Dr. Ahmed Al-khalidi	جامعة الحلة الأهلية /قسم التخدير/المرحله الثالثه/اجهزة تخدير/نظري

Ventilators are used to provide controlled ventilation (intermittent positive pressure ventilation; ***IPPV***).
Some have the facilities to provide other ventilatory modes. They can be used in the operating theatre, intensive care unit, during transport of critically ill patients and also, at home.

In its simplest form, a modern positive pressure ventilator, consists of a **compressible air reservoir or turbine, air and oxygen supplies, a set of valves and tubes, and a disposable or reusable "patient circuit"**. The air reservoir is pneumatically compressed several times a minute to deliver room-air, or in most cases, an air/oxygen mixture to the patient. If a turbine is used, the turbine pushes air through the ventilator, with a flow valve adjusting pressure to meet patient-specific parameters. When over pressure is released, the patient will exhale passively due to the lungs' elasticity, the exhaled air being released usually through a one-way valve within the patient circuit called the patient manifold.

The patient circuit usually consists of a set of three durable, yet lightweight plastic tubes, separated by function (e.g. inhaled air, patient pressure, exhaled air). Determined by the type of ventilation needed, the patient-end of the circuit may be either noninvasive or invasive.

Noninvasive methods, such as continuous positive airway pressure (CPAP) and non-invasive ventilation, which are adequate for patients who require a ventilator only while sleeping and resting, mainly employ a nasal mask.

Invasive methods require intubation, which for long-term ventilator dependence will normally be a tracheotomy cannula, as this is much more comfortable and practical for long-term care than is larynx or nasal intubation.

Classification of ventilators:

There are many ways of classifying ventilators:

1. The *method of cycling* is used to change over from inspiration to exhalation and vice versa:

a) *volume cycling*: when the predetermined (tidal volume) is reached during inspiration, the ventilator changes to exhalation.

b) *time* cycling: when the predetermined (inspiratory duration) is reached, the ventilator changes to exhalation. The ***cycling is not affected by the compliance*** of the patient's lungs. Time cycling is the most commonly used method.

c) *pressure* cycling: when the predetermined (pressure) is reached during inspiration, the ventilator changes over to exhalation. The duration needed to achieve the critical pressure ***depends on the compliance of the lungs***.
(The stiffer the lungs are, the quicker the pressure is achieved and vice versa. The ventilator delivers a different tidal volume if compliance or resistance changes**)**.

d) *flow* cycling: when the predetermined (flow) is reached during inspiration, the ventilator changes over to exhalation. This method is used in older design ventilators.

2. *Inspiratory phase gas control*:

a) *volume*: a preset volume is delivered

b) *pressure*: a preset pressure is not exceeded.

3. *Source of power* – can be electric or pneumatic.

4. *Suitability for use* in theatre and/ or intensive care.

5. *Suitability for pediatric practice*.

6. *Method of operation* (pattern of gas flow during inspiration):

a) *pressure* generator: the ventilator produces inspiration by generating a constant and predetermined (pressure). The inspiratory flow changes with changes in lung compliance.

b) *flow* generator: the ventilator produces inspiration by delivering a

predetermined (flow) of gas. The flow remains unchanged by changes in lung compliance.

7. *Sophistication*: new ventilators can function in many of the above modes. They have other modes, e.g. SIMV, PS and CPAP.

8. *Function*:

a) *minute volume dividers*: fresh gas flow (FGF) powers the ventilator. The minute volume equals the FGF divided into preset tidal volumes thus determining the frequency.

b) *bag squeezers* replace the hand ventilation of a Mapleson D or circle system. They need an external source of power.

c) *lightweight portable*: powered by compressed gas and consists of the control unit and patient valve.

Characteristics of the ideal ventilator

1. The ventilator should be simple, portable, robust and economical.
2. It should be versatile and supply tidal volumes up to 1500 mL with a respiratory rate of up to 60/min and variable I: E ratio. It can be used with different breathing systems. It can deliver any gas or vapor mixture. The addition of positive end expiratory pressure (PEEP) should be possible.
3. It should monitor the airway pressure, inspired and exhaled minute and tidal volume, respiratory rate and inspired oxygen concentration.
4. There should be facilities to provide humidification. Drugs can be nebulized through it.
5. Disconnection, high airway pressure and power failure alarms should be present.
6. There should be the facility to provide other ventilatory modes, e.g. SIMV, CPAP, PS……
7. It should be easy to clean and sterilize.