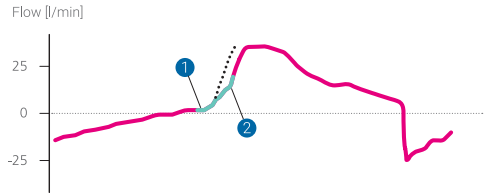
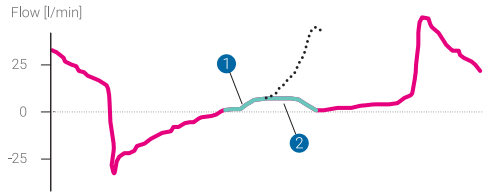
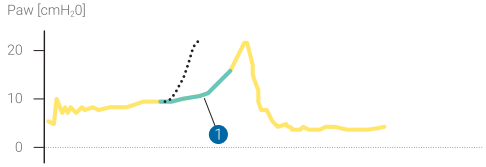
Patient-ventilator asynchrony reference card

Asynchrony	Description	On the waveform	Waveform example	Common possible causes
Trigger asynchronies - during the beginning of inspiration				
Delayed triggering	The time interval between the patient's inspiratory effort and the delivery of a mechanical breath is increased	Flow waveform: Look for a longer-than-normal time interval between the positive deflection in flow ❶ and the delivery of ventilatory support ❷		Trigger threshold set too high Ventilator pneumatics Presence of AutoPEEP Low respiratory drive Weak inspiratory effort
Ineffective effort	The patient's inspiratory effort fails to trigger the delivery of a mechanical breath	Flow waveform: Look for an abrupt change in the steepness of the waveform ❶ (decrease in expiratory flow or increase in inspiratory flow) that is not followed by ventilatory support ❷		Trigger threshold set too high Pressure support too high Set frequency and/or inspiratory time too high (in controlled modes) Tidal volume set too high Presence of AutoPEEP Low respiratory drive Weak inspiratory effort Sedation
Auto triggering	A mechanical breath delivered without an inspiratory effort	Pressure waveform: Look for a delivered mechanical breath showing no drop in airway pressure ❶ at the beginning of the inspiratory phase		Trigger threshold set too low Air leaks in the endotracheal tube cuff, ventilator circuit, or chest tube Flow oscillations (water or secretion in the circuit, cardiac oscillations)
Flow asynchronies - during the gas delivery				
Flow asynchrony	The delivered flow does not meet the patient's inspiratory flow demands	Pressure waveform: Look for an upward concavity ❶ preceding the end of the mechanical breath		Inappropriate selection of ventilation mode (more frequent in volume-controlled modes) High inspiratory effort In volume-controlled modes: Inappropriate flow settings In pressure-controlled modes: Inappropriate P-ramp settings

..... "Correct" waveform, in case of good patient-ventilator synchrony

Patient factors | Ventilator-related factors | Patient-ventilator interface

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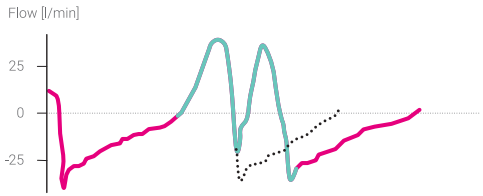
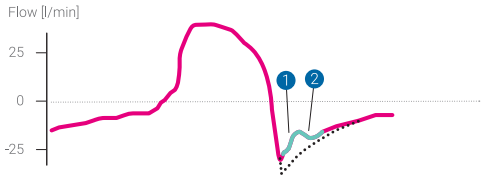
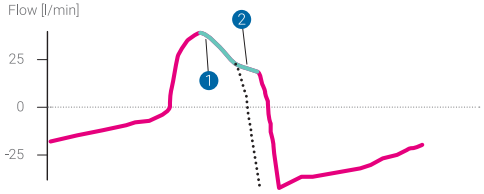
Asynchrony	Description	On the waveform	Waveform example	Common possible causes
Termination asynchronies - during the end of inspiration				
Double triggering	Two (or more) mechanical breaths are delivered during one single inspiratory effort	Flow waveform: Look for two assisted breaths without expiration between them or with an expiration interval of less than half of the mean inspiratory time (often visually displayed as a waveform with two inspiratory peaks)		Cycling criteria (ETS) set too high Pressure support too low P-ramp too short Flow starvation High respiratory drive Time constant too short Double triggering can be an effect of and/or promoted by reverse triggering or early cycling
Early cycling	The duration of the mechanical breath is shorter than the duration of the patient's inspiratory effort	Flow waveform: Look for a small bump ❶ at the beginning of expiration (after peak expiratory flow) followed by an abrupt initial reversal in the expiratory flow ❷		In pressure support ventilation: Cycling criteria (ETS) set too high Low levels of ventilator pressure support Time constant too short In time-cycled ventilation: Short inspiratory time
Delayed cycling	The duration of the mechanical breath is longer than the duration of the patient's inspiratory effort	Flow waveform: Look for a change in the slope of the inspiratory flow: a fast decrease ❶ followed by an exponential (less steep) decline ❷		In pressure support ventilation: Cycling criteria (ETS) set too low Pressure support too high P-ramp too long In pressure control ventilation: Cycling criteria (ETS) set too low Inspiratory time too long In volume control ventilation: Low flow Long inspiratory time High tidal volume

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References: Arellano, D.H., Palliative Medicine & Care. 2017;4(4):1-6. DOI: 10.15226/2374-8362/4/4/00147 | Arnal, J.M., Monitoring Mechanical Ventilation Using Ventilator Waveforms, Springer International Publishing. 2018. ISBN: 9783319586540) | Dres, M., Current opinion in critical care. April 2016;22(3):246-253. DOI: 10.1097/MCC.0000000000000307 | Holanda, M.A., Jornal Brasileiro de Pneumologia. 2018;44(4):321-333. DOI: 10.1590/S1806-37562017000000185 | Mellot, K.G., Critical Care Nurse. 2009 December; 29(6): 41–55. DOI: 10.4037/ccn2009612.

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