Lao PDR Integrated Emergency Response Training 2025

Update in EMS
Ventilation & Oxygen therapies

Dr Margot CASSUTO

Chiang Rai Provincial health office
National Institute for Emergency Medicine
Bokeo Provincial Health Office Lao
Bokeo Hospital, Lao
SAMU 92
IRESU
Chiangrai Prachanukroh Hospital
Chiang Khong Crown Prince Hospital
With the support of the French Embassy in Lao

COT
Conventional Oxygen Therapy

COT: indications

- Any hypoxemic situation
- Without :
  - Ventilatory exhaustion
  - Neurological disorders
- Therapeutic objectives
  - Oxygen saturation > 93%
  - Clinical normalization (Respiratory Rate)
- « Appropriate dosage »
  - Oxygen = medication: neither too much nor too little...

COT: limitations & contraindications

Chronic hypercapnia

→ Titration of oxygen administration
→ Objective: Patient's SpO2 level
if unknown: 88- 92%

COT: Inhalation equipment - Low $FiO_2 < 40\%$

- Nasal cannula
- Easy to fit
- Good tolerance
- Very low FiO_2
- Limited indications
- No rebreathing

COT: Inhalation equipment - Mild $FiO_2 \approx 50\%$

- Simple mask
- Easy fitting
- Safe to use
- FiO2 at best 50%, adjustable
- Reservoir size: 100-200 mL
- Slight rebreathing

Moderate O_2 flow
Moderate FiO_2

COT: Inhalation equipment - High FiO_2 > 70%

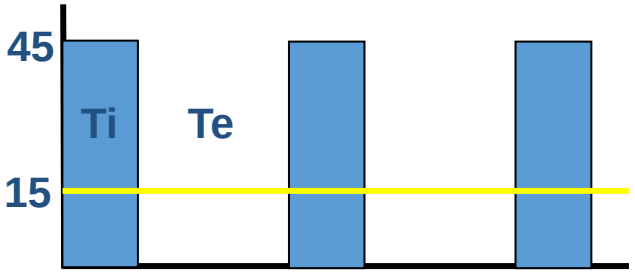
Non-rebreather mask = High concenration mask

- Easy to fit
- Reservoir size: 300-600 mL
- High FiO2, up to 100%
- Slight rebreathing
- Risk of misuse
- Beware of poor positioning...

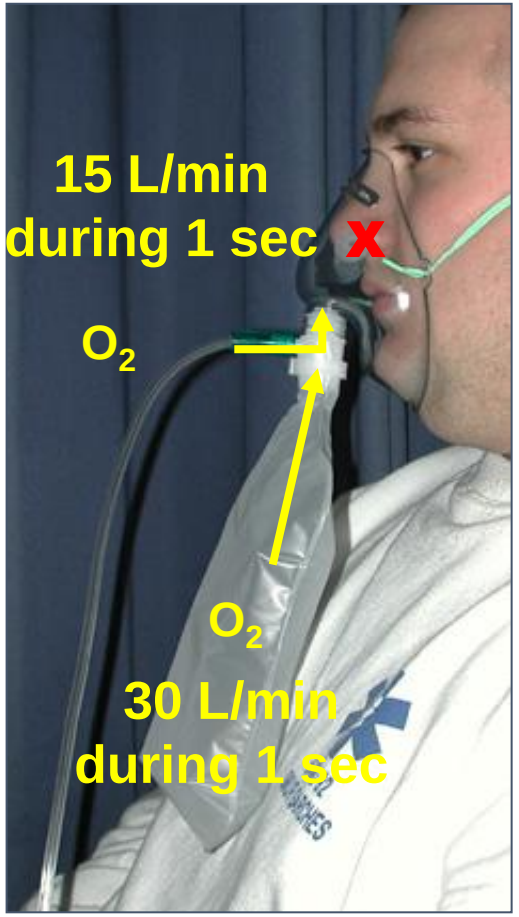
COT: Inhalation equipment - High FiO_2 > 70%

High concentration mask

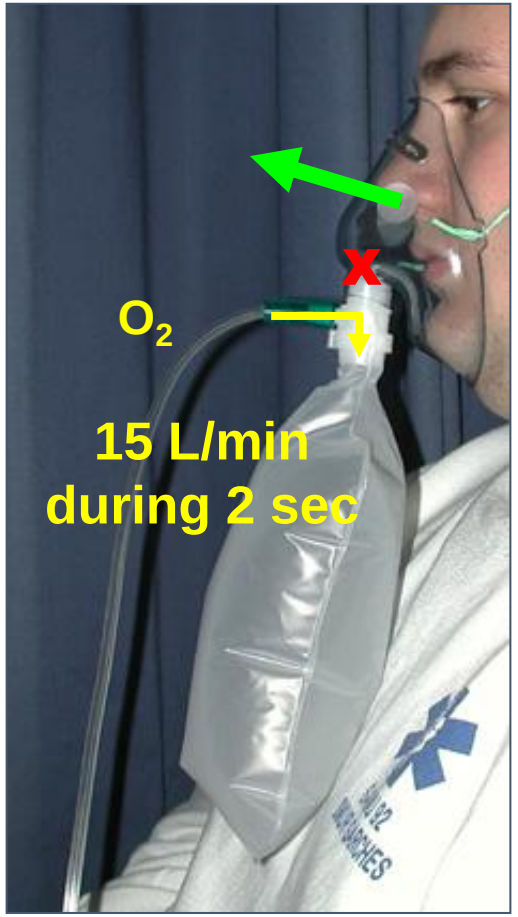
Example
F = 20
TV = 8 mL/kg = 600 mL
MV = 12 L/min
I/E = ½
Inspiratory flow = 36 L/min



Oxygen flow rate must be > the patient's Minute Ventilation rate



Inspiration



Expiration

COT: Insufflation device

Bag-valve-mask (BVM) ventilation

- Not really suitable for oxygen therapy
- Only for pre-oxygenation prior to intubation

COT: Calculating remaining Oxygen level

- Internal volume x Remaining pressure

  P x V = Cste

- Safety margins

  The « last 30 bars »

  Consumption: +20%

Pressure reading	**200 bars**
Safety	**- 30 bars**
Working Pressure	**170 bars**
Volume	**5 litres**
Quantité available	**850 litres**

Actual flow	**6 L/min**
+ Safety	**1,2 L/min**
=	**7,2 L/min**
(850 / 7,2)	
Autonomy	**120 min**

Intensive Care Med (2023) 49:727–759
https://doi.org/10.1007/s00134-023-07050-7

CONFERENCE REPORTS AND EXPERT PANEL

ESICM guidelines on acute respiratory distress syndrome: definition, phenotyping and respiratory support strategies

Giacomo Grasselli[1,2*], Carolyn S. Calfee[3], Luigi Camporota[4,5], Daniele Poole[6], Marcelo B. P. Amato[7],

Helms *et al. Annals of Intensive Care (2024) 14:140*
https://doi.org/10.1186/s13613-024-01367-2

Annals of Intensive Care

RESEARCH **Open Access**

Oxygen therapy in acute hypoxemic respiratory failure: guidelines from the SRLF-SFMU consensus conference

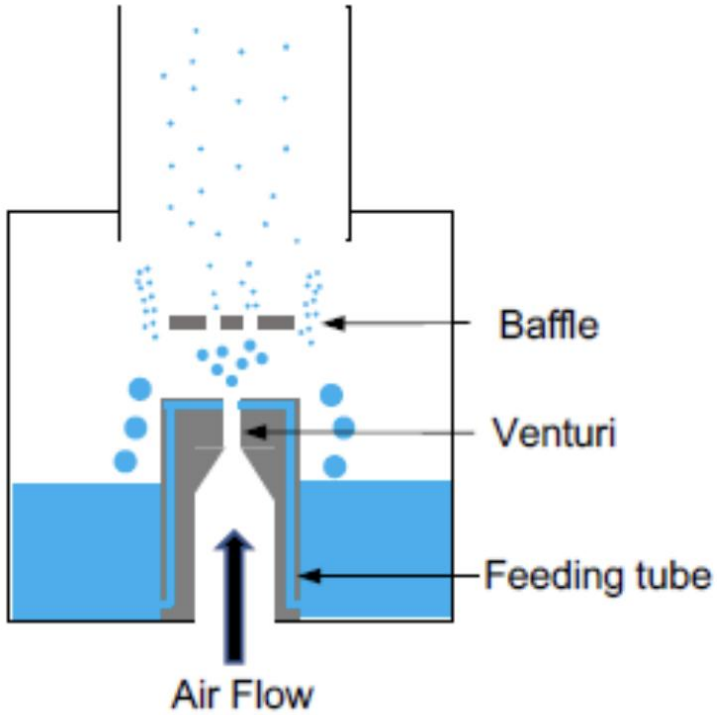
Julie Helms[1,2*], Pierre Catoire[3], Laure Abensur Vuillaume[4], Héloise Bannelier[5], Delphine Douillet[6,7], Claire Dupuis[8,9], Laura Federici[10], Melissa Jezequel[11], Mathieu Jozwiak[12,13], Khaldoun Kuteifan[14], Guylaine Labro[14], Gwendoline Latournerie[15,16], Fabrice Michelet[17], Xavier Monnet[18], Romain Persichini[19], Fabien Polge[20], Dominique Savary[21,22], Amélie Vromant[23], Imane Adda[24,25] and Sami Hraiech[26,27]

Recommandations

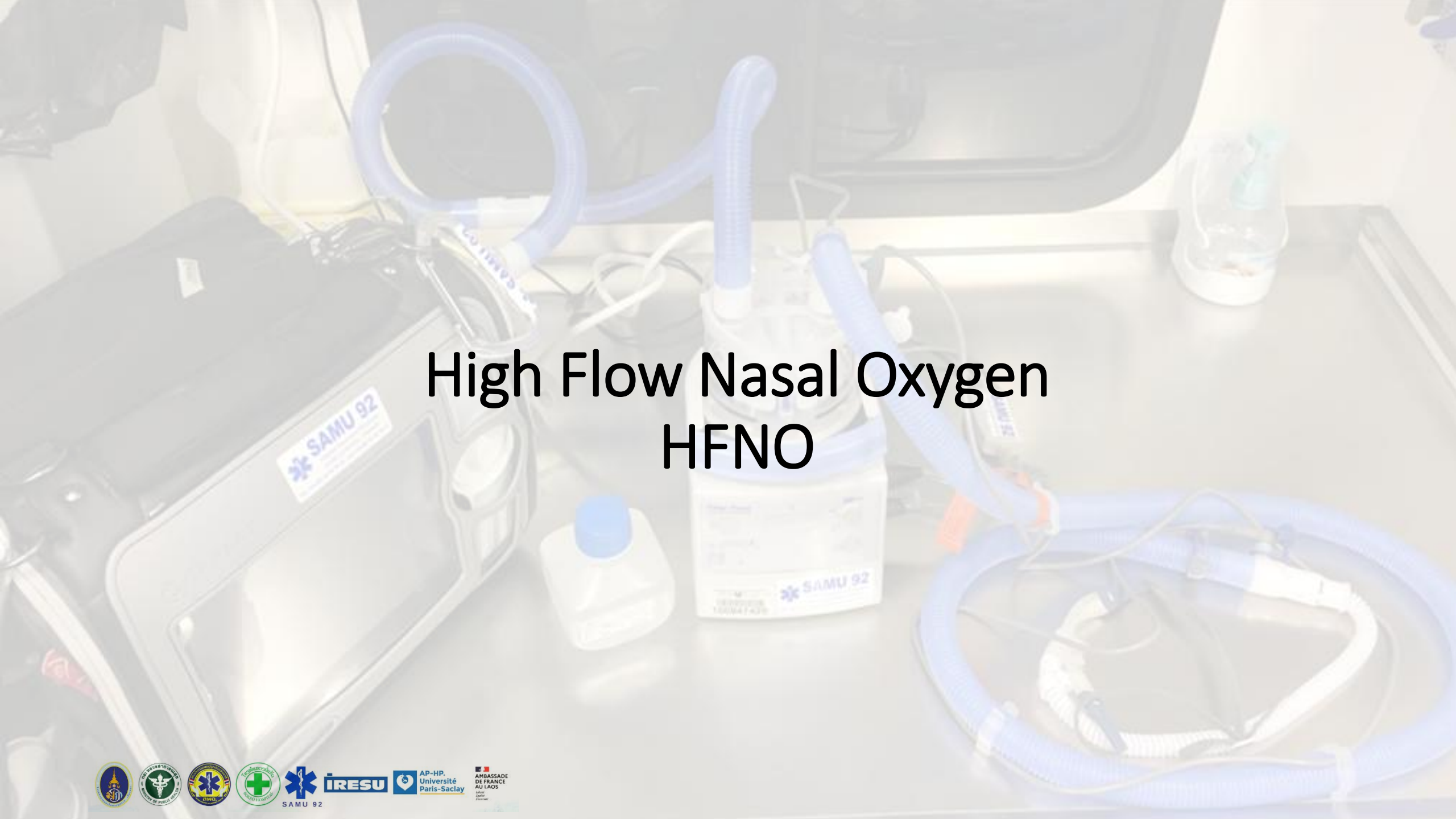
Indications	Mode of ventilation	Level of evidence
AHRF • not due to cardiogenic pulmonary edema • AHRF not due to COPD	Low tidal volume 4-6l/min > larger tidal volume HNFO > COT HNFO/ CPAP	To reduce mortality (High level ESCIM 2023) To reduce risk of intubation (Moderate ESCIM 2023) No recommendation on mortality (High level ESCIM 2023)
AHRF from covid	CPAP/ NIV > HNFO > COT	To reduce the risk of intubation (high level ESCIM 2023) No recommendation on mortality
AHRF not due to cardiogenic pulmonary edema	CPAP/ NIV >HNFO	Moderate level No recommandation
AHRF due to cardiogenic and COPDS	NIV > COT and HNFO	To reduce mortality Strong recommendation (American Thoracic Society/European Respiratory Journal guidelines 2017)

Aerosol Therapy

Conventional aerosol therapy



Jet Nebuliser



High Flow Nasal Oxygen
HFNO

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HFNO : High Flow Nasal Oxygen

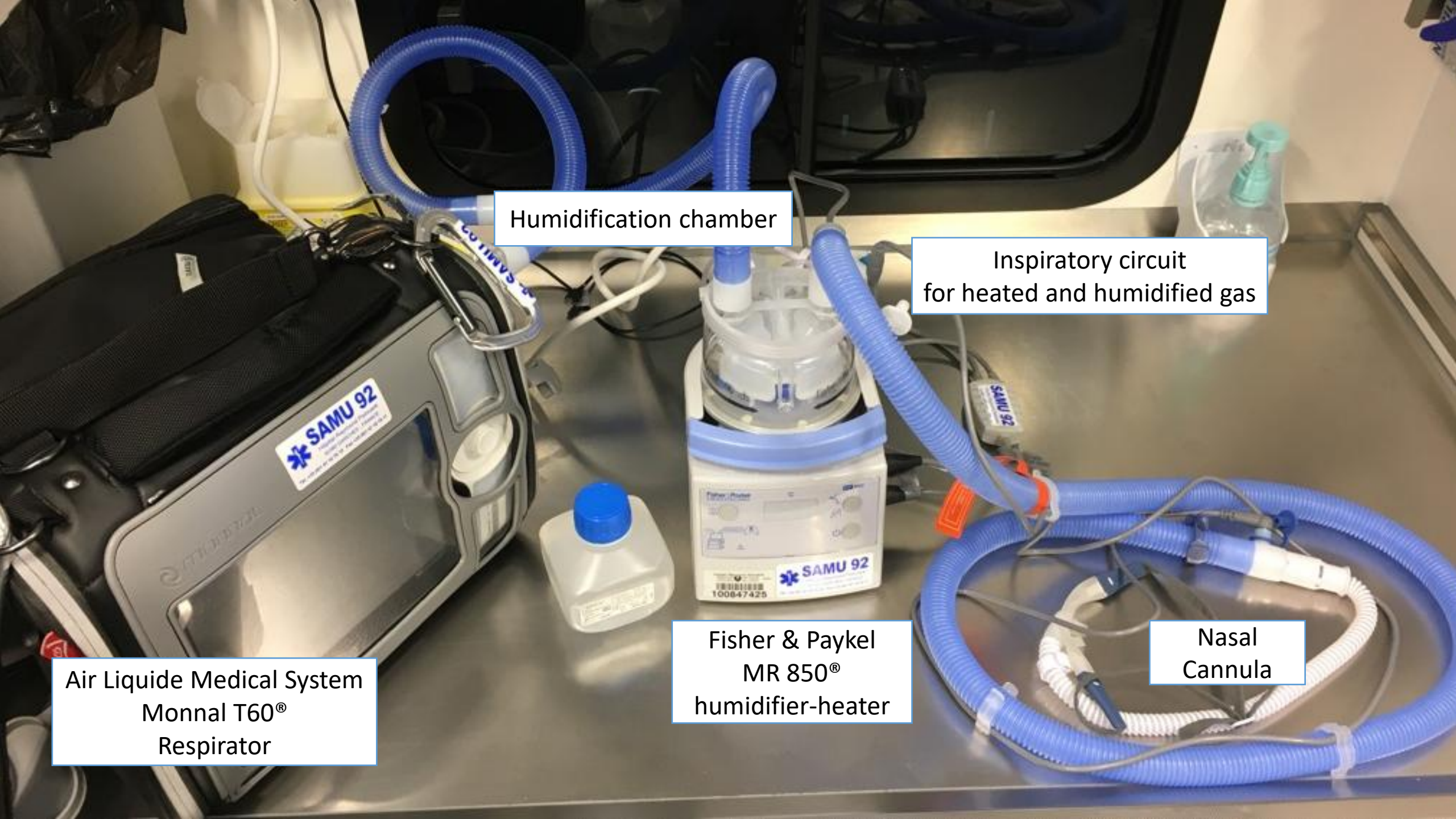
- Non-invasive, continuous administration
- of an air-O2 mixture (FiO2 21 to 100%)
- heated, humidified gas
- high flow rate (50-60 L/min)
- nasal route

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JUNE 4, 2015 VOL. 372 NO. 23

High-Flow Oxygen through Nasal Cannula in Acute Hypoxemic Respiratory Failure

Jean-Pierre Frat, M.D., Arnaud W. Thille, M.D., Ph.D., Alain Mercat, M.D., Ph.D., Christophe Girault, M.D., Ph.D., Stéphanie Ragot, Pharm.D., Ph.D., Sébastien Perbet, M.D., Gwénael Prat, M.D., Thierry Boulain, M.D., Elise Morawiec, M.D., Alice Cottereau, M.D., Jérôme Devaquet, M.D., Saad Nseir, M.D., Ph.D., Keyvan Razazi, M.D., Jean-Paul Mira, M.D., Ph.D., Laurent Argaud, M.D., Ph.D., Jean-Charles Chakarian, M.D., Jean-Damien Ricard, M.D., Ph.D., Xavier Wittebole, M.D., Stéphanie Chevalier, M.D., Alexandre Herbland, M.D., Muriel Fartoukh, M.D., Ph.D., Jean-Michel Constantin, M.D., Ph.D., Jean-Marie Tonnelier, M.D., Marc Pierrot, M.D., Armelle Mathonnet, M.D., Gaëtan Béduneau, M.D., Céline Delétage-Métreau, Ph.D., Jean-Christophe M. Richard, M.D., Ph.D., Laurent Brochard, M.D., and René Robert, M.D., Ph.D., for the FLORALI Study Group and the REVA Network*

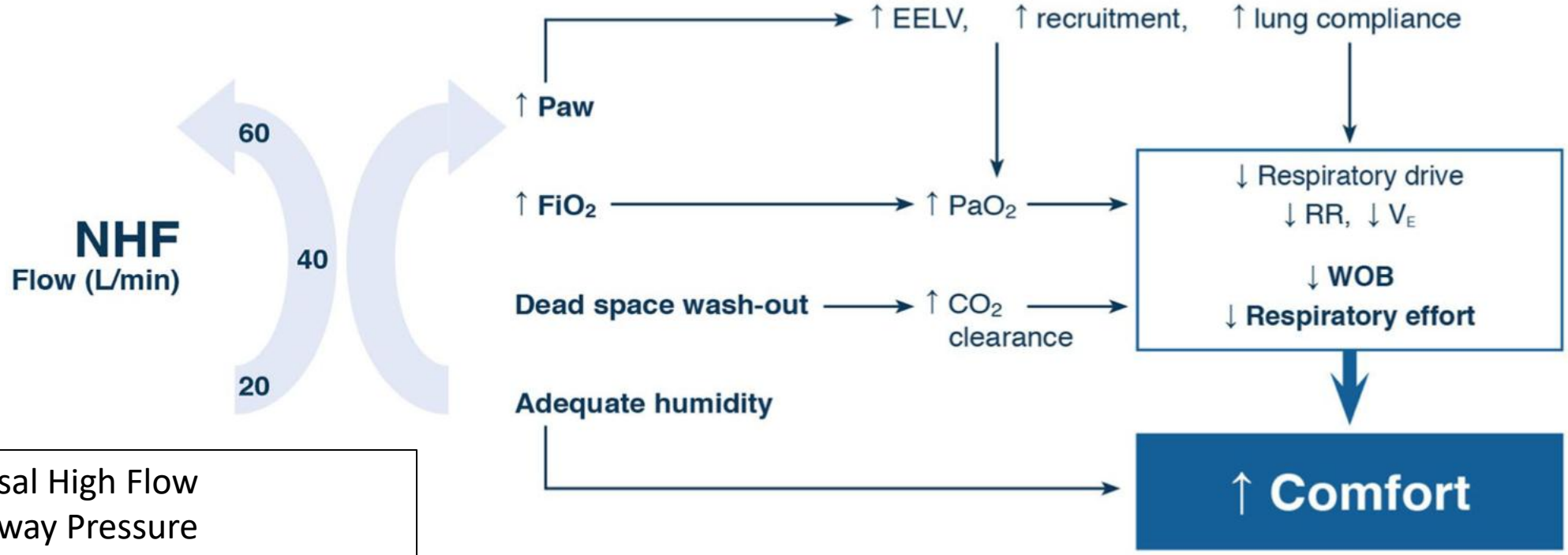

Humidification chamber
Inspiratory circuit
for heated and humidified gas
Air Liquide Medical System
Monnal T60®
Respirator
Fisher & Paykel
MR 850®
humidifier-heater
Nasal
Cannula
SAMU 92

HFNO : Physiological effects

Advantages over Conventional Oxygen Therapy :

- Delivery of constant, fixed, high FiO2
- Dead space wash out
- Decreased ventilatory work and improved patient comfort,
- Generation of a positive expiratory pressure (3 to 5 cm H2O), which can lead to alveolar recruitment (optimal effect with high gas flow: 60 L/min)
- Improved secretion clearance thanks to gas humidification and heating

HFNO : Physiological effects



NHF = Nasal High Flow
Paw = Airway Pressure
EELV = End-Expiratory Lung Volume
RR = Respiratory Rate
V_t = minute Volume
WOB = Work of Breathing

*Use of **nasal high flow oxygen** during **acute respiratory failure**.*
Ricard JD, Roca O, Lemiale V, Corley A, Braunlich J, Jones P, Kang BJ, Lellouche F, Nava S, Rittayamai N, Spoletini G, Jaber S, Hernandez G.
Intensive Care Med. 2020 Dec;46(12):2238-2247. doi: 10.1007/s00134-020-06228-7.

HFNO : Indication

Acute hypoxemic respiratory failure non-hypercapnic

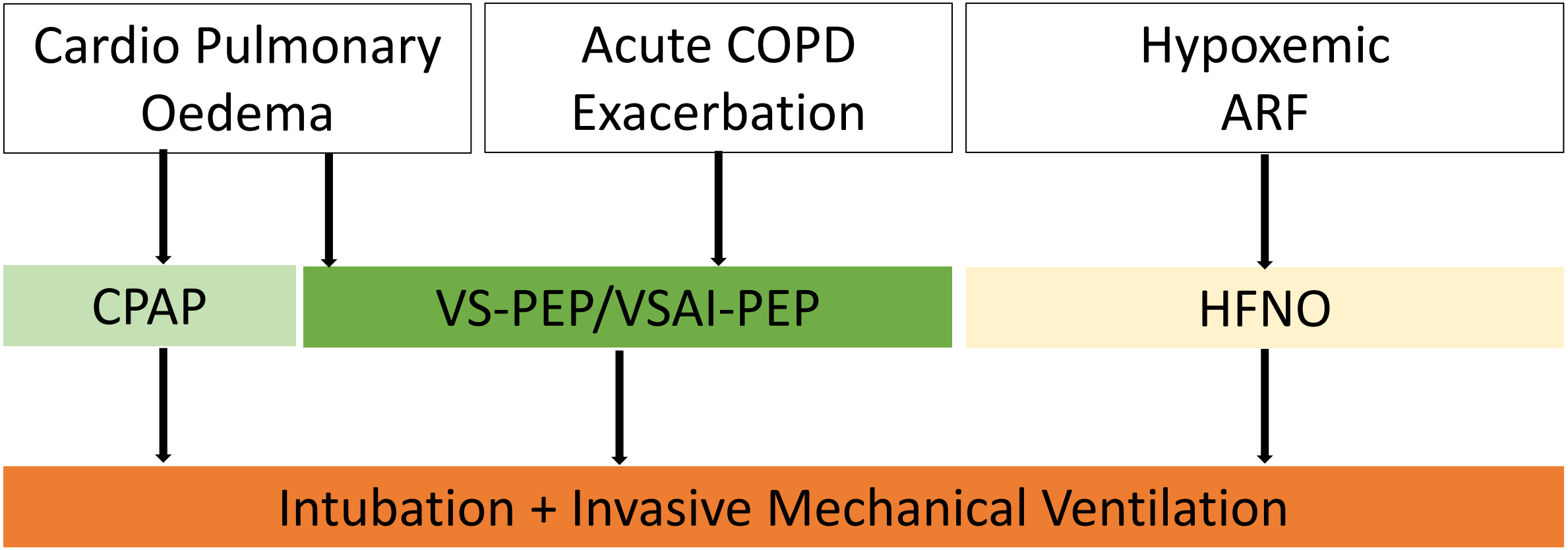
FR > 25/min

Signs of respiratory distress

$PaO_2/FiO_2 \leq 300$ mmHg or $SpO_2 < 92\%$ on COT

without shock or other associated failure.

Acute Respiratory Failure (ARF)



Non Invasive Ventilation
Or Non Invasive Ventilation Pressure Support

2022

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CONFERENCE REPORTS AND EXPERT PANEL

ESICM guidelines on acute respiratory distress syndrome: definition, phenotyping and respiratory support strategies

Giacomo Grasselli[1,2*], Carolyn S. Calfee[3], Luigi Camporota[4,5], Daniele Poole[6], Marcelo B. P. Amato[7],

Guidelines for the respiratory management of ARDS

Indications	Mode of ventilation	Level of evidence
AHRF • not due to cardiogenic pulmonary edema • AHRF not due to COPD	Low tidal volume 4-6l/min > larger tidal volume HFNFO > COT HFNO/ CPAP	To reduce mortality (High level ESCIM 2023) To reduce risk of intubation (Moderate ESCIM 2023) No recommendation on mortality (High level ESCIM 2023)
AHRF from covid 19	CPAP/ NIV > HNFO > COT	To reduce the risk of intubation (high level ESCIM 2023) No recommendation on mortality
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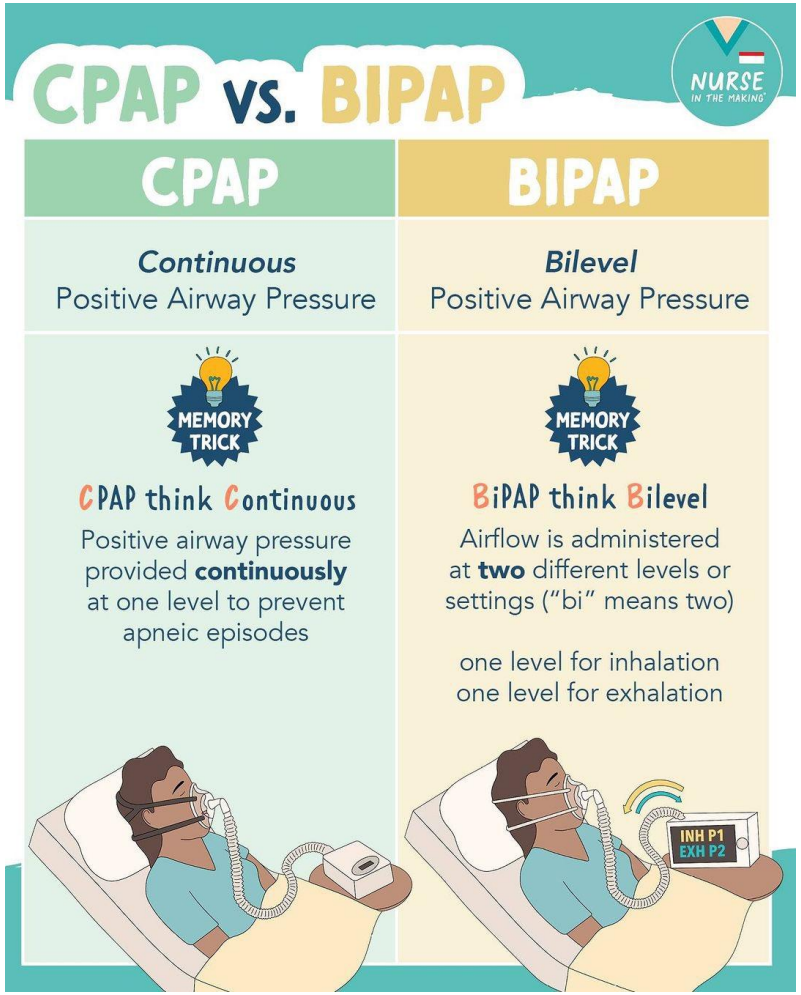
AHRF due to cardiogenic and COPDS	NIV > COT and HFNO	To reduce mortality Strong recommendation (American Thoracic Society guidelines 2017)

Non Invasive Ventilation and CPAP

- Positive Expiratory Pressure (PEP) : Increases functional residual capacity by recruiting collapsed or flooded alveoli
- Non invasive ventilation pressure support (NIVPS)
  - ➢CPAP or Continuous Positive Airway Pressure
  - ➢Bilevel Inspiratory Positive Airway Pressure (BIPAP)= Noninvasive pressure support ventilation with inspiratory support



Indications for emergency non invasive ventilation pressure support

- **Strong evidence, recommended**
  - COPD exacerbation
  - Weaning from mechanical ventilation in COPD patients
  - OAP
  - Hypoxemia in immunocompromised patients

- **Intermediate evidence**
  - Lung disease in COPD patients
  - Acute hypoxemic respiratory failure
  - Patients with intubation limitations: COPD or OSA
  - Preoxygenation of a patient requiring emergency intubation (Delayed Sequence Intubation)

NIVPS contraindications

Absolute contraindication

- Facial trauma/burns
- Fixed upper airway obstruction
- Active vomiting
- Respiratory or cardiac arrest
- Inability to protect the airway

Relative contraindication

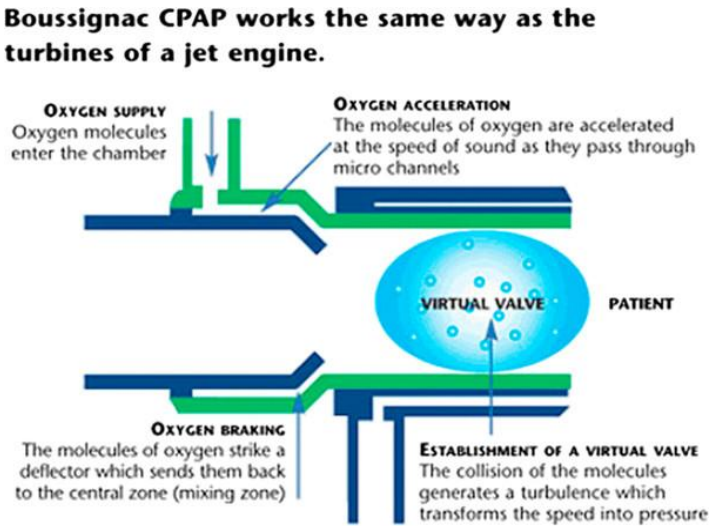
- A recent facial, upper airway surgery
- Life-threatening hypoxemia
- Altered mental status/agitation
- Copious respiratory secretions
- Undrained pneumothorax
- Severe co-morbidity

Boussignac CPAP system

- Small disposable plastic cylinder
- Fits on the mask
- Generate positive pressure by accelerating

a flow of oxygen

- Cardiogenic Pulmonary edema +++
- Require a lot of oxygen



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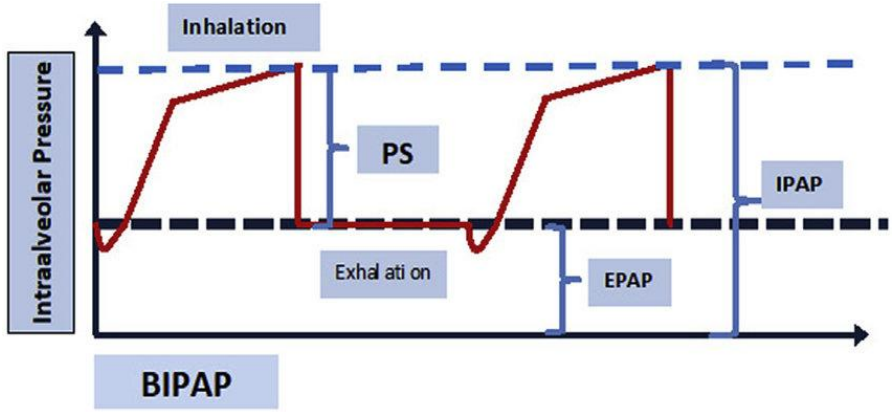
Boussignac CPAP settings

- Initial flow between 12 and 15l/min
- Then adjust O2 flow to obtain a PEP to be gradually increased (max 10cmH2O)

- Cheap
- Doesn't need electricity
- 4 different size
- Can be used with nebulizer

- No specific alarm linked to Boussignac: usual alarms
- Regularly check the pressure delivered on the manometer
- Require a lot of oxygen

BIPAP Settings (1)



- IPAP= EPAP + Pressure support
- Respiratory rate and inspiration time defined by the patient
- Variable delivered tidal volume to be monitored

Tidal volume
- Normal ~ 6 cc/kg (~400 ml)
- Very low tidal volumes (<4-5 cc/kg) suggest hypoventilation.

Minute ventilation
- Normal ~6-7 liters/min.
- Very low minute ventilation (<5 liter/minute) suggests hypoventilation.

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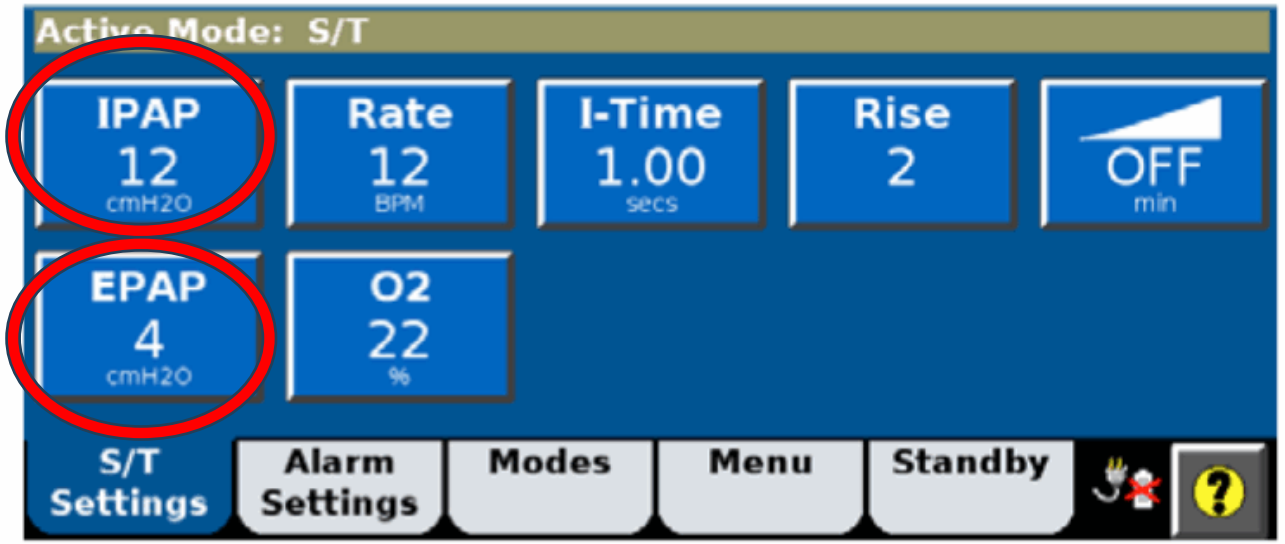
BIPAP Settings (2)

- EPAP: Initially low 4 cmH2O

  Increase up to 10 cmH20 in case of cardiogenic pulmonary oedema

- Pressure support to be increased progressively: start around 8 cmH2O max 15 for e



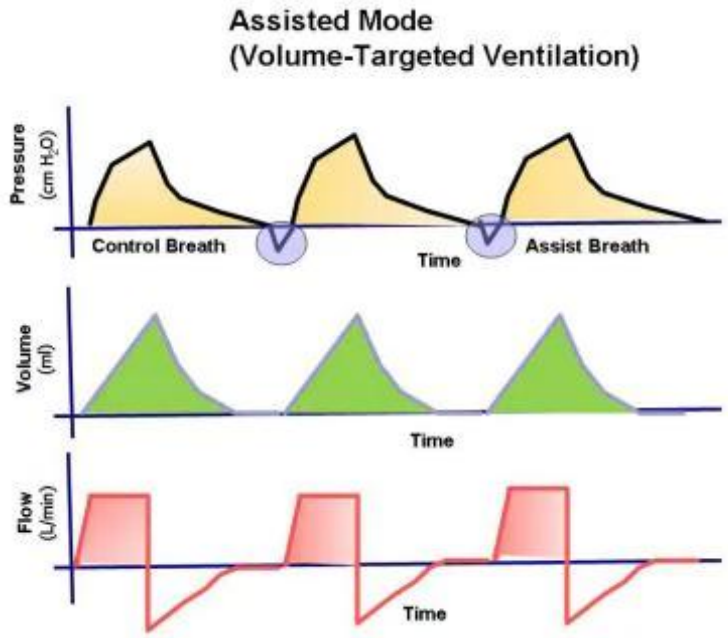
BIPAP Settings (3)

- Inspiratory and expiratory trigger: often preset
- Inspiratory trigger:

Value of intrathoracic depression

Generated at the start of inspiration

Recognized by the ventilator as an insufflation signal.

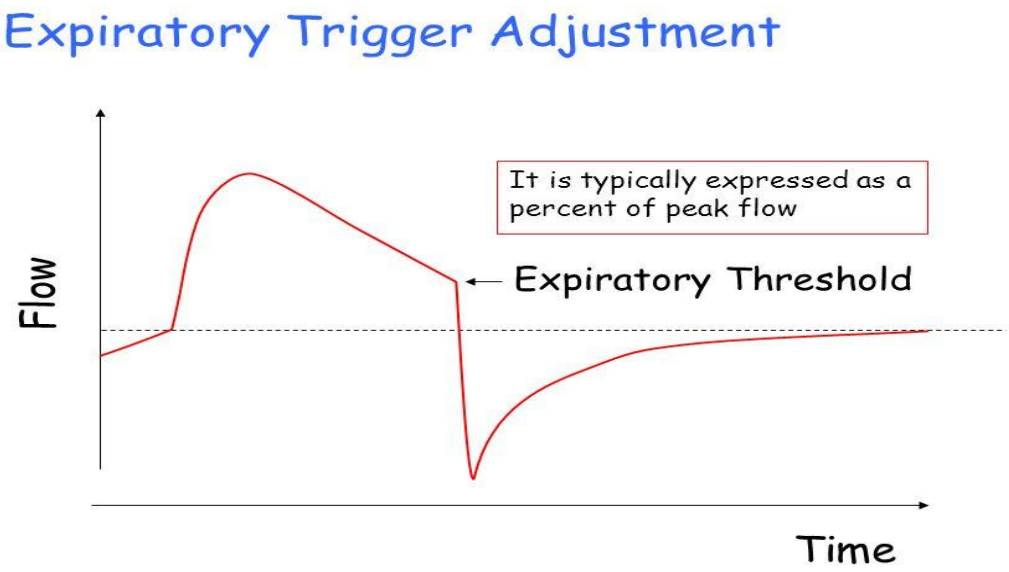


BIPAP Settings (4)

- Expiratory trigger:

Peak inspiratory flow (PIF) decay threshold,

Expressed as a percentage of PIF



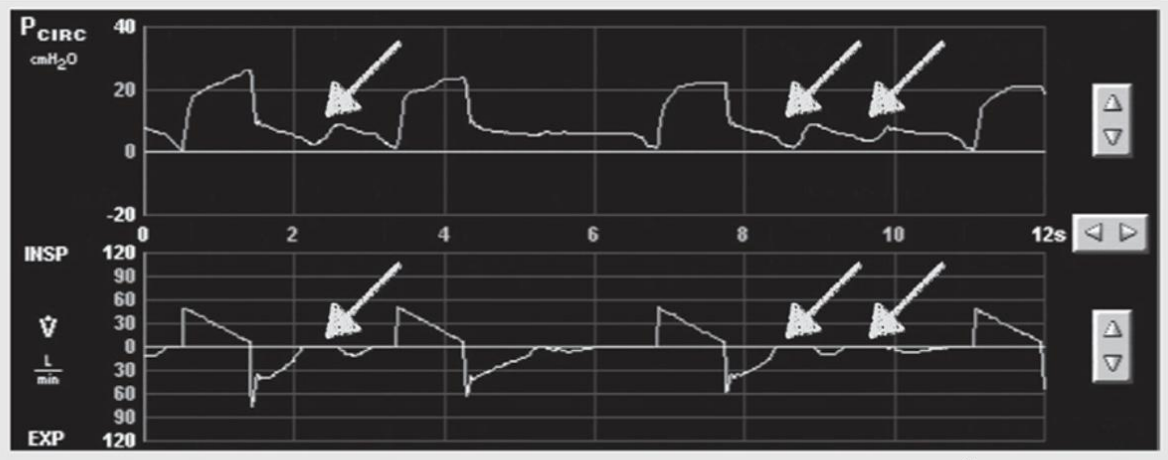
Asynchrony risk

- CPAP presents virtually no risk of asynchrony with the patient

- NIPSV: high risk of patient-ventilator asynchrony (source of NIV failure)
  - Inadequate level of support: the flow rate is too low and it does not meet patient demands.
  - Auto-PEEP is too high and the patient expends a lot of effort trying to defeat it
  - Prolonged insufflation by ventilator preventing patient from exhale

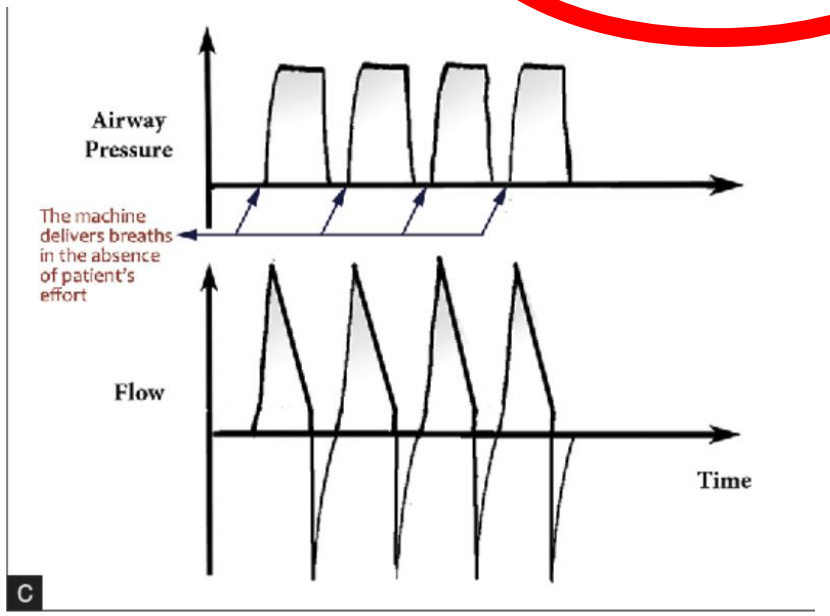
Asynchrony due to trigger setting

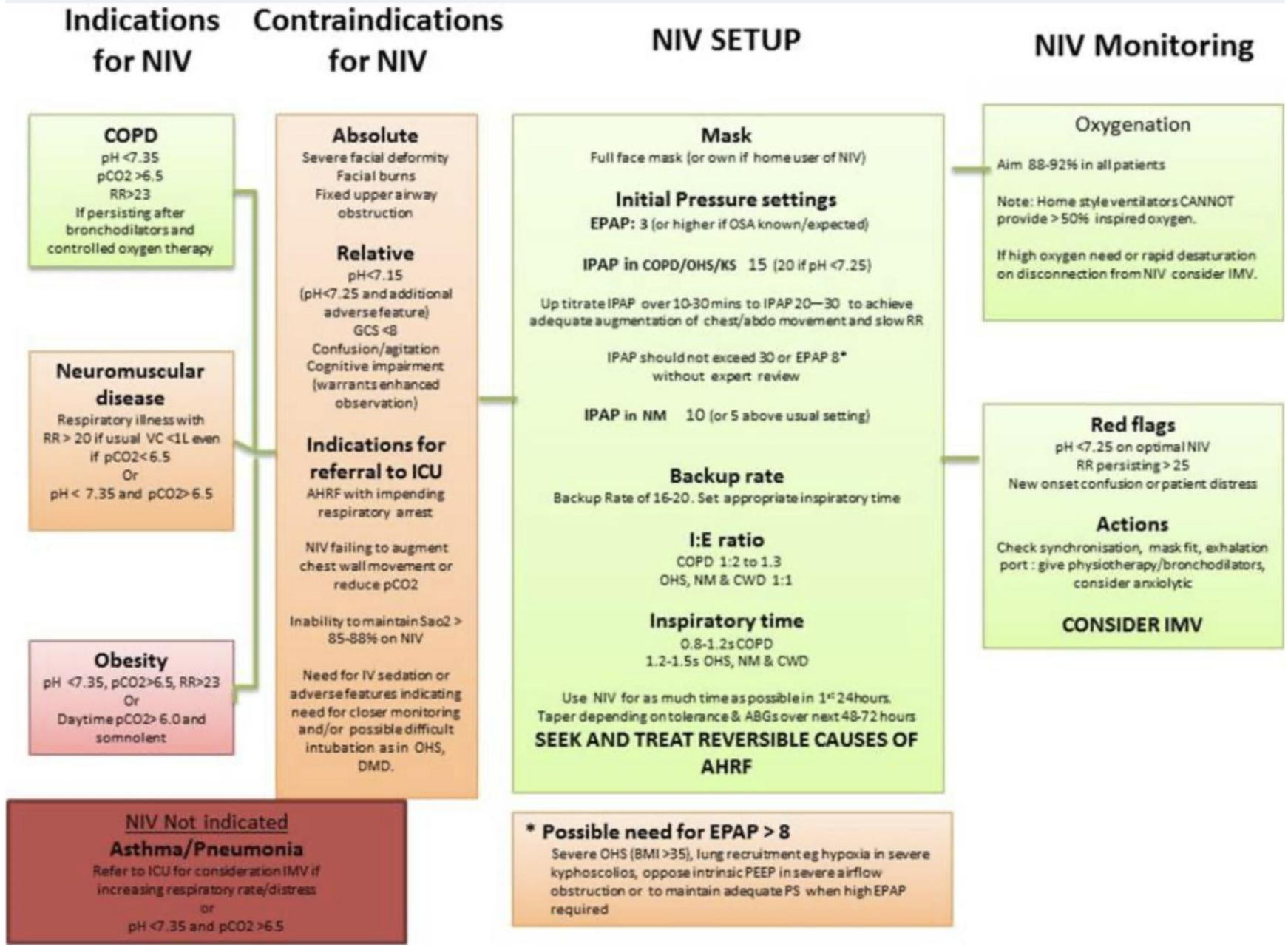
Improve trigger sensitivity



รูปที่ 3 แสดงความผิดปกติของ waveform แบบ ineffective triggering สาเหตุ : กล้ามเนื้อหายใจเข้าอ่อนแรง, ตั้ง trigger

Lower trigger sensitivity




Indications for NIV
Contraindications for NIV
NIV SETUP
NIV Monitoring
COPD
pH <7.35
pCO2 >6.5
RR>23
If persisting after bronchodilators and controlled oxygen therapy
Neuromuscular disease
Respiratory illness with RR > 20 if usual VC <1L even if pCO2< 6.5
Or
pH < 7.35 and pCO2> 6.5
Obesity
pH <7.35, pCO2>6.5, RR>23
Or
Daytime pCO2> 6.0 and somnolent
Absolute
Severe facial deformity
Facial burns
Fixed upper airway obstruction
Relative
pH<7.15
(pH<7.25 and additional adverse feature)
GCS <8
Confusion/agitation
Cognitive impairment
(warrants enhanced observation)
Indications for referral to ICU
AHRF with impending respiratory arrest
NIV failing to augment chest wall movement or reduce pCO2
Inability to maintain Sao2 > 85-88% on NIV
Need for IV sedation or adverse features indicating need for closer monitoring and/or possible difficult intubation as in OHS, DMD.
Mask
Full face mask (or own if home user of NIV)
Initial Pressure settings
EPAP: 3 (or higher if OSA known/expected)
IPAP in COPD/OHS/KS 15 (20 if pH <7.25)
Up titrate IPAP over 10-30 mins to IPAP 20—30 to achieve adequate augmentation of chest/abdo movement and slow RR
IPAP should not exceed 30 or EPAP 8* without expert review
IPAP in NM 10 (or 5 above usual setting)
Backup rate
Backup Rate of 16-20. Set appropriate inspiratory time
I:E ratio
COPD 1:2 to 1.3
OHS, NM & CWD 1:1
Inspiratory time
0.8-1.2s COPD
1.2-1.5s OHS, NM & CWD
Use NIV for as much time as possible in 1st 24hours.
Taper depending on tolerance & ABGs over next 48-72 hours
SEEK AND TREAT REVERSIBLE CAUSES OF AHRF
Oxygenation
Aim 88-92% in all patients
Note: Home style ventilators CANNOT provide > 50% inspired oxygen.
If high oxygen need or rapid desaturation on disconnection from NIV consider IMV.
Red flags
pH <7.25 on optimal NIV
RR persisting > 25
New onset confusion or patient distress
Actions
Check synchronisation, mask fit, exhalation port : give physiotherapy/bronchodilators, consider anxiolytic
CONSIDER IMV
NIV Not indicated
Asthma/Pneumonia
Refer to ICU for consideration IMV if increasing respiratory rate/distress
or
pH <7.35 and pCO2 >6.5
* Possible need for EPAP > 8
Severe OHS (BMI >35), lung recruitment eg hypoxia in severe kyphoscolios, oppose intrinsic PEEP in severe airflow obstruction or to maintain adequate PS when high EPAP required

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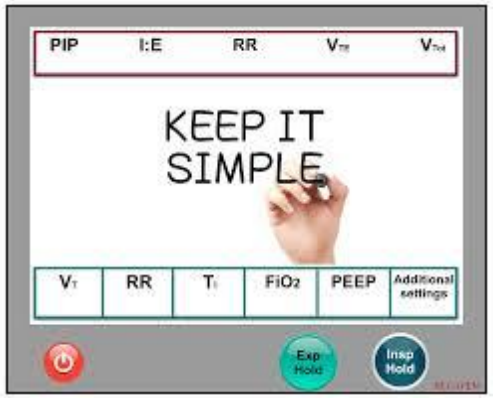
What to remember about non invasive ventilation

- Non-invasive respiratory support strategies:

  Low flow and high flow oxygen and NIV

  -> Improve oxygenation and unload respiratory muscles

  -> Have been implemented to avoid sedation and tracheal intubation.

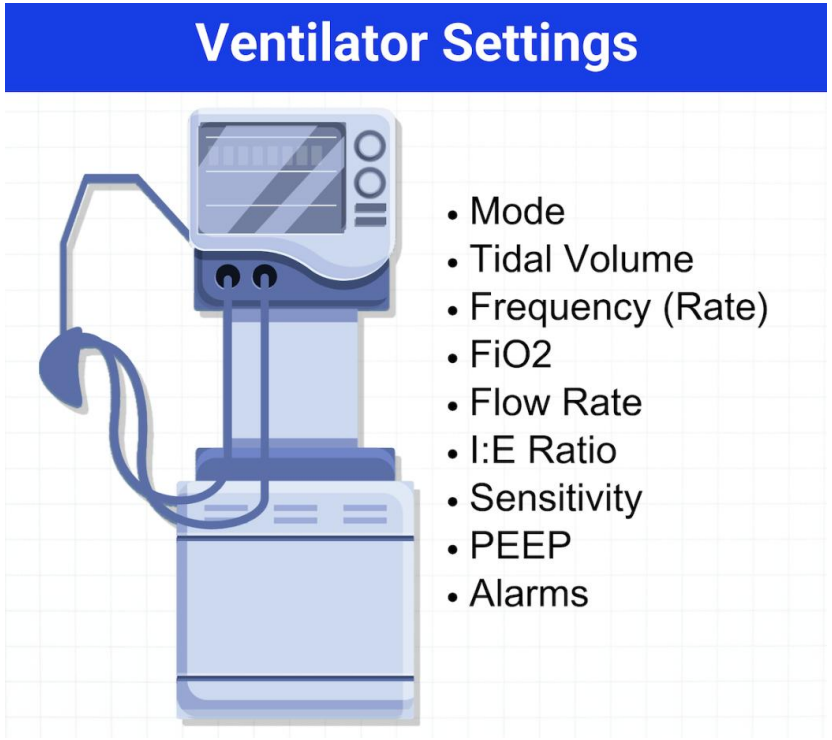


- Non invasive respiratory support must be introduced early but should not delay intubation if needed.
- The general tendency is not to intubate if an other solution is available

Invasive mechanical ventilation

Mechanical ventilation

- Deep sedation (possibly curarization) is required to adapt the patient to the ventilator.
- The physician determines all ventilatory parameters:

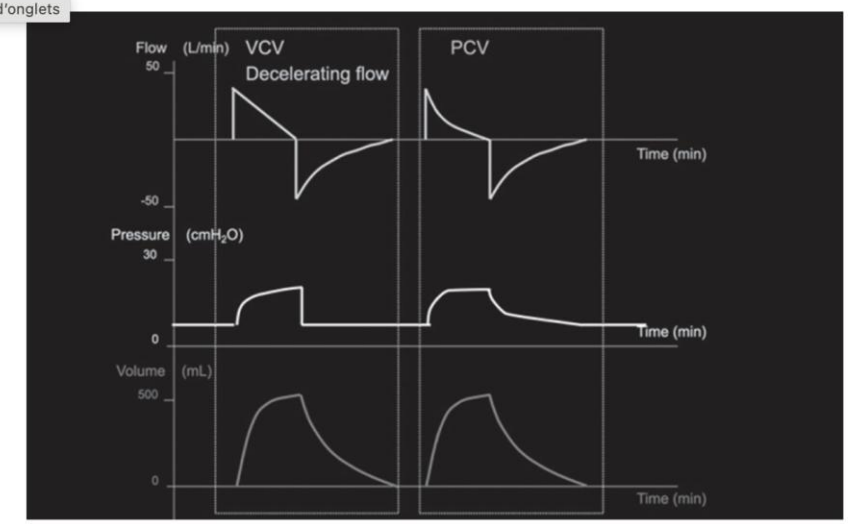


Mechanical ventilation settings

- Tidal volume: 6 to 8 ml/kg : IDEAL WEIGHT

  In case of barotrauma risk : reduce to 6ml/kg
- RR: 12 to 20
- Volume insufflated per min (V min)

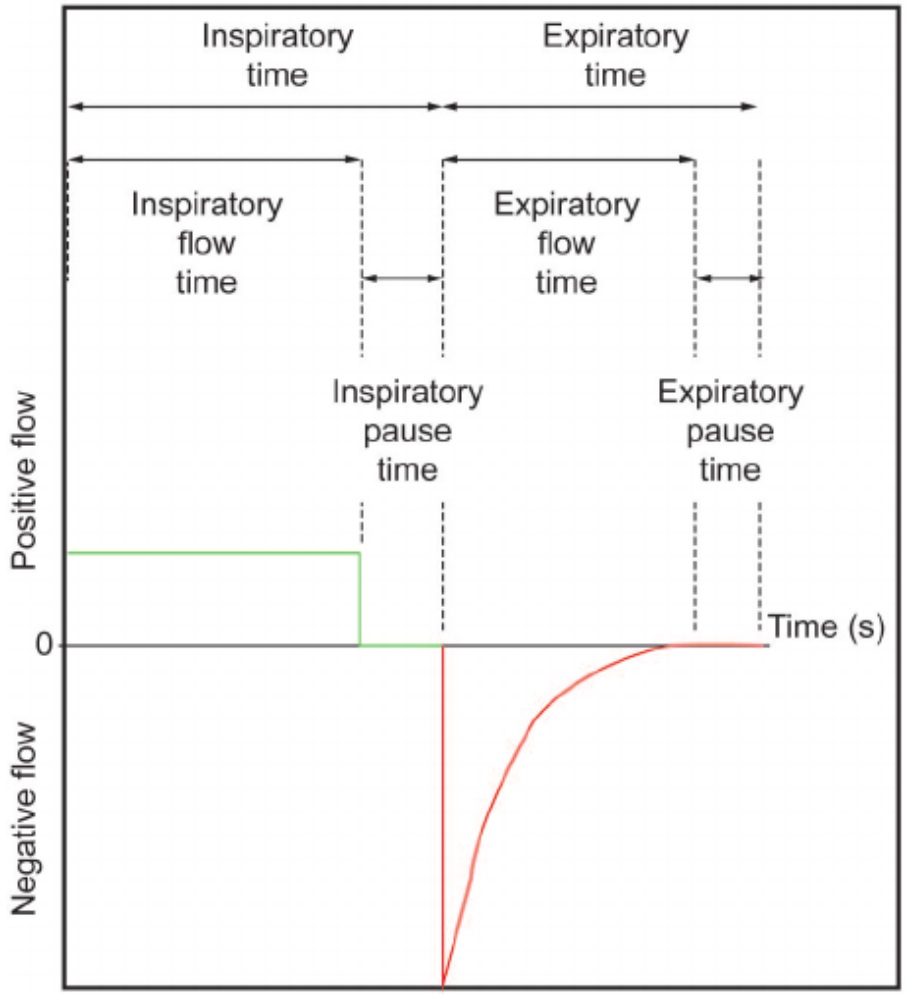
  V min= VT x FR
- IFO2: adjusted for SaO2 > 93%



รูปที่ 1 แสดง waveforms ปกติของการตั้งเครื่องช่วยหายใจแบบ volume controlled ventilation (VCV) แบบ decelerating flow และ pressure controlled ventilation (PCV); wave form ที่ใช้แยกระหว่าง VCV กับ PCV คือ pressure-time waveform โดย ใน VCV, pressure จะค่อย ๆ เพิ่มสูงขึ้นเรื่อย ๆ จนสูดสุดที่ end-inspiration แต่ใน PCV, pressure จะเพิ่มถึง target ที่ถูกตั้งไว้และจะคงที่ตลอดช่วงการหายใจเข้า

Mechanical ventilation settings

- I/E:= Inspi time /Expi time
- In the current situation, I/E=1/2 corresponds to an inspiratory flow rate of 30 l/min (to be adjusted).
- PEP: if neaded (cardiogenic pulmonary oedema for exemple)



Monitoring

Noninvasive ventilation

Clinical criteria:

- Respiratory rate
- Signs of struggle (expiratory brake++)
- Tolerance

SpO2

Ventilator criteria: Tidal volume

Mechanical ventilation

Clinical criteria:

- Non-efficient ventilation: cyanosis, mottling
- Complication: auscultatory asymetry

Alarms: Pressure sensors

Pression Alarms

- Peak pressure or P max, generated by tidal volume:

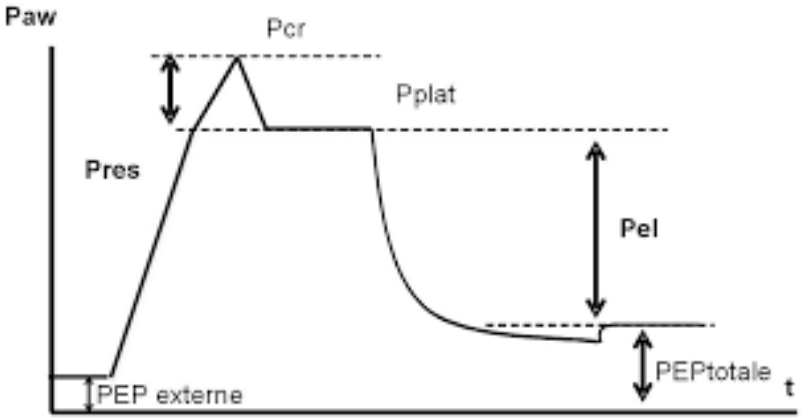
resistance of large bronchi and circuit not correlated with alveolar pressure

- Alveolar pressure= end- inspiratory airway pressure = Plateau Pressure Pplat) :

reflects the traumatic risk induced by ventilation

- Pplat must always be < 30cmH2O
- If no P Plat available

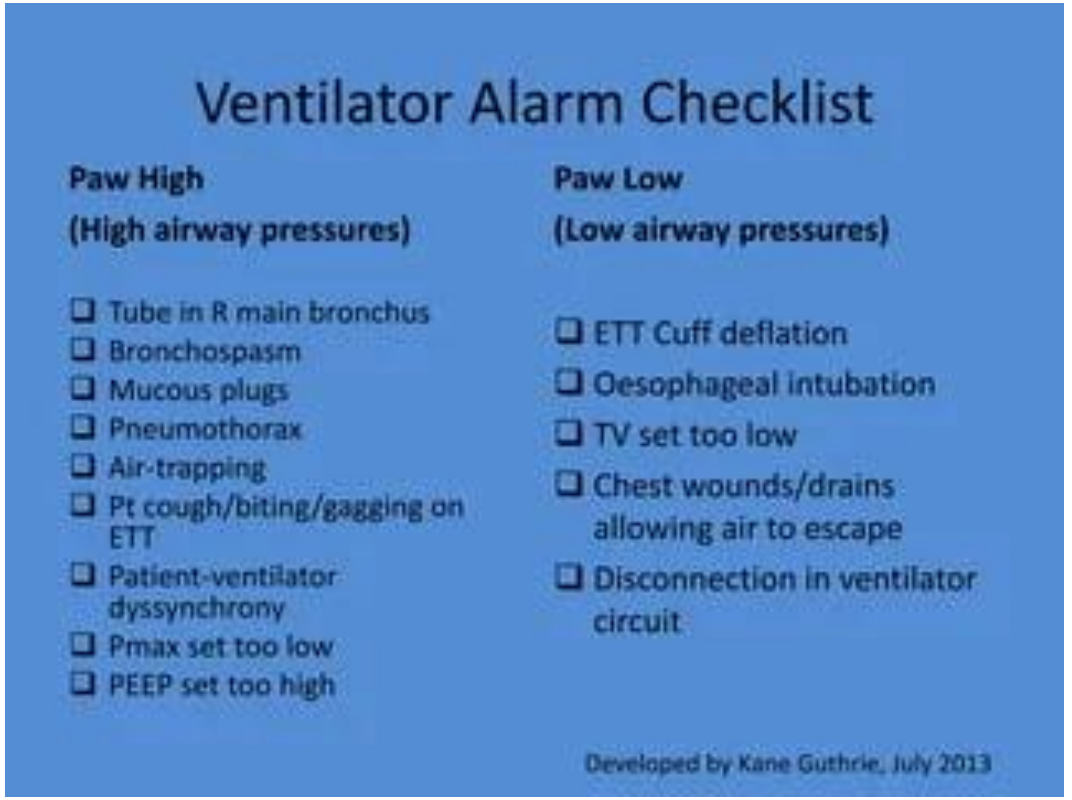
-> objective is Pmax < 40 cmH2O



Pression alarm check list

- Do not silence a ventilator until you are aware of the reason for the ventilator alarm.
- 3 checks : Patient, probe, circuit
- Pmax is the more frequent

- If the patient is in distress after your checks, initiate with bag-valve-mask ventilation



Mechanical ventilation and nebulization

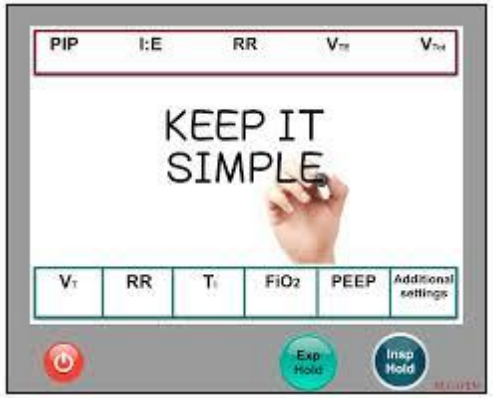
Conventional aerosol therapy

Nebulization with Aerogen

What to remember

- Invasive mechanical ventilation

  - Start with low tidal volume (6ml/kg)
  - to avoid per intubation instability
  - and barotrauma
  - Choose carefully the alarm settings
  - Be systematic when alarm sounds
  -> 3 checks: Patient, Probe, circuit



Thank you !

ขอบคุณมากครับ

ขอบคุณมากค่ะ

ຂອບໃຈ

Chiang Rai Provincial health office
National Institute for Emergency Medicine
Bokeo Provincial Health Office Lao
Bokeo Hospital, Lao
SAMU 92
IRESU
Chiangrai Prachanukroh Hospital
Chiang Khong Crown Prince Hospital

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