



Mechanical ventilators circuit types

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Abstract

Clinicians might have opportunities to recognize different types of mechanical ventilators circuits and compare them in critical care situations. As a clinician it is important to know the features of those configurations and take them into consideration when choosing modes and settings for patients because it affects the outcome of monitoring and ventilators' performance.

There are three types of ventilators circuits: double limb, single limb with exhalation valve, and single limb with exhalation port.

Keywords: Ventilator circuits, exhalation valve, exhalation port

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Ventilators & patient circuit type

Different technologies used in mechanical ventilation (IV & NIV)

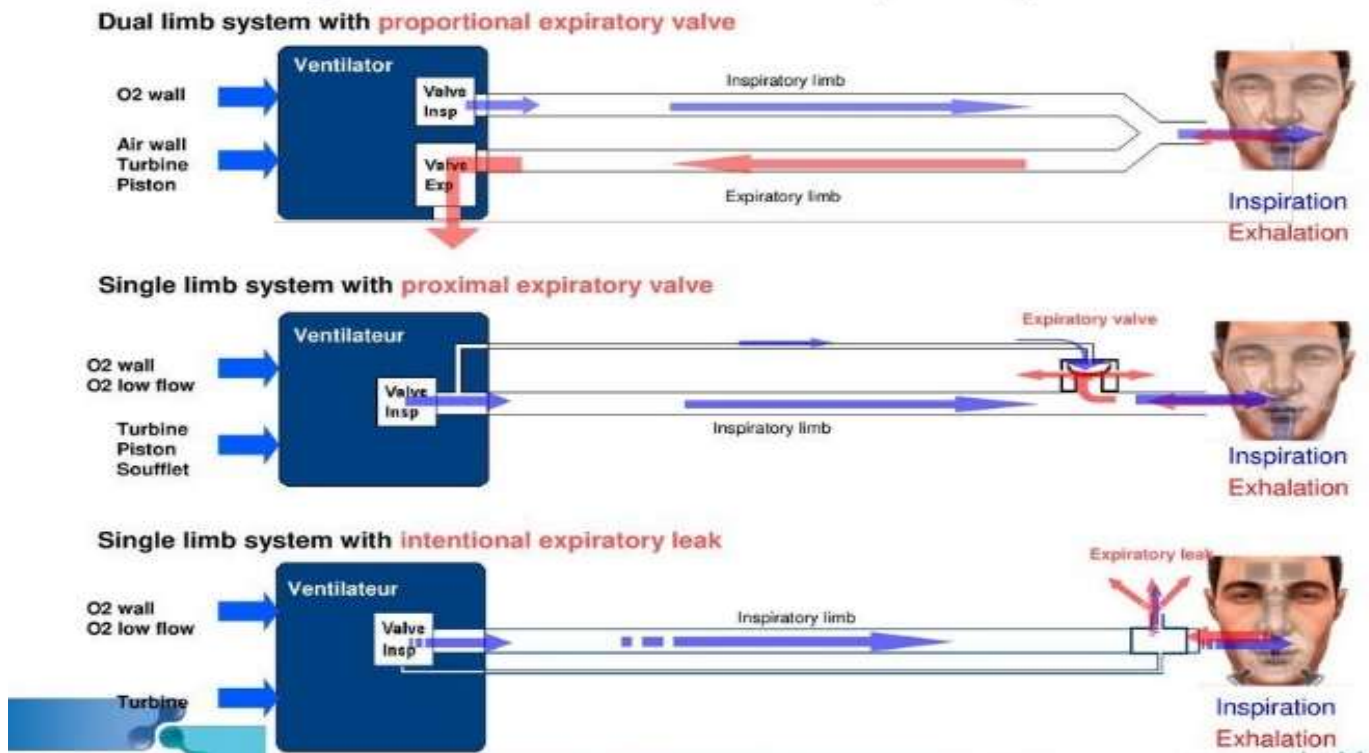


Figure 1: Different types of ventilator circuits. Inspiration: blue, expiration: red. Image credit: flight medical

Double limb circuit

Double limb circuits are used in most critical care ventilators during invasive and non-invasive modes. On the inspiratory side an inspiratory non-return (unidirectional) valve is connected to the ventilator. On the expiratory side an expiratory non-return (unidirectional) valve is connected to the ventilator.¹ During inhalation the gas is delivered to a patient and is not lost into the exhalation circuit while during exhalation the gas is not lost in the inhalation circuit. Because of that structure, there is no intentional leak system to prevent rebreathing. There is an amount of gas that does not reach the patient, this is called the compressive volume generated by a ventilator and could reach up to 20% of the delivered gas.² It is affected by the patient's lung compliance, the circuit compliance, and the pressure gap between inside and outside of circuit.

New generation critical care ventilators have functions to compensate for the compressive volume.¹

Single limb circuit with exhalation valve

Exhalation valve is located proximal to the patient and usually is connected between the circuit and the interface. An exhalation valve is controlled by pressure signal. During inhalation the increased pressure in the circuit occludes the valve to prevent leakage and deliver the gas to the patient. During exhalation, the valve is released; the pressure difference between the circuit (higher pressure) and the valve (lower pressure) makes the valve open and releases the exhaled gas from there. Exhalation valve may control PEEP level as well. When there is leakage, it is difficult to estimate the tidal volume as the pneumotachograph inside of the ventilator would not measure the exhaled tidal volume. Moreover, the flow monitor displays increase when exhalation valve opens in some built-in software. That might cause misleading.¹

This circuit is mainly used for non-invasive ventilators but could be used by some invasive ventilators as well.

Single limb circuit with exhalation port

This is the most common circuit for non-invasive ventilators and home use ventilators due to simple and easy management for caregivers. Exhalation port between the single circuit and the interface (patient's mask or tracheostomy) allows intentional leakage to prevent rebreathing. In inhalation, the gas is delivered to the patient as the tidal volume and partially the gas flows out through the exhalation port. In exhalation the gas partially flows out through the exhalation port but the rest goes back through the tube and the exhaled volume is measured via pneumotachograph in the ventilator. Although ventilator with exhalation port could compensate for the leakage from estimation of leak and avoid rebreathing, it could misestimate depending on the level of PEEP, the patient's exhalation time, the patient's tidal volume and the exhalation port (valve flow).¹

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