Patient - ventilator asynchronies

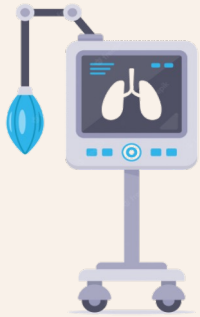
Dyspnea, agitation

Muscle lesion, VILI

Hyperinflation, auto-PEEP

↑ Work of breathing, ↑ $\dot{V}O_2$

Poor sleep quality



Sedation
NMB

↓ Muscle strength

Pain

Mechanical changes

Fever / Sepsis

↓ pH

↑ Respiratory drive

Circuit problems/ filters

Leaks

Malfunction

Modes and settings

Patient

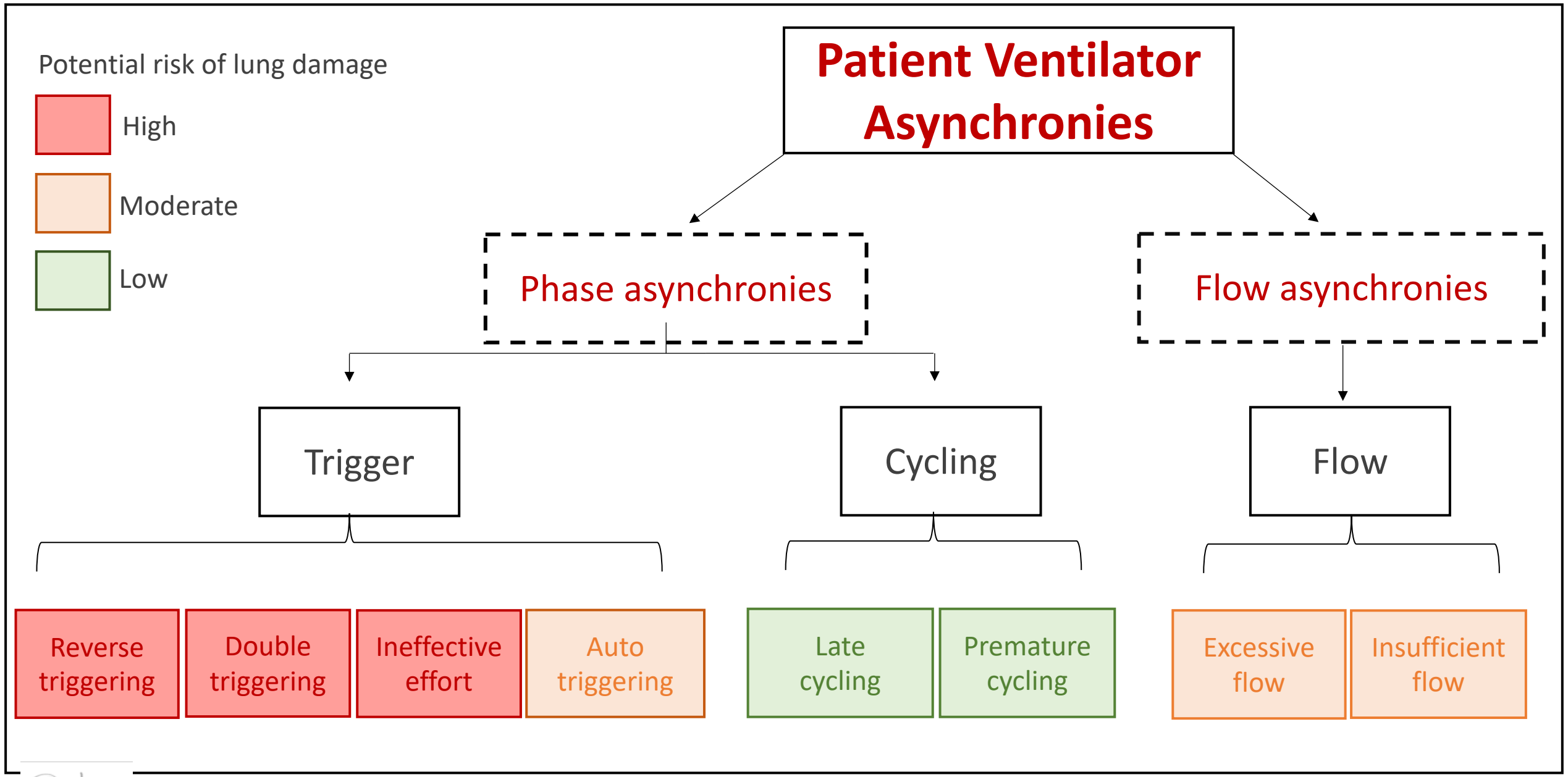
Asynchronies

Ventilator and accessories

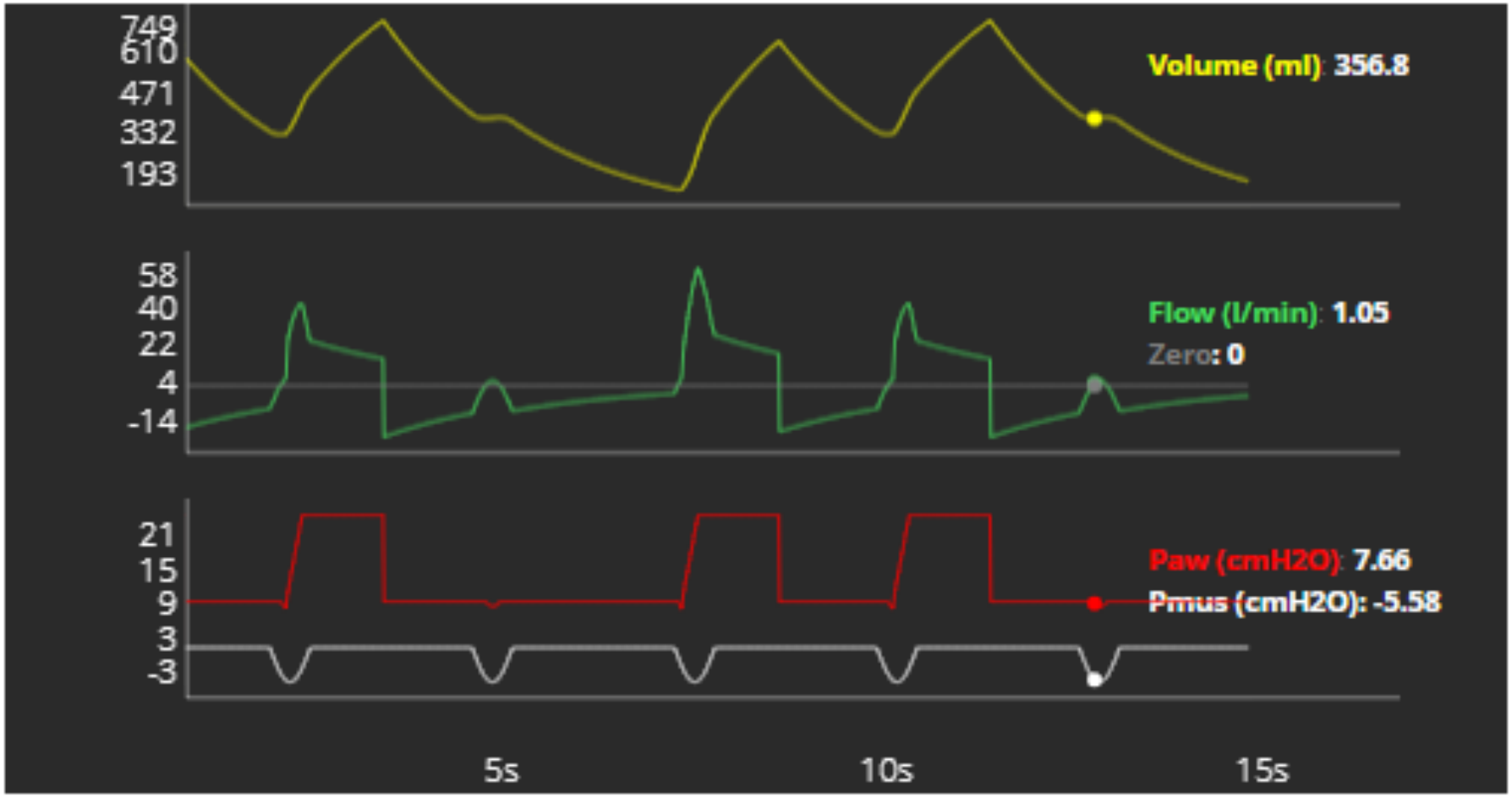
↑ MV duration

↓ Survival

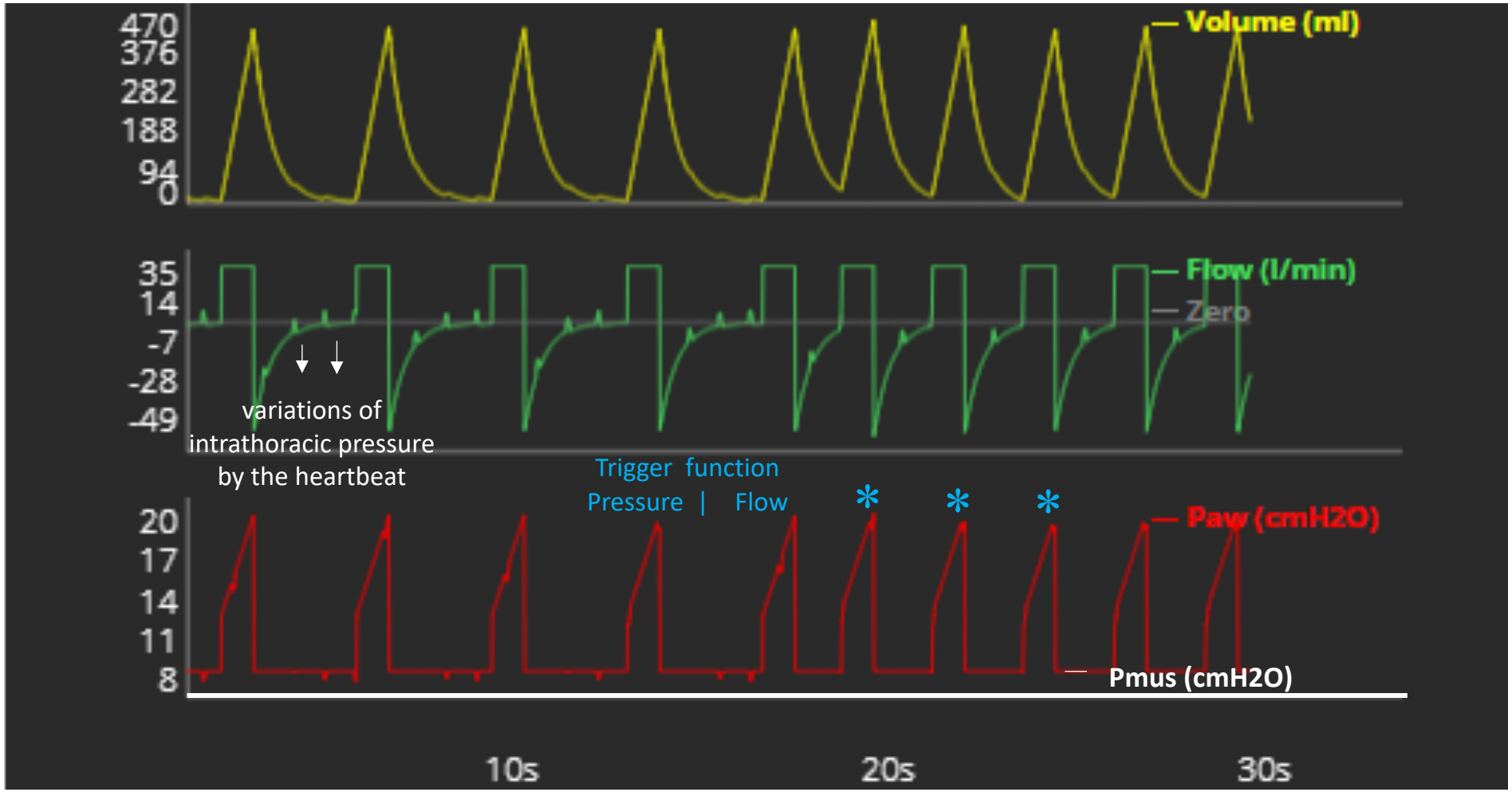
xlung


Potential risk of lung damage
High
Moderate
Low
Patient Ventilator Asynchronies
Phase asynchronies
Flow asynchronies
Trigger
Cycling
Flow
Reverse triggering
Double triggering
Ineffective effort
Auto triggering
Late cycling
Premature cycling
Excessive flow
Insufficient flow

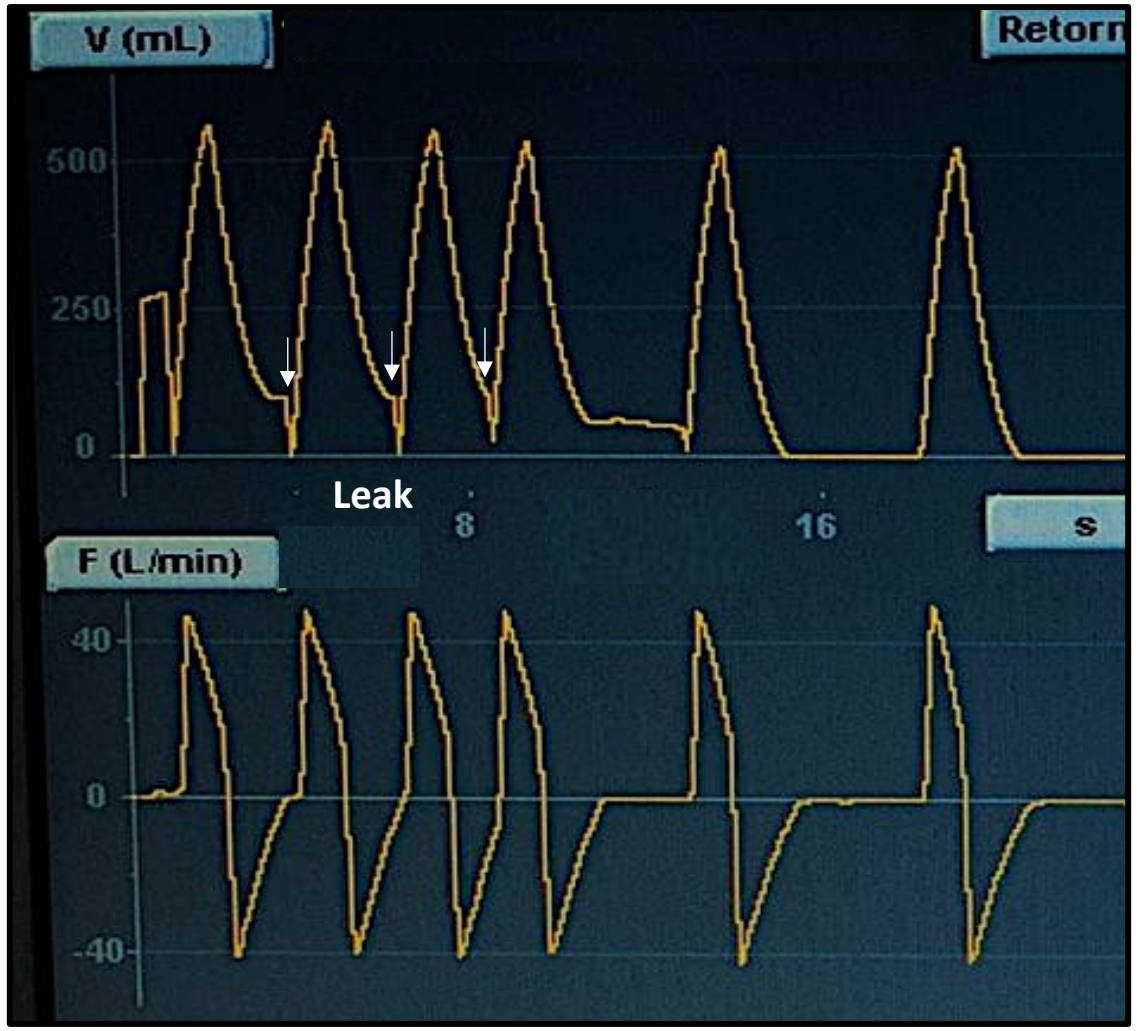
Ineffective effort



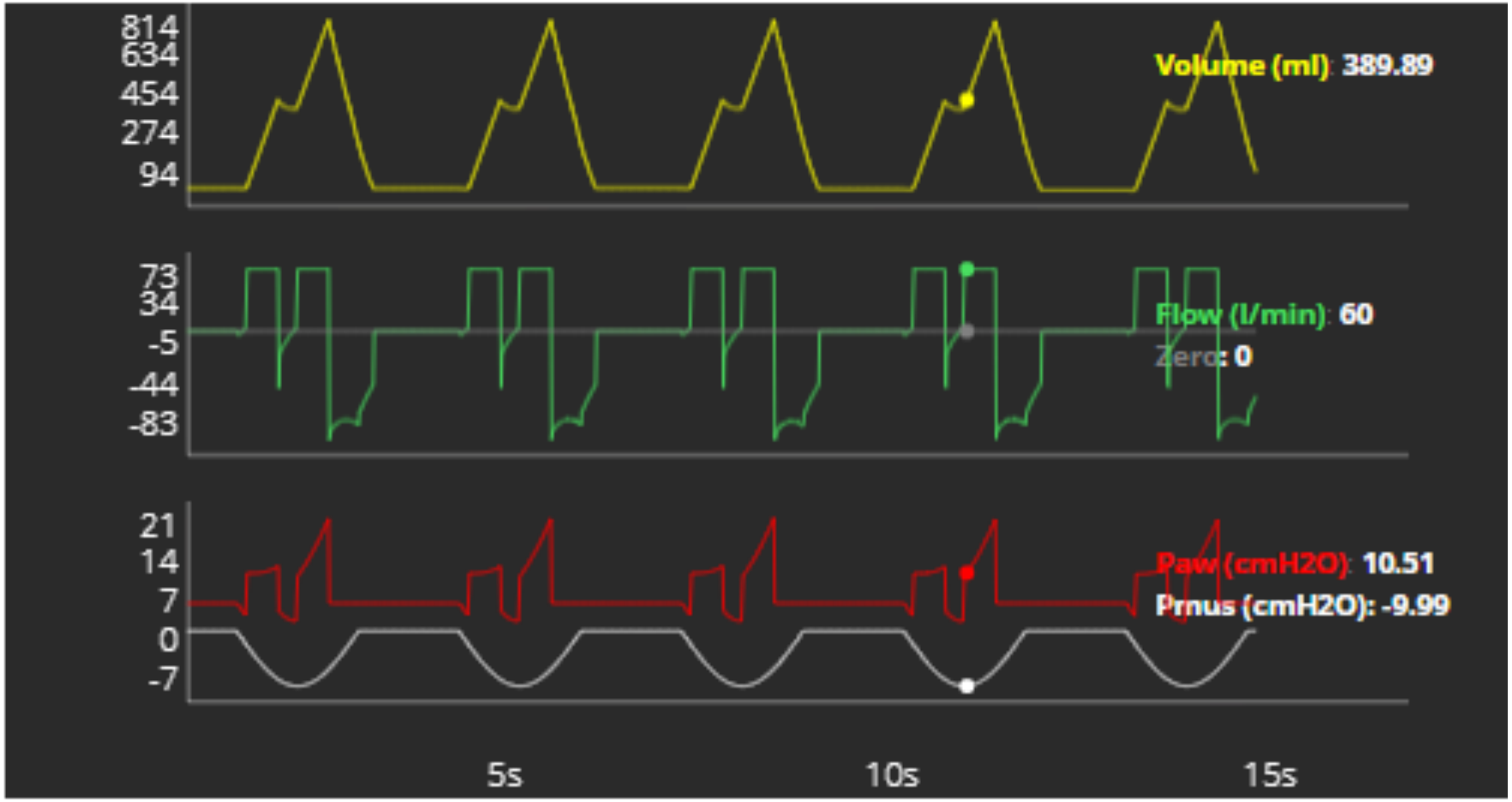
Autotriggering



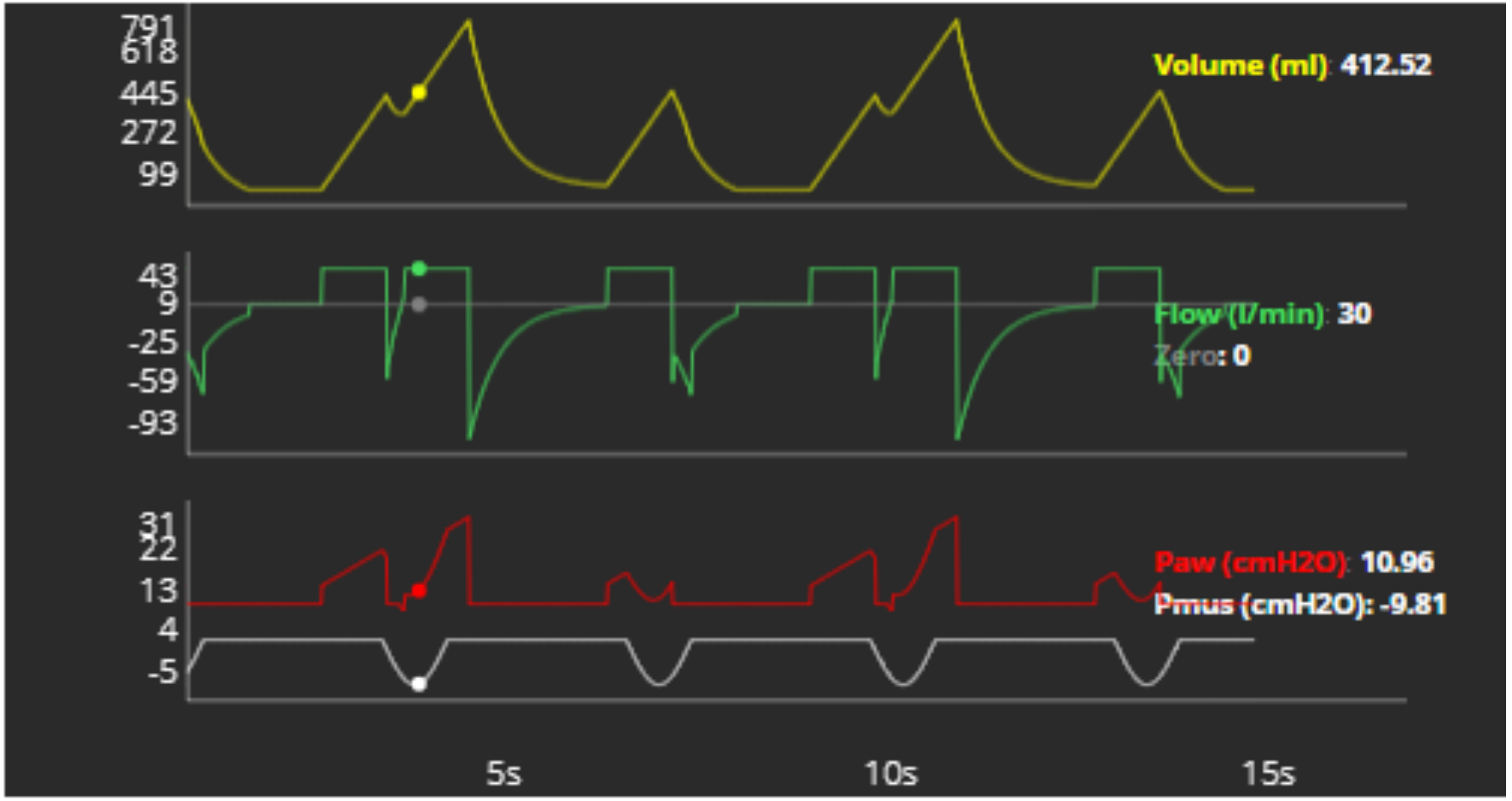
Autotriggering due to air leaks



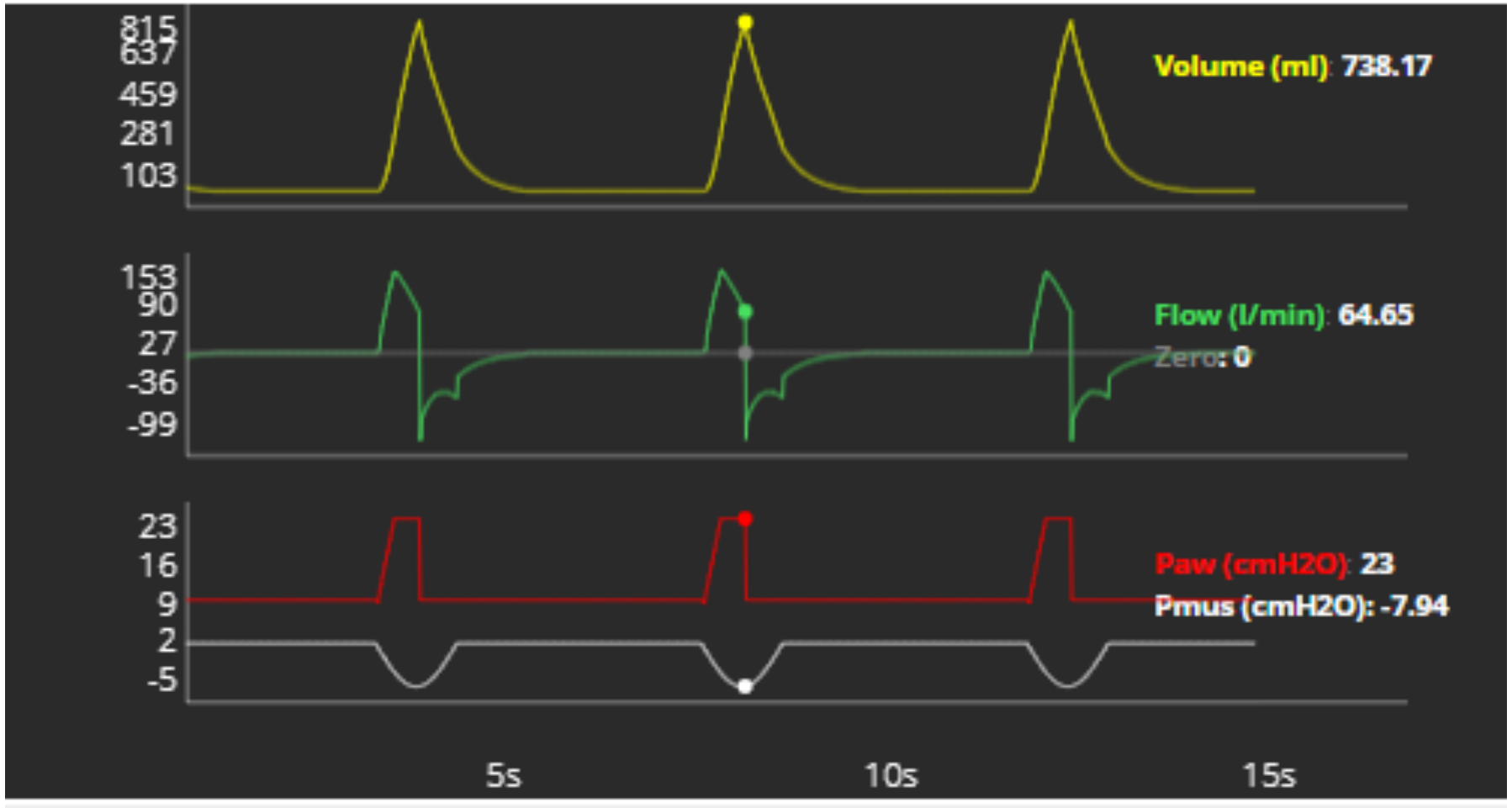
Double triggering



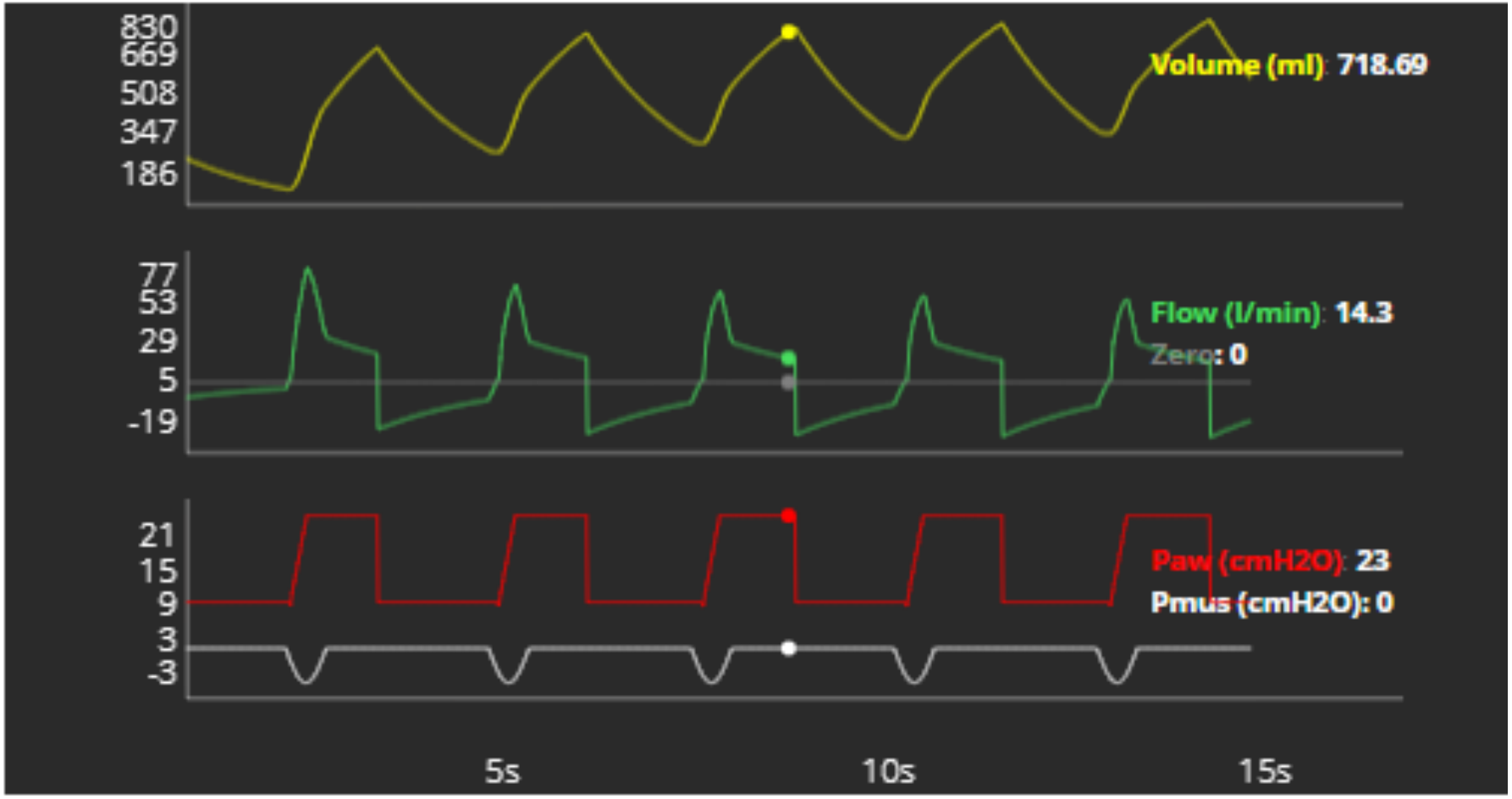
Reverse triggering



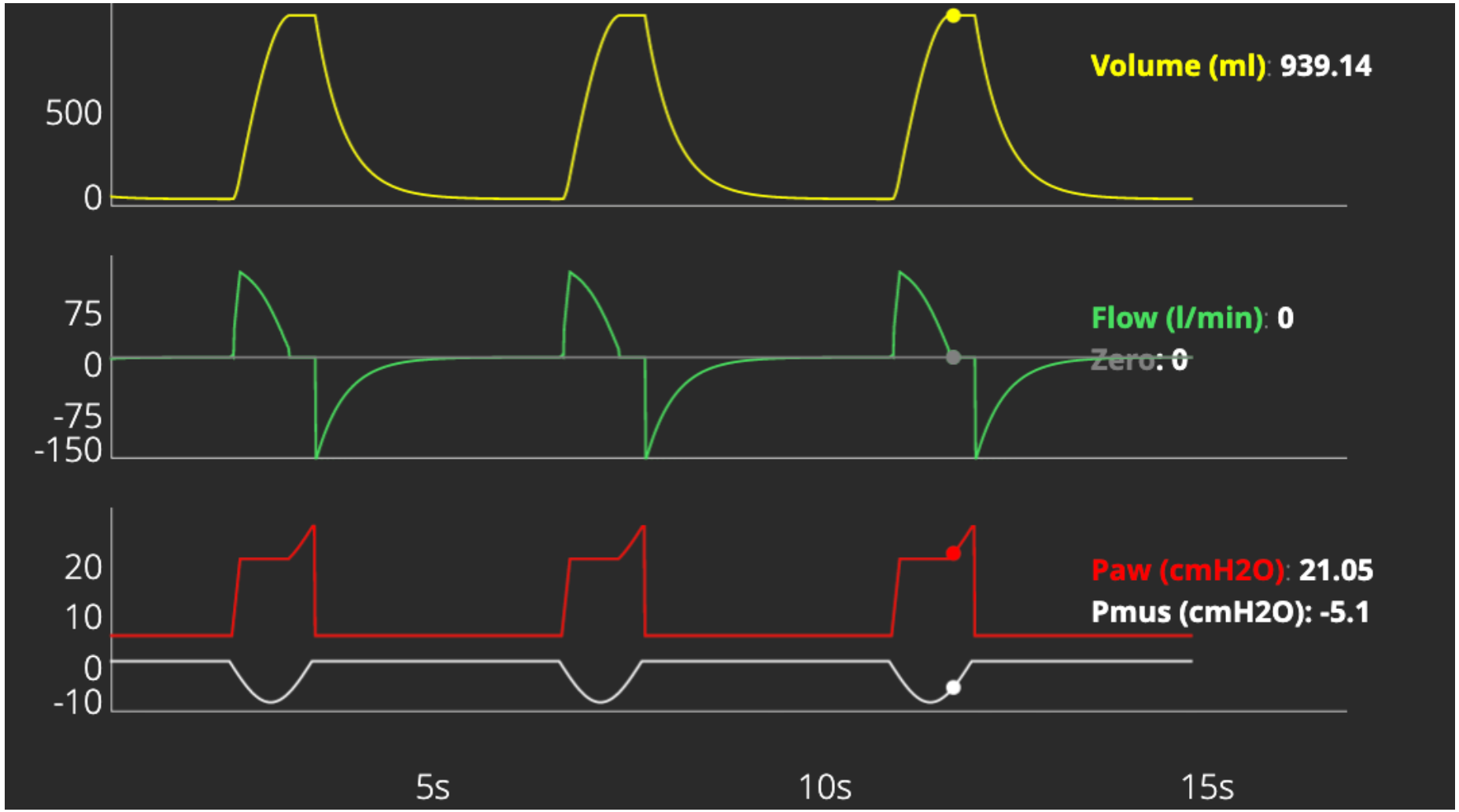
Premature cycling



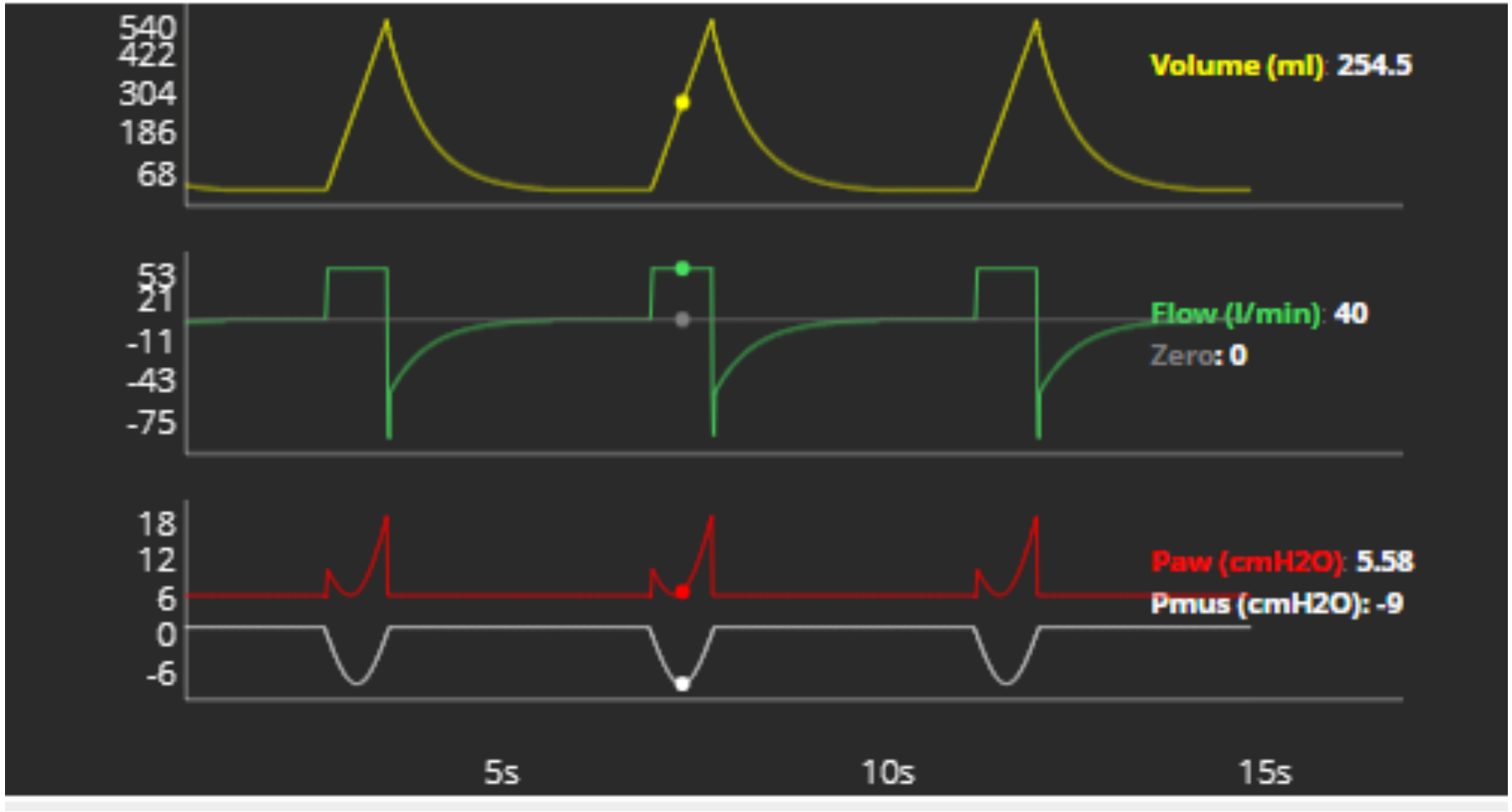
Late cycling



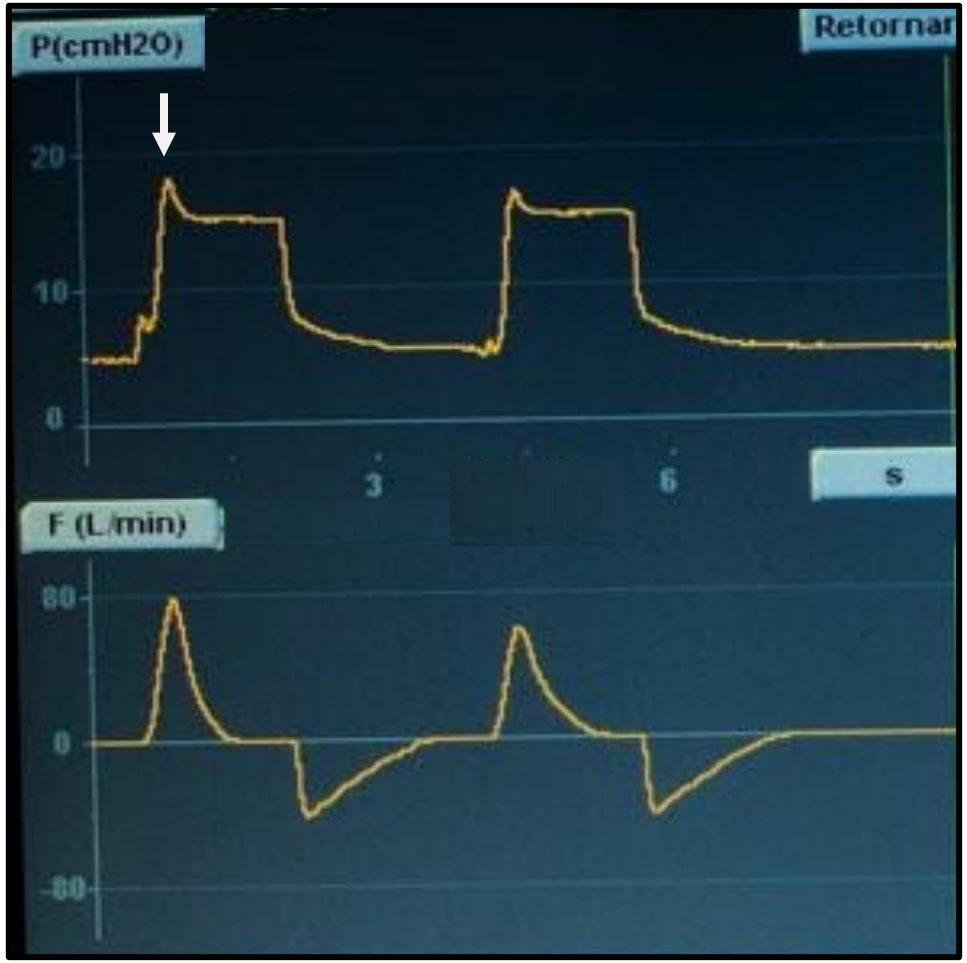
Late cycling with pressure overshoot



Insufficient flow



Excessive flow



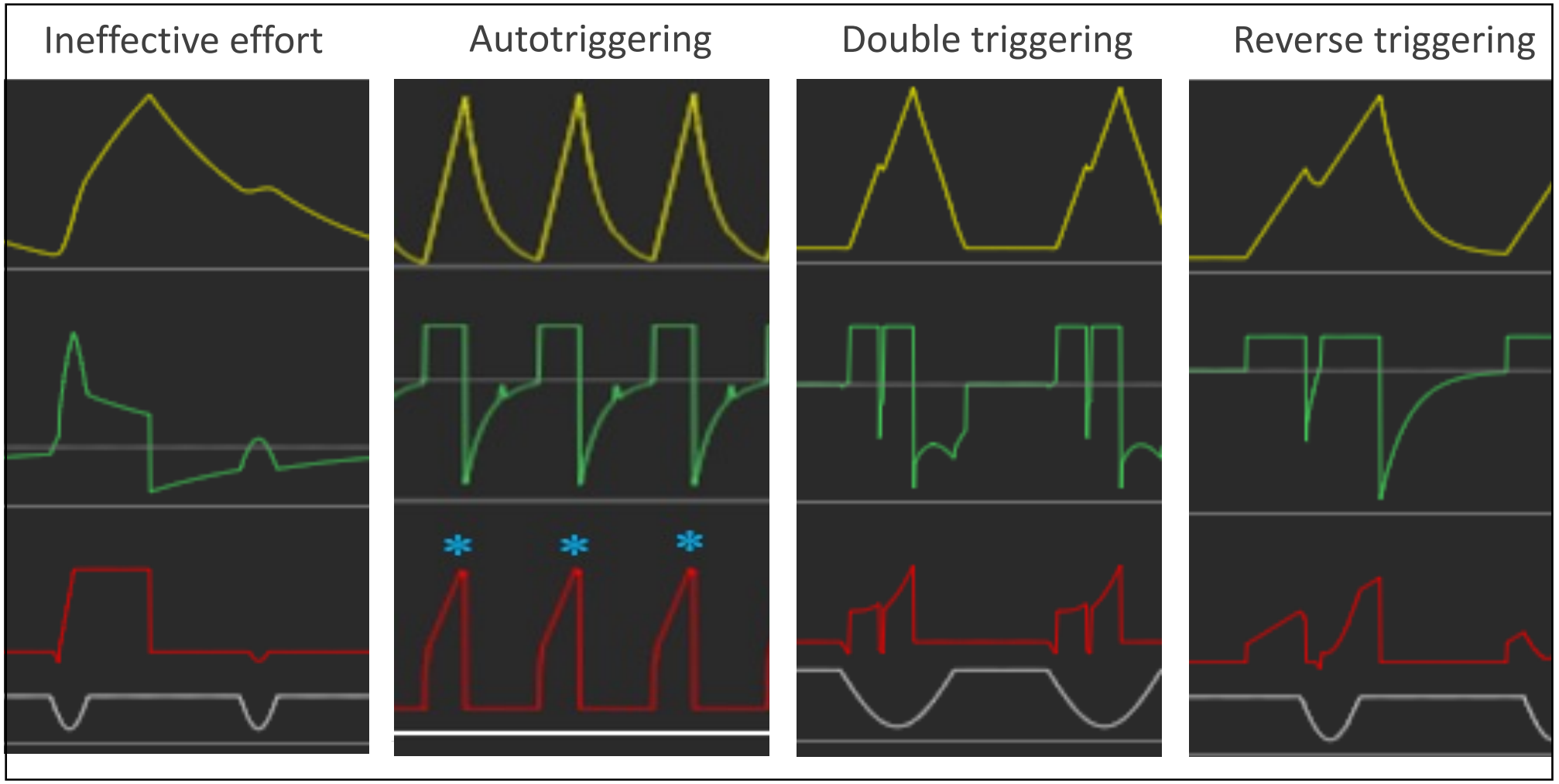
Trigger asynchronies
Mechanisms, risks and possible solutions

Variants	*Reverse triggering*	*Double triggering*	*Ineffective effort*	*Autotriggering*
Mechanisms	Diaphragm activation due to reflex mechanisms induced by a mechanically controlled cycle	Patient's neural respiratory time > ventilator mechanical time	Decreased Pmus / respiratory drive Decreased sensitivity Auto-PEEP	Leaks Heartbeat transmissions Secretions/condensate into the circuit
Risks	Breath stacking VILI	Breath stacking VILI	Muscle injury Dyspnea Respiratory drive increase	Hyperventilation Auto-PEEP
Possible solutions	Reduce sedation or NMB infusion depending on the clinical context	Increase of the ventilator inspiratory time	Reduce/remove sedation Increase sensitivity Increase/titrate PEEP	Circuit cleaning Appropriate trigger setting

Cycling and flow asynchronies
Mechanisms, risks and possible solutions

	Cycling		Flow	
Variants	*Premature cycling*	*Late cycling*	*Insufficient flow*	*Excessive flow*
Mechanisms	Mechanical ventilator inspiratory time < patient neural inspiratory time	Mechanical ventilator inspiratory time > patient neural inspiratory time	Flow rate < patient ventilatory demand	Flow rate > patient ventilatory demand
Risks	Respiratory discomfort Dyspnea	Respiratory discomfort Dyspnea Hyperinflation	Dyspnea Increased respiratory drive and work of breathing	Airway pressure overshoot
Possible solutions	Increase ventilator inspiratory time	Decrease ventilator inspiratory time	Flow increase (VCV) Use PCV or PSV modes	Reduce flow or increase rise time in PCV or PSV modes

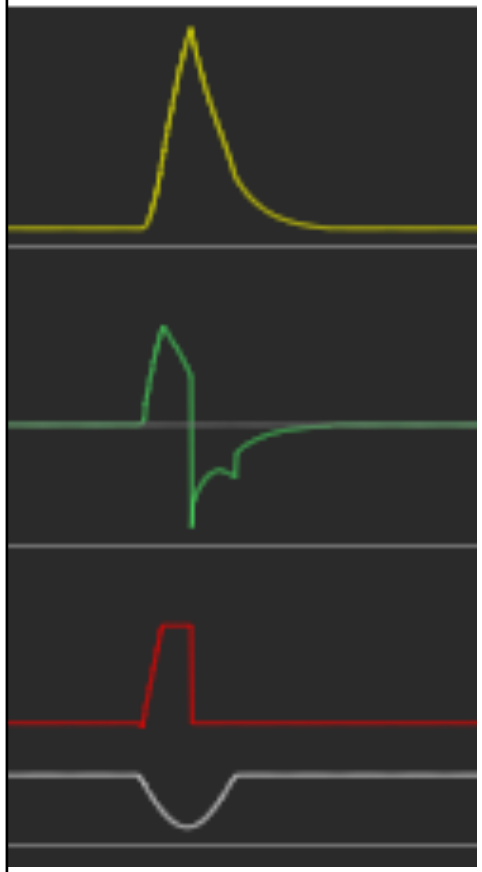
Trigger asynchronies



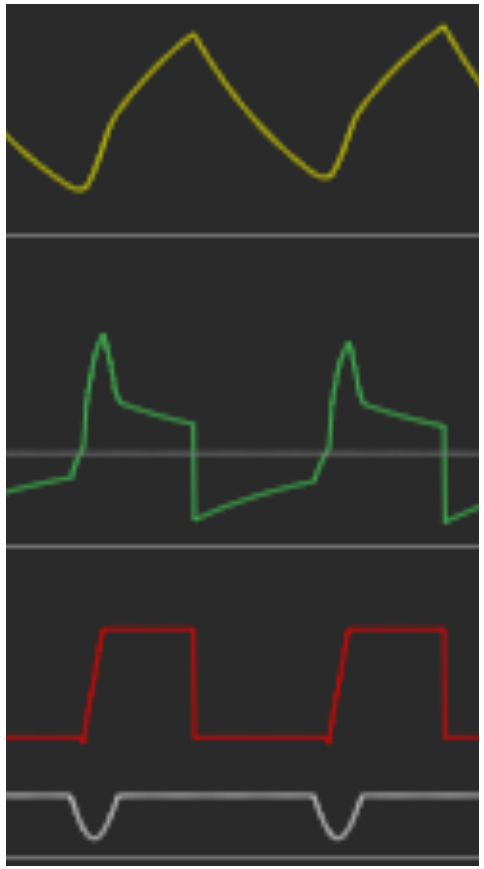
Cycling asynchrony

Flow asynchrony

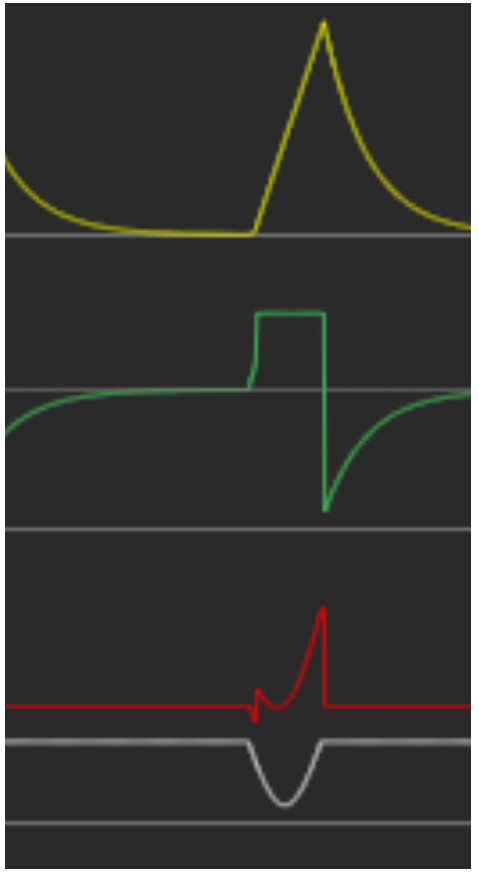
Premature cycling



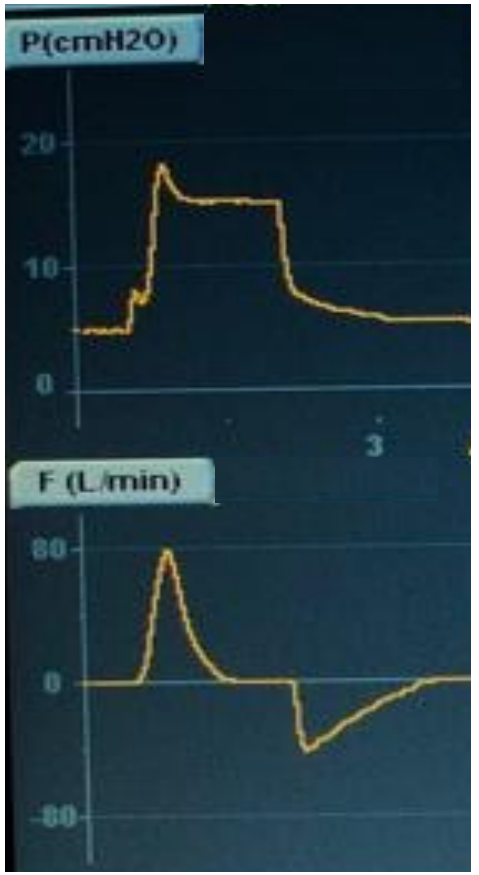
Late cycling



Insufficient flow



Excessive flow



Recommendations for evaluating patient x ventilator asynchronies through ventilator curves analysis at the bedside

- Adjust the scale of the curves (flow, volume and pressure)
- Check curves with the screen frozen
- Imagine the effect and shape of the Pmus (usually it is the opposite of the flow curve variation)
- Determine if the problem is related to:
- The patient

    - check physical exam, temperature, drive, fever, sedation, NMB, muscle strength

- Ventilator

    - Modes, settings, equipment characteristics, circuit and accessories.