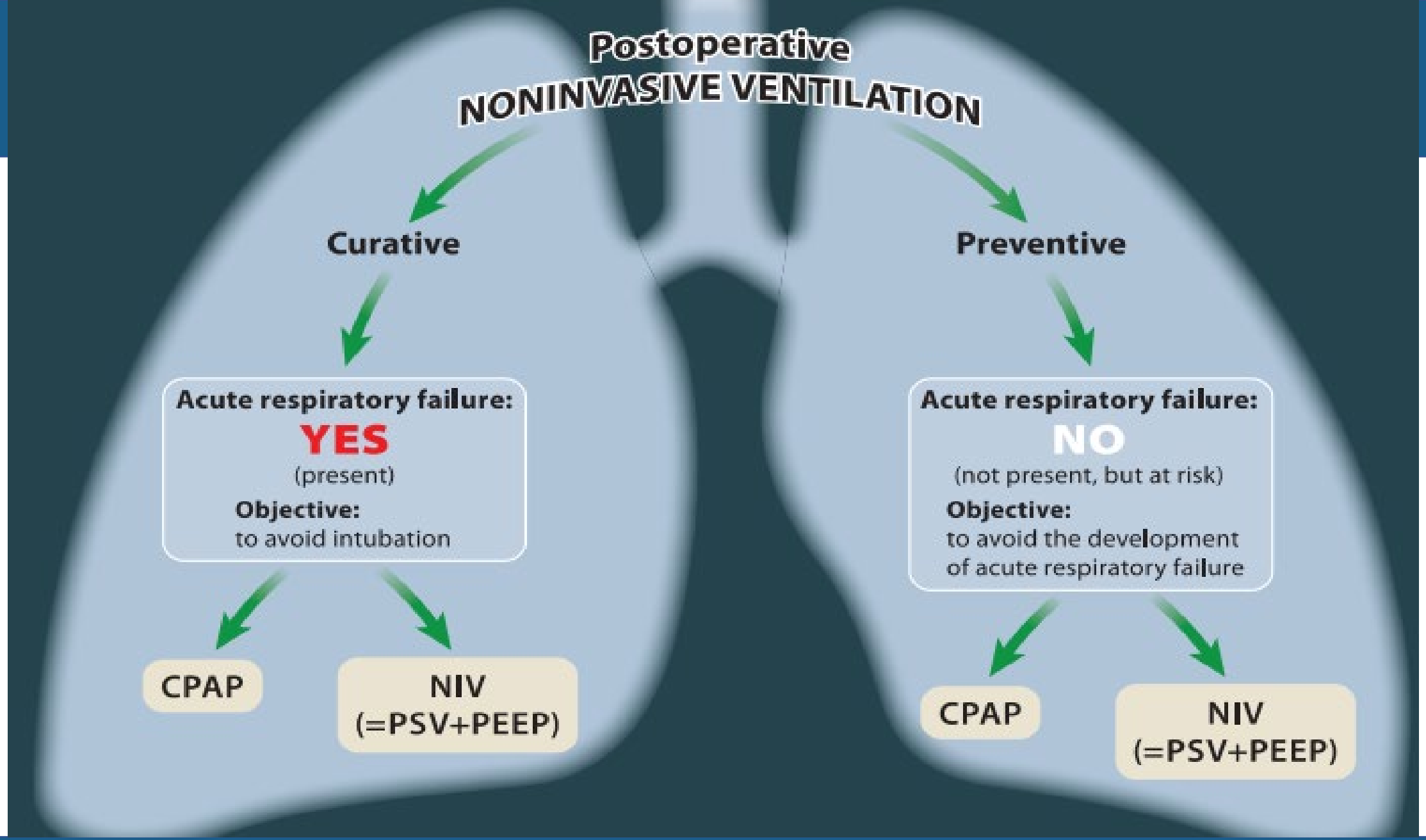
Benefits

- Matches inspiratory flow
- Delivers set F_iO_2
- Delivers fully conditioned gas
- Enhances comfort
- Provides positive airway pressure (up to 4 cmH_2O)
- Washout of nasopharyngeal dead space
- Reduces inspiratory effort

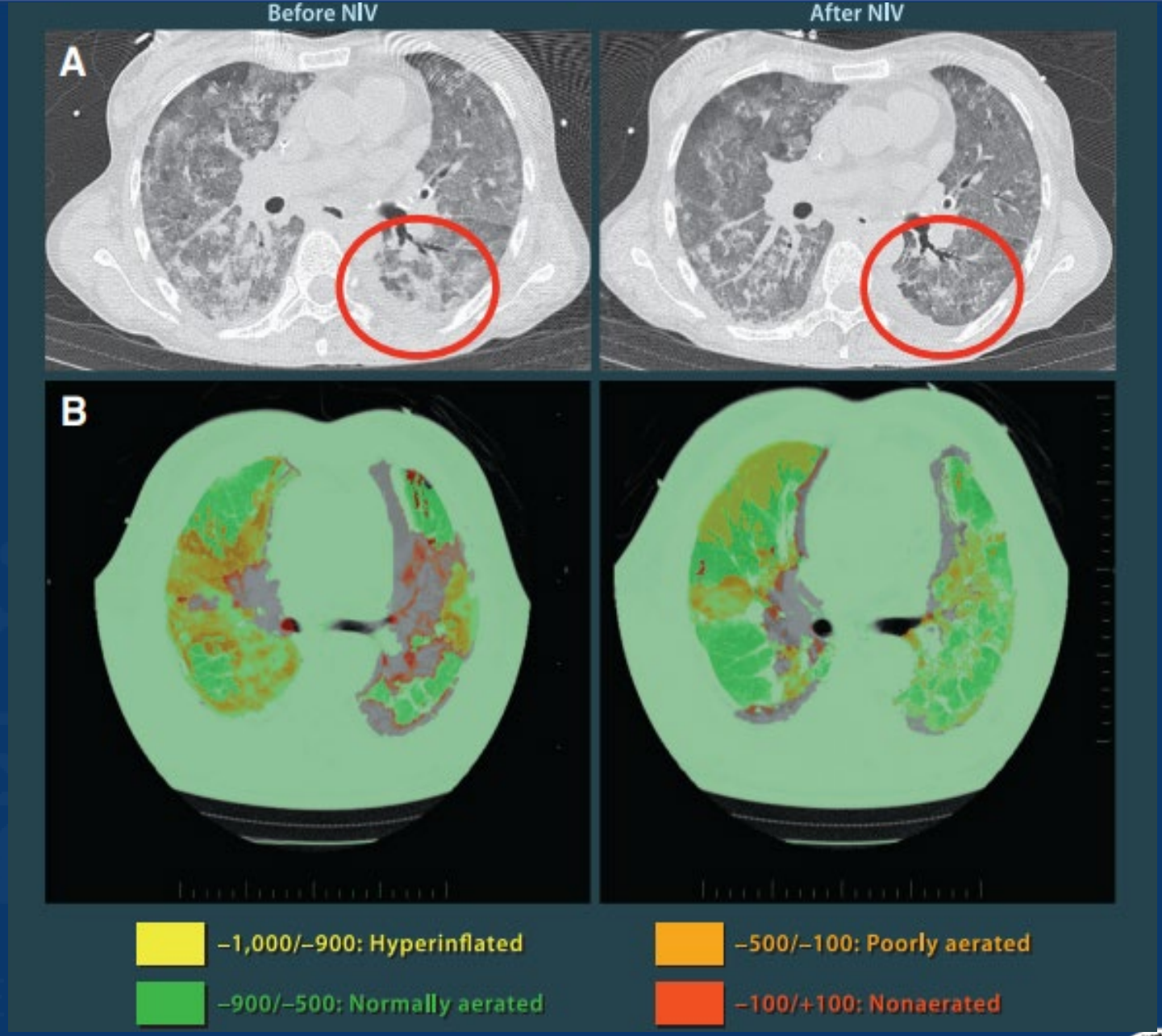
Pitfalls

- Small amount of PEEP delivered

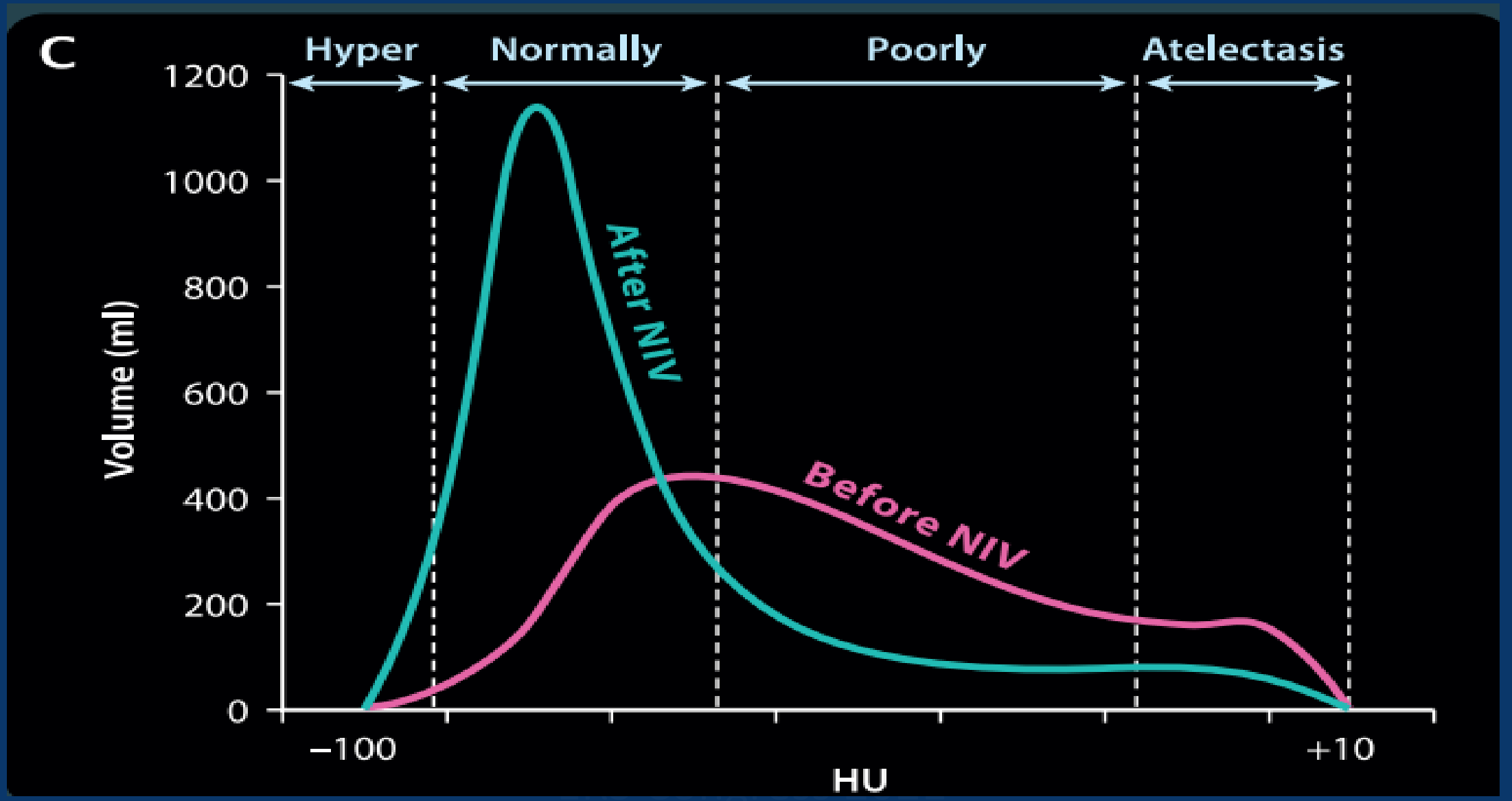




- A) Representative CT slices of the lung obtained before NIV in spontaneous breathing (left panel) and after 30 min of NIV
- (B) A color encoding analysis is applied for both CT images obtained before (left panel) and after 30 min of NIV (right panel).
- Nonaerated voxels (CT attenuation between 100 and 100 Hounsfield Units [HU]) were colored in red, poorly aerated voxels (CT attenuation between 500 and 100 HU) in orange, and normally aerated voxels (CT attenuation between 500 and 900 HU) in green



Jaber et al., Anesthesiology 2010;112: 453-461



Protocol for Initiation of Curative Postoperative Noninvasive Ventilation

1. Appropriately monitored location; oximetry, vital signs as clinically indicated.

2. Patient in bed sitting at > 30° angle.

3. Select and fit interface.

4. Check initial settings in the ventilator before connecting to the mask of the patient:

- ❑ *Ventilatory mode: PSV*
- ❑ *Inspiratory trigger: –1 to –2 l/min or –1 to –2 cm H_2O (i.e., lowest level without induced auto-triggering)*
- ❑ *Slope delivered pressure: moderate to maximal*
- ❑ *Initial PSV level: 3 to 5 cm H_2O*
- ❑ *Expiratory trigger (expiratory cycling setting if available): flow: 40 to 60% or time cycled: fixed inspiratory time to 1 s*
- ❑ *Initial PEEP level: 3 to 5 cm H_2O*
- ❑ *Initial F_{IO_2}: 50-60%*

5. After briefly explaining the NIV method to the patient, apply headgear; avoid excessive strap tension (one or two fingers under strap); encourage patient to hold mask. Propose to the patient to breathe through the mask for a few seconds without connecting to ventilator.

6. Connect interface to ventilator tubing and turn on ventilator.

7. Start with low pressures (as set previously) and gradually increase PSV (usually 10 to 15 cm H_2O) and PEEP (5 to 10 cm H_2O) as tolerated without major leaks to achieve alleviation of dyspnea, decreased respiratory rate, increased expiratory tidal volume (to achieve 6–10 ml/kg) and good patient-ventilator synchrony. Never exceed total inspiratory pressure (PSV+PEEP) of more than 25 cm H_2O.

8. Set F_{IO_2} to keep $Spo_2 \geq 95\%$.

9. Check for air leaks, and readjust straps as needed or decrease pressure levels if major leaks.

10. Add humidifier as indicated (heated humidifier or heated and moisture exchanger with low internal volume to avoid excess dead space).

11. Encouragement, reassurance, and frequent checks and adjustments as needed.

12. Monitor blood gases (within 1 to 2 h and then as needed).

13. Duration: initial period for 60 to 90 min at 2- to 3-h intervals (range, 8 to 12 h/day).

Table 1. Contraindications for the Use of Postoperative Noninvasive Ventilation (NIV)

Absolute

- Cardiac or respiratory arrest
- Multiple organ failure
- Severe agitation or encephalopathy
- Copious secretions
- Uncontrolled vomiting
- Inability to protect airway
- Severe upper gastrointestinal bleeding or hemoptysis
- Immediate endotracheal intubation necessary (except for preoxygenation NIV)
- Facial trauma
- Hemodynamic instability or unstable cardiac arrhythmia

Relative

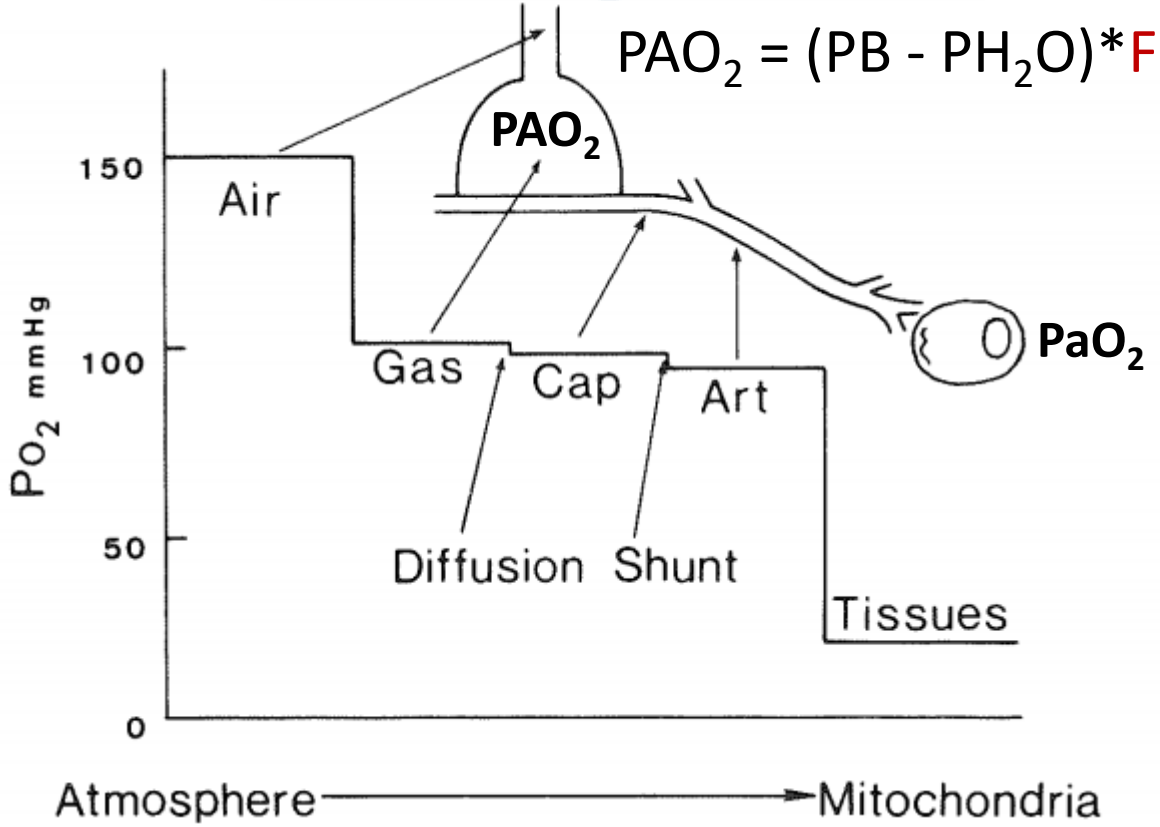
- Mildly decreased level of consciousness
- Progressive severe respiratory failure
- Uncooperative patient who can be calmed or comforted

Non-invasive respiratory support: how does it work

COT

FIO_2 > 21% ➔ ↑ PAO_2 (Alveolar partial pressure of oxygen) ➔ ↑ PaO_2 and SaO_2

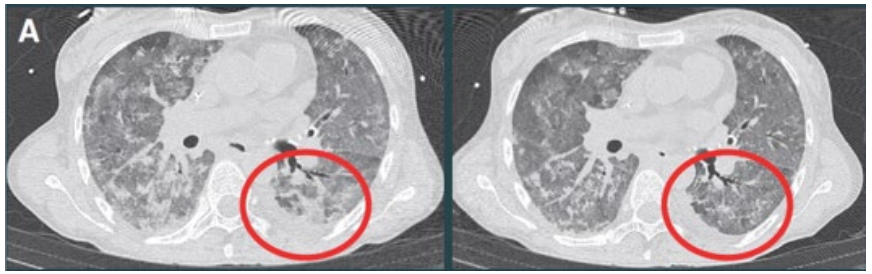
$PAO_2 = (PB - PH_2O)*FIO_2 - (PaCO_2/R)$



West. Respiratory physiology. The basics.Book.

Non-invasive respiratory support: how does it work?

CPAP



Jaber et al., Anesthesiology 2010;112: 453-461

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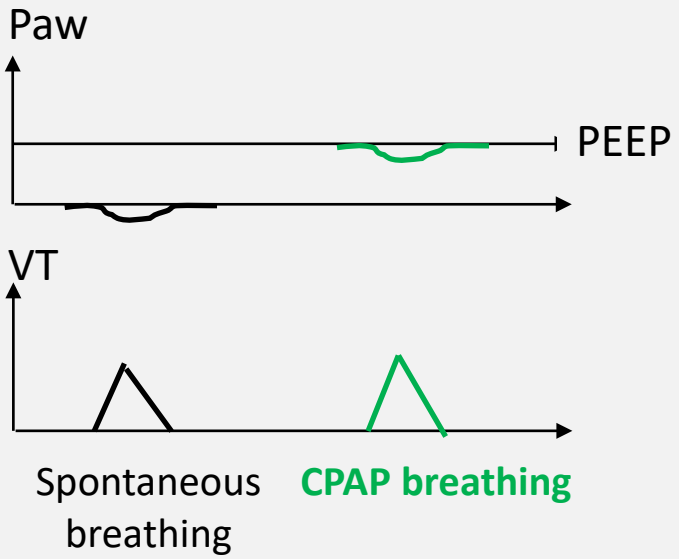
Alveolar recruitment

+

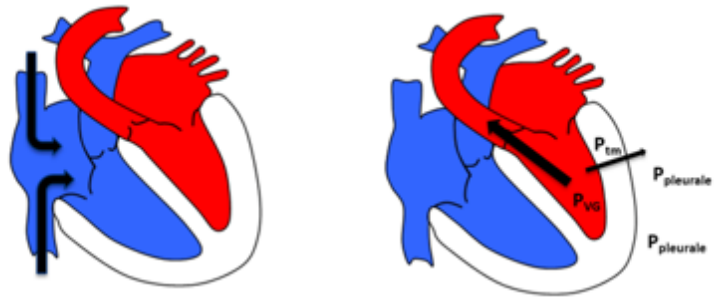
Prevents atelectasis

+

Improve oxygenation



Can ↓ Dyspnea



↓ cardiac preload and

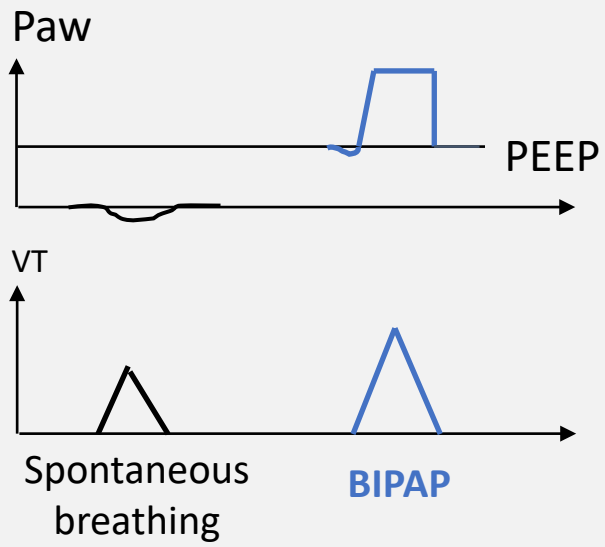
↓ left cardiac afterload

L'Her et al., AJRCCM 2005; 172: 1112-1118

Non-invasive respiratory support: how does it work?

NIPPV

Same effects as CPAP

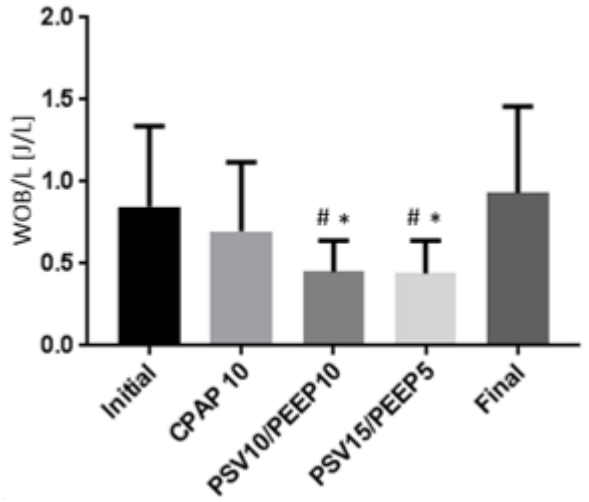


↑ Minute ventilation
↓ $PaCO_2$

Brochard, NEJM 1990; 323: 1523-1530

COPD patients, acute exacerbation

↓ WOB (and drive)



L'Her et al., AJRCCM 2005; 172: 1112-1118

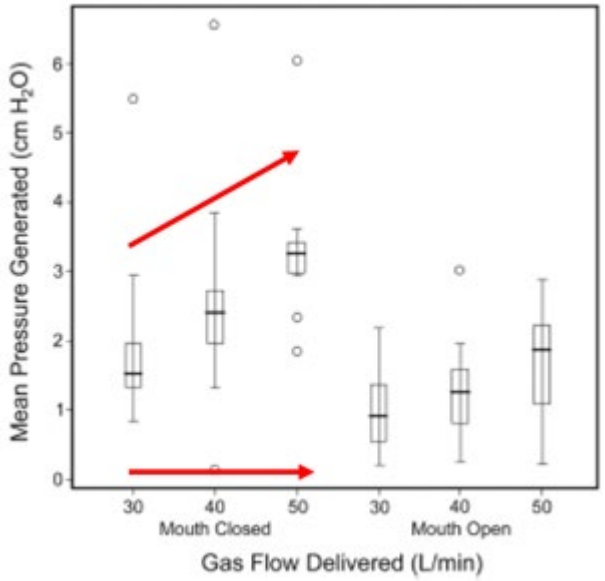
ALI patients

High Flow Nasal Oxygen Therapy : how does it work?

HFNT

FIO_2 21-100%
Gas flow 20-60 L/min
Active humidification

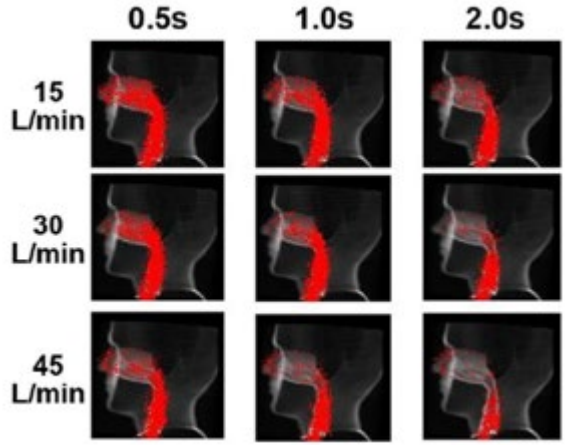
Small amount of PEEP



1-3 cmH_2O
(mouth closed)

Parke et al. Respir.Care 2011; 56:1151-1155
12 patients w/o respiratory distress

Washout of the anatomical deadspace

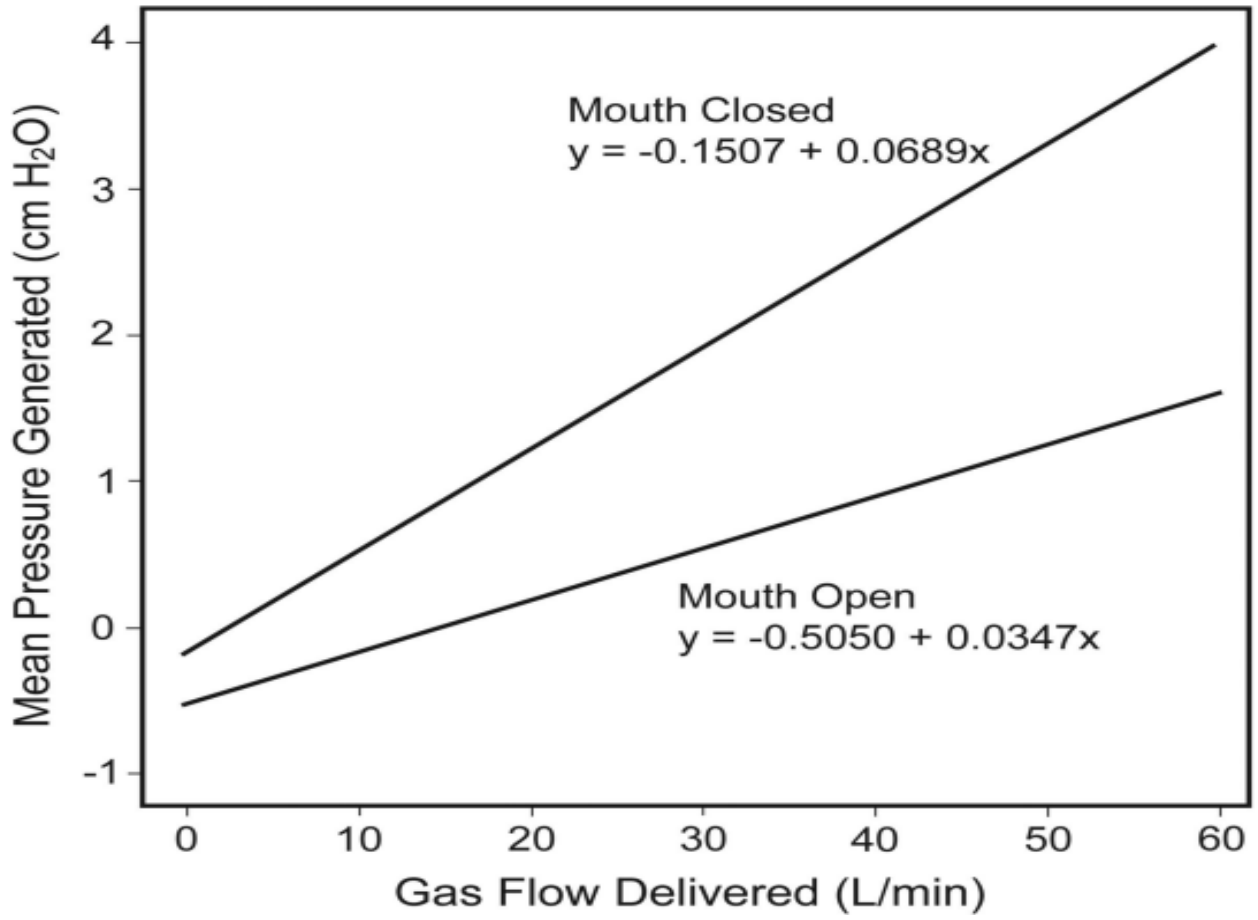


Möller et al. JApplPhysiol 2015; 118:1525-1532

↓ WOB, ↓ RR and ↑VT

Delorme et al. Crit care med. 2017;45:1981-8
Mauri et al. AJRCCM 2017;195:1207-15.

High Flow Nasal Oxygen Therapy : how does it work?



Parke et al. Respir.Care 2011; 56:1151-1155

Key messages / Conclusions

- Hypoxaemia is frequent in the peri-operative and periprocedural period
- Few data available regarding respiratory support in this setting
- ESA/ESICM guidelines → no grade 1 A recommendation, only 2 grade 1 B recommendations

R1	Use of NIPPV or CPAP (based on local expertise) is preferred to COT to improve oxygenation	1B
R6	Use NIPPV or CPAP immediately post extubation for hypoxaemic patients at risk of developing acute respiratory failure after abdominal surgery	1B

- When only low grade recommendations are available, considering the mechanisms of action of each support available can help

Thank You

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