AUTOCYCLING

In the precedent post by Enrico we have explained the various types of trigger and the importance they have during the beginning of the inspiratory phase and the cycling to the expiratory phase during mechanical ventilation.

The **inspiratory trigger** is a device that allows a kind of communication between the patient and the ventilator: for each activation of the patient's inspiratory muscles that reach the threshold of the selected trigger there is an insufflation by the ventilator (on the chosen modality). Today I will explain something that alters all of this: **autocycling.**

Autocycling is defined as an inspiratory act generated by the ventilator in the absence of an activation of the inspiratory muscles during assisted ventilation.

The ventilator "cycles" spontaneously, giving a respiratory act that the patient has not initiated. Normally, **assisted** ventilation modalities require, to start the inspiratory assistance, the **activation of the trigger** that derives from the inspiratory effort of the patient.

If all respiratory cycles were to be generated by autocycling (rare event!), the patient would **not** ventilate in assisted modality as we would think, but with a real controlled ventilation.

There are 2 important aspects:

1. The patient in assisted ventilation **must activate the trigger** to obtain the flow from the ventilator.
2. If the patient in **assisted ventilation** modality obtains the flow **without** activating with his inspiratory muscles the trigger, it means that the ventilator is **autocycling.**
   Normally, in the absence of diaphragmatic activity, the ventilators after a short apnea period produce an acoustic alarm and support the patient with preset controlled ventilation called "backup ventilation". But autocycling escapes this control mechanism. When autocycling is present, there is no apnea and the ventilator does not produce any alarm. Autocycling is to be considered **the most important, devious and dangerous asynchrony.**

Why does the ventilator autocycle?

In the presence of a **very sensible trigger** there are some predisposing factors for the generation of autocycling as the **cardiogenic oscillations, air leaks and the condensate** in the circuit. These factors can "cheat" the ventilator that interprets erroneously these factors as if they spring from the inspiratory muscles.

HOW TO DETECT AUTOCYCLING?

We start with the case of a patient that ventilates in assisted modality (PSV), on the pressure-time curve is well visible the classic dip that anticipates the insufflation **(figure 1).** This unmistakable notch is the sing of the trigger generated by the diaphragm. In the image the patient demands all respiratory cycles and the ventilator responds with the delivery of the set support: so far so good!

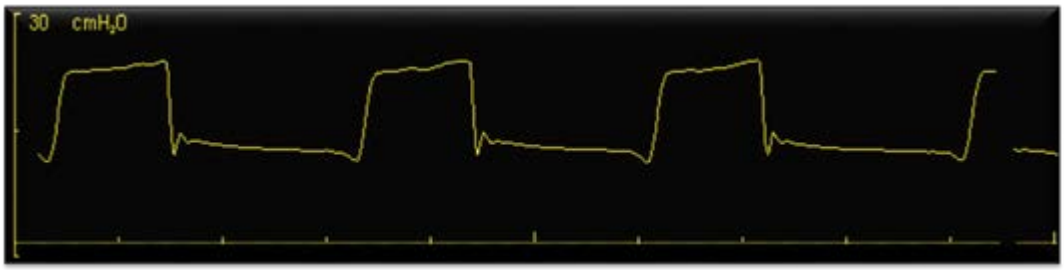

Figure 1. *The beginning of each insufflation of the ventilator is preceded by a notch.*

In figure 2 we show the graphic monitoring of a patient that ventilates in PSV with a highly sensible flow-trigger.

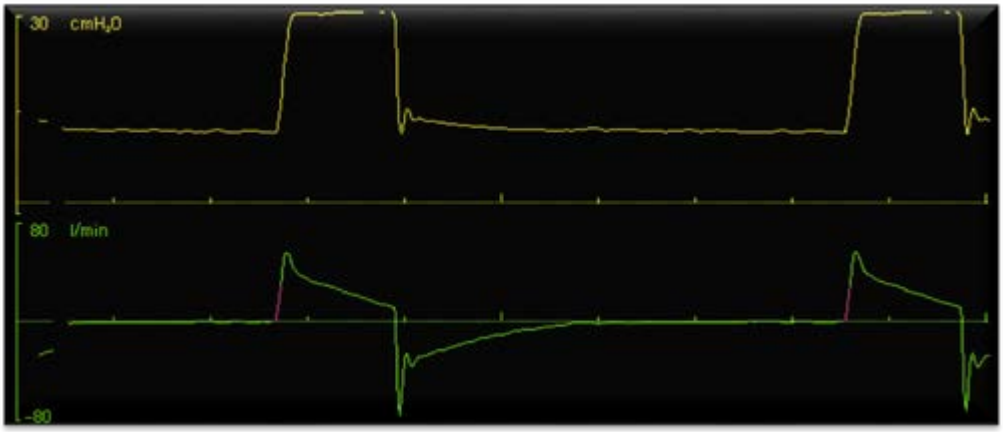

Figure 2. The start of each insufflation is NOT preceded by any notch on the pressure-time curve.

Watch the pressure time curve, no trigger sign is visible, the classical notch before the inspiratory support is missing. The ventilator generates a pressure support even if the patient in fact didn't ask for it.
In this case the cause of autocycling can be tracked back to the cardiac activity. If you watch carefully, there are some minimal cardiac oscillations transmitted to the airways, and some of them were able to activate the trigger twice. Another important detail not to neglect is the fact that **the patient is passive:** on the pressure trace a square wave can be seen. Similarly on the flow curve, after an initial peak, a linear decreasing profile is seen. This morphology is exactly equal to pressure **controlled** ventilation! The expiratory phase (physiological), ends after approximately 2 seconds, but is then followed by a long interval of 2,5 seconds in which the flow remains on the zero line (each tick is one second). This is a second proof that certifies the passivity of the patient.

Next I bring another example of autocycling in a patient that ventilates in PSV with the monitoring of the **diaphragmatic electrical activity.**

As we can see in **figure 3**, only **the second** of the four respiratory acts is effectively demanded by the patient: it is well visible before the inspiration the classical trigger sign. Watch the last of the showed curves, only in the second respiratory act the **diaphragm actually depolarizes,** as shown on the curve derived from the Edi catheter.

Figure 3: The fourth trace on the bottom shows the graphical profile of the diaphragm contraction force given by the Edi catheter.

There is no trigger sign on the first, third and fourth respiratory act, a classic sign of autocycling, confirmed in this case by the **absence of diaphragm electrical activity (reason why the trace is flat in the other acts).**
Synthesising, we have autocycling when in assisted ventilation there is no sign of trigger on the pressure-time curve and when the traces of our graphical monitoring resemble a controlled ventilation.

Why should we watch out for this asynchrony?

An early detection of autocycling, i.e. the abolition of the trigger activity, is a clinical priority, as it can lead to the ventilator induced diaphragm dysfunction (VIDD), one of the main causes of prolonged or impossible weaning.

To conclude, let me try and give some small practical advice:

1. When the patient ventilates in assisted modality be sure that there are **signs of trigger.** If the classical notch on the pressure curve is missing the ventilator is autocycling. Possible solutions:
    a. Check that there is no condensate in the respiratory circuit. The water fluctuation can create some air oscillation in the respiratory apparatus and the ventilator with a soft trigger can mistake this signal as patient activity.
    b. In the absence of condensate, remember that the most frequent cause of autocycling is the oscillation of air in the respiratory apparatus determined by the **transmission of the heart beat. Here a less sensible trigger** can solve the problem.
    c. Air leaks can generate autocycling, verify the circuit integrity.
2. **Detect the signs of patient passivity. A square wave on the pressure trace, with a linear decreasing flow are signs of a passively insufflated patient**. A patient with autocycling has waves shaped similarly to controlled ventilation.
3. If available, check or the **electrical activity of the diaphragm,** measured with an Edi catheter.

Best wishes to all and a thank to the mounting number of triggerlab.org readers,

Cristian

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