BASICS OF MECHANICAL VENTILATION
FREE ONLINE COURSE

Patient-Ventilator Dyssynchrony

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Conflicts of interest

• Our clinical research laboratory has received equipment or research grants for clinical research projects from the following companies:
  – Covidien (PAV+)
  – Air Liquide (CPR)
  – Sentec (tcPCO2)
  – Philips (Sleep)
  – Fisher Paykel (Optiflow)
Patient-Ventilator dyssynchrony

- Most patients are ‘assisted’ by the ventilator
- This assistance is supposed to be **synchronous** with patient’s respiration
- The main reason for **sedation** is to ‘adapt’ the patient to the ventilator and avoid dyssynchrony
- Dyssynchrony on the vent is associated with **longer duration of ventilation and higher mortality**
- Part of this association may be mediated by **inadequate management**
...ICU ventilators

Medtronic
PB

Avea

Hamilton

Engström

Draeger

Maquet
Getinge

Air Liquide
Good Synchrony: Paw follows Pes
What dose of ventilation?

Dysfunction

Respiratory Distress

Patient-Ventilator Asynchrony

Normal WOB

Patient-Ventilator Asynchrony

VILI
VALI
VIDD

Dose of Ventilatory Support
Patient-Ventilator dyssynchrony

• Many **different types** of dyssynchrony
• Detected from waveforms, alarms, agitation or often **undetected**
• Step 1: **understand** the type of dyssynchrony and its mechanism
  – How is the **patient** (agitation, sleepiness, work of breathing)? Respiratory Drive (**P0.1** [1-3.5 cmH2O])
  – How much **ventilation** / needs?
  – How much **sedation** / needs?
Patient-Ventilator dyssynchrony

- Step 1: understand the type of dyssynchrony and its mechanism
- Step 2: adjusting *ventilator* settings
- Step 3: need to *increase* respiratory drive? (reducing ventilation and/or sedation)
- Step 4: need to *decrease* respiratory drive? (increasing ventilation and/or sedation)
Recorded waveforms 2014-10-01 15:48:36

PSV

30 cmH₂O

80 l/min

-80 -700 ml

5 μV

15 cmH₂O

80 l/min

-80 -700 ml

5 μV

15 cmH₂O
Assistance in excess

- Auto-triggering
- Apneas
- Ineffective Efforts or Missed Cycles
When to suspect auto-triggering?


during controlled ventilation:
- RR > adjusted RR
- Respiratory alkalosis

during assisted ventilation:
- Sudden increase or persistently high respiratory rate
- Absence of an airway pressure drop at beginning of the cycle
- PSV: short cycle with a flow signal distortion
- ACV: abrupt airway pressure increase
Assistance in excess

• *Auto-triggering*

• Apneas

• Ineffective Efforts or Missed Cycles
Pressure support ventilation
Pressure support ventilation
Assist-Control

Pressure Support

Arousal

C4-A1
O3-A2
ROC
LOC
Chin
Leg
Vt
RC
AB
SpO2
EKG

1 min

Parthasarathy, AJRCCM 2002;166:1423
Reduction of patient-ventilator asynchrony by reducing tidal volume during pressure-support ventilation

Airway Pressure (cmH$_2$O)

Baseline PS-ZEEP
Baseline PS-PEEP
Optimal PS
Optimal Ti

Intensive Care Med 2008
Asynchrony Index (%)

Baseline PS-PEEP

Optimal PS

Thille et al., Intensive Care Med 2008
Dyssynchrony related to excessive assistance

- Patient sleepy
- Low respiratory drive
- → Decrease ventilation
- → Decrease sedation
Insufficient Assistance

- Air hunger or flow starvation
- Double triggering, breath stacking and short cycles
Ventilation assistée-contrôlée
Ventilation assistée-contrôlée
Ventilation assistée-contrôlée
Peak Flow and Work of Breathing

Under Assistance

Airway Pressure (cmH$_2$O)

Flow (L/min)

Beginning of patient's effort

End of patient's effort

Double Triggering

Continuation of patient’s effort
**Under Assistance**

- **Airway Pressure (cmH₂O)**
  - **Flow (L/min)**
  - **Esophageal Pressure (cmH₂O)**

**Double Triggering**

- **Beginning of patient’s effort**
- **End of patient’s effort**
- **Continuation of patient’s effort**
Effect of Lung Recruitment and Titrated Positive End-Expiratory Pressure (PEEP) vs Low PEEP on Mortality in Patients With Acute Respiratory Distress Syndrome
A Randomized Clinical Trial

Writing Group for the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial (ART) Investigators
Volume Assist-Control

Passive

Active

Pressure Assist-Control

Passive

Active

Akoumianaki E et al AJRCCM 2014
Dyssynchrony related to insufficient assistance

- Patient working hard
- High respiratory drive
- → Increase sedation
Excessive Sedation?

- Respiratory Entrainement or Reverse Triggering
Accidental observation...
Clinical consequences: VT increase
Clinical consequences: double cycle
Reverse triggering dyssynchrony 24 hours after initiation of mechanical ventilation
Ricard Mellado Artigas, L. Felipe Damiani, Thomas Piraino, ...Laurent Brochard
In revision

40% (1 µV) or 26% (3 µV) patients have > 10% RT
ACV

Flow (L/s)

Airway Pressure (cmH₂O)

Double triggering

8 s

Time (s)
Dyssynchrony related to reverse triggering

• Patient sedated
• respiratory drive?
  → Decrease sedation?
  → Increase ventilation?
Reverse Triggering

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Reverse triggering is a type of dyssynchrony that occurs when a patient effort occurs after (is triggered by) the initiation of a ventilator (non-patient triggered) breath. Usually, it is a phenomenon occurring over many consecutive breaths and also referred to as 'entrainment'. Diagnosis The visual detecting of reverse triggering is slightly different between modes of...

Read More

Name this Asynchrony 4

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P0.1 < 1 cmH2O

P0.1 > 3.5 to 4.0 cmH2O

Telias I et al AJRCCM 2020 In press