SARI CLINICAL CARE TRAINING

ACUTE RESPIRATORY DISTRESS SYNDROME LIBERATION FROM INVASIVE MECHANICAL VENTILATION

World Health Organization

HEALTH EMERGENCIES programme

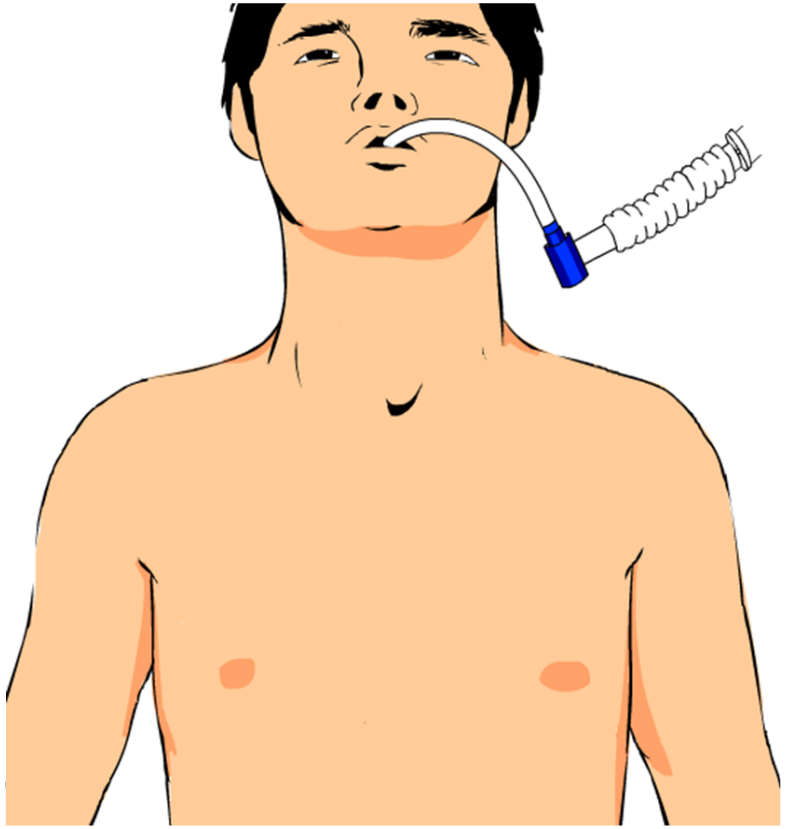
Learning objectives

At the end of this lecture, you will be able to:

- Describe the benefits of a protocolized liberation strategy for patients on invasive MV.
- Formulate a daily spontaneous breathing trial (SBT) protocol adapted to your hospital.
- Discuss indications for tracheostomy.

Definitions

- **Weaning:**
  - gradual discontinuation of mechanical ventilation.
- **Spontaneous breathing trial (SBT):**
  - abrupt reduction of mechanical ventilatory support to minimum levels(usually 30–120 minutes).
- **Extubation:**
  - removal of the endotracheal tube.

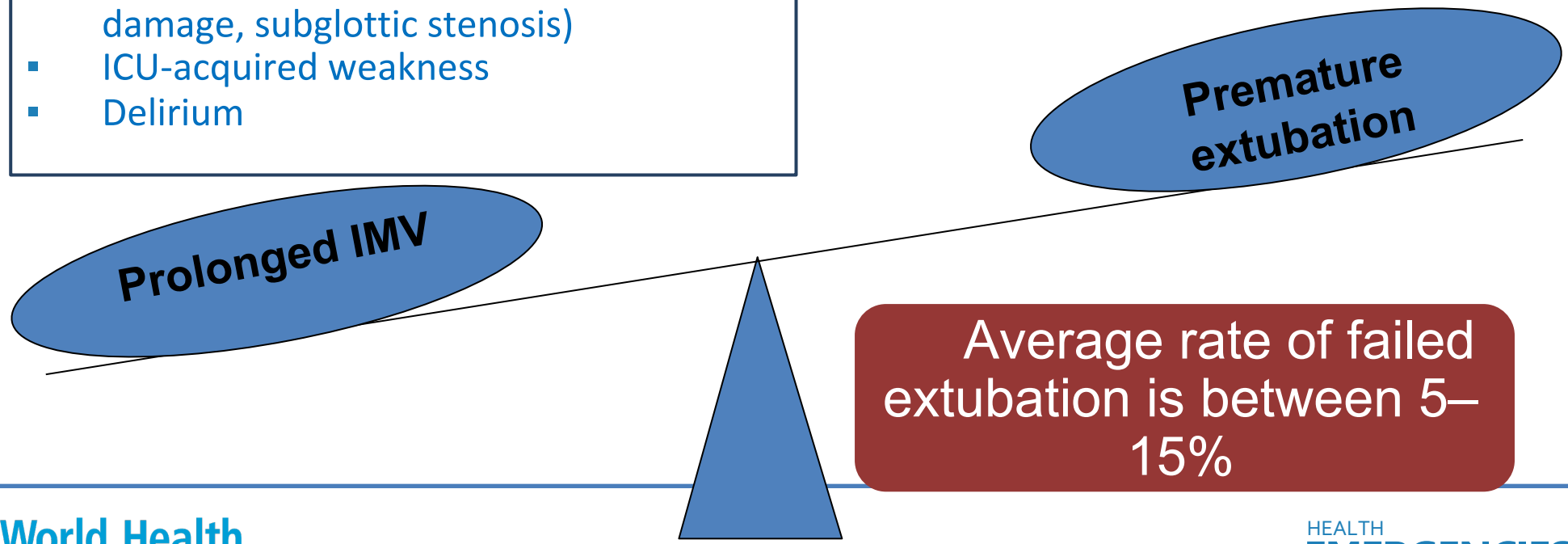


Permission obtained from Dr. Gomersall

Risks of invasive mechanical ventilation and premature extubation

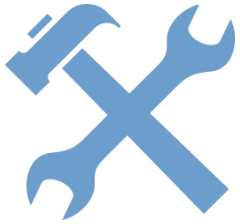
- Longer ICU stays
- Higher hospital costs
- Nosocomial infections (ventilator associated infections, such as pneumonia, sinusitis)
- Upper airway trauma (vocal cord damage, subglottic stenosis)
- ICU-acquired weakness
- Delirium

- Longer ICU stay
- Increased risk of death



Average rate of failed extubation is between 5–15%

Implementation of SBT protocol improves patient outcomes



- Conducting a daily, protocolized SBT has been shown to be beneficial alone **and** more so, when combined with SAT protocol:
  - decreased days of IMV (faster time to extubation, without increase in failed extubation!)
  - decreased days of ventilator-associated infections
  - decreased days of delirium
  - improved muscle weakness and functionality
  - Improved survival at one year!

Seven-step approach

Step 1: Daily assessment for patient readiness to breathe spontaneously

Step 2: Conduct the SBT safely

Step 3: Evaluate patient's performance on the SBT

Step 4: Assess safety for extubation

Step 5: Extubate

Step 6: Monitor-record-interpret-respond

Step 7: Deliver quality care: implement as part of ABCDEF protocol

Step 1

Daily assessment for readiness to breathe spontaneously (1/2)

- Reversal/improvement of reason for mechanical ventilation.
- Consistent, spontaneous respiratory efforts:
  - adjust sedation and ventilator rate to promote consistent, spontaneous respiratory efforts to prevent disuse respiratory muscle wasting.
- Stable and adequate oxygenation:
  - $SpO_2 \geq 88\%$ or $PaO_2 \geq 55$ mmHg or 8 kPa
  - PEEP ≤ 8 cm H_2O
  - $FiO_2 \leq 0.50$.
- Stable and adequate ventilation:
  - no acidosis (pH > 7.30)
  - minute ventilation consistently ≤ 15 L/min.

Daily assessment for readiness to breathe spontaneously (2/2)

- Haemodynamic stability:
  - no significant vasopressors (e.g. dopamine ≤ 5 µg/kg/min).
- No current use of neuromuscular blocking agents or evidence of persistent blockade.
- Absence of deteriorating conditions such as septic shock or multi-organ failure.
- Absence of active myocardial ischaemia.

Adapt a protocol to your ICU.

Step 2

Conduct a SBT (1/2)
Three commonly used SBT methods

- **Low level pressure support trial**
  - PS 5–7 cm H_2O
  - PEEP 5 cm H_2O.
- **Low level CPAP trial**
  - CPAP 5 cm H_2O.
- **T-piece trial or flow-by (PS 0, PEEP 0)**
  - disconnection of patient from ventilator
  - not recommended in infants and small children.

Low-level PS increases SBT pass rate and does not increase post-extubation failure rate compared with T-piece or CPAP.

How to conduct a SBT (2/2)

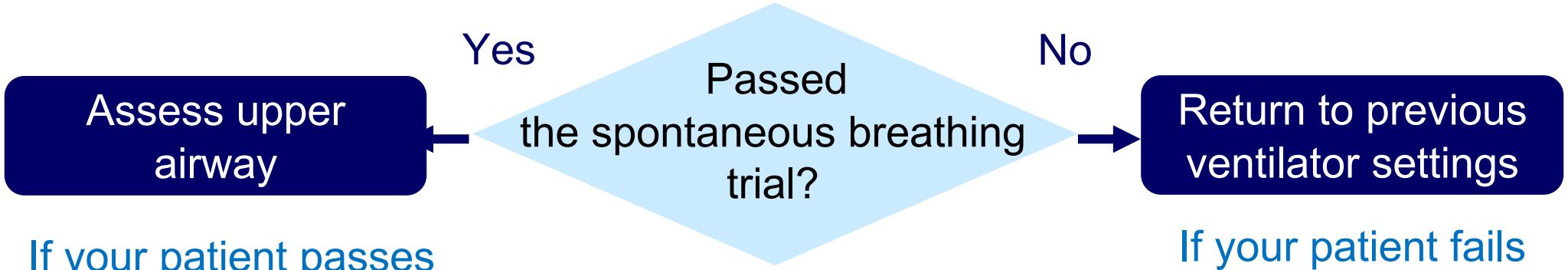
- Coordinate the SBT with SAT.
- Monitor the patient closely for the initial 5 min:
  - coach patients as they transition to spontaneous breathing
  - recognize early signs of respiratory failure
  - detect need for re-institution of increased ventilatory support.
- Continue SBT for at least 30 min or up to 2 hours as long as there are no signs of respiratory failure.

SBT considerations

- Abrupt discontinuation of support can promote intolerance in a minority of patients (i.e. anxious patient):
  - a gradual PS wean over 10–15 min in steps of ~ 2 cm H_2O can differentiate those who truly cannot tolerate an SBT from those prone to psychogenic dyspnea
  - suspect this in patients who continually fail an SBT without apparent physiologic basis.

Step 3

Evaluate your patient's performance



Monitor

Patient

Oxygenation

Ventilation

Cardiovascular

A SBT failure is characterized by...

- Development of any sign of respiratory failure:
  - respiratory rate > 35/min consistently
  - SpO_2 < 90%
  - apnea or periodic breathing (unstable drive)
  - hypoventilation.

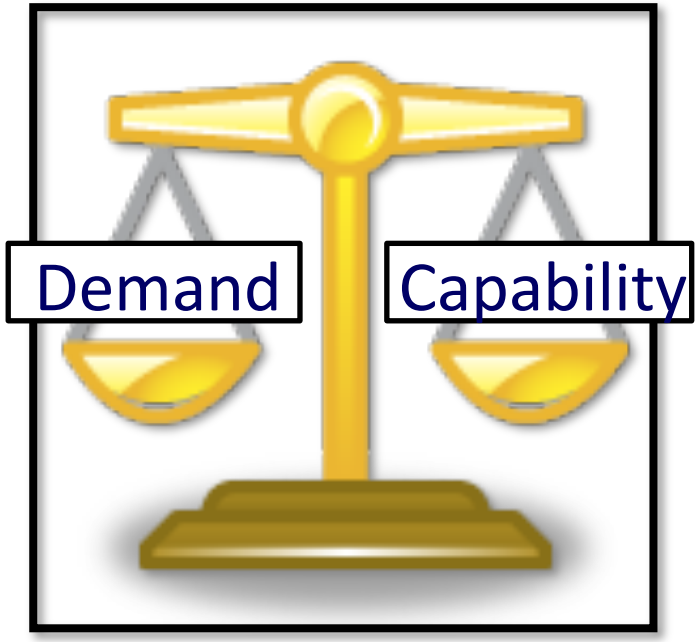
    - Increase in $PaCO_2$ ≥ 10 mmHg or 1.3 kPa.
    - pH < 7.3.
    - Respiratory rate < 8/min.

A SBT failure is characterized by...

- Development of ≥ two signs of impending failure:
  - respiratory distress (e.g. paradoxical breathing, pronounced accessory muscle recruitment/tracheal tugging/nasal flaring, abdominal muscle recruitment)
  - severe agitation, acute change in mental status, diaphoresis
  - haemodynamic instability (> 20% change in HR or SBP, arrhythmia).

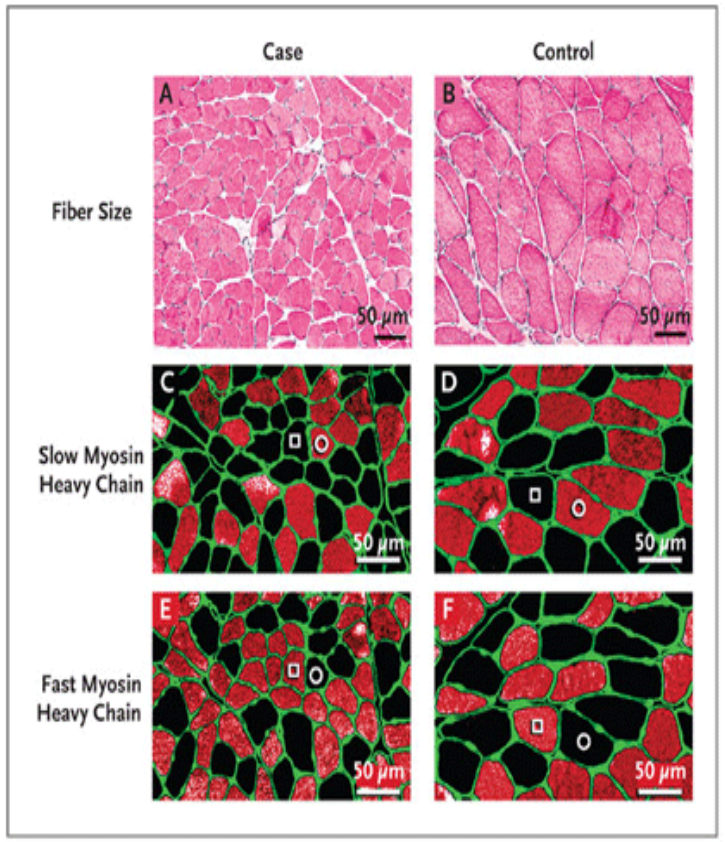
SBT failures: determine why and treat

- Decreased respiratory system compliance
- Increased airways resistance
- Increased alveolar ventilation
- Increased dead space
- Imposed loads (asynchrony, overfeeding)



- Neural drive
- Respiratory muscle strength
- Respiratory muscle endurance

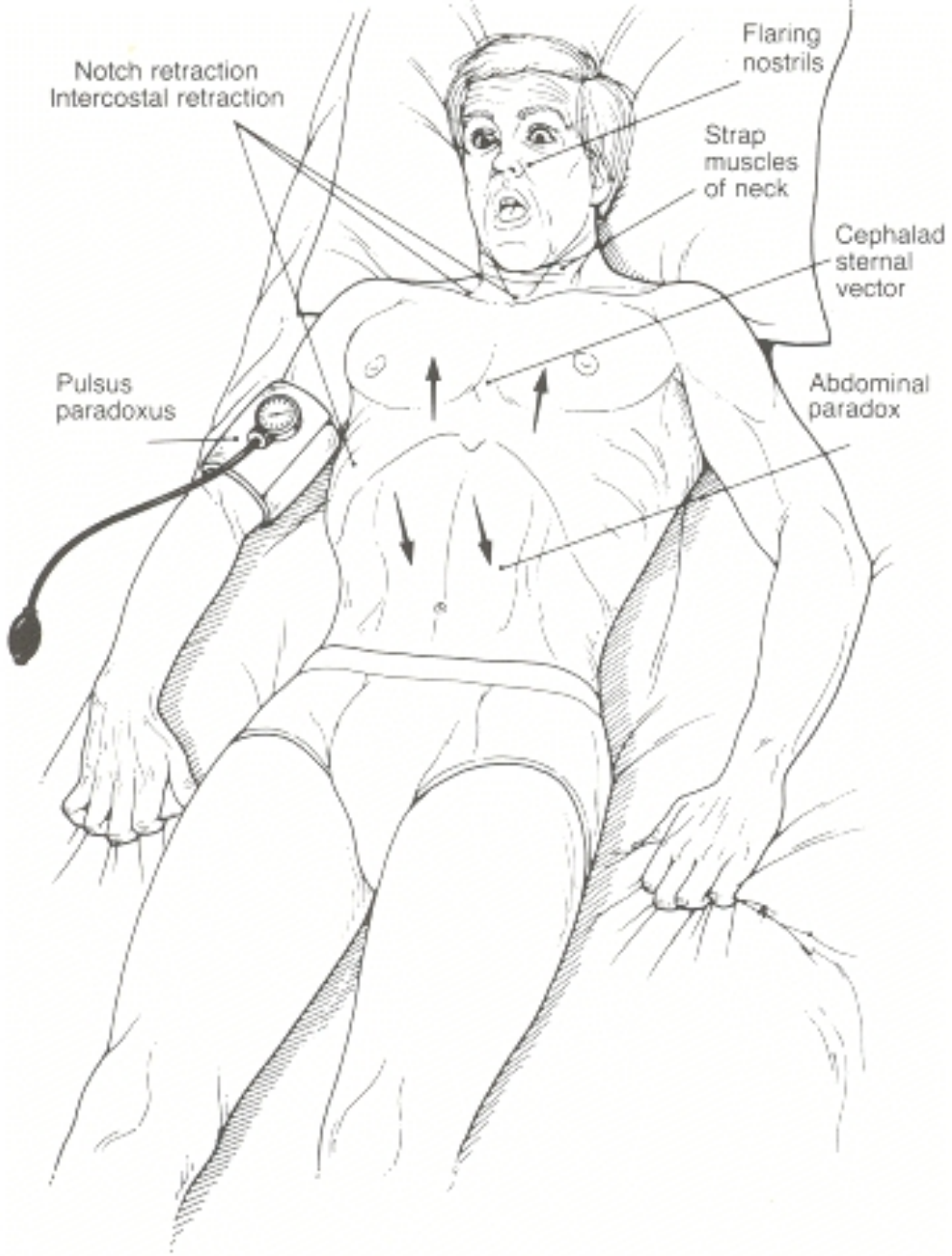
Diaphragmatic muscle weakness



Levine et al. NEJM 2008

- Controlled ventilation causes rapid atrophy of diaphragmatic muscles.
- Avoid respiratory muscle fatigue during weaning:
  - overt signs of distress coincide early muscle failure. Placing patients back on full support decreases chances of causing sustained muscle injury.
- Remember, early mobility (i.e. ABCDEF bundle) improves overall strength and reduces days of IMV.

Signs of respiratory distress:

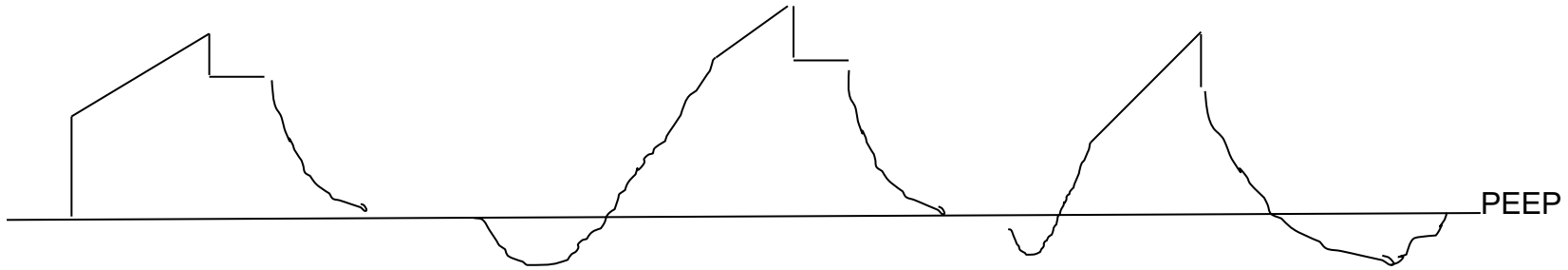


Recognize and treat patient-ventilator asynchrony

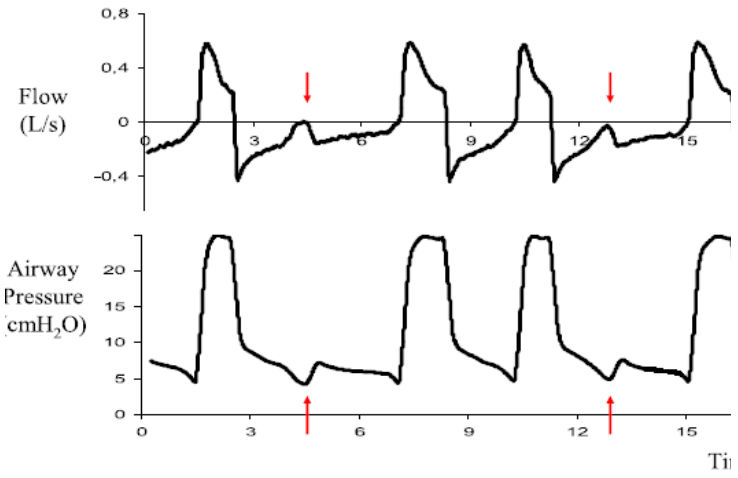
- Asynchrony is associated with longer duration of MV.
- May occur during spontaneous or assisted ventilation:
  - physical signs: agitation, sweating, nasal flaring, abdominal paradox, intercostal retractions, tachycardia
  - tachypnea alone ≠ asynchrony.
- May occur at various parts of respiratory cycle (trigger, inspiration, cycle, expiration):
  - timing asynchrony: mismatch between neural and ventilator inspiratory times and cycling of breaths
  - flow asynchrony: patient flow not matched by ventilator.

How asynchrony manifests using graphics

- Hints:
  - flow-mismatching (resistive loading) and trigger-delay (threshold loading) are perceived by patients (and therefore manifested early in inspiration)
  - VT-mismatching (elastic loading) are perceived and appear at end-inspiration/early expiration).



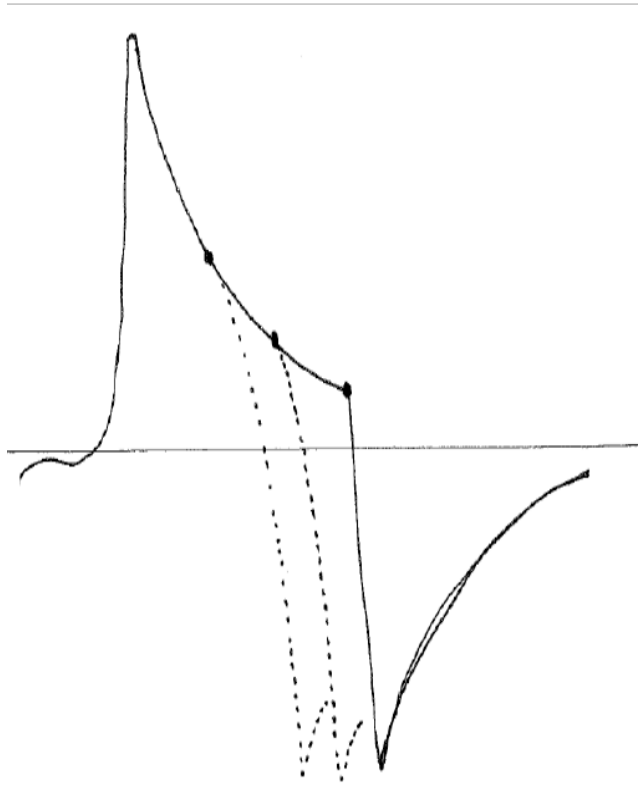
Ineffective trigger



- Patient inhales but gets no ventilator breath.
- Count missed and triggered breaths for total breaths.

- Set sensitive inspiratory trigger
  - Psens -1 to -2 cm H2O or 2–5 L/m.
- Aggressively treat bronchospasm.
- Suction trachea for secretions.
- Eliminate water from ventilator tubing.
- If auto-PEEP, then use PEEP:
  - PEEP ~2 cm H_2O < auto PEEP
  - limit 8–10 cm H_2O.
- Gradual reduction of support:
  - in PSV, reduce PS
  - in AC, reduce TV or shorten iT (limit is 0.7 sec, 0.6 sec amplifies dead space
  - reduce PEEP.

Examine waveforms: premature or delayed cycling



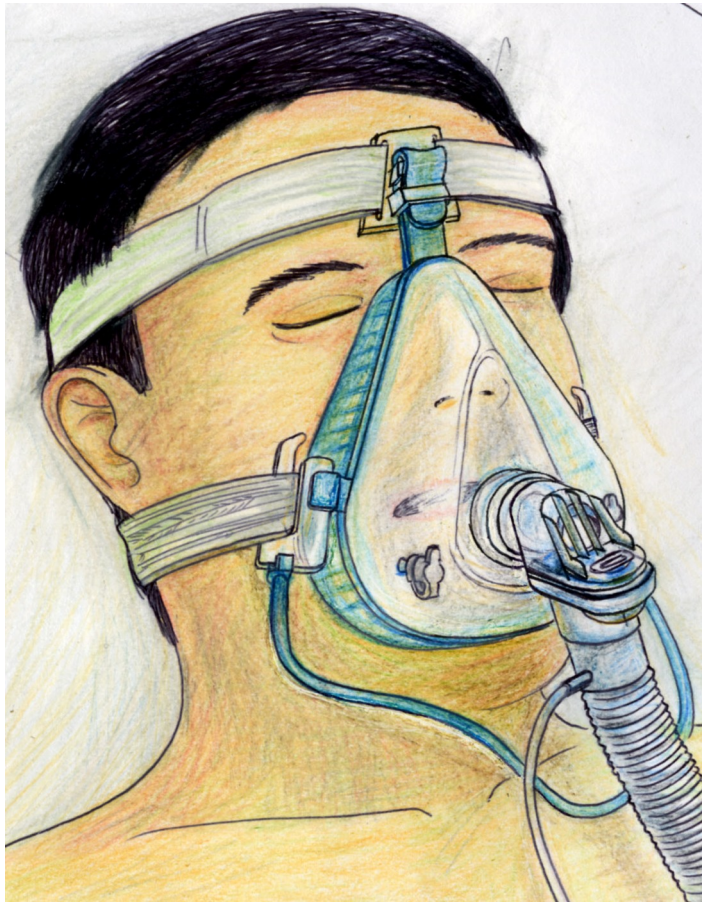
- In PSV, ventilator cycles to allow expiration at % of peak inspiratory flow:
  - usually set at 25%.
- In patients with asthma/COPD on PSV, delayed cycling is common:
  - increase % to as high as 40%.
- In ARDS, premature cycle is common:
  - reduce % to as low as 10%.

Rest overnight and try again tomorrow

- Rest patient with ventilatory support tailored to:
  - avoid muscle fatigue
  - avoid development of further muscle atrophy (use assisted mode), and
  - avoid asynchrony.
- Treat reason for failure:
  - e.g. diuresis for pulmonary oedema, replete electrolytes if levels are low.
- Early mobility and exercise.
- Conduct daily SBT evaluation next day.

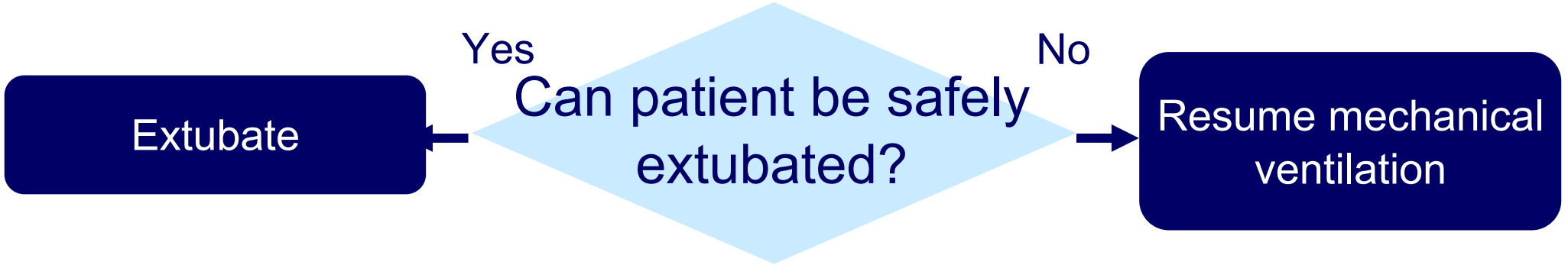
Extubation to NIV for patients who fail several SBTs

- **For patients with ARDS:**
  - extubation to NIV is **not recommended** as there is insufficient evidence.
- **For patients with acute hypercapneic respiratory failure:**
  - extubation to NIV is a reasonable option in expert centres.



Step 4

Assess for safety of extubation (1/2)



1. **Is there adequate cough?**
2. **Are there copious secretions?**
3. **Are there risks for post-extubation stridor?**

There is little clinical trial evidence to support the subsequent recommendations, though experts agree: AJRCCM, 2017.

Assess for safety of extubation (2/2)

- Cough is necessary to protect airway:
  - usually a qualitative assessment.
- Suctioning more often than every 2 hours is associated with extubation failure:
  - usually a qualitative assessment.
- Risk factors for post-extubation upper airway stridor:
  - difficult intubation
  - facial or neck infection, trauma or surgery
  - morbid obesity
  - prolonged intubation
  - female gender
  - anasarca.

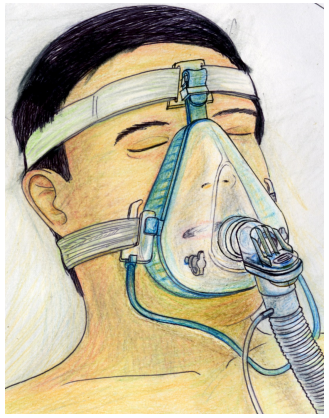
Assess for safety of extubation (2/2)

- Conduct a **cuff leak test in high-risk patients.** If cuff leak below threshold or absent:
  - delay extubation
  - consider short course of steroids
  - diuresis prior to extubation
  - reassess.

- If decision is made to proceed with extubation despite poor leak, have equipment and personnel at bedside to re-intubate.

Step 5

Extubate



- Remove endotracheal tube.
- Provide immediate oxygen therapy:
  - recent trial found use of high-flow oxygen immediately post-extubation in patients with P/F < 300 is:
    - associated with improved oxygenation, more comfort and less need for re-intubation when compared to venturi mask.
  - High risk patients (i.e. COPD, CHF) may benefit from immediate, preventative NIV post-extubation:
    - associated with fewer ICU days and morbidity and mortality.

Step 6

Step 6: Monitor-record-interpret-respond

- Frequently monitor the patient over the following 24–48 hours:
  - in high-risk patients, monitor immediately for signs of post-extubation stridor or other signs of airway emergency
  - incidence ~ 1–3%, most within 8 hours following extubation.

- If respiratory failure develops, this is a failed extubation:
  - **do not** delay re-intubation:
    - delay associated with increased mortality.
  - NIV only useful as a temporizing measure in this situation and should not delay re-intubation.

Special considerations for severe ARDS

- Patients may have prolonged course of IMV.
- The initial reduction of high levels of PEEP should be done gradually:
  - 2 cm H_2O once or twice a day.
- Once readiness criteria are met, a pressure support trial is preferable to the other methods.

Tracheostomy (1/2)

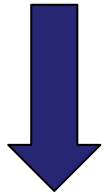
- Early tracheostomy in patients requiring prolonged mechanical ventilation does not reduce mortality.
- In general, patients that require prolonged ventilation (> 10–14 days) and are expected to survive, may benefit from tracheostomy:
  - clinicians may remove the patient from the ventilator more aggressively as artificial airway is in place.
- Careful consideration of risk and benefit of this invasive intervention coupled with good communication with patient/surrogate is key.

Tracheostomy (2/2)

- Special considerations:
  - if critically ill patient has prolonged need for mechanical ventilation but prognosis is poor, then tracheostomy is unlikely to provide benefit
  - patients with neurologic injury and potential for meaningful recovery, may benefit from early tracheostomy.

ABCDEF bundle

Create a workflow at your hospital that allows reliable implementation of all practices to ensure optimal outcomes.



Days IMV, length of stay, delirium, long-term cognitive and disability impairments, and mortality.

Summary

- Use a daily coordinated SBT protocol to liberate patients from mechanical ventilation to improve patient outcomes.
- The reason for SBT failure in patients should be identified and treated and an attempt made the following day.
- The airway should be assessed prior to extubation in patients successfully passing the SBT.
- Monitor the patient after extubation over the next 48 hours for signs of respiratory failure and need for re-intubation.
- Implementation as part of an ABCDEF bundle will lead to more optimal patient outcomes.

Acknowledgements

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