patient ventilator interaction

general

- Patient-ventilator asynchrony is common, is often unrecognized and underestimated, and is often inappropriately treated in the clinical setting.

patient factors

The patient interacts with the ventilator based on three physiologic variables
1. Ventilatory drive, or when inspiration starts
2. Ventilatory requirements, or how much flow and volume are necessary to satisfy metabolic demands
3. Timing of the integrated circuits generating the respiratory rhythm, as measured by the duration and ratio of inspiratory time to total breath cycle duration

ventilator factors

General:
The ventilator interfaces with the patient's physiology based on three technologic variables:
1. The inspiratory trigger, or when the ventilator starts to deliver flow, volume, and pressure
2. The delivery mechanisms of gas-that is, the algorithm used by the ventilator to assist ventilation through the delivery of flow, volume, or pressure
3. The cycling criteria, or when the ventilator stops assisting the inspiratory effort and lets the patient exhale spontaneously

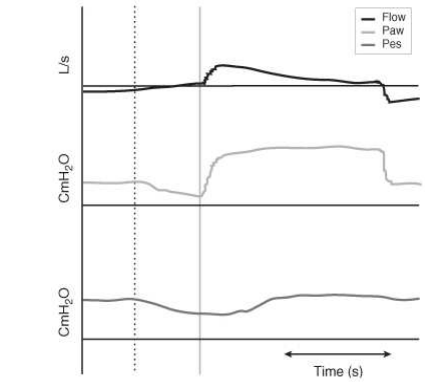
Total Ventilator-Controlled Mechanical Support.
- In this method, the patient's breathing pattern is totally controlled by the ventilator. The pressure generated by the respiratory muscles is abolished by paralysis or sedation.
- Flow, volume, and pressure are imposed by the ventilator, and the patient's breathing pattern is totally replaced by that of the ventilator.
- The risk of patient-ventilator asynchrony is therefore abolished, but there are potential risks associated with sedation and paralysis, respiratory muscle atrophy, lung damage due to overdistention, patient discomfort, and difficulty weaning after prolonged controlled mechanical ventilation.

Partial Patient-Controlled Mechanical Support.
- With this method, spontaneous breathing activity is partially preserved.
- The need for sedation and paralysis may be reduced, disuse atrophy of the respiratory muscles may be minimized, and the weaning process may be accelerated, provided the patient's ventilatory demand and ventilator settings are synchronized.
- The ability to restore gas exchange, unload respiratory muscles, and relieve patient dyspnea with partial patient-controlled mechanical support therefore depends on the absence of patient-ventilator asynchrony.

respiratory drive-trigger asynchrony

- The goal of the ventilator trigger is to track inspiratory effort in order to couple the patient's effort with the delivery of pressure, flow, or volume.

inspiratory pause asynchrony

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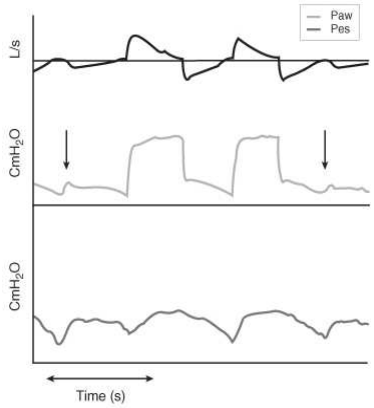
Representative tracings show the interaction between patient effort and triggering of the ventilator. The delay between the beginning of inspiratory muscle activity *(dotted line)* and the beginning of mechanical inflation *(solid line)* can cause an inspiratory phase asynchrony. Flow, flow generated at the airway opening; Paw, pressure applied at the airway opening; Pes, esophageal pressure.

ineffective triggering

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Representative tracings show ineffective triggering due to the ventilator's inability to detect the patient's "request" for an assisted breath. As indicated by the *arrows*, a substantial inspiratory effort generates only a bump in the flow and pressure tracings, instead of a mandatory assisted breath. Flow, flow generated at the airway opening; Paw, pressure applied at the airway opening; Pes, esophageal pressure.

ventilatory requirement gas delivery asynchrony

- Gas delivery asynchrony occurs when ventilator-delivered flow, volume, and pressure are insufficient to meet the patient's ventilatory demand.
- Pressure-targeted breath may better match the patient's ventilatory requirements, because pressure is the independent variable; as a consequence, flow is continuously adjusted by the ventilator to maintain a constant pressure.

ventilator time cycling asynchrony

- Ventilator-patient asynchrony occurs when the patient is trying to exhale but the ventilator is still delivering gas.
- In patients ventilated with a time-cycled breath, expiratory phase asynchrony takes place when the patient's neural inspiratory time is shorter or longer than the ventilator inflation time.
- For proper cycling off and optimal patient-ventilator synchrony, the ventilator needs to track patient's inspiratory flow. The algorithm for the "expiratory trigger" depends on the manufacturer, but most ventilators use a percentage of a drop in inspiratory flow or a preset terminal flow.