Waves Curves & RT’s

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Disclosure

I have no actual or potential conflict of interest in relation to this presentation

This presentation is for informational/educational purpose only

In the beginning there was.....

- Drager pulmotor

Ventilator in a box
Non Invasive Route

Chest Respirator ‘aka’ Chest Cuirass

Philip Drinker & Louis Agassis Shaw
Tank Respirator (1927)

Drinker’s iron lung cost about $1,500—the average price of a home
John Emerson Iron Lung (1931)

Emerson's Iron Lung was quieter and cheaper $1000

1952 Polio

Puritan Bennet MA 1 (1967)
Drager EV-A (1982)

PB 7200 (1983)

Current ICU Ventilators
Non Acute Care Ventilators

So what’s all the Fuzz?

- We survived without monitors
- Cost of the device
- In the end half the therapist/clinicians don’t know how to interpret graphs
- Is it worth it??

What does the literature say

- Quote studies
- Used more frequently in the Neo/Ped areas
- Diagnostic/trending and troubleshooting tool
- Every student, fresh grad and practicing Rt should be competent in interpreting wave forms
Optimizing patient-ventilator synchrony is essential in managing patients who require prolonged mechanical ventilation in the long-term acute-care hospital. Daily ventilator checks (that include calculation of the lung compliance) and the availability of pressure-volume graphs can help ensure the correct settings.

Appropriate recognition and management of patient-ventilator asynchrony require bedside assessment of ventilator graphics as well as direct patient observation.

Asynchrony is an important and common problem that can occur at several points in the breathing cycle. The Pigtail Sign On Flow Pressure Loops Is a New Way To Detect Secretions and frequency of suctioning.

Are you convinced?
Like any visual picture or art, information about waveforms cannot easily be conveyed in words or taught in didactic lectures.

**DID YOU KNOW**

Regardless of the type of mode or breath:

- 4 parameters will always be displayed as scalar graph.
- Pressure, Volume, Flow & Time.
- The type of graph you select will depend on what you are trying to monitor or troubleshoot.
- 2 types of waveform graphics.

**Scalar Graph**

- **Pressure**
- **Flow**
- **Volume**

- **Expiration**
- **Inspiration**
- **Time/sec**

- Inspiratory phase: Active
  - Affected by ventilator modes and settings
- Expiratory phase: Passive
  - Affected by respiratory system
  - Affected by the patient's respiratory component
  - Ventilator of compliance, leak
**Inverse Ratio Ventilation** OR

- **cmH2O**
- **L/min**
- **mL**
• Inspiratory time is shortest for square wave flow form
• Highest peak inspiratory pressures (PIP)
• Low mean airway pressure (MAP)
  - helps with venous return and cardiac output
  - Mostly use with Volume control mode
• Usually preferred as the initial flow rate since it meets the flow demand of the patient.
  Decreases air hunger
• Flow waveform can be changed depending on the ventilator options
FLOW WAVEFORM - DESCENDING RAMP

- Increases inspiratory time (if not fixed) or peak inspiratory flow rate (if inspiratory time is fixed)
- Least peak inspiratory pressures
- Decreases expiratory time, potential for auto PEEP
- Increases mean airway pressure
  - helps lung inflation and improves oxygenation
- Always used with Pressure control mode
- Similar to square wave, its preferred for AC/SIMV patients
  - as the initial flow rate meets the flow demand of the patient.
  - Decreases air hunger

FLOW WAVEFORM: SINUSOIDAL

- Inspiratory time is the shortest
- Comfortable for patient since it mimics natural breathing
- Flow starvation
  - Low Mean Inspiratory pressure
    - better venous return and cardiac output
- Used with CPAP/spontaneously breathing modes
  - Should not be used with control/assist modes.

FLOW WAVEFORM: Ascending Ramp

- Longer I-Time
- Initial start up flow is slow
- Used with CPAP/BiPAP modes as a ramp feature
- Not recommended for patients on A/C mode
- Leads to air hunger, Dy synchrony–
Loop Graph

Non intubated patient

Inspiration

Expiration

Intubated patient

Flow

Volume

Non intubated patient

PEFR

PIFR

Intubated patient

VT

FRC

PEFR

PIFR

VT

Loop Graph

Controlled

Assisted

Spontaneous

Loop graph

Leak
- Incomplete loop, the waveform never returns to baseline or zero
- Cause – Et tube cuff leak, leak around area of chest tube, BP fistula, loose circuit connection
- Fix – Check the inspiratory and expiratory circuit of the ventilator, replace the ruptured Et tube or insert a bigger size

Also an indication that the prior swelling or edema has decreased
Loop Graph - Leak

Scalar Graph - Leak

Scalar graph

Auto PEEP
- The expiratory flow does not return to baseline before the beginning of the next breath
- **Cause** – Hyperventilation which decrease E time, Short E Time, increased RAW can lead to air trapping
- **Fix** – Increasing expiratory time, increasing the flow and increasing PEEP/MAP
Water/secretion in the circuit

Autotriggering can occur sometimes due to water in the tubing.

Loop graph

Overdistension
- penguin or bird beak formation at the top of the loop
- Cause – high VT or Pressure
- Fix – decrease VT or Inspiratory pressure
- Remember VE will decrease
It is a good graph to monitor the constant change in RAW and compliance of the patient lung

Loop graph

Obstruction
- peaking of the loop (or a concave area) with a decreased flow rate, increased RAW
- Cause – secretion in the airway, bronchospasm, water in the tubing, plugged airway
- Fix – Suction the patient, bronchodilator therapy, empty the condensation in the ventilator circuit
Scalar Graph - Bronchospasm

Loop graph

Compliance
- The farther the loop moves to the right and the more horizontal it is to the pressure axis the lower the compliance of the lung
- Cause – Patients with RDS, pulmonary edema, BPD
- Fix – Surfactant replacement therapy, optimum PEEP

Lung compliance

- > 45 = 1 Compliance
- < 40 = 1 Compliance
To sum it all up

Ventilator graphics and monitoring capabilities present RT’s with multiple opportunities to:

- Apply respiratory physiology at the bedside and to use them to improve patient care and outcomes
- Become experts in reading waveform and graphics like telemetry staff and use it as a diagnostic tool
- Incorporated it into your everyday practice to optimize ventilator settings
- Make ventilator graphics and waveforms a vital part of your curriculum, orientation/preceptor program and daily rounds similar to chest radiograph and electrocardiogram.
- Use it when trouble shooting ventilator related issues

Similar to an artwork

Appreciation and understanding waveforms takes practice

Artist: Oleg Shuplyak

ANY QUESTIONS?

Waves, Curves, and RT’s