

# Ventilator Graphics and Asynchrony Let's Look Again

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Credits:

Special thanks to Drager®, Maquet®, and Dr. Jeffrey Johnson (Denver Health)

# Learning Objectives

As a result of this course, participants will be able to:

- **Recognize** ventilator graphics that represent the most common causes of ventilator **asynchrony**.
- **Identify** necessary **corrective procedures** after an assessment of ventilator graphics.
- **Explain** the specific **cause** of an abnormal ventilator scalar.



## Disclaimer:

Expertise in the interpretation of **ventilator waveforms** does not necessarily guarantee the ability to successfully correct any of the underlying causative factors

# Variables of PPV

❖ Flow

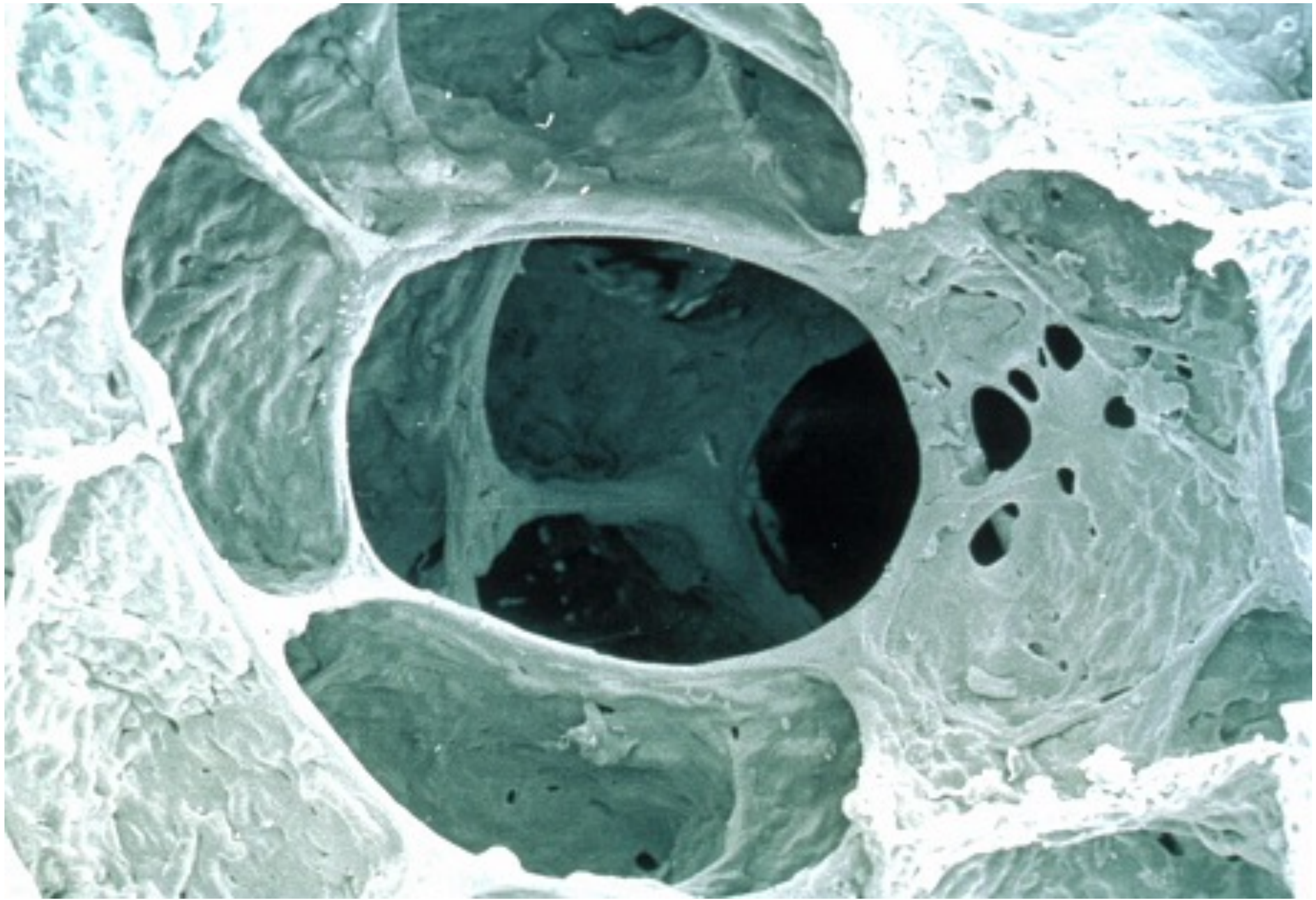
❖ Pressure

❖ Volume

❖ Time







# Equation of Motion

$$P_{\text{VENT}} + P_{\text{MUSC}} = (E \times V) + (R \times V)$$

- ❖  $P_{\text{vent}}$  – pressure generated by ventilator > PEEP
- ❖  $P_{\text{musc}}$  – pressure generated by inspiratory muscles
  
- ❖  $E$  – respiratory system elastance
- ❖  $V$  –  $\Delta$  lung volume above FRC
  
- ❖  $R$  – respiratory system resistance
- ❖  $V$  - flow

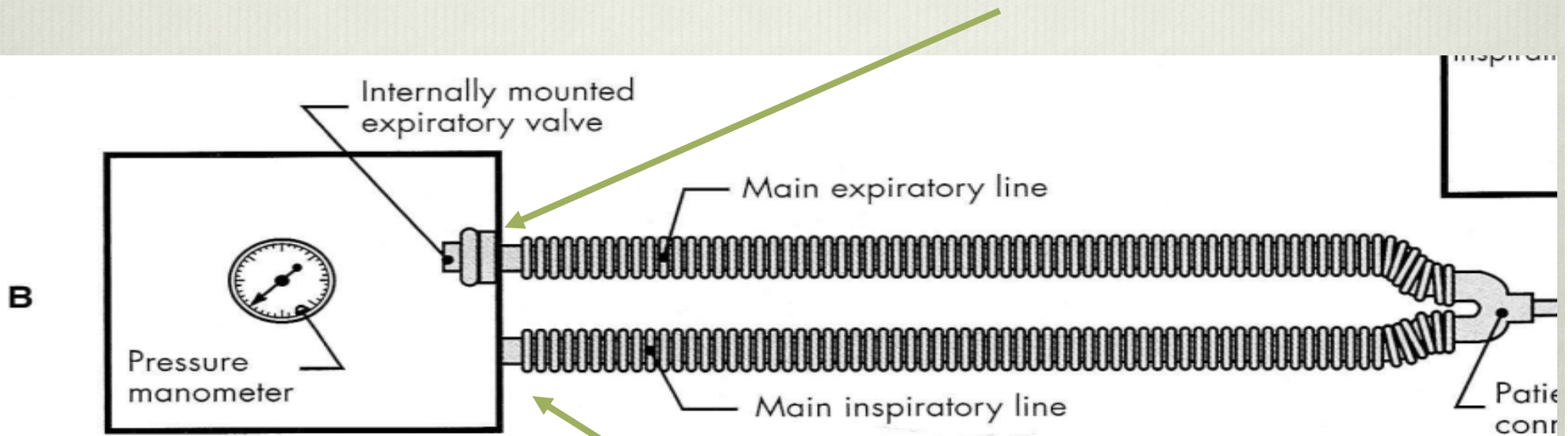
# The Respiratory Equation of Motion

$$\Delta \text{ Pressure} = R_{aw} \times \text{Flow} + CL/\text{Volume}$$

Airways    ET tube    Lung    Chest Wall



# Sensors Simplified



“The eye should learn  
to listen before it looks.”

***Robert Frank***

“A picture is worth a thousand words...”

...and a ventilator waveform is worth a second look.

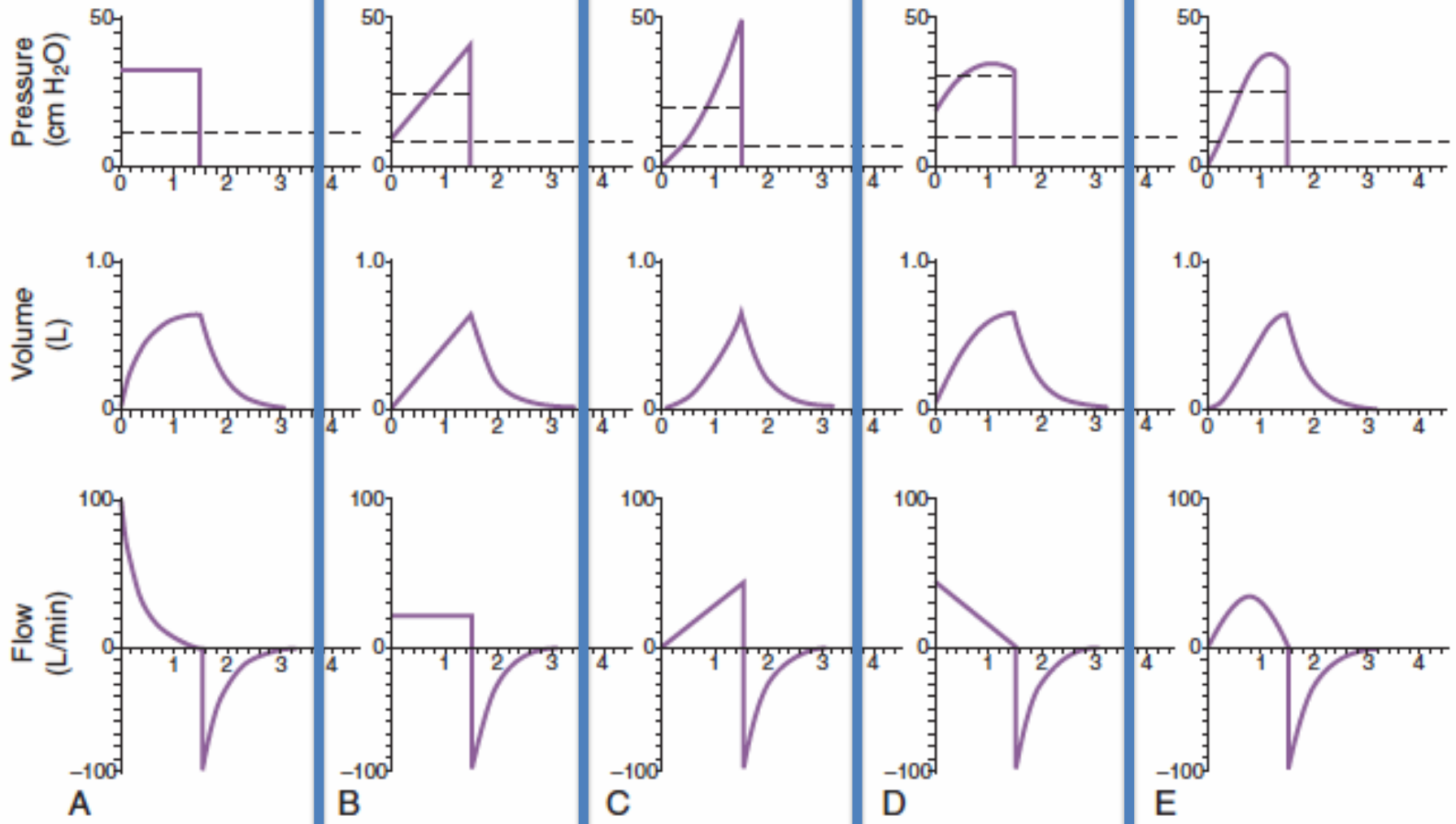
# Professor Chatburn's Recommendations

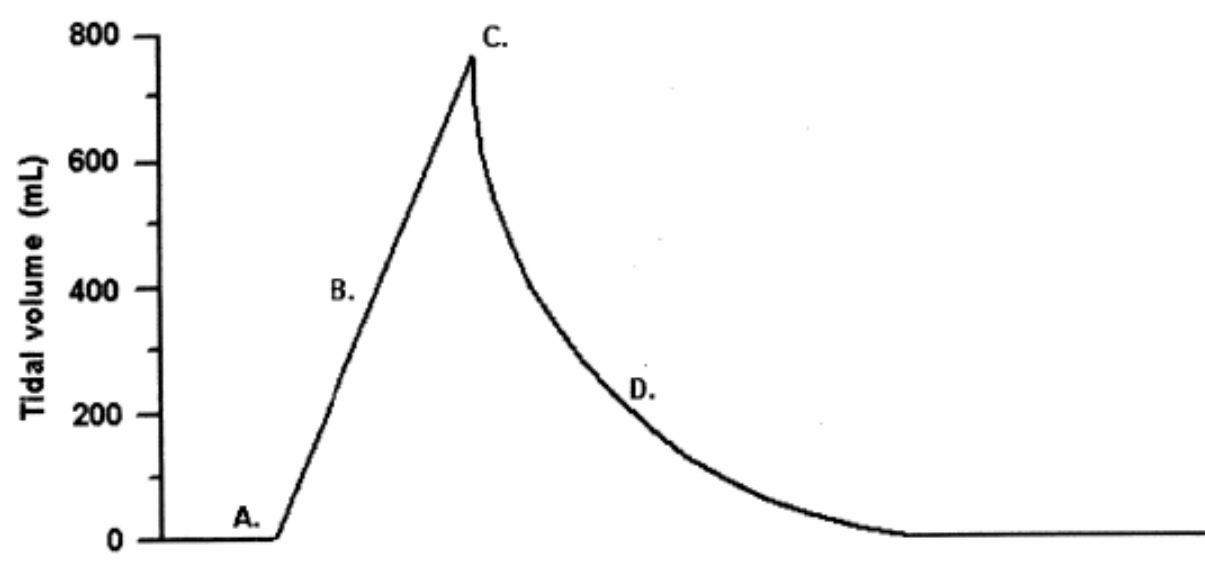
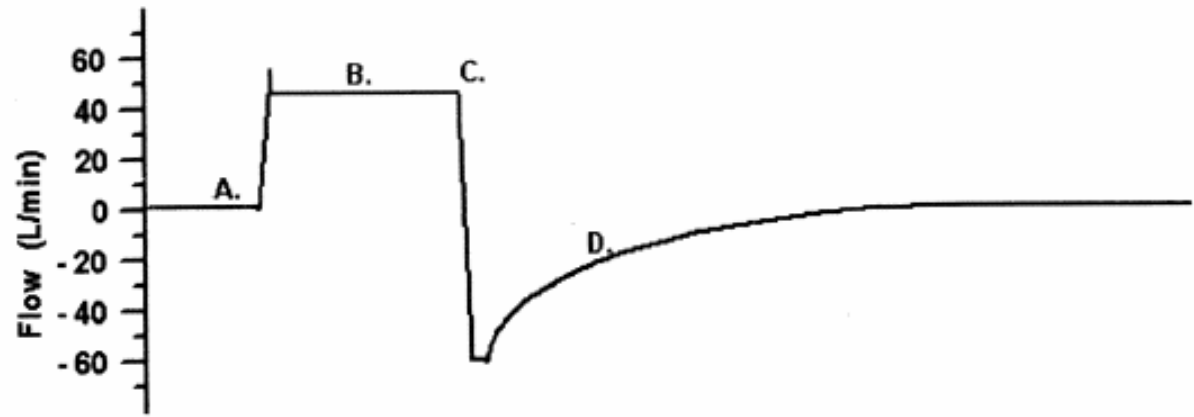
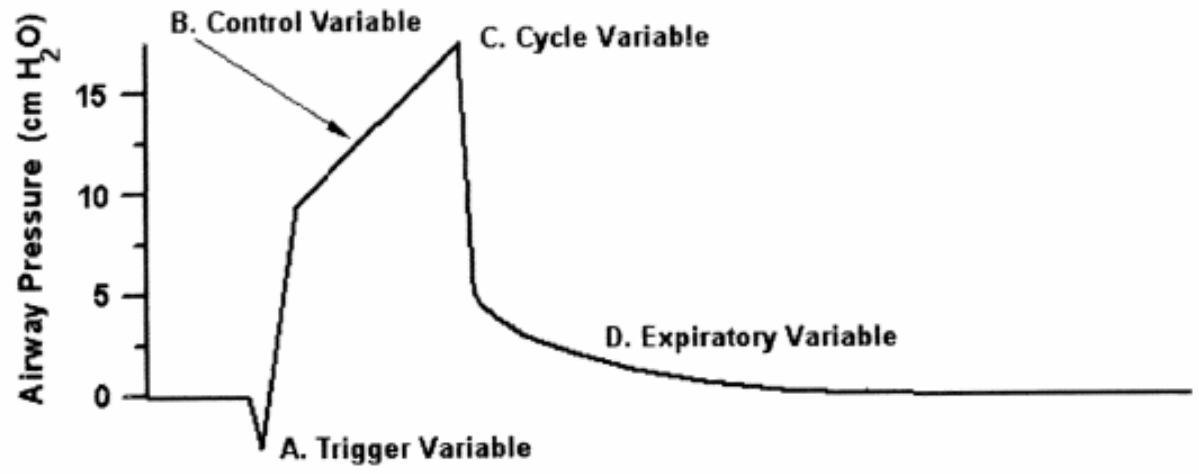
Identify the  
**Ventilation  
Mode** and  
**Control  
Variable**

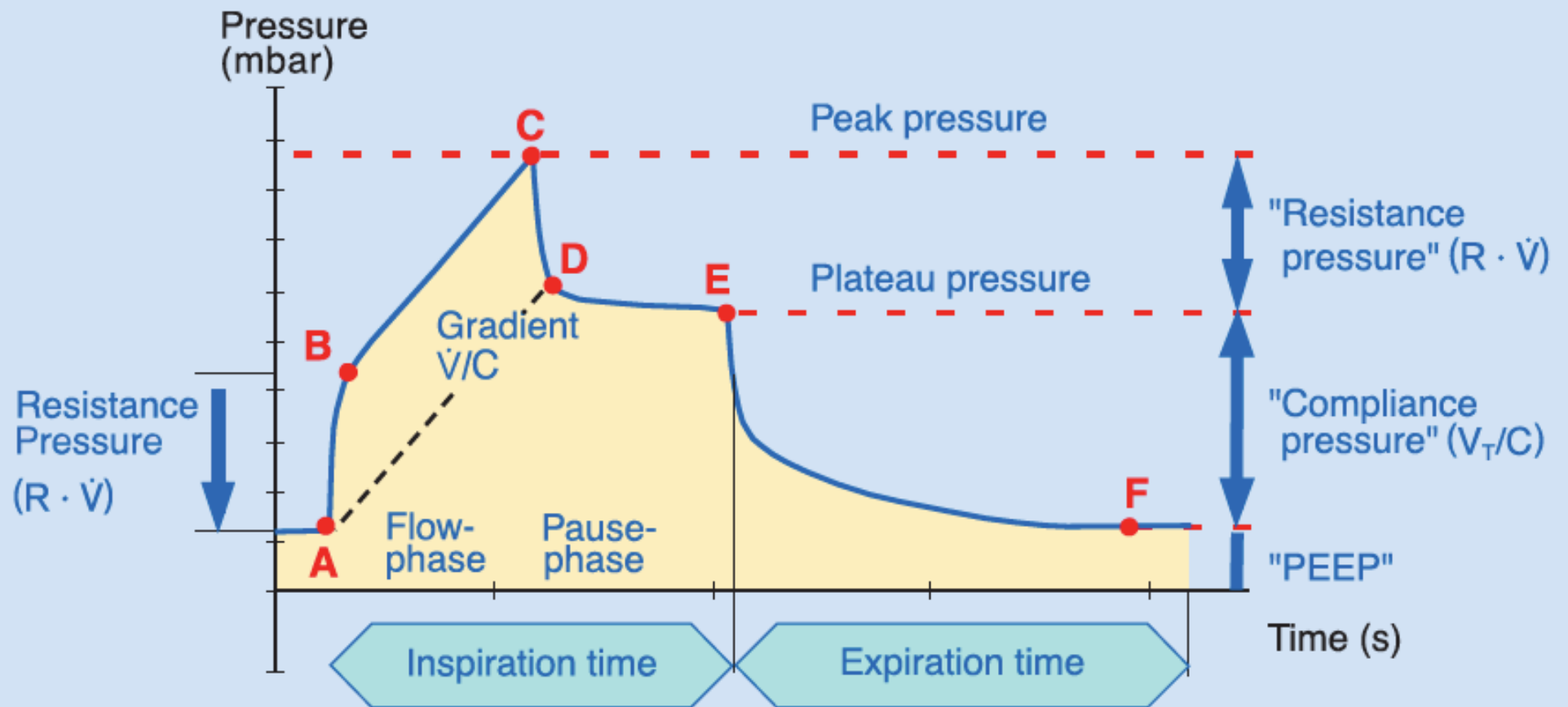


# **WARNING**

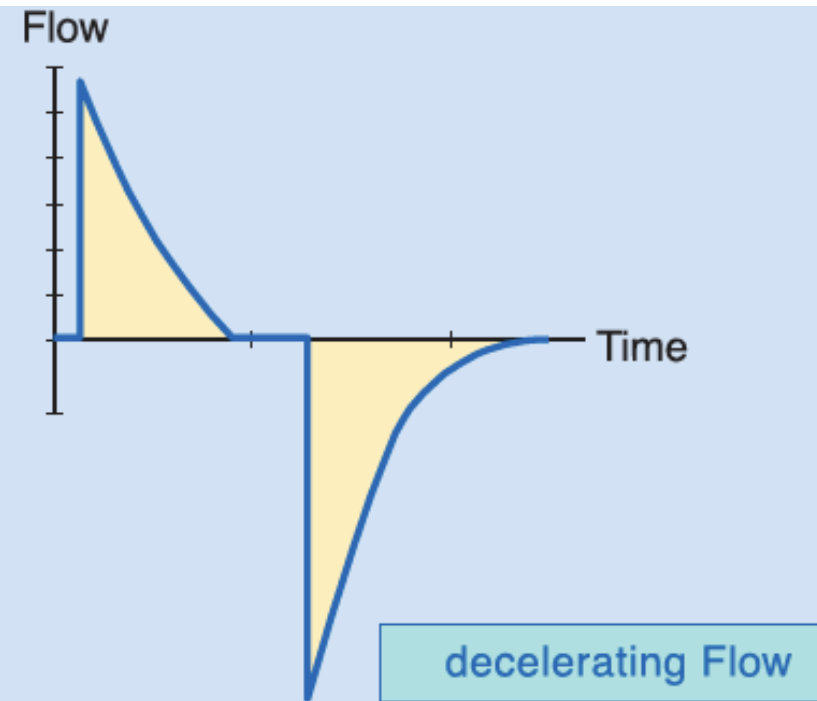
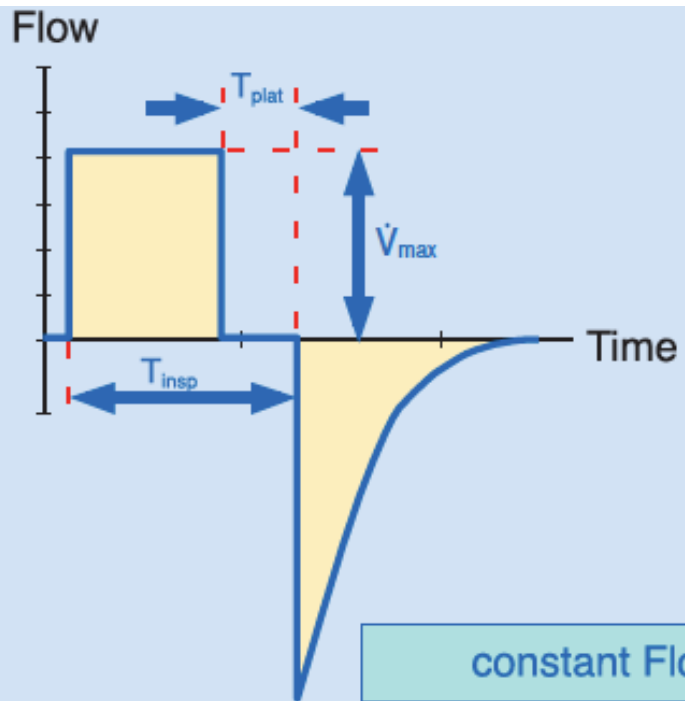
**This gallery contains graphic  
images that some viewers  
may find disturbing**

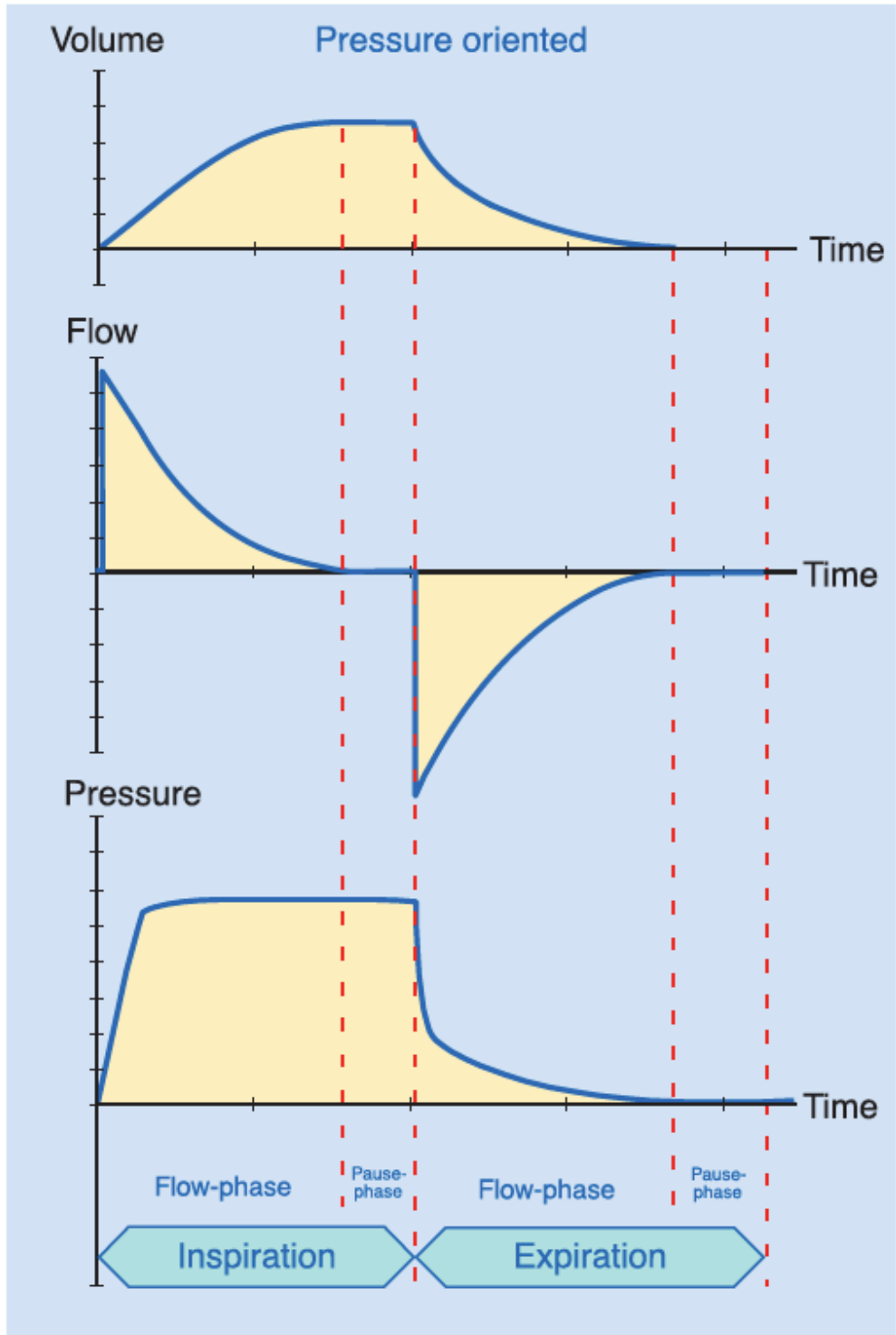
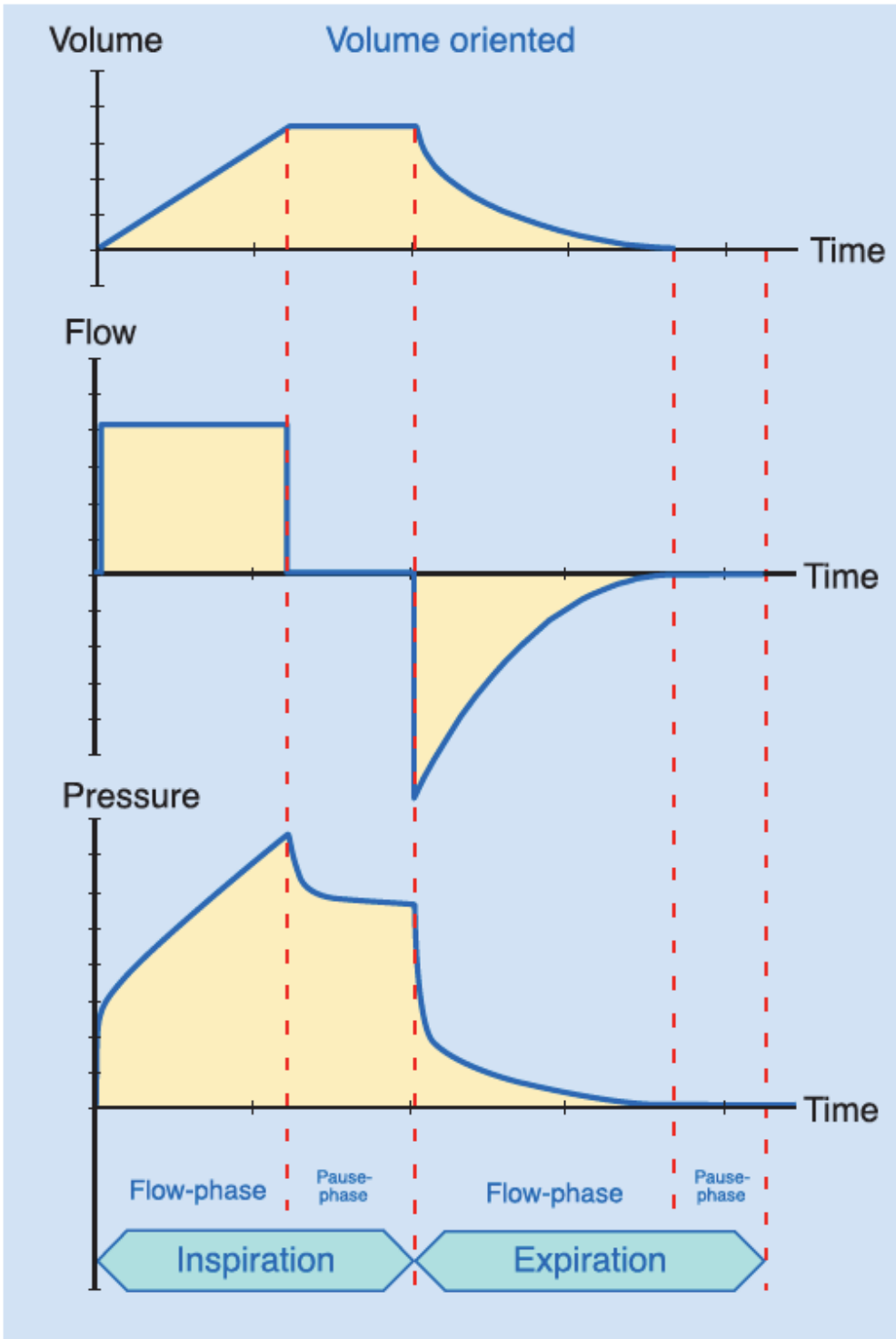






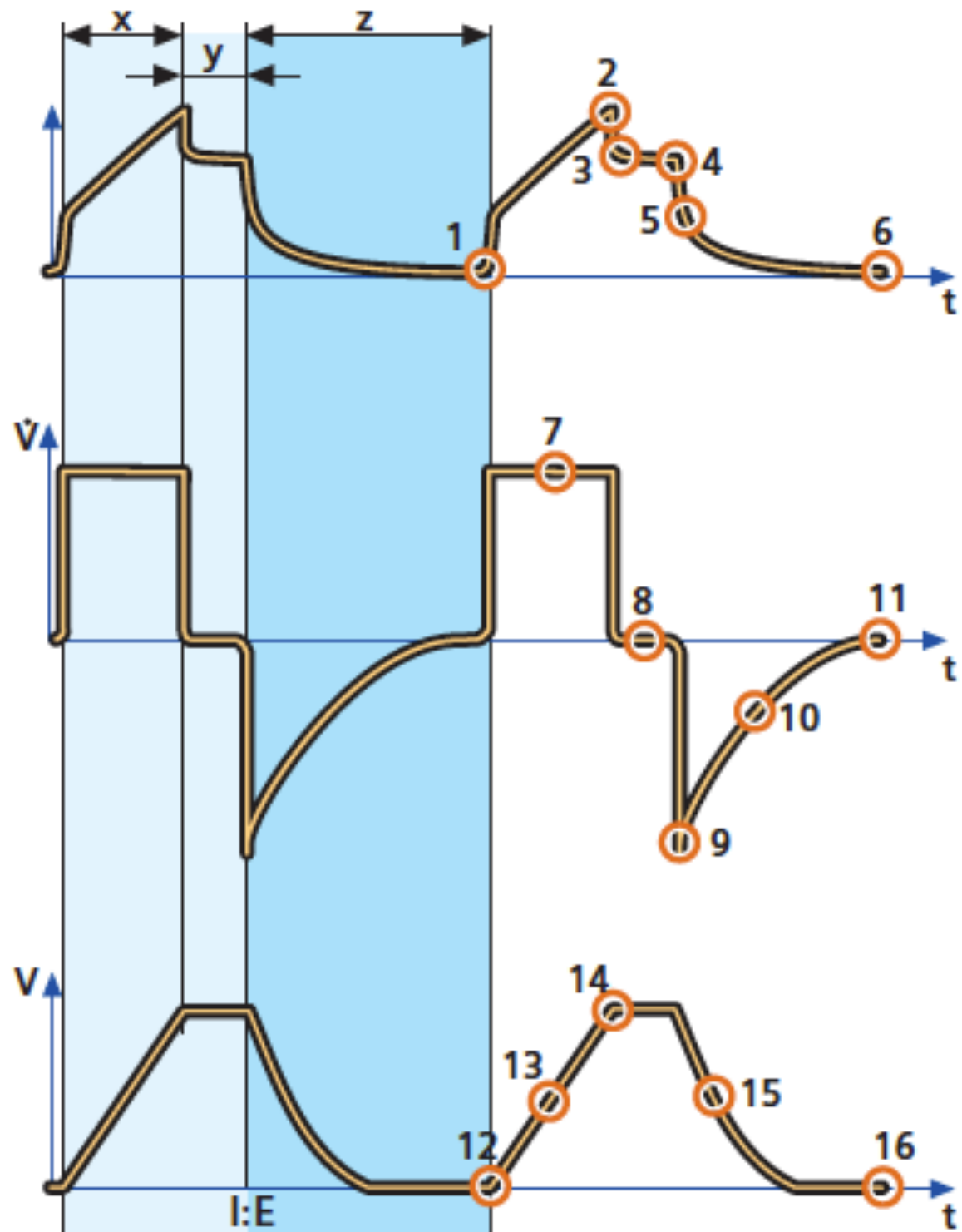
$(\dot{V}_{insp} = \text{const.})$

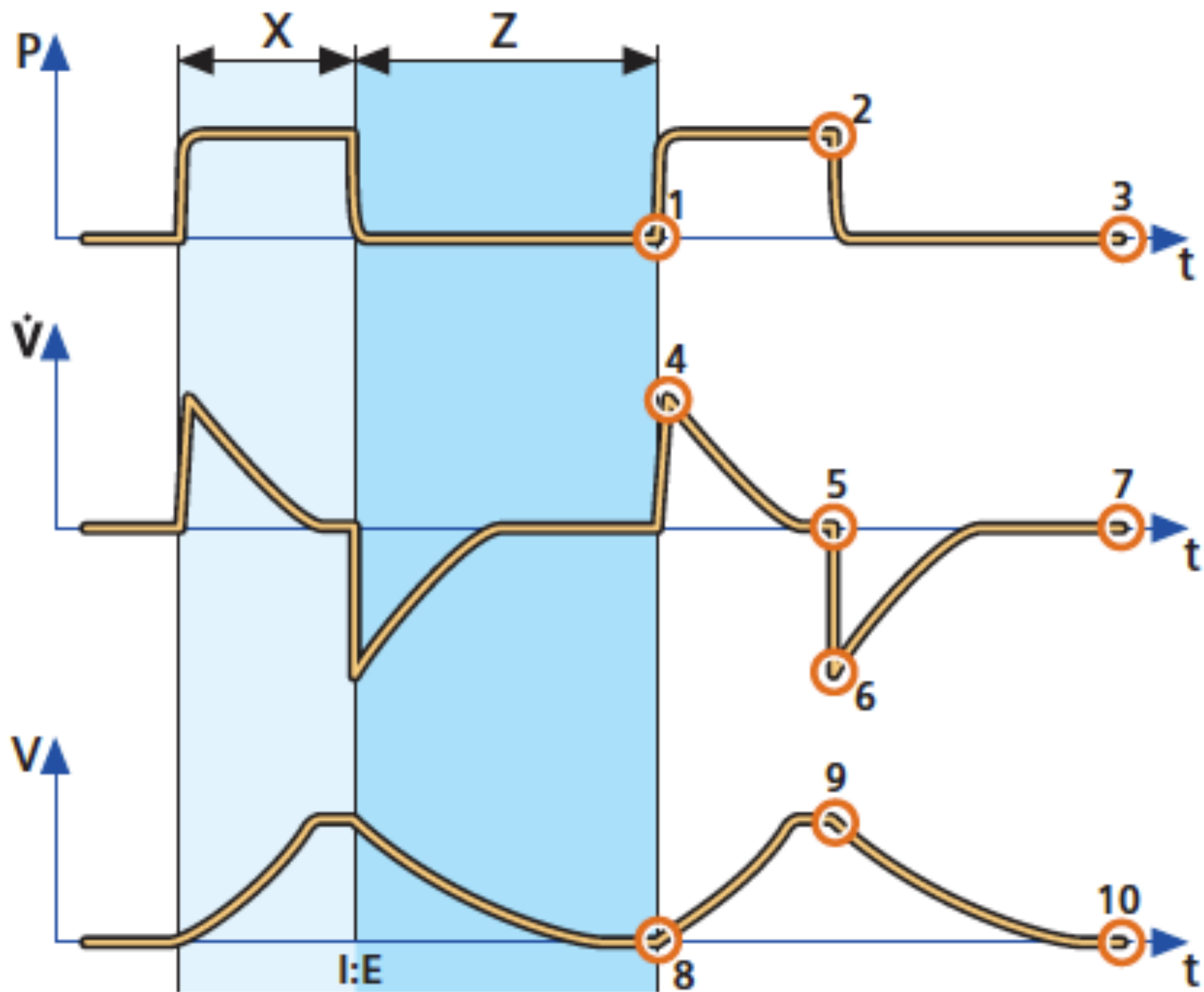




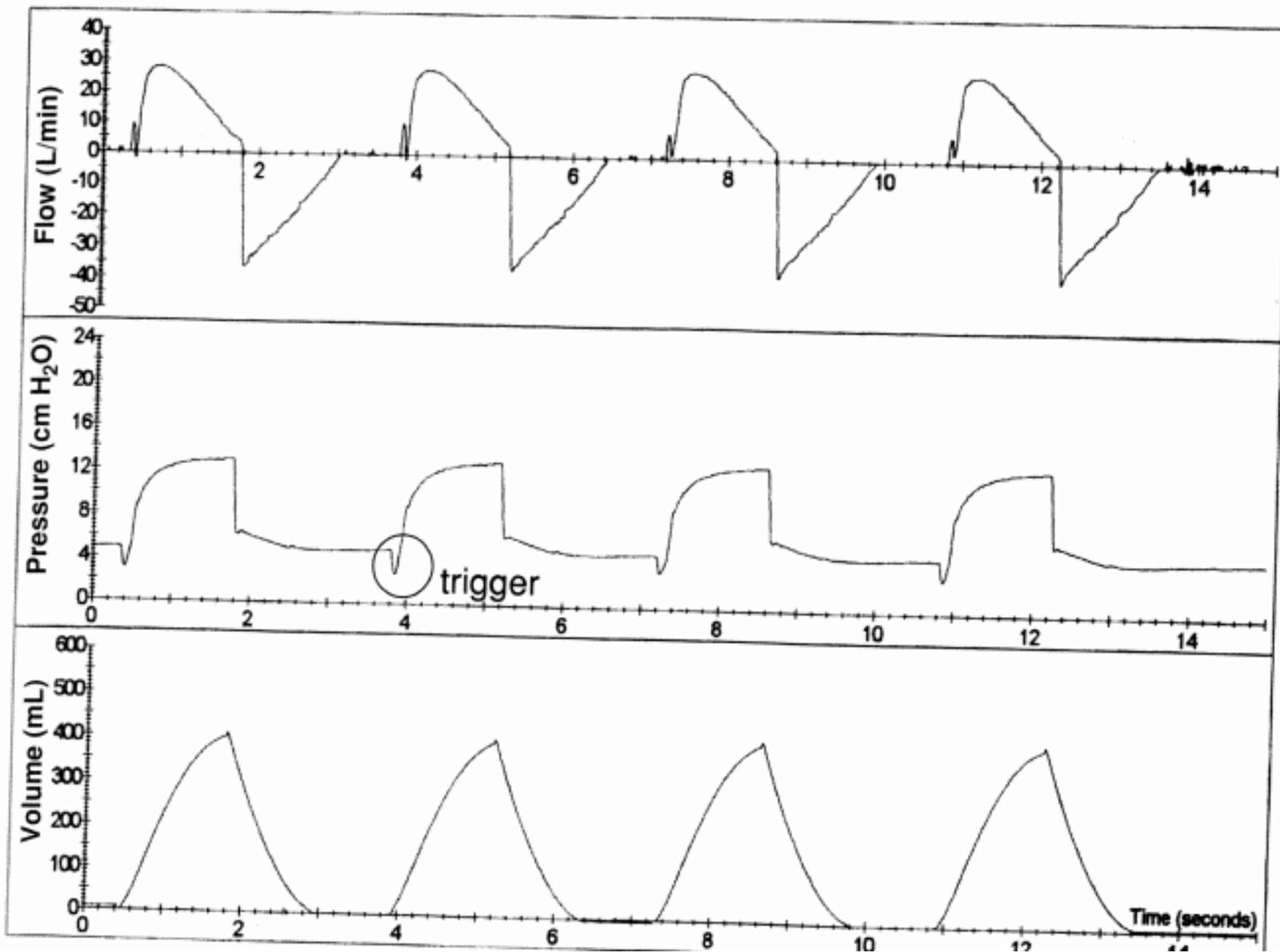
**WHEN THE RN STARTS**

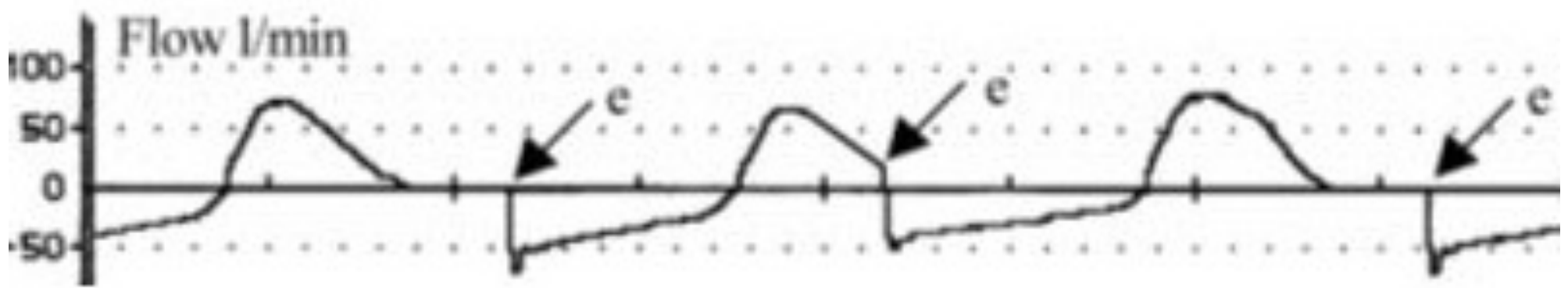
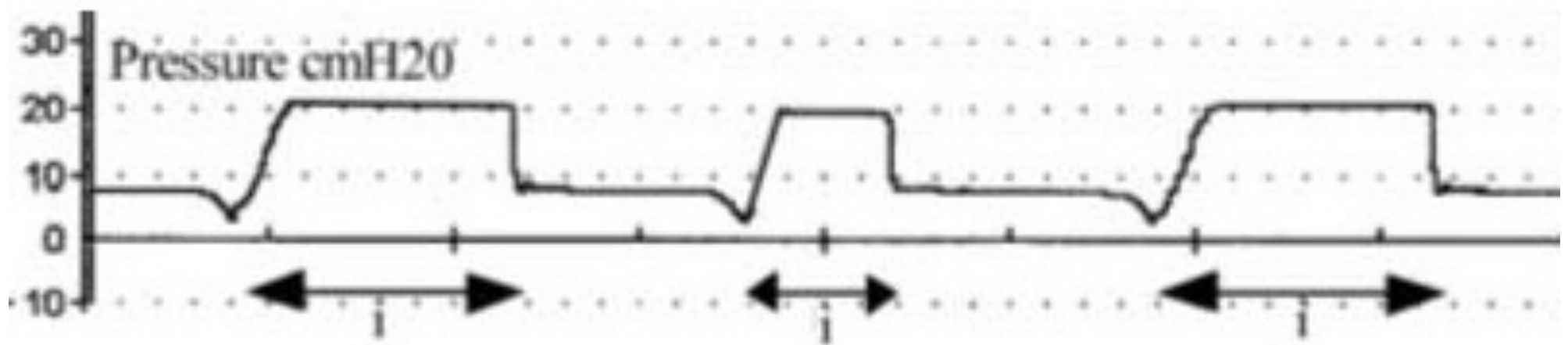
**TURNING THE PATIENT  
DURING YOUR VENT CHECK**

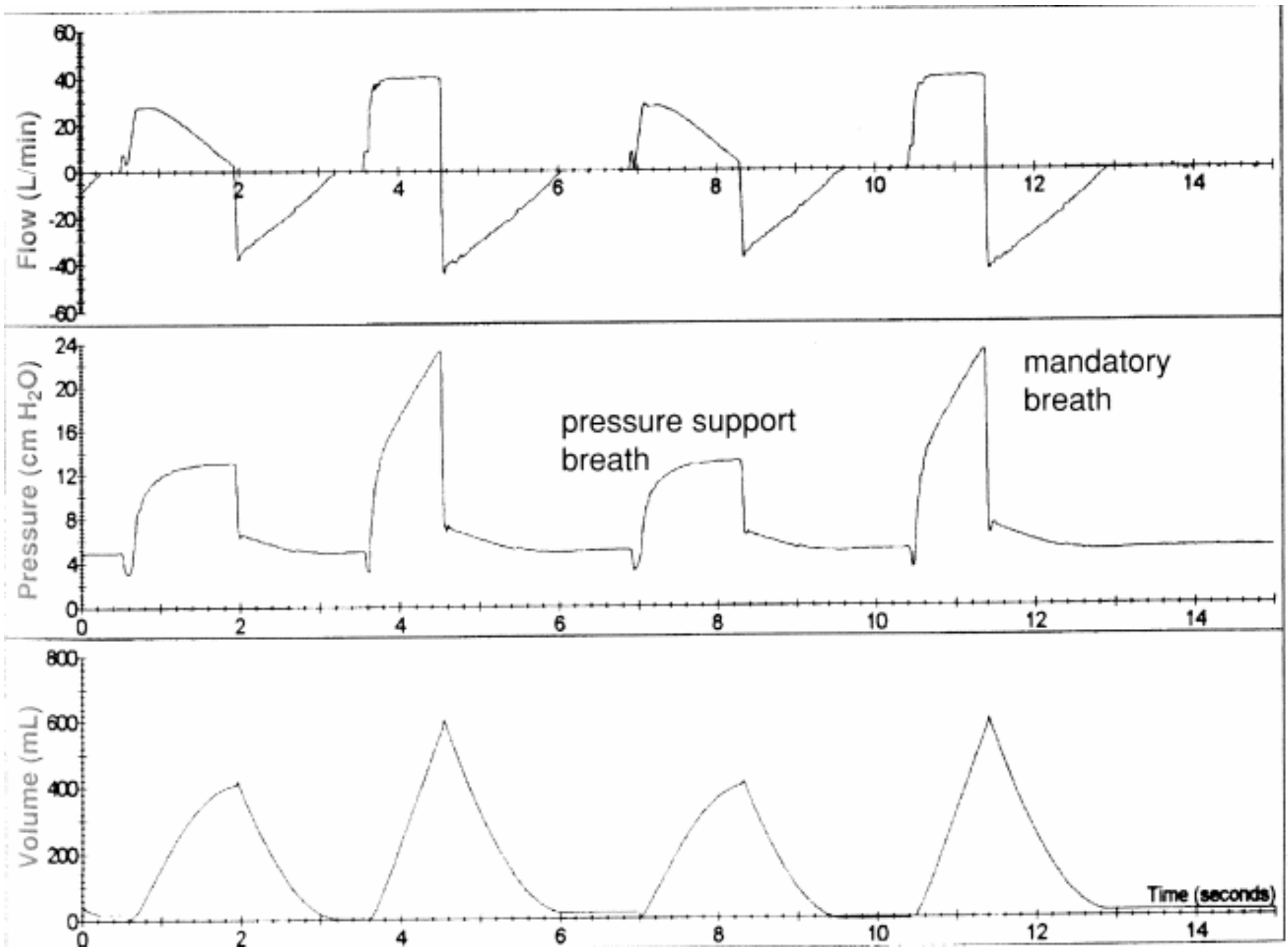


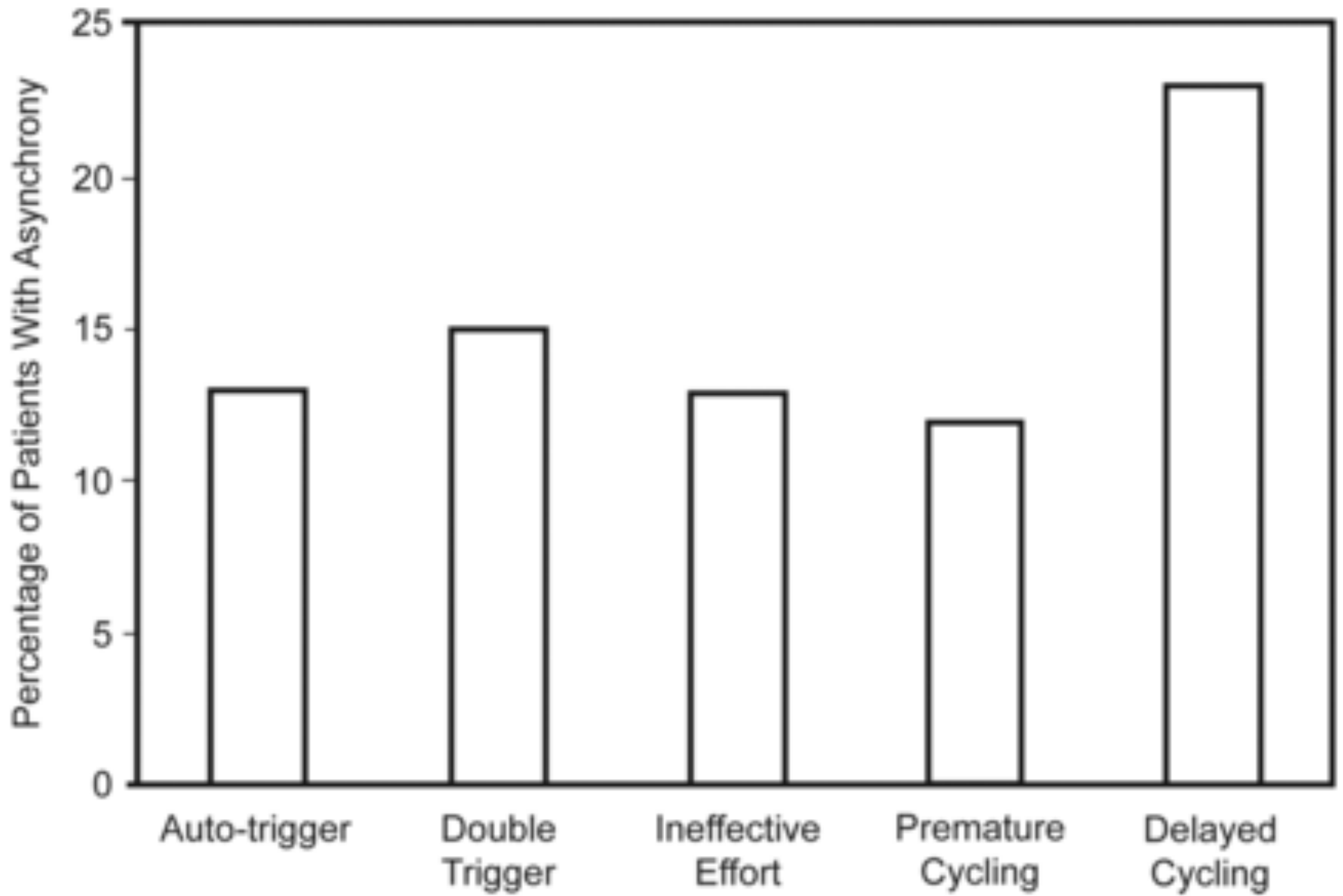


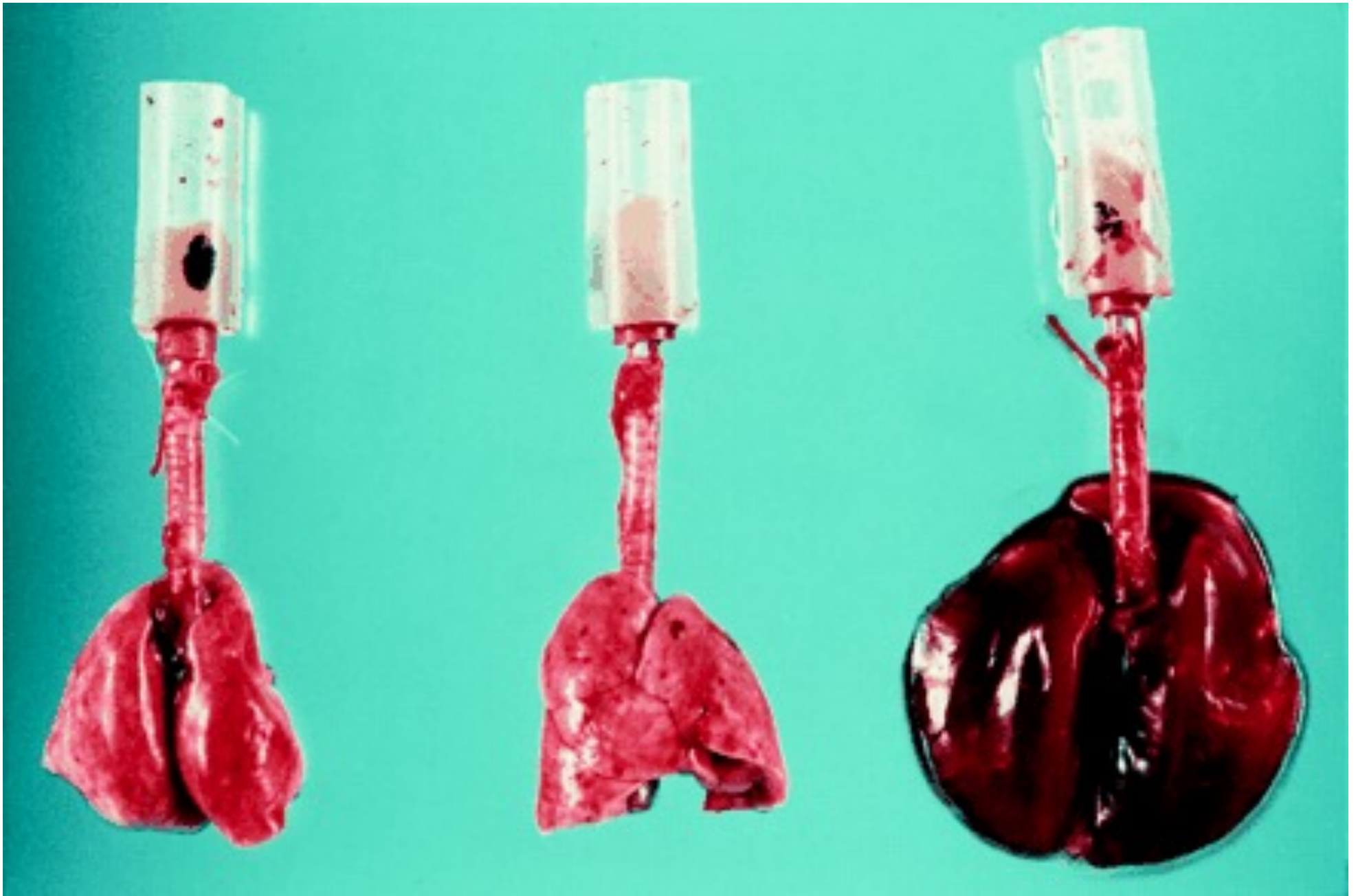






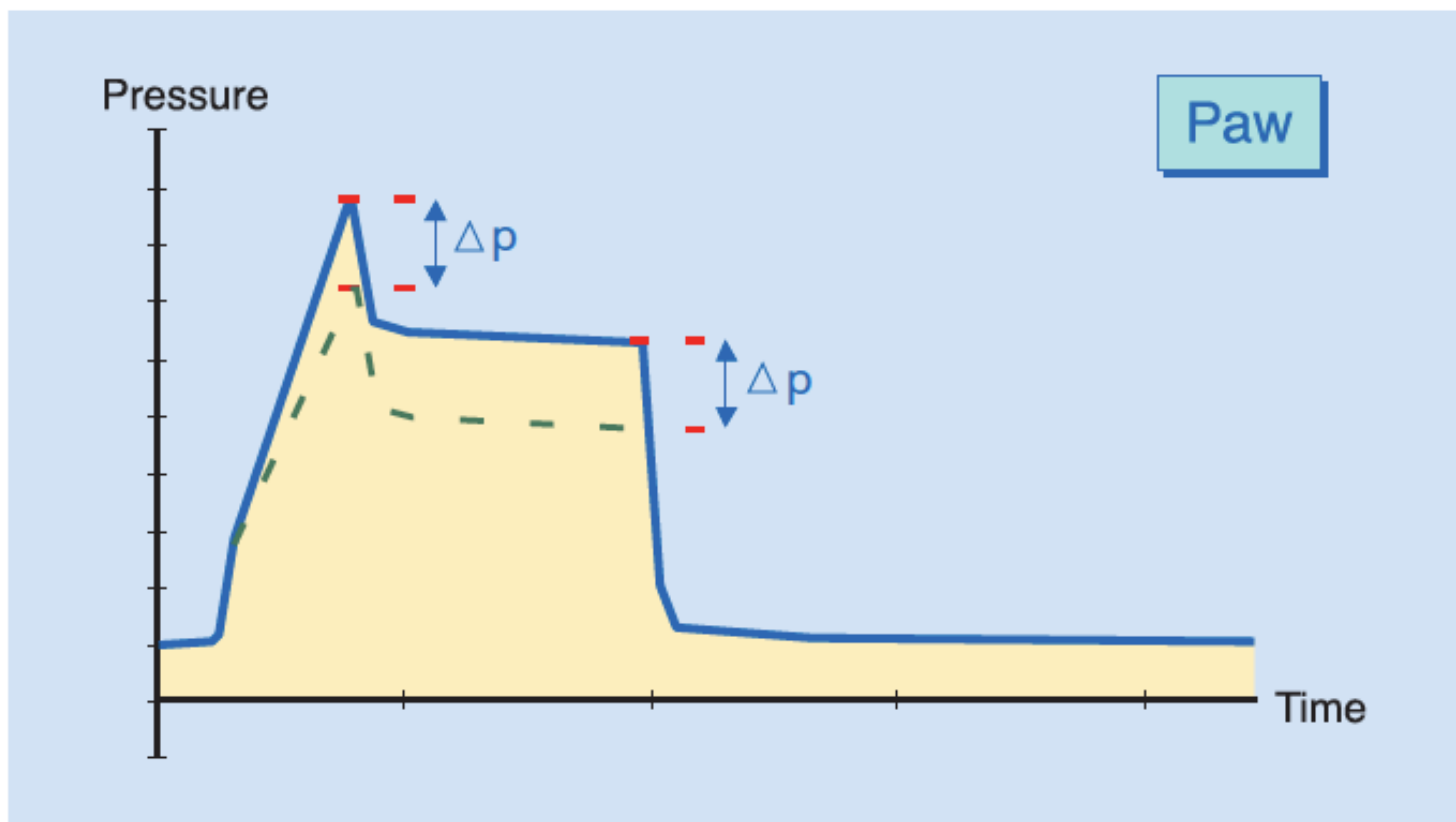






Dreyfuss, et al.; Am Rev Respir Dis. 1985 Oct;132(4):880-4.



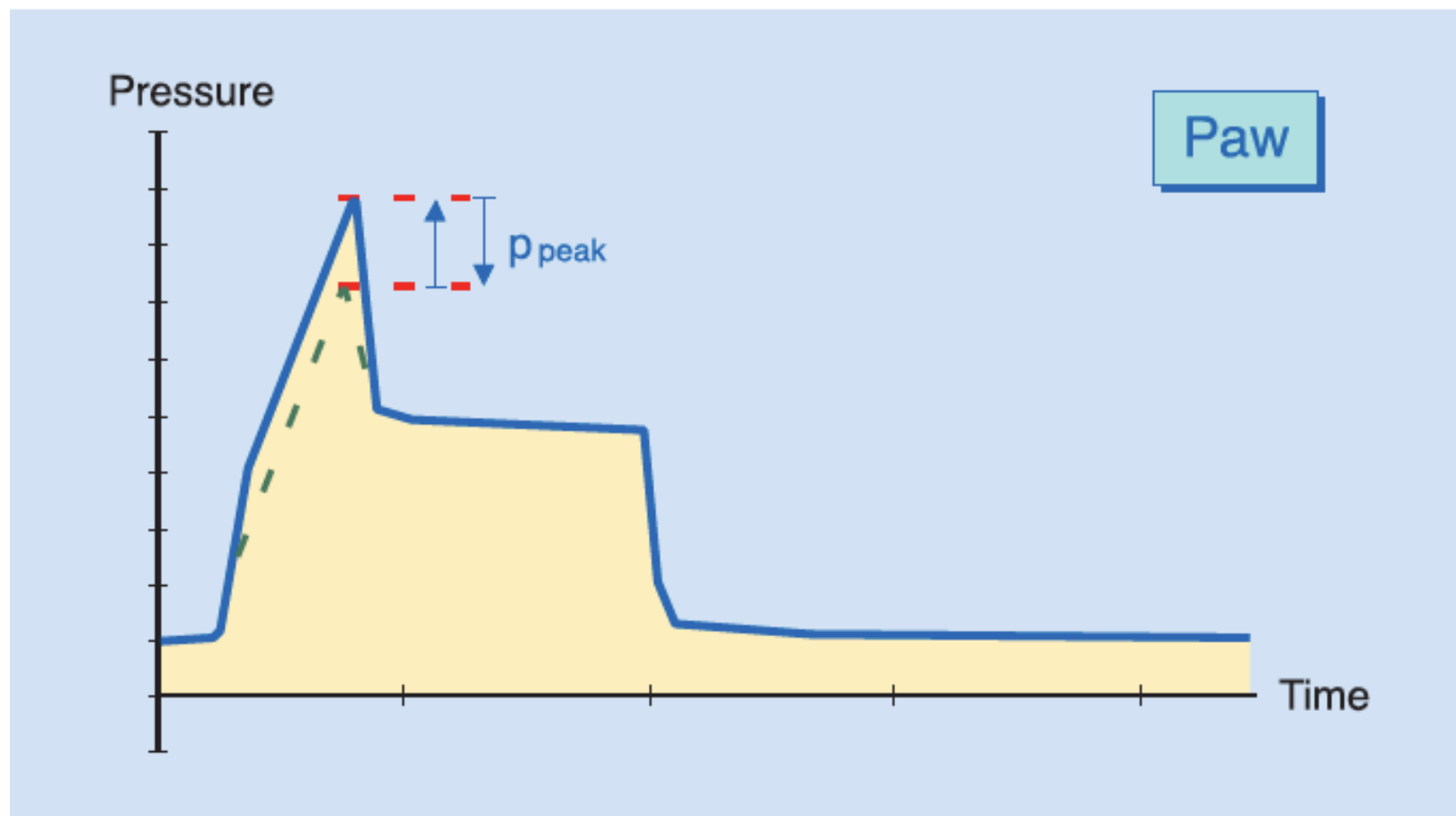


### Changes in compliance

When compliance changes the plateau and peak pressures change by the same amount of the pressure difference  $\Delta p$ .

increasing compliance → plateau and peak pressures fall

decreasing compliance → plateau and peak pressures rise



### Changes in inspiratory airway resistance

When the inspiratory airway resistance changes the peak pressure changes and the plateau pressure remains the same.

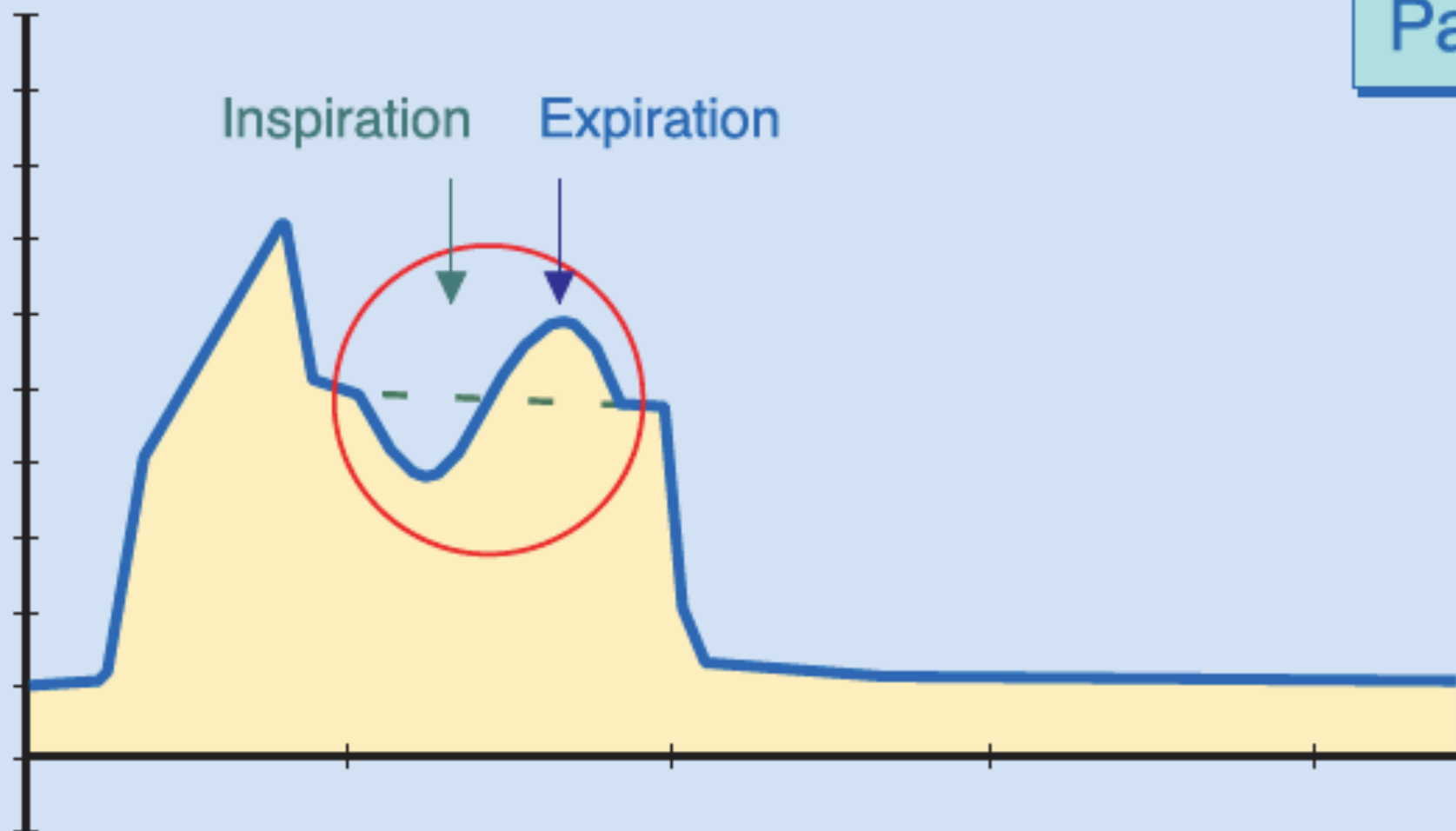
increasing resistance  $\rightarrow$  peak pressure rises  
decreasing resistance  $\rightarrow$  peak pressure falls

Pressure

Paw

Inspiration

Expiration



Time



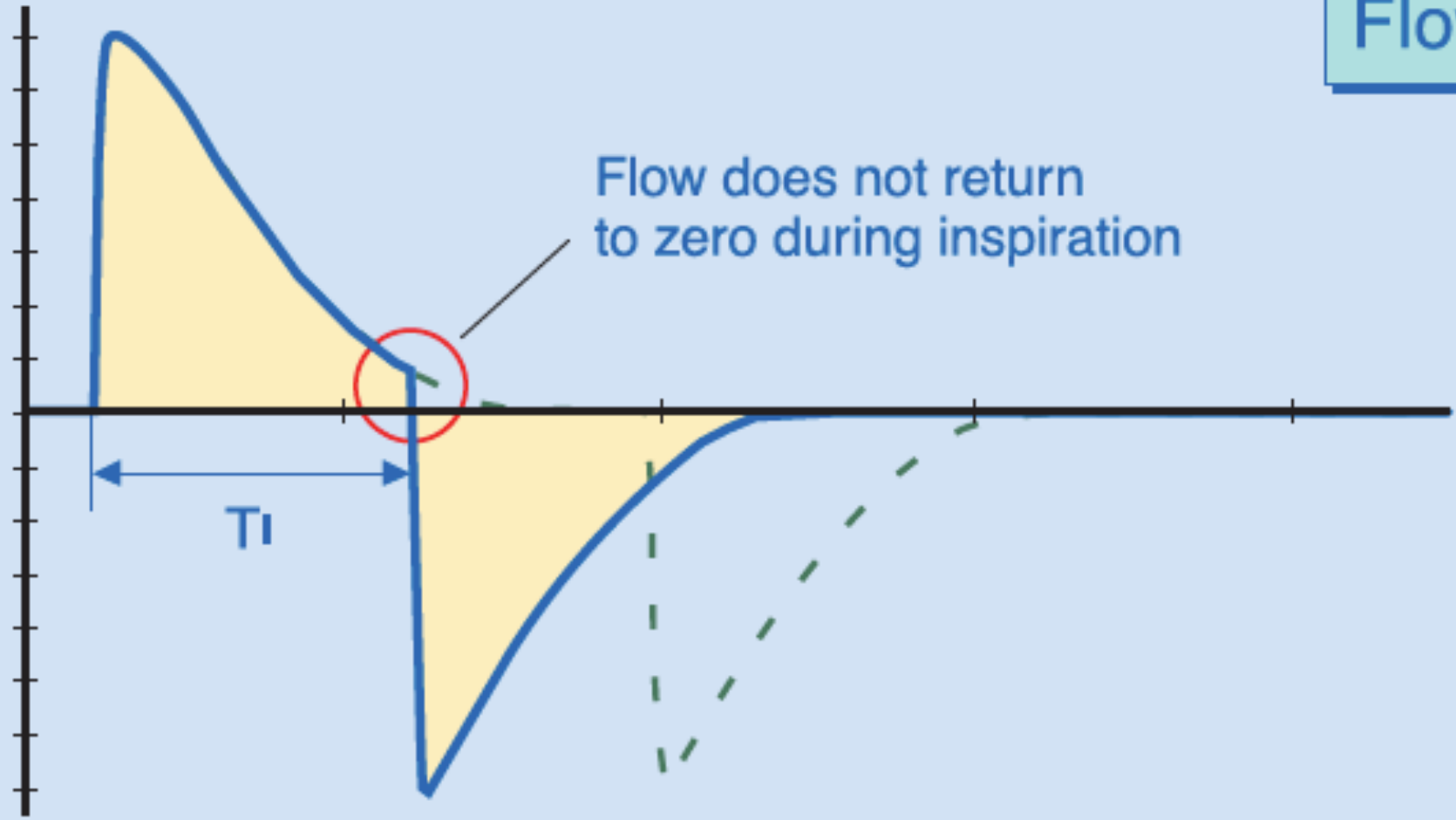
Flow

Flow

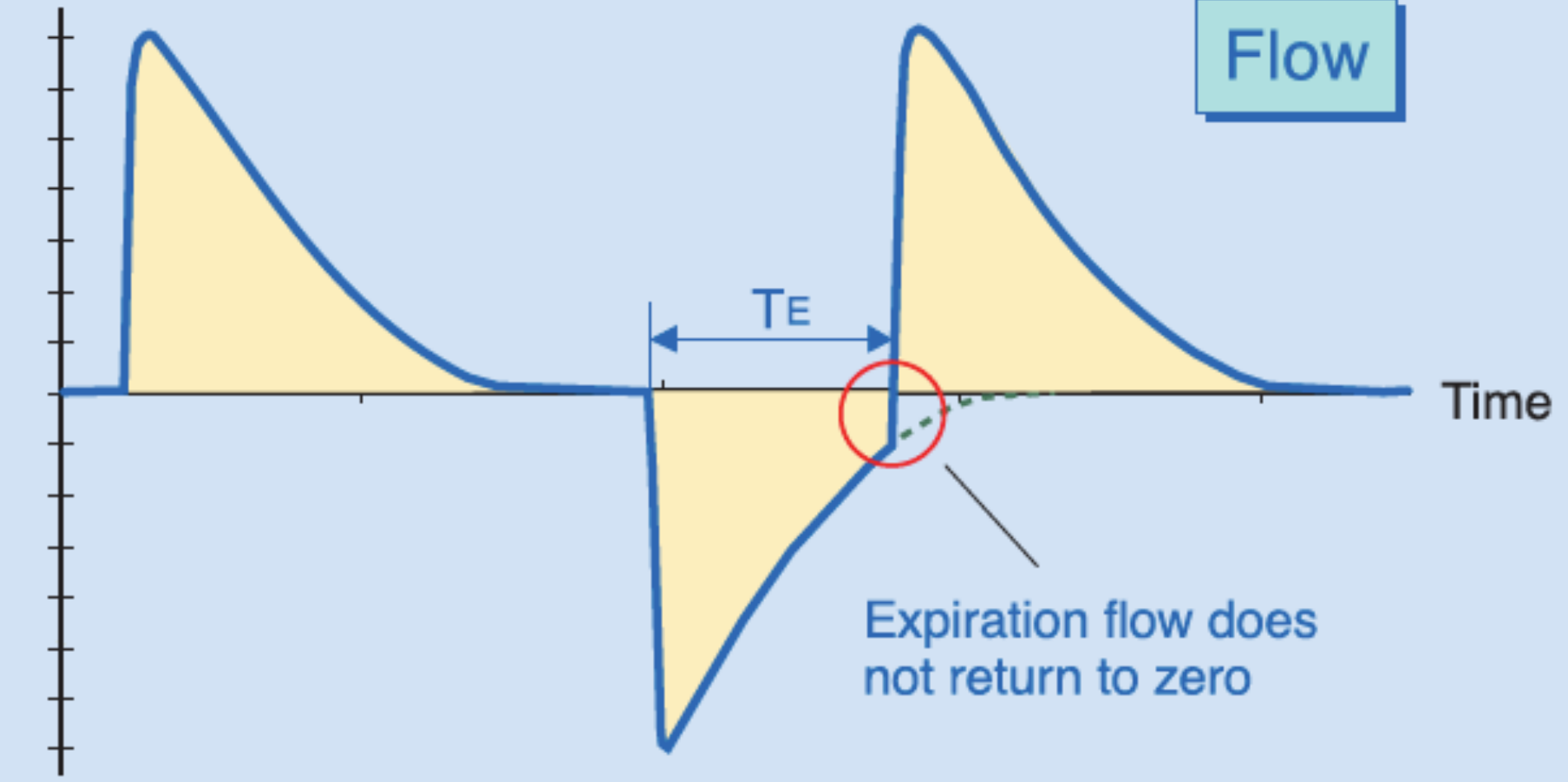
Time

Flow does not return to zero during inspiration

$T_i$



Flow



Flow

$T_E$

Time

Expiration flow does not return to zero

Flow



Flow

Time



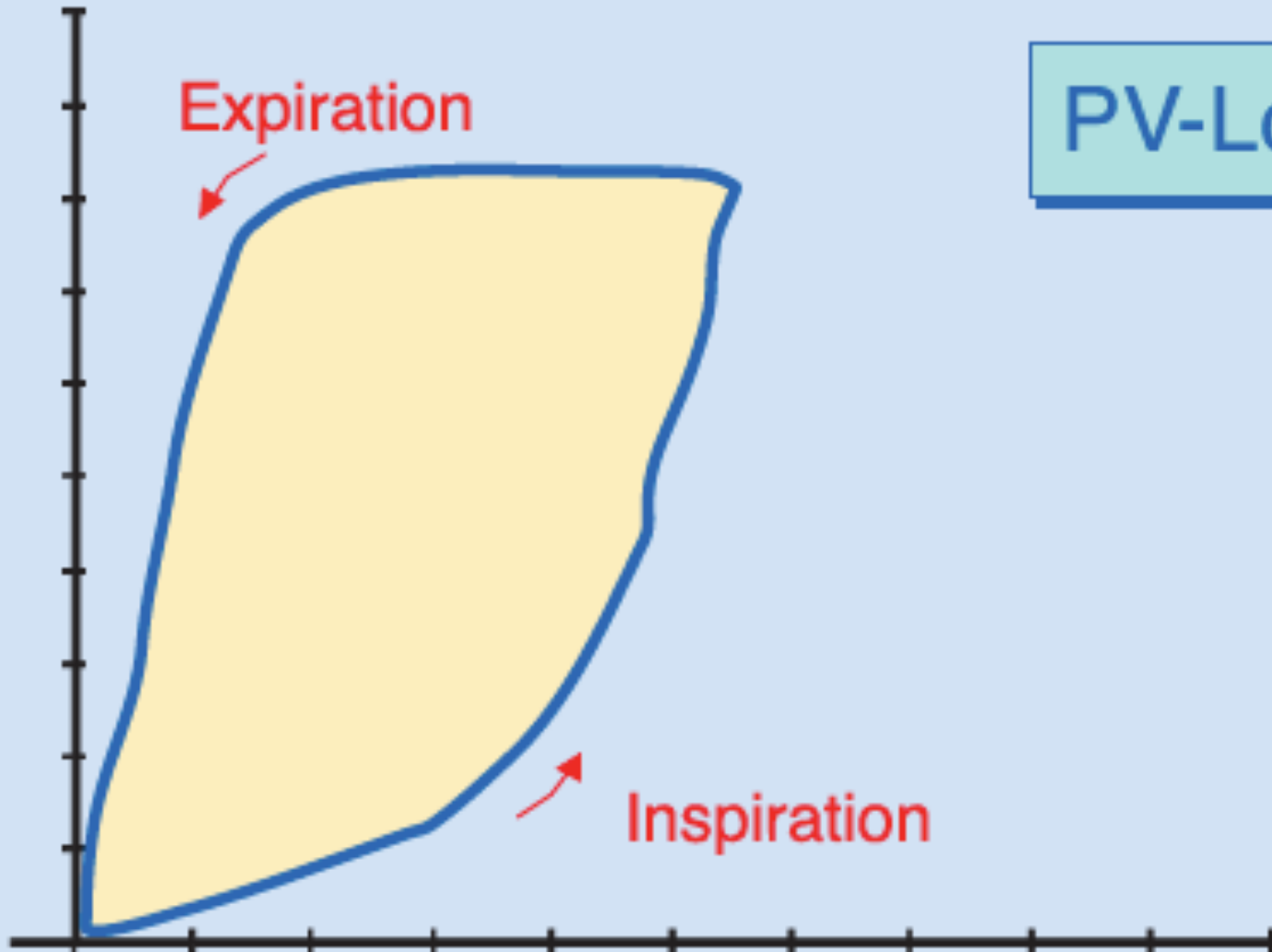
Volume

Expiration

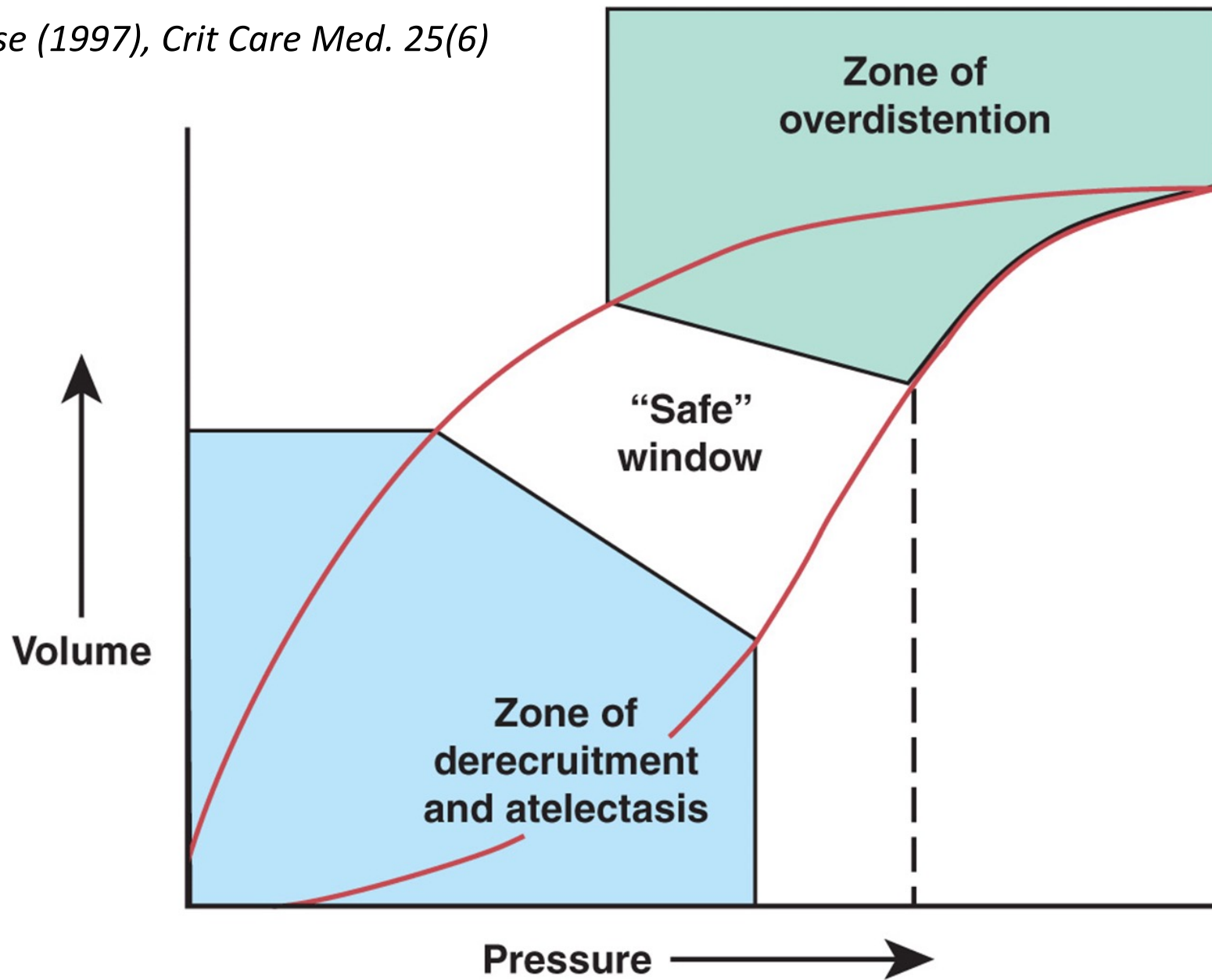
PV-Loop

Inspiration

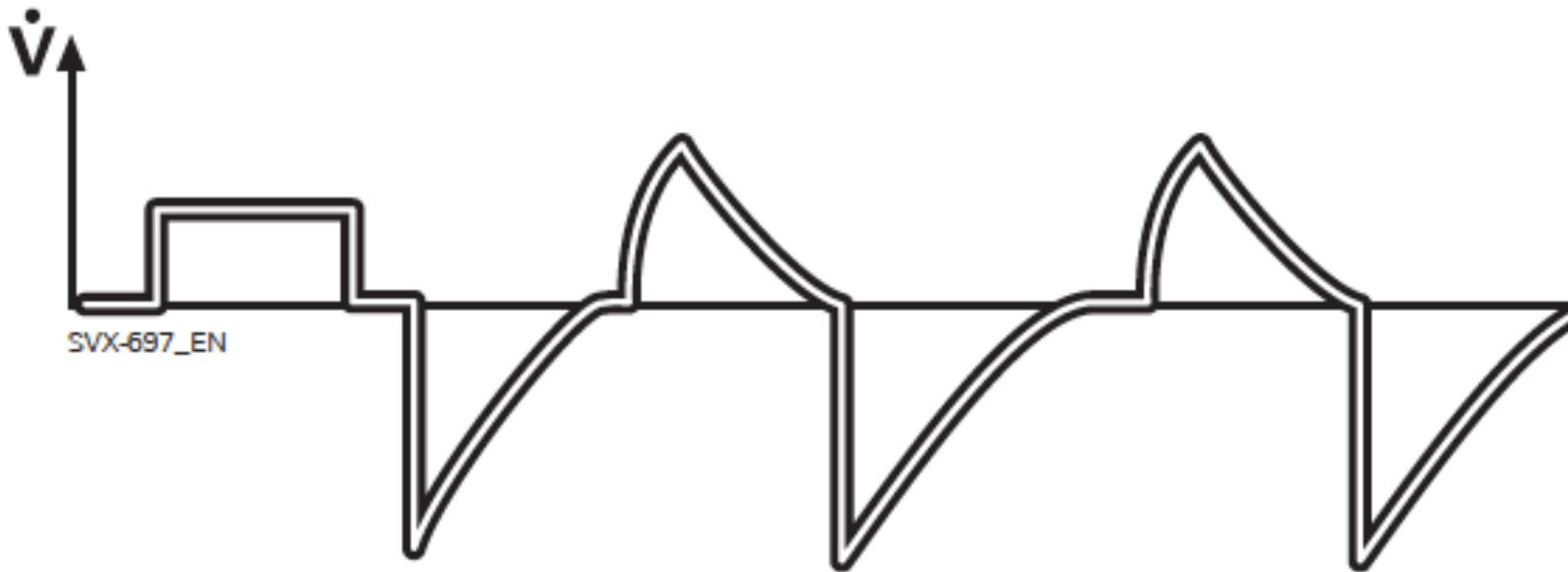
Pressure



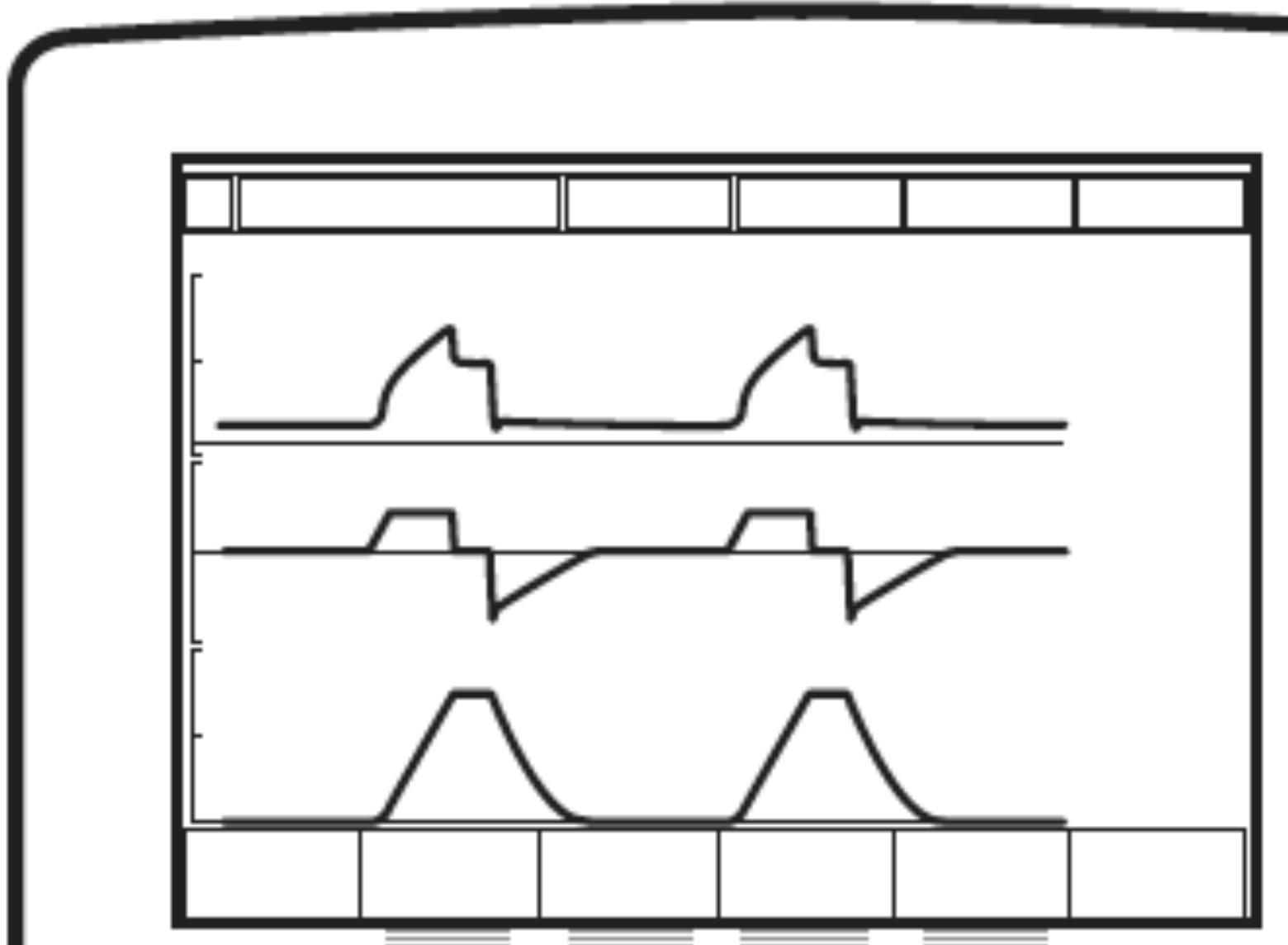
*Froese (1997), Crit Care Med. 25(6)*



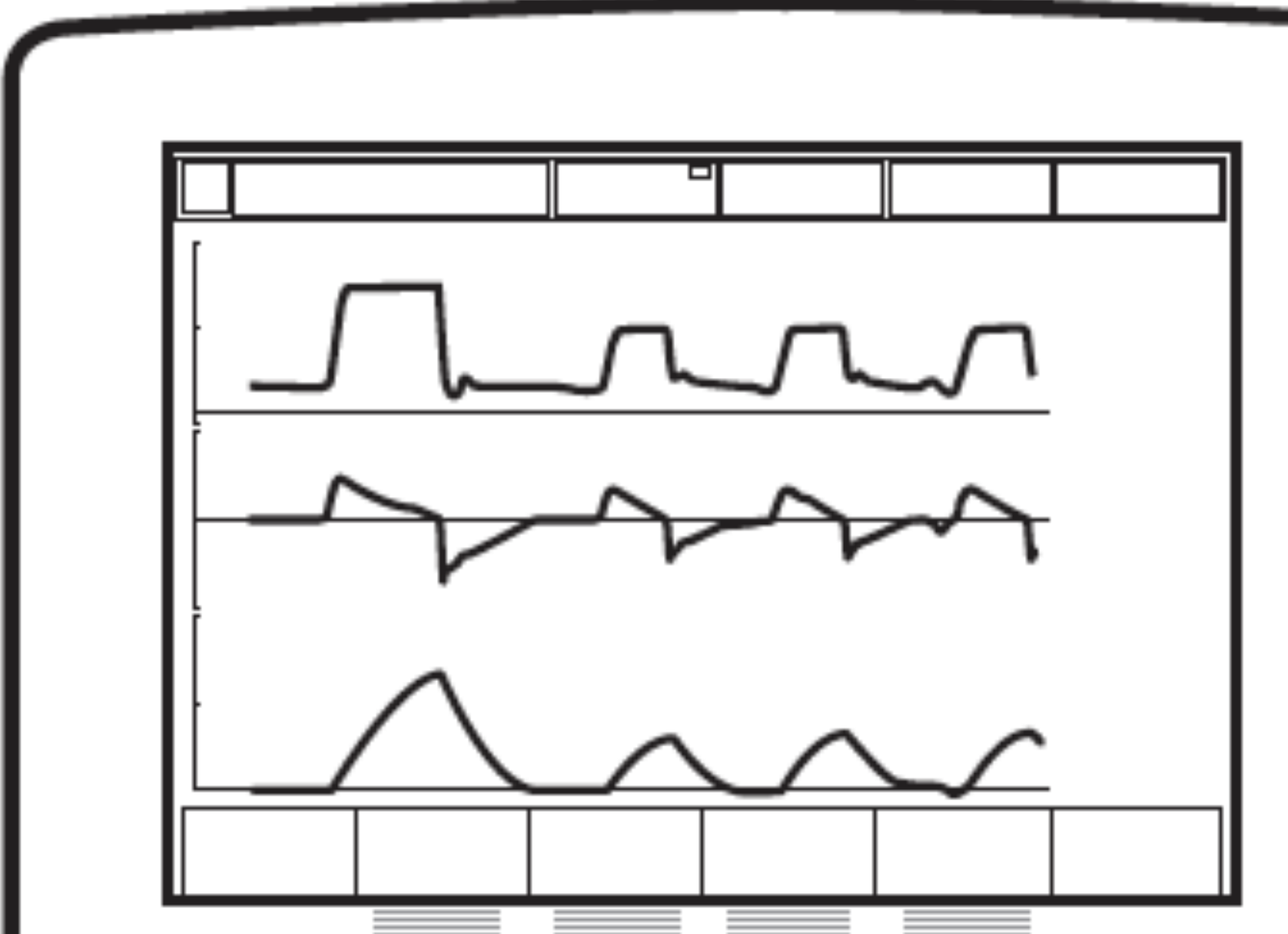
# What mode does this represent?



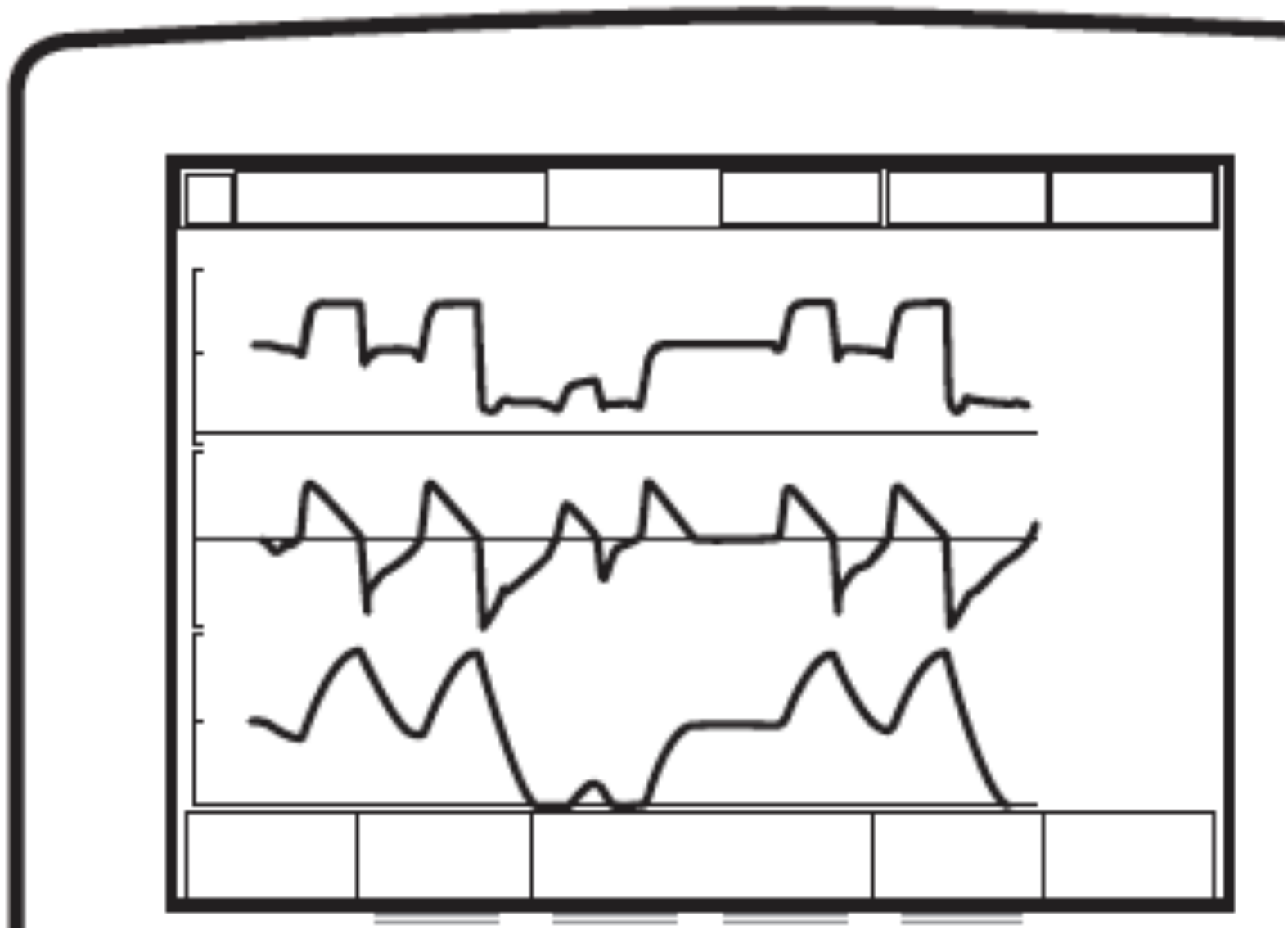
**What are your primary concerns?**



# What Do You Notice? (Mode?)

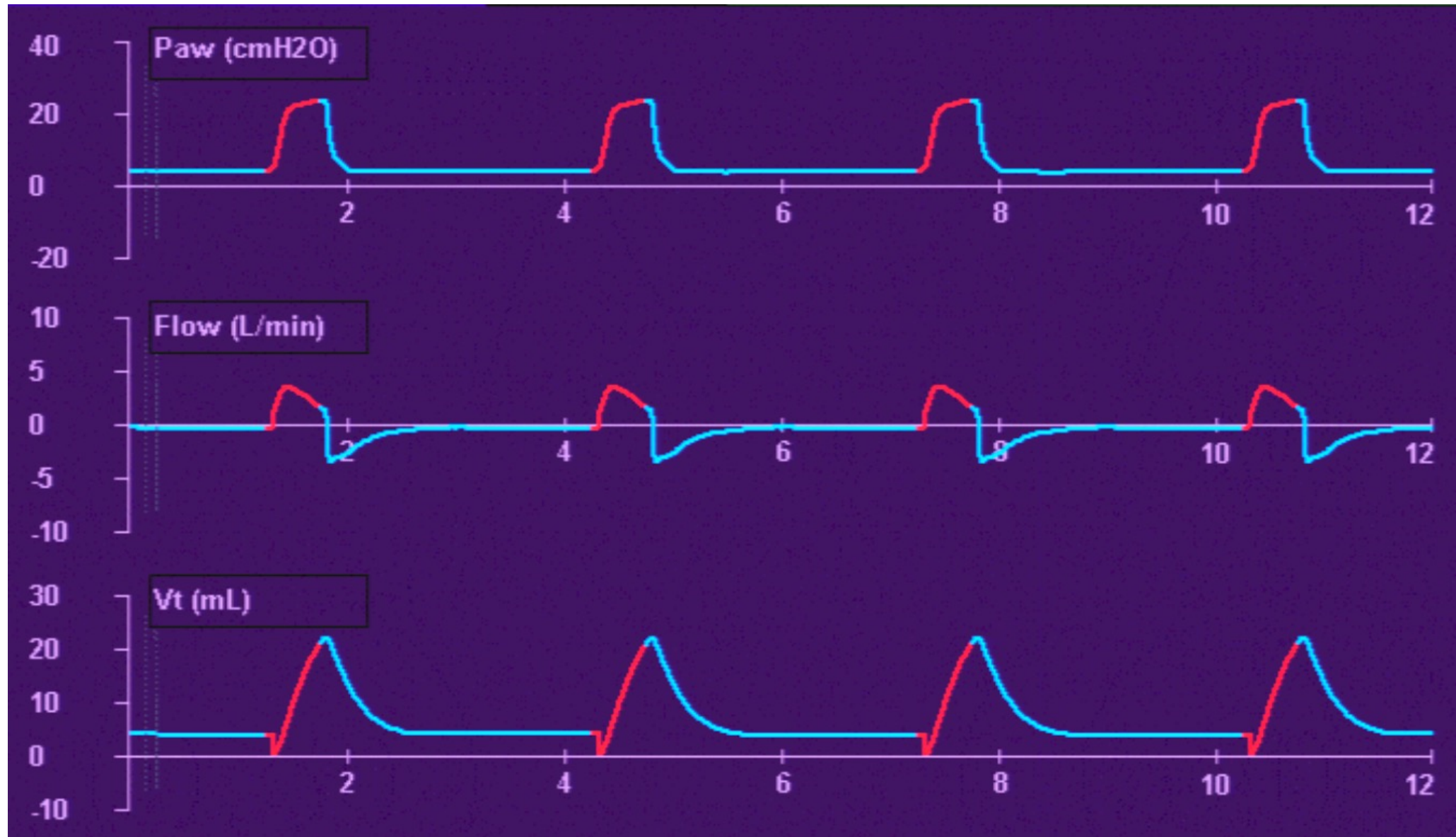


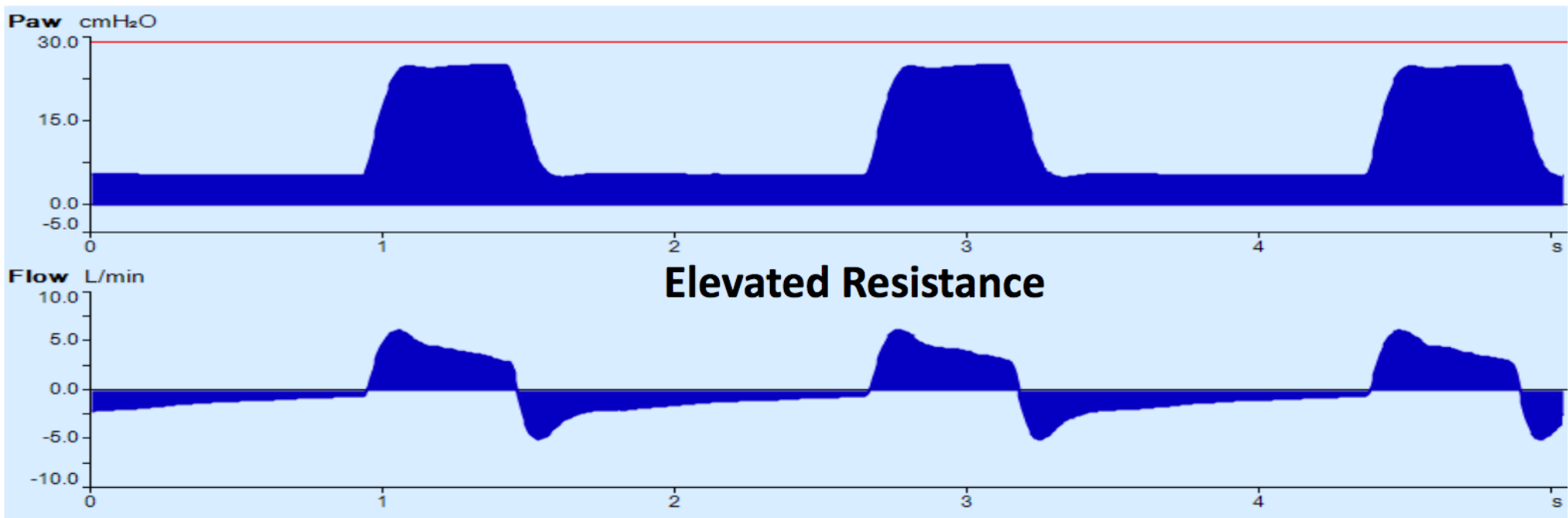
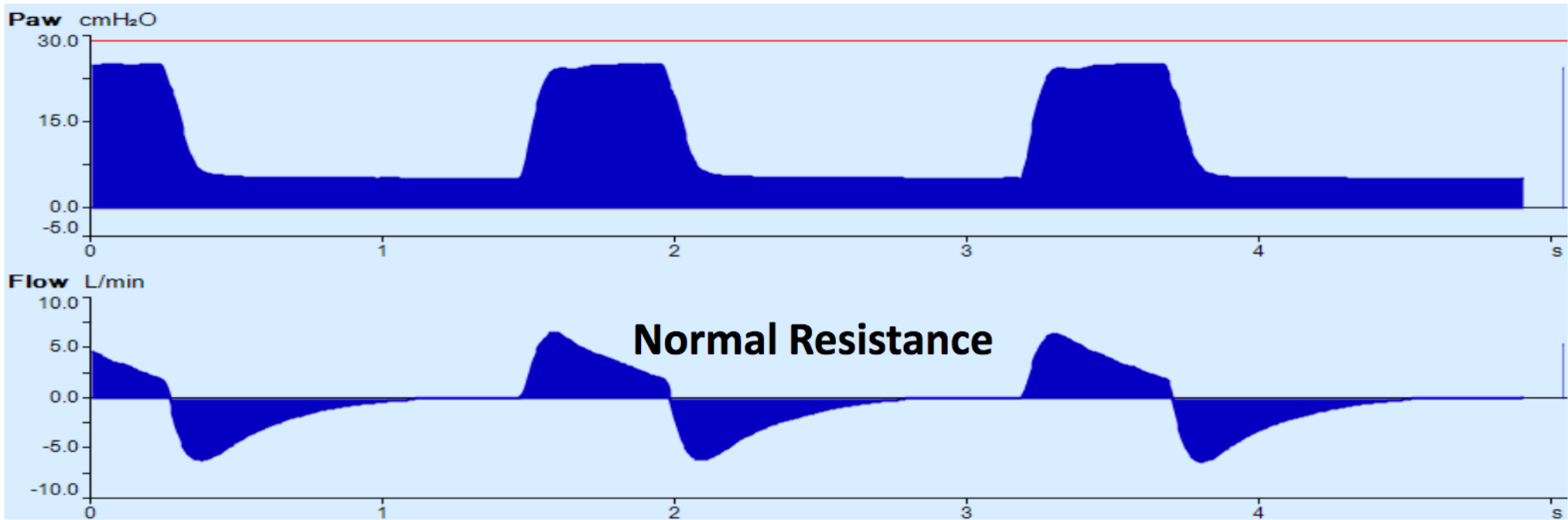
**What mode is shown here?**

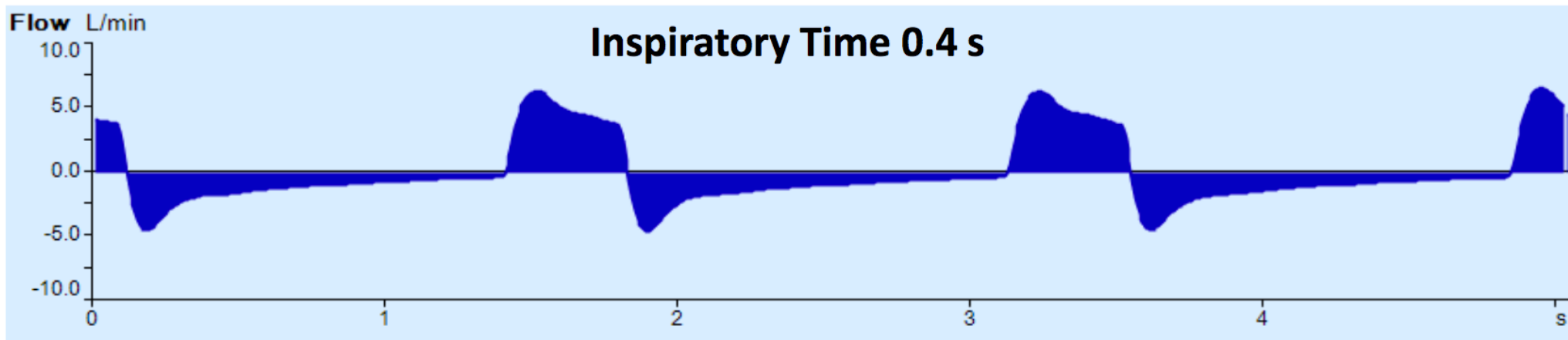
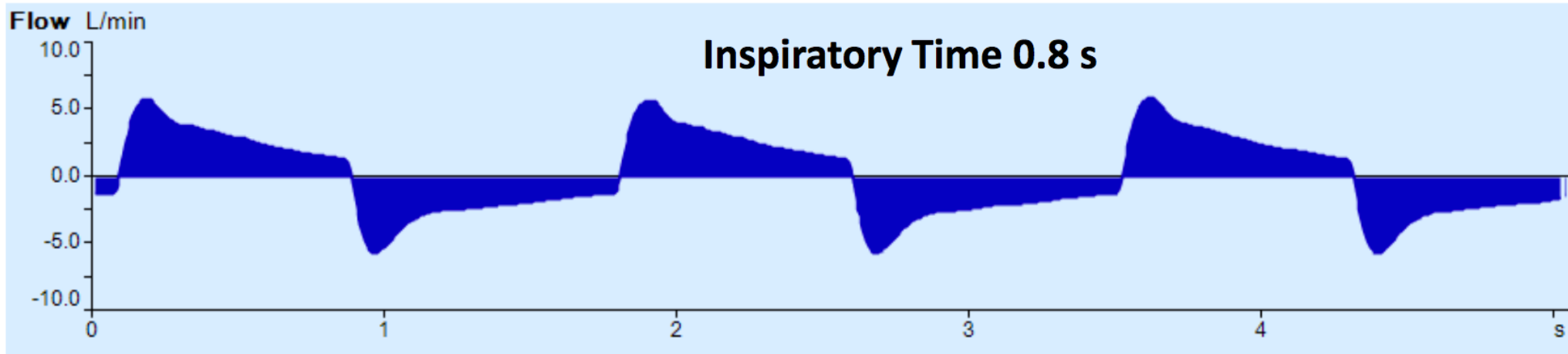


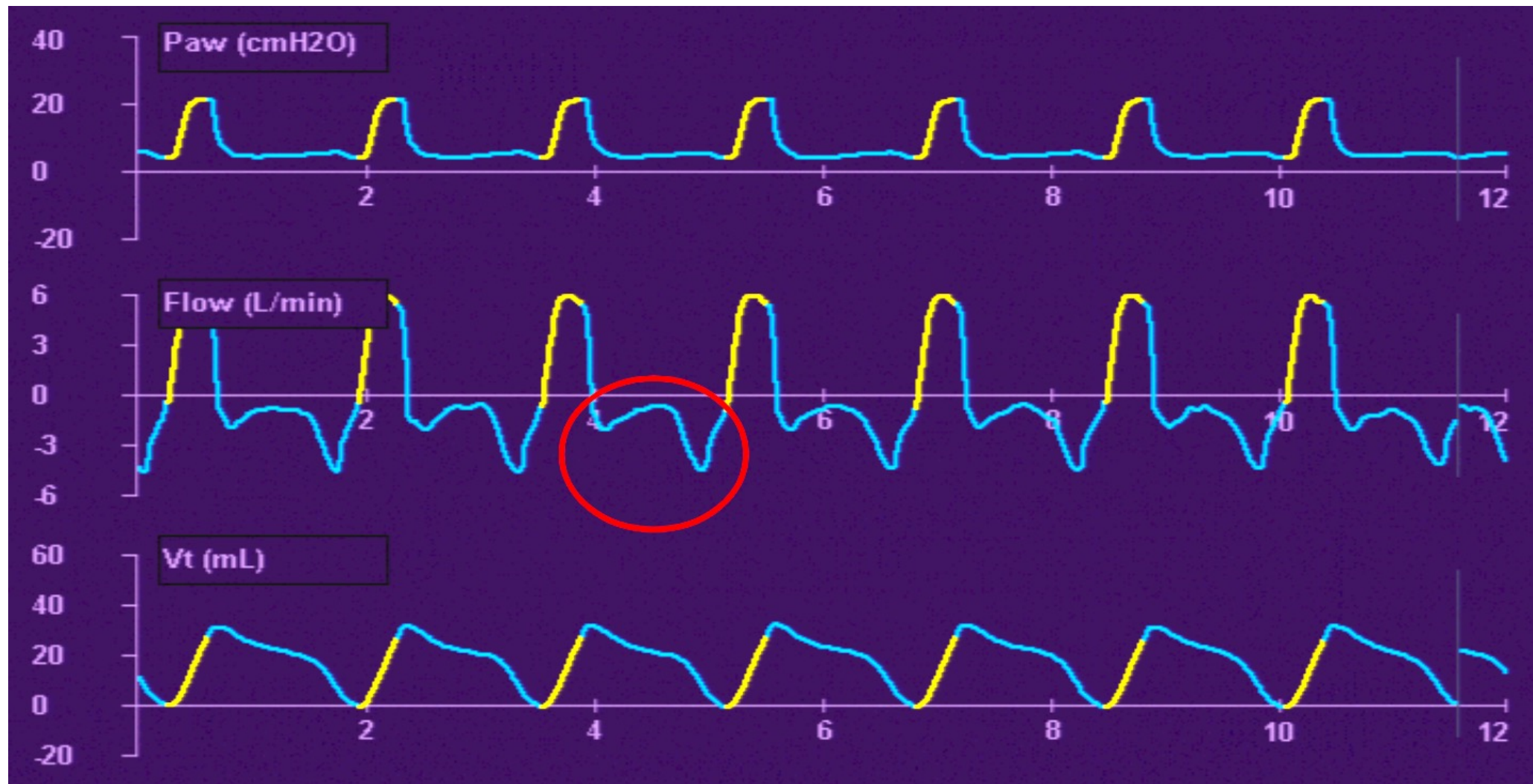


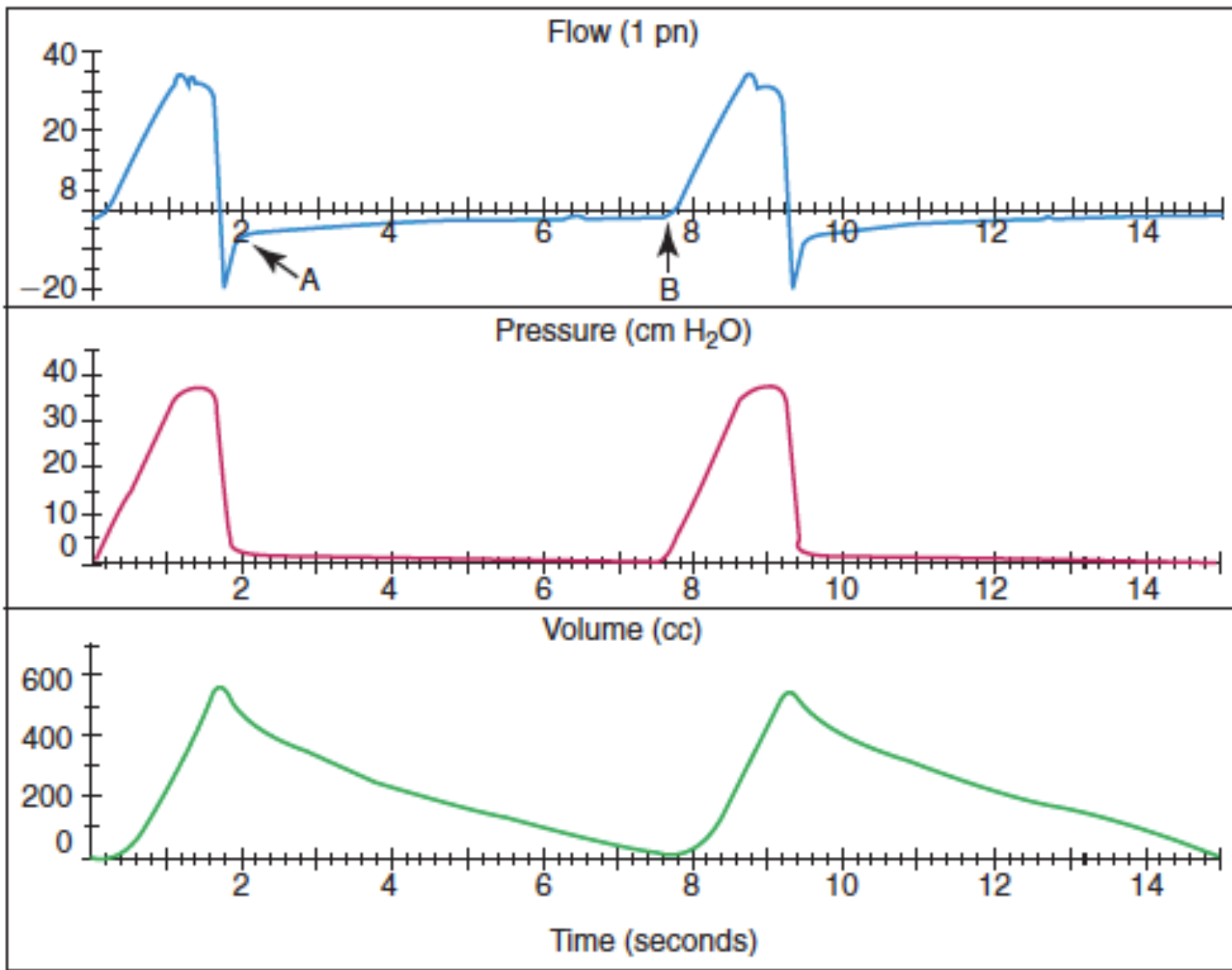
**CHALLENGE ACCEPTED**

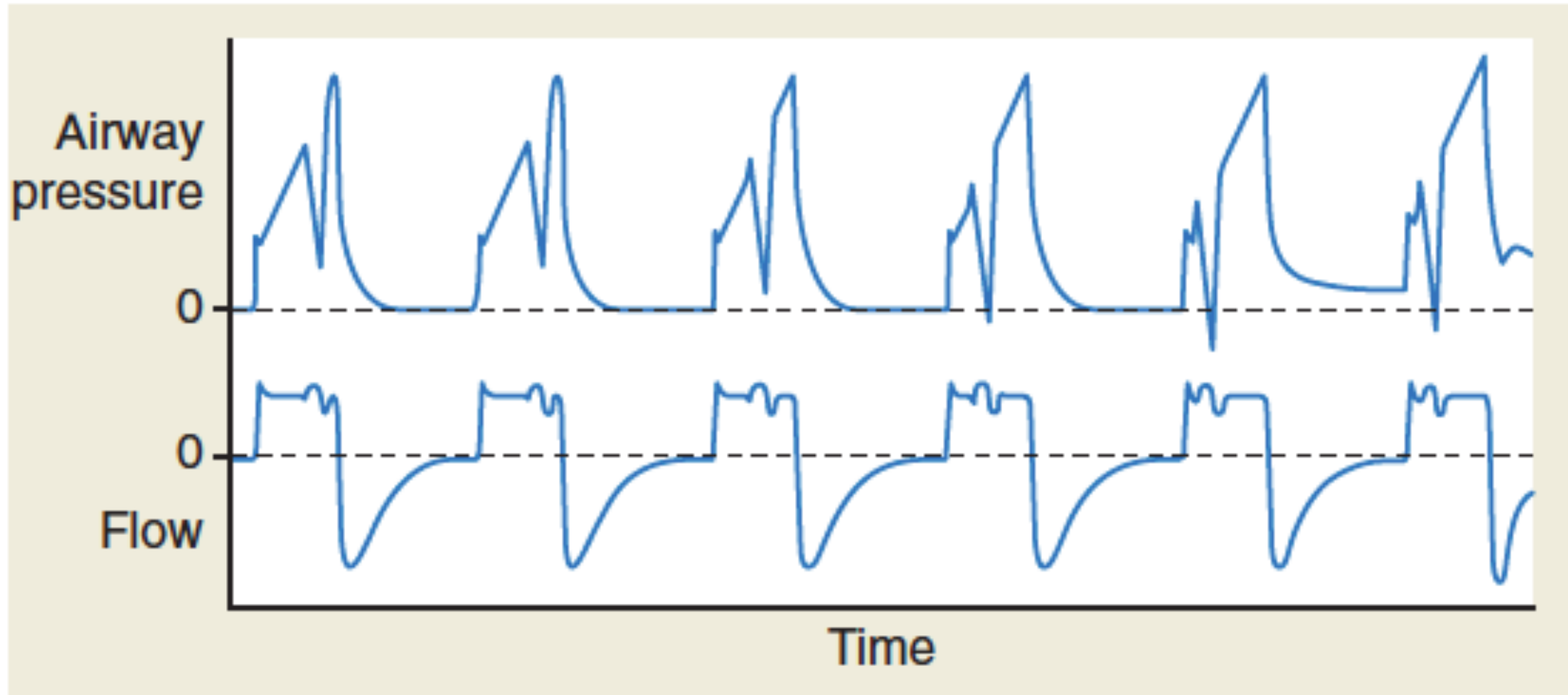




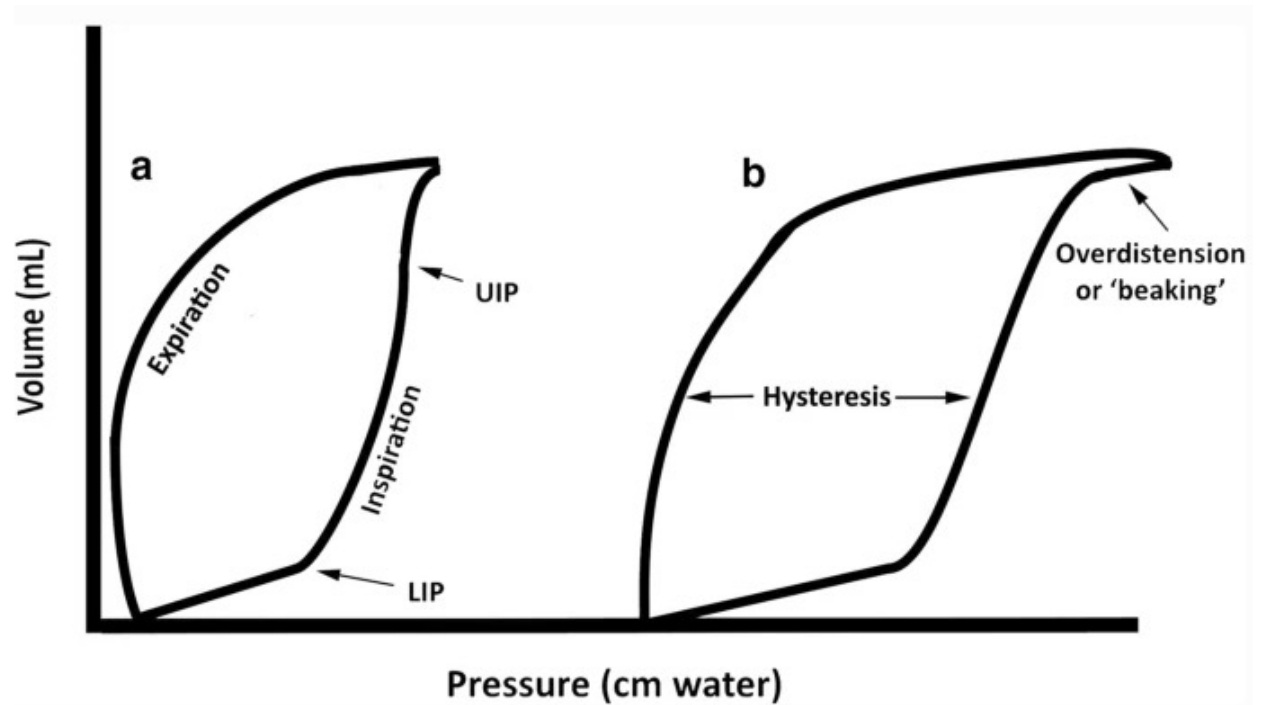
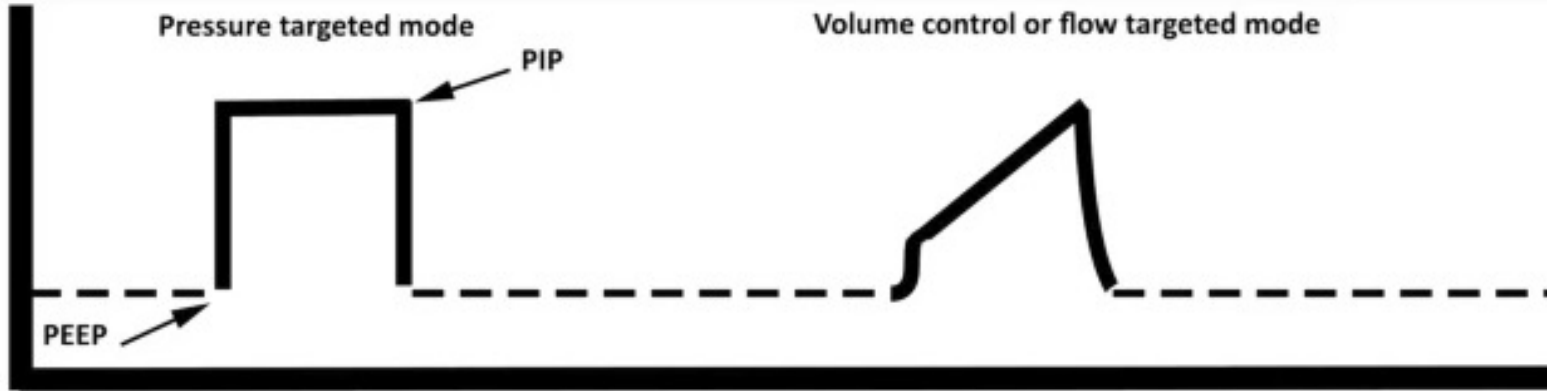




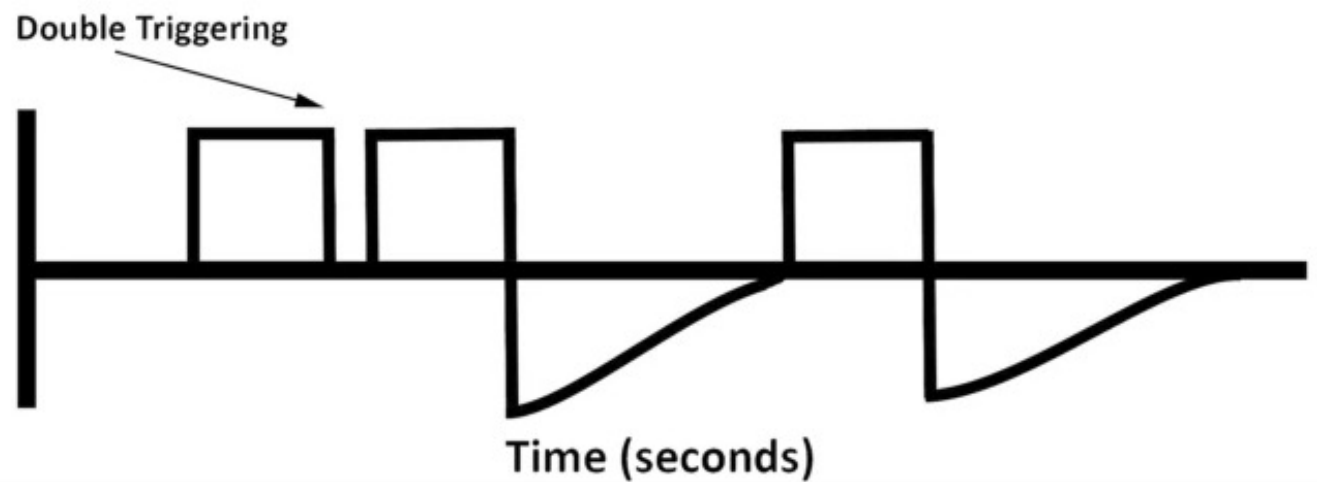
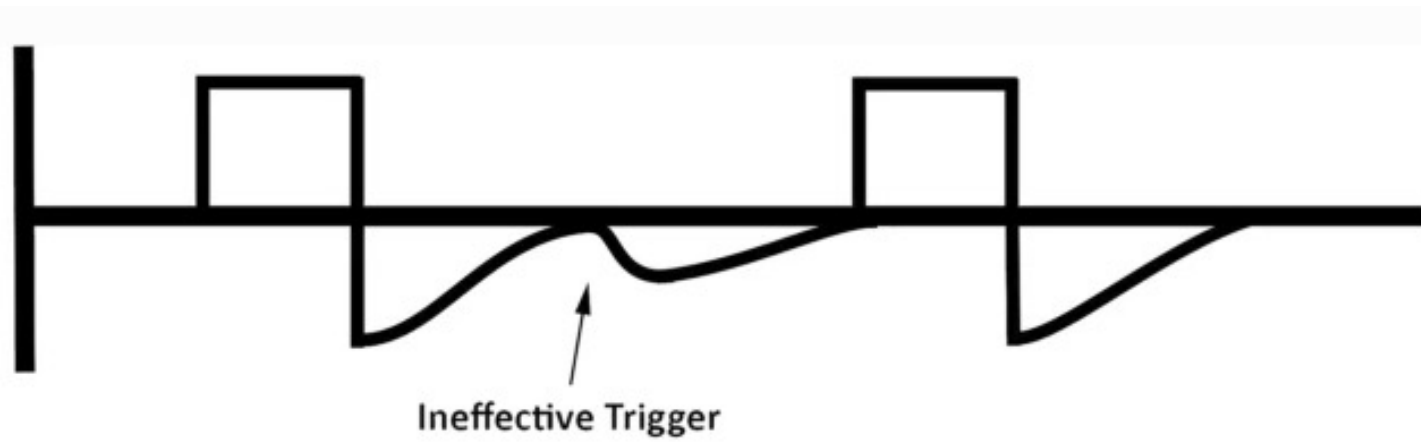




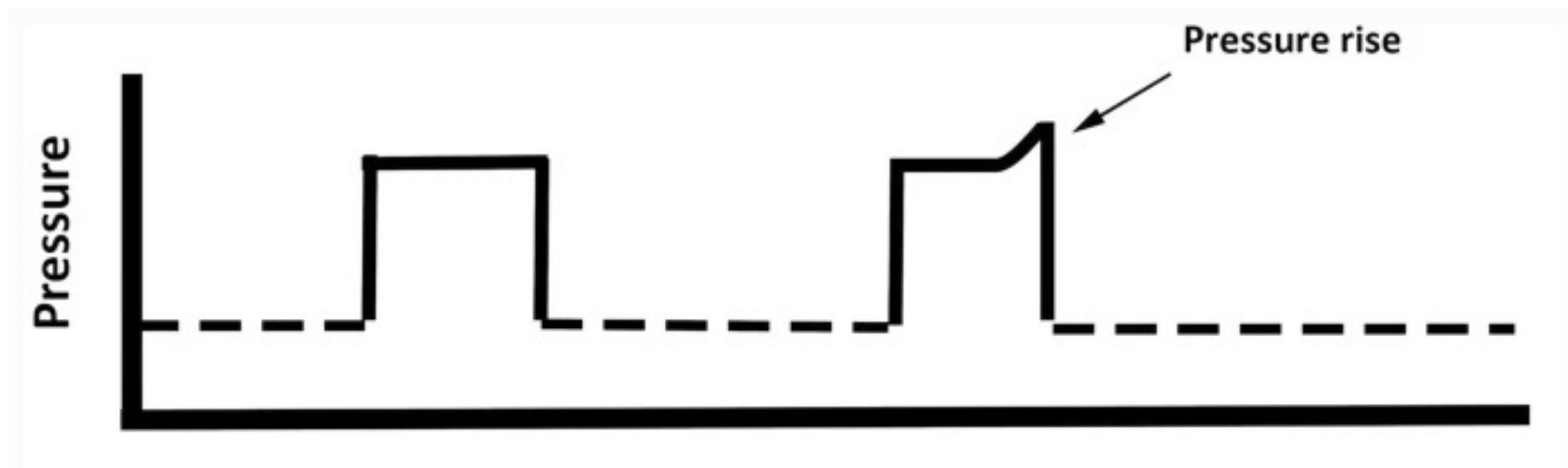
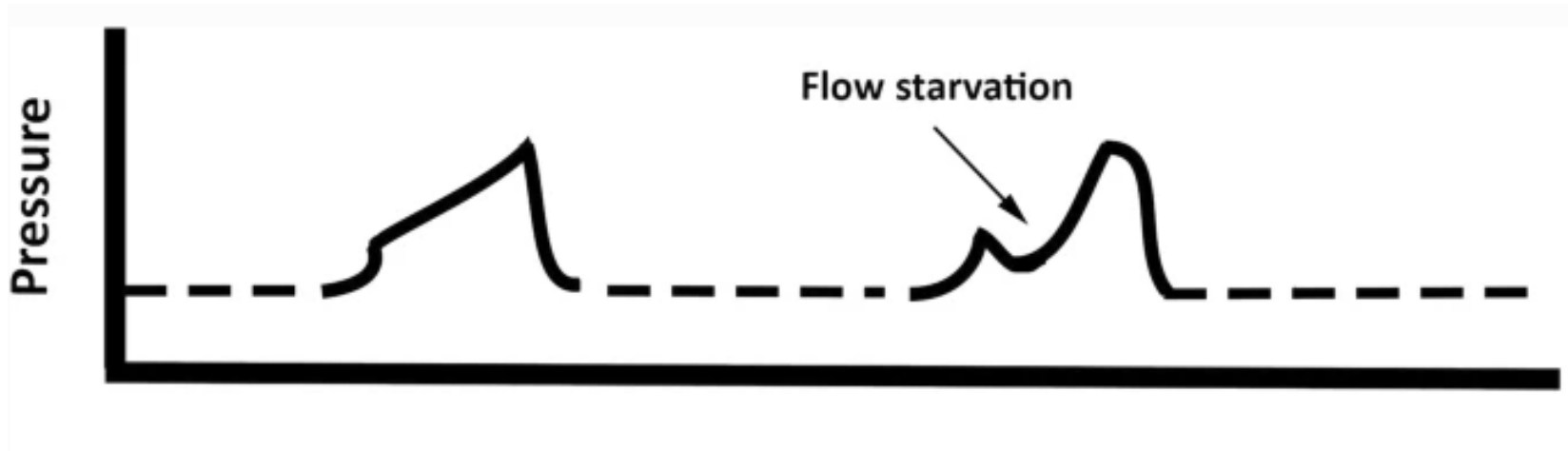




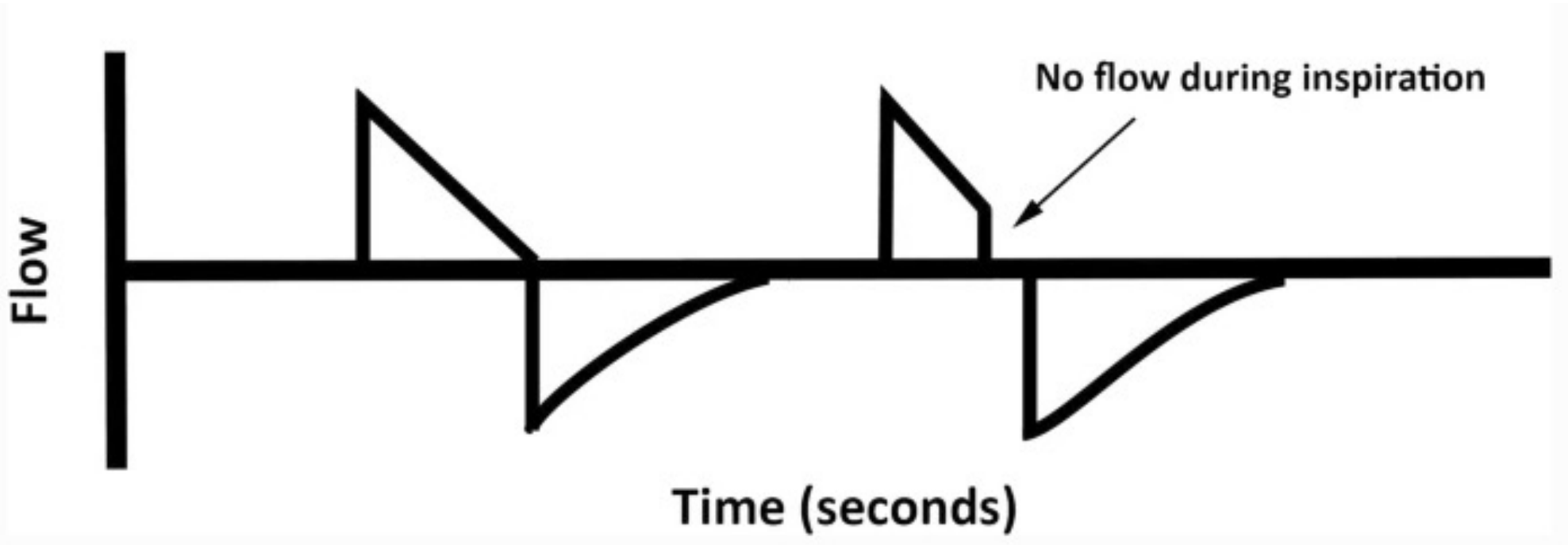
Source: Emrath (2021). *Current Pediatrics Reports* v.9



Source: Emrath (2021). *Current Pediatrics Reports* v.9



Source: Emrath (2021). *Current Pediatrics Reports* v.9



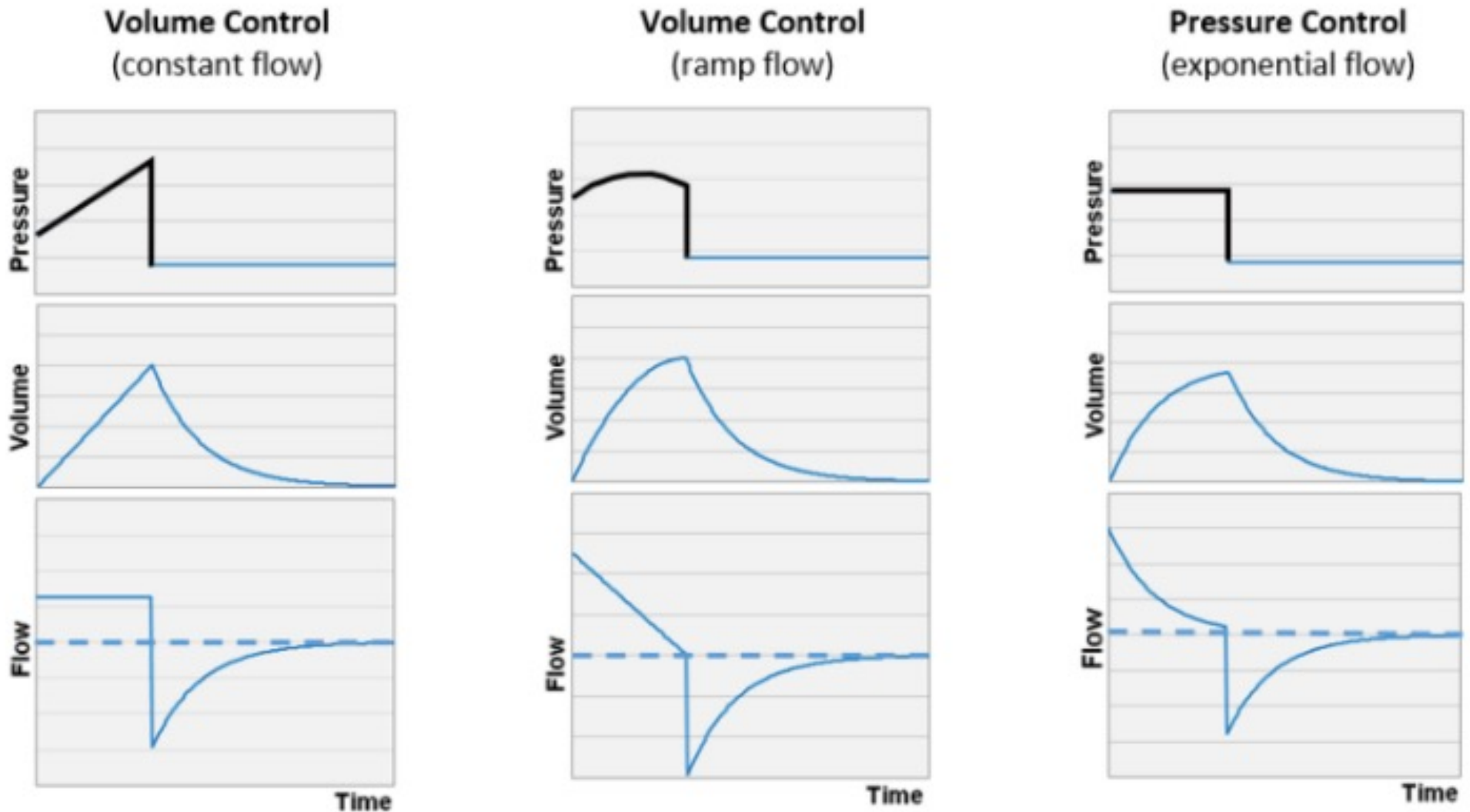
Source: Emrath (2021). *Current Pediatrics Reports* v.9

THERE'S A LITTLE AUTOPEEP ... HE NEEDS  
THE FLOW UPPED TO 65 ... THE ET TUBE CAN  
COME BACK 2cm ... HIS FOLEY BAG IS FULL ...  
AND HE WANTS TO WATCH THE LIONS GAME.



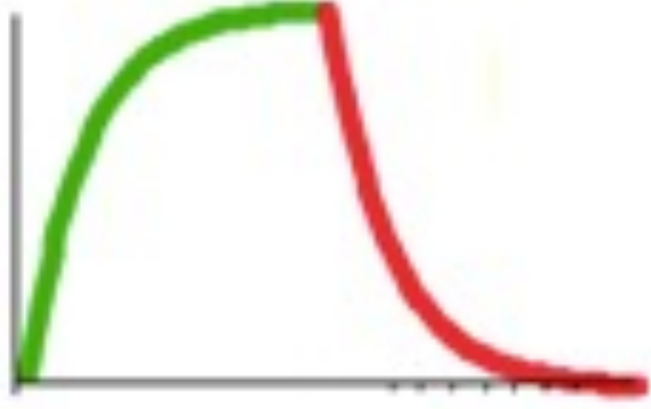
TED WAS THE MASTER OF INTERPRETING  
VENTILATOR GRAPHICS.

Figure 1. Idealized graphic representations of ventilator pressure, volume, and flow waveforms.

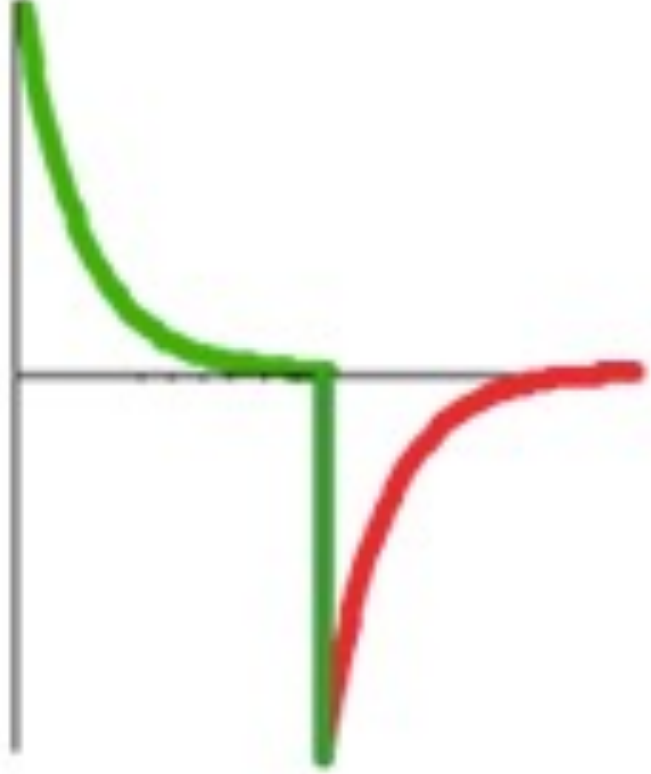


Source: (2021) Chatburn & Mireles-Cabodevilla. "Understanding Ventilator Graphics"

**volume**

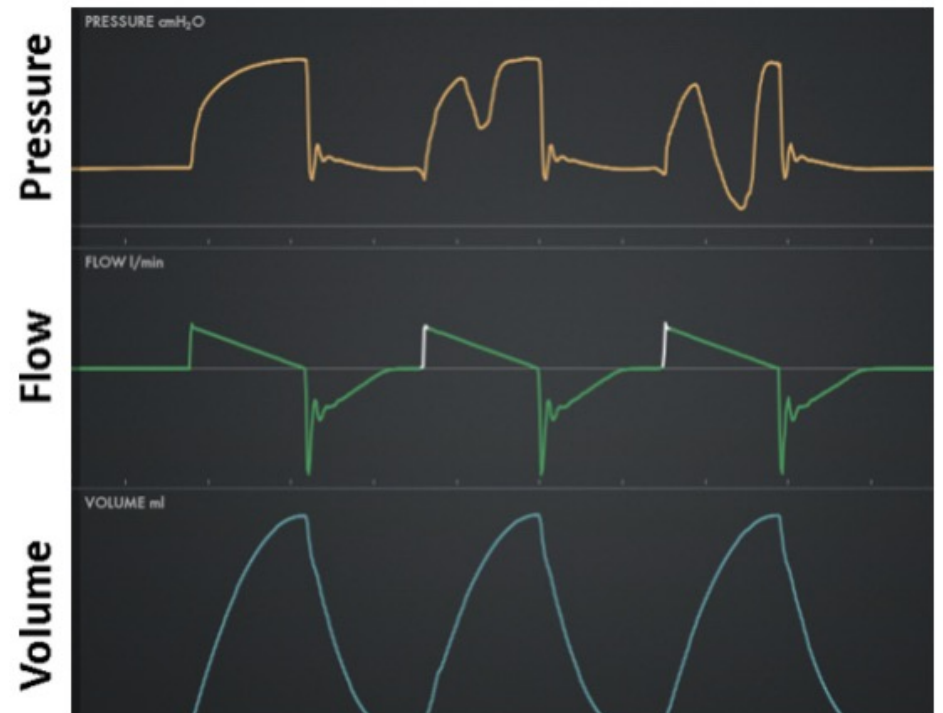


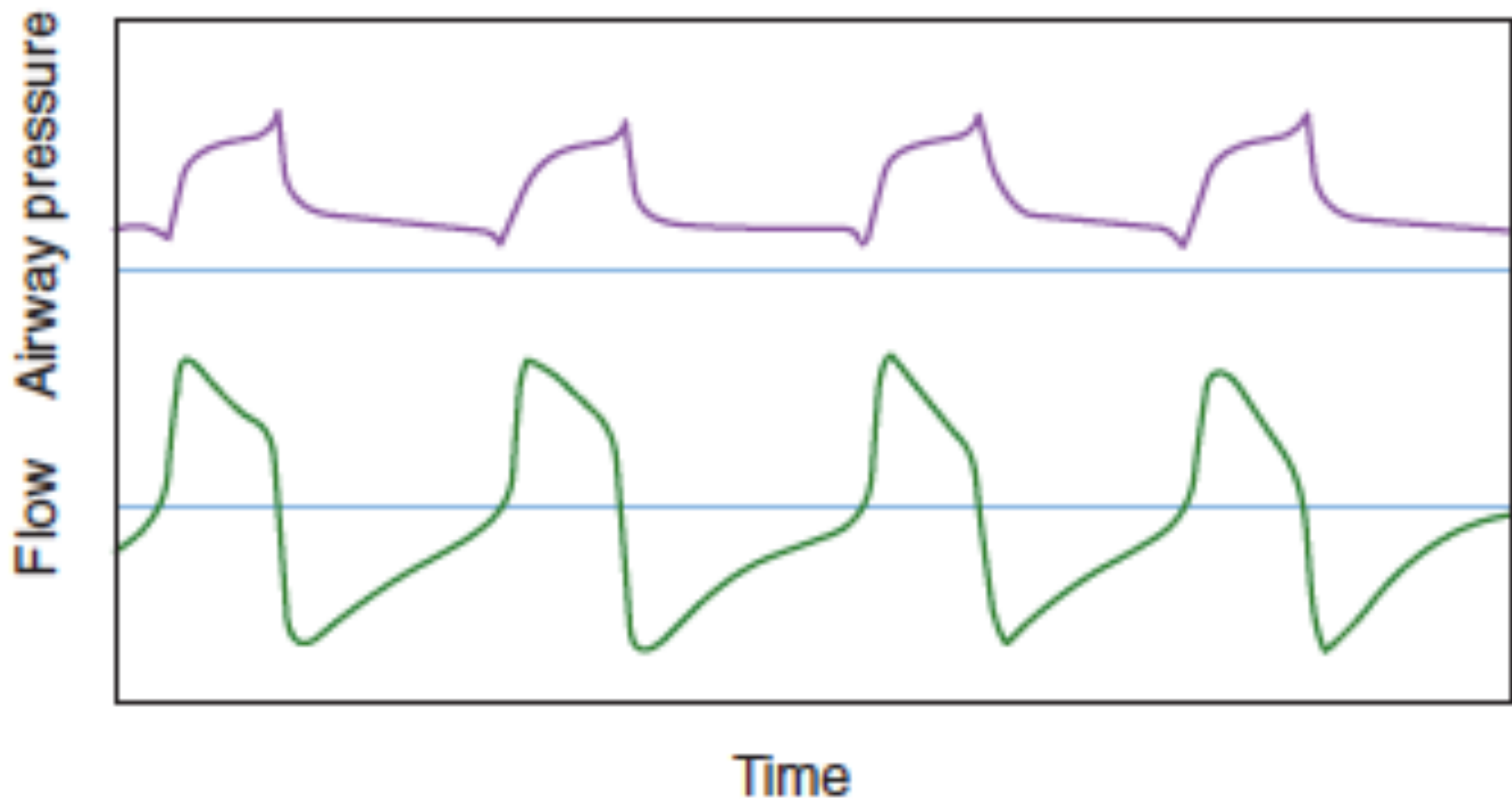
**flow**



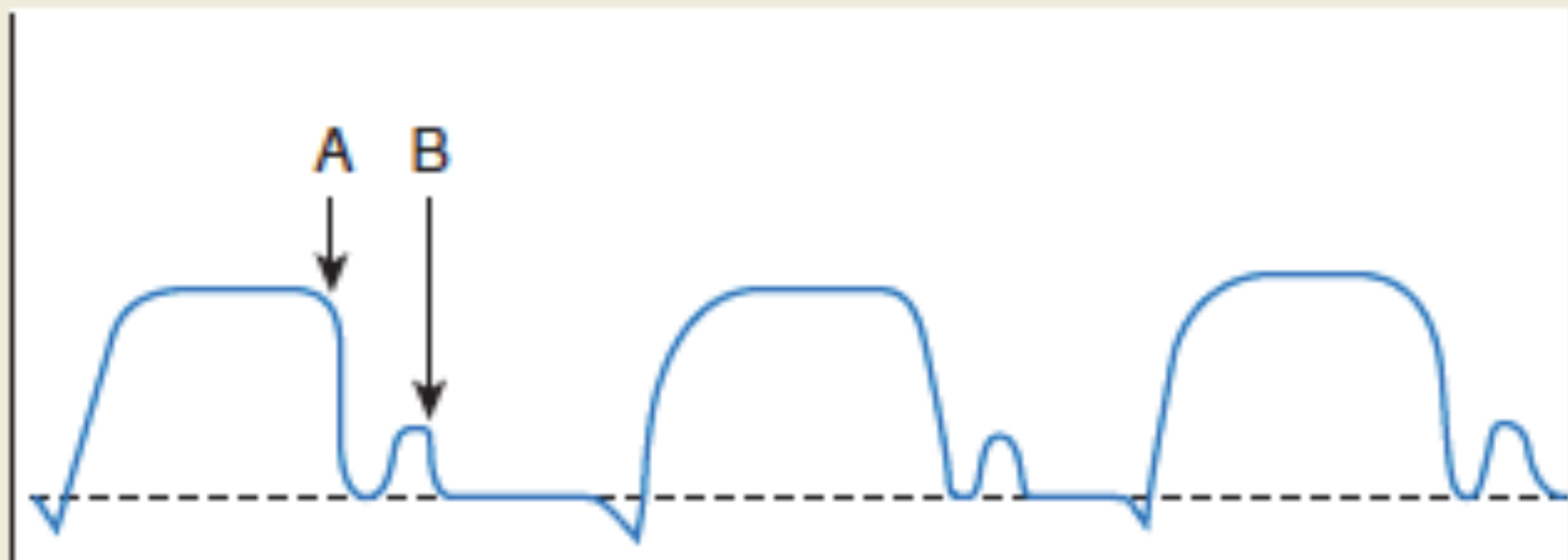


Source: (2021) Chatburn & Mireles-Cabodevilla. "Understanding Ventilator Graphics"

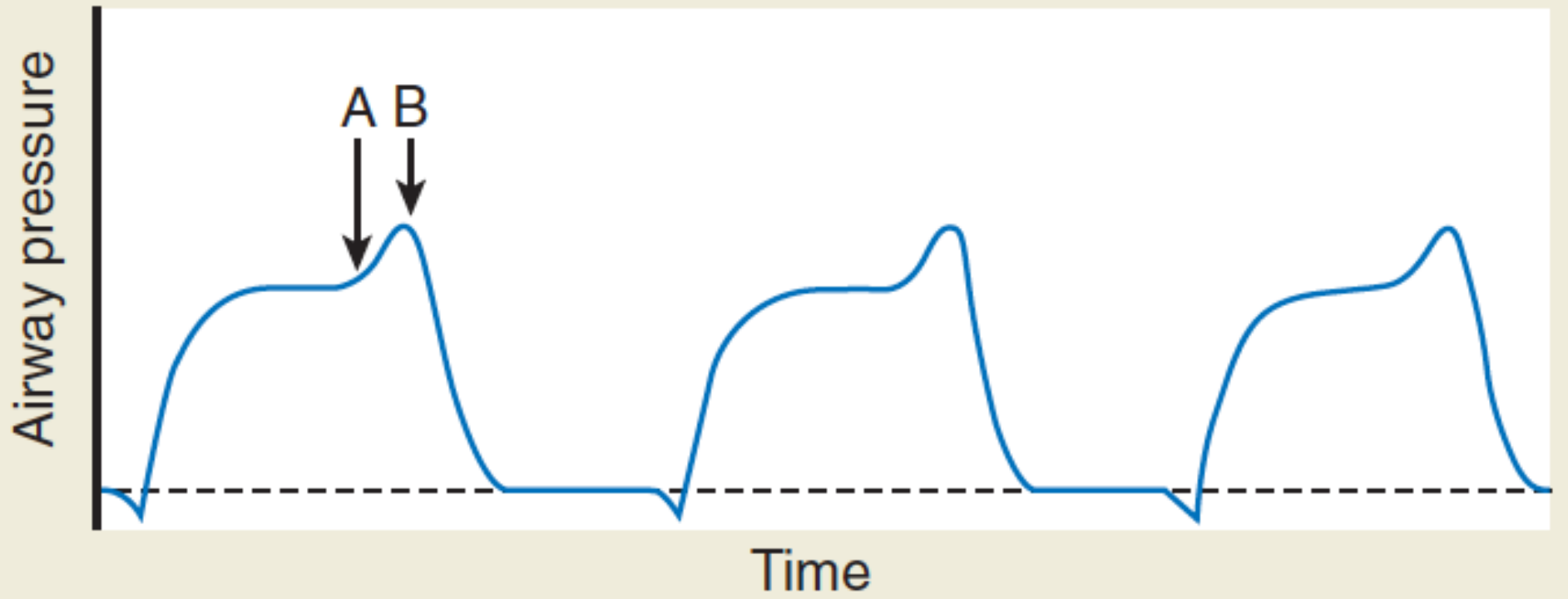




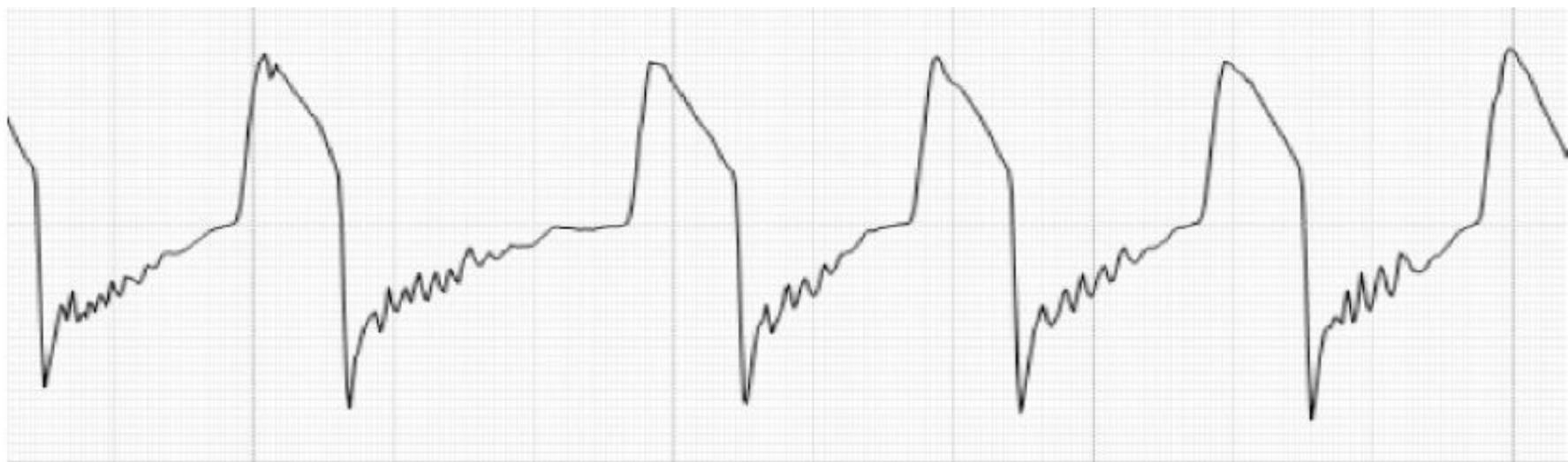
Airway pressure



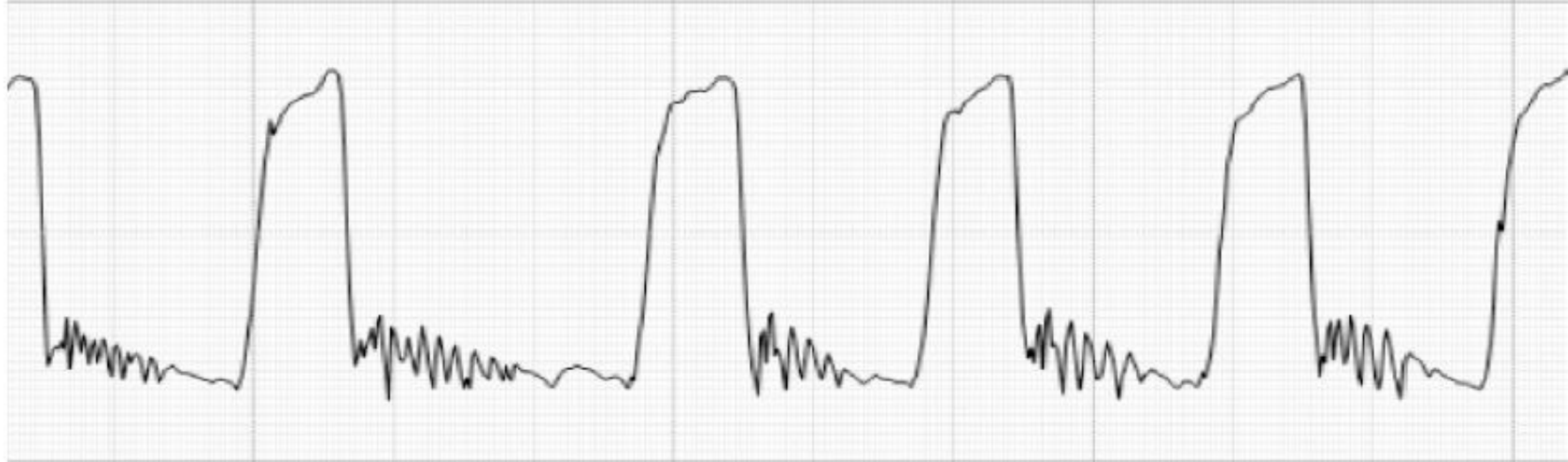
Time



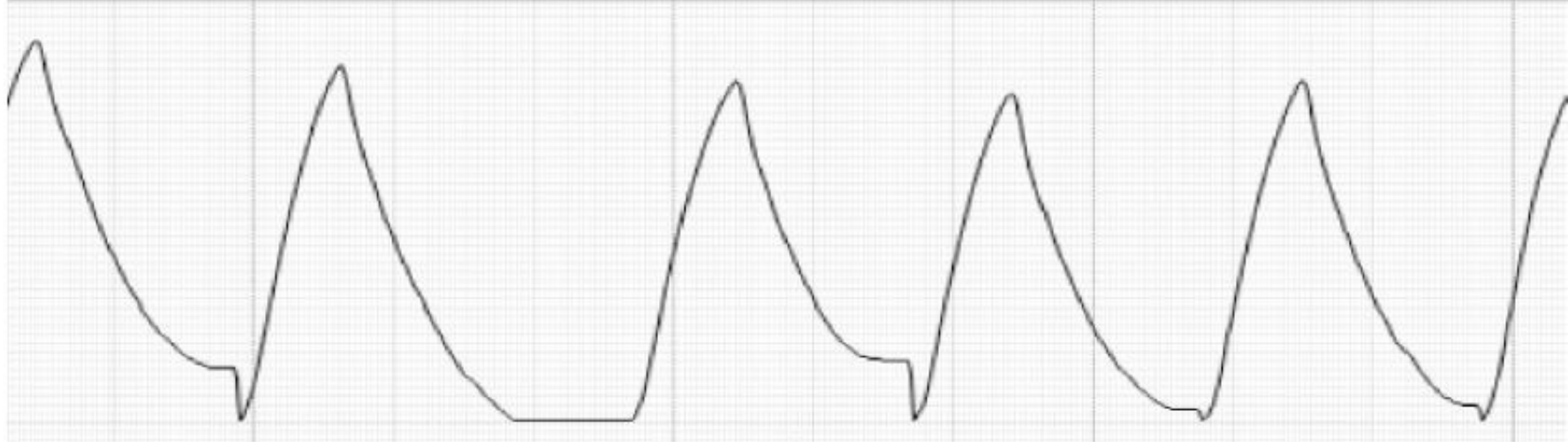
Q

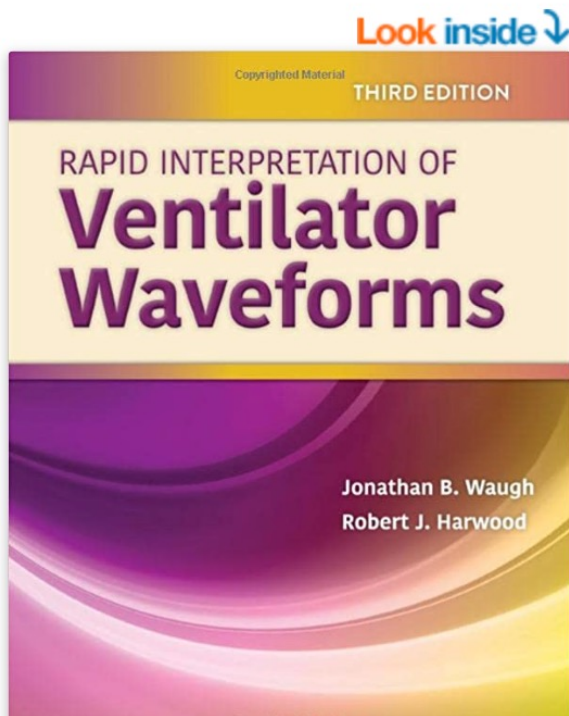


Paw



Vol





# Rapid Interpretation of Ventilator Waveforms

## 3rd Edition

by [Jonathan Waugh](#) (Author), [Robert J. Harwood](#) (Author)

★★★★☆ 6 ratings

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A futuristic, glowing tunnel with purple and blue lights and a checkered floor. The tunnel is composed of many small, reflective panels that create a shimmering effect. The floor is a checkered pattern of light and dark squares. The walls and ceiling are also made of these panels, with bright blue and purple light streaks running along the edges. The overall atmosphere is high-tech and digital.

[Tim.Gilmore@lsuhs.edu](mailto:Tim.Gilmore@lsuhs.edu)

Thanks for listening.