CHILD AND ADOLESCENT NURSING PRACTICUM

Topic 8

Oxygen Therapy in Pediatric

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Objectives of learning

The topic aims to develop in students an understanding of, and an ability to use oxygen therapy in pediatric

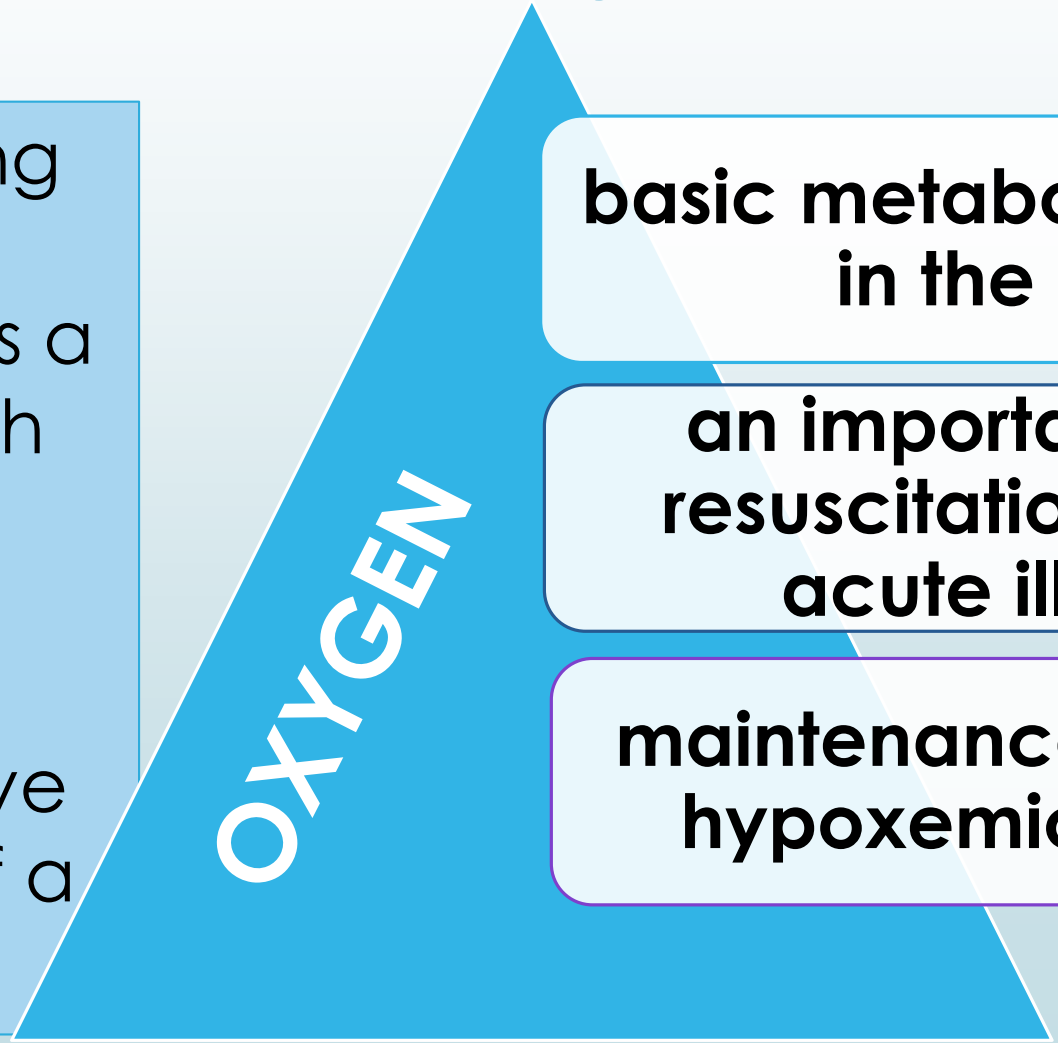
- Indications & Contraindications
- Types of oxygen therapy using in pediatric
- Treatment & Methods

What's about OXYGEN

- Colorless, odorless, tasteless gas
- Makes up 21% of room air
- It's NOT flammable but does support rapid burning.
- It's Considered as a medical gas.
- It's important for maintaining human live, depend on a continuous supply of O2 to sustain aerobic metabolism.
- The main purpose from O2 is energy

Oxygenation is optimal in an upright position

- ✓ Awake patients requiring oxygenation support should be upright unless a contraindication to such positioning is present
- ✓ Each patient's airway anatomy merits consideration to achieve optimal oxygenation of a patient.



basic metabolic demand in the body

an important part of resuscitation in many acute illnesses

maintenance of chronic hypoxemic diseases

Oxygen Therapy

Refers to supplemental oxygen given to people who, aren't able to get enough naturally largely due to breathing disorders.

Hypoxemia

Hypoxemia>>> decrease in the arterial O2 content in the blood

- **Hypoxemia** (low oxygen in your blood) can cause **hypoxia** (low oxygen in your tissues) when your blood doesn't carry enough oxygen to your tissues to meet your body's needs.
- The word hypoxia is sometimes used to describe both problems.

Indications

Chronic

- Chronic obstructive pulmonary disease (COPD)
- Cystic fibrosis
- Pulmonary fibrosis
- Sarcoidosis

Indications

Acute

Medical emergencies requiring high concentrations of oxygen in all cases: Shock

- Sepsis
- Major trauma
- Cardiac arrest and during resuscitation
- Anaphylaxis
- Carbon monoxide and cyanide poisonings
- Transfusion-related acute lung injury (TRALI)

Indications

Acute

Medical emergencies which may or may not require oxygen administration

- Asthma
- Bronchitis
- Acute heart failure or heart failure exacerbations
- Pulmonary embolism

Detection >>> ASSESSMENT

- Clinical evaluation
- Pulse oximetry
- ABG

DETECT>>> ASSESSMENT

- Depends on:

- age of the patient
- oxygen requirements/therapeutic goals
- patient tolerance to selected interface
- humidification needs

Clinical evaluation

Symptoms	Signs
Mental confusion	Tachypnea
Personality changes	Tachycardia
Restlessness	Hypertension
Dyspnea	Arrhythmias
Palpitation	Heart failure, Seizures
Angina	Coma, Cyanosis

Pulse oximetry

Based on the Red and Infrared light absorption

- Oxygenated hemoglobin absorbs more Infrared light and allows more Red light to pass through •
- Deoxygenated (or reduced) hemoglobin absorbs more Red light and allows more Infrared light to pass through. Normal SpO2 values vary between 95 and 100%

Pulse oximetry

The most readily accepted indication for supplemental oxygenation is hypoxemia or decreased levels of oxygen in the blood. With oxygen administration indicated at saturations below these levels.

patients with chronic hypercapnic conditions, target oxygen saturations are generally between 88 to 92%

commonly measured with pulse oximetry

healthy patient, oxygen saturation targets are generally at 92 to 98%

ABG

Blood gases are a measurement of how much O2 and CO2 are in your blood + pH

Normal Values

-PaO2 : 75 to 100 mm Hg (10.5 to 13.5 kPa)

-PaCO2 : 38 to 42 mm Hg (5.1 to 5.6 kPa)

-PH : 7.38 to 7.42

-SaO2 : 94% to 100%

-HCO3 : 22 to 28 mEq/L

ABG

PaO_2 as an indicator for Oxygen therapy

80 – 100 mm Hg : Normal

60 – 80 mm Hg : cold, clammy extremities

< 60 mm Hg : cyanosis

< 40 mm Hg : mental deficiency memory loss

< 30 mm Hg : bradycardiac arrest

PaO_2 < 60 mm Hg is a strong indicator for oxygen therapy

	Date: 22/07/08 Time: 13:45	Units	Arterial Ref Range
BLOOD GASES			
Temperature	37.0	Deg. C	
pH	7.42		7.35-7.45
pCO2	**29L**	mmHg	35-45
HCO3 (Std)	**20L**	mmol/L	22.0-30.0
Base Excess	**-5.1L**	mmol/L	-3.0/3.0
pO2	**123H**	mmHg	75-100
O2 Sat	99	%	95-100
ELECTROLYTES (Whole Blood)			
Potassium	**3.0L**	mmol/L	3.5-5.5
Sodium	**133L**	mmol/L	135-145
Chloride	109	mmol/L	95-110
iCa++	1.14	mmol/L	1.12-1.30
Glucose	**8.2H**	mmol/L	3.6-7.7
Lactate	0.8	mmol/L	0.2-1.8
BLOOD CO-OXIMETRY			
Total Hb	**84L**	g/L	115-150
Reduced Hb		%	0-5
CarbOxy Hb		%	0.5-1.5
Meth Hb		%	0-1.5

MONITORING

Physical examination for C/F of hypoxemia

Pulse oximetry

ABG analysis

- pH
- pO_2
- pCO_2

Mixed venous blood oxygenation

Treatment & Methods

- Depends on:

- age of the patient
- oxygen requirements/therapeutic goals
- patient tolerance to selected interface
- humidification needs

Classification of oxygen therapy using in pediatric

- Low Flow Administration
- **High Flow Administration**
- **Positive Pressure**
- **Other**

Low-flow devices: • Provide oxygen at flow rates that are lower than patients' inspiratory demands • When the total ventilation exceeds the capacity of the oxygen reservoir, room air is entrained

High-flow devices: • Provide a constant FiO2 by delivering the gas at flow rates that exceed the patient's peak inspiratory flow rate and by using devices that entrain a fixed proportion of room air

Low flow (Variable performance devices)

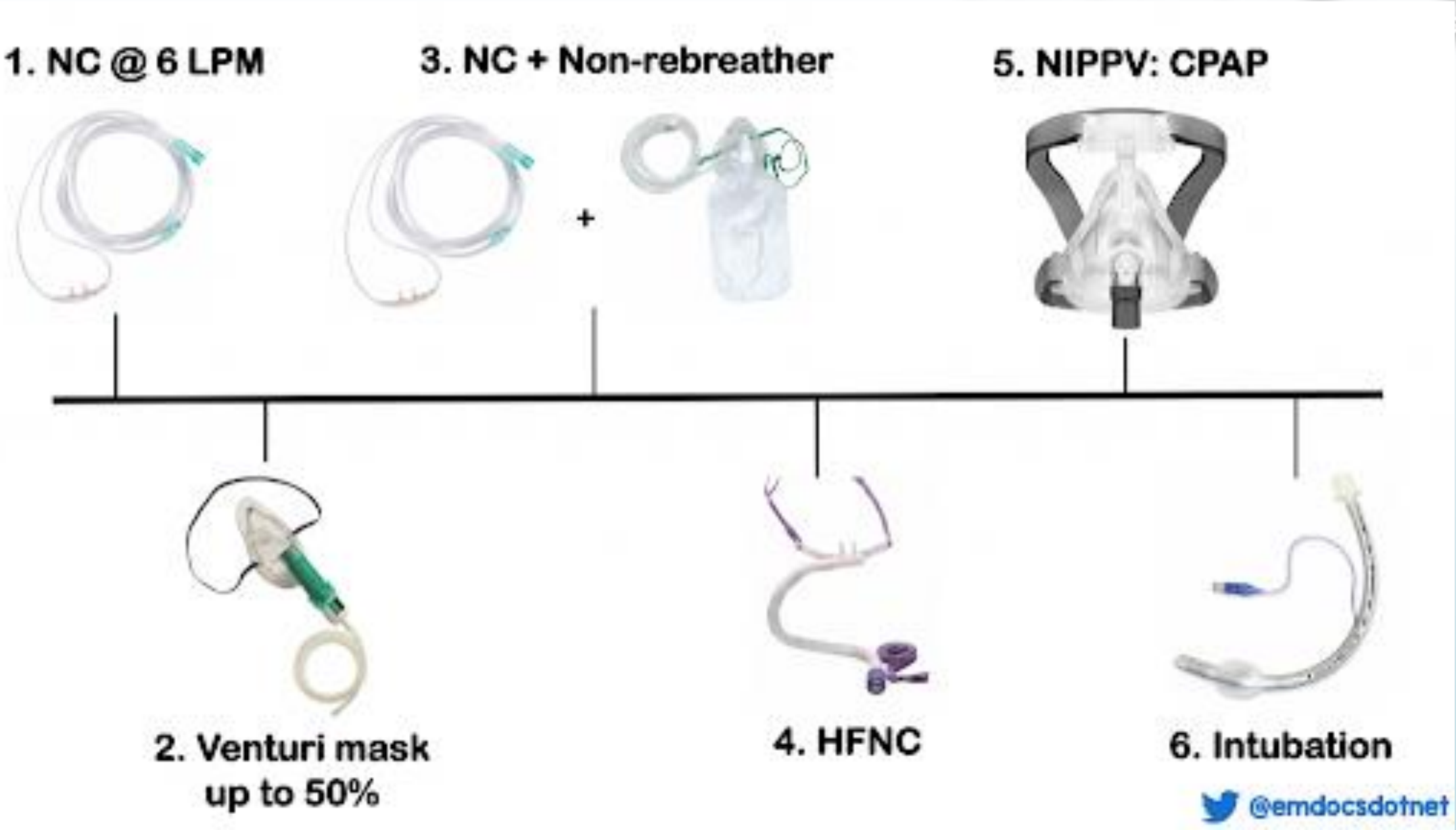
- Nasal cannula
- Nasal catheter
- Transtracheal catheter

Reservoir system (Variable performance device)

- Reservoir cannula
- Simple face mask
- Partial rebreathing mask
- Non rebreathing mask
- Tracheostomy mask

High flow (Fixed performance devices)

- CPAP, BiPAP
- High-flow nasal oxygen therapy (HFNO)
- Ventilators


1. NC @ 6 LPM
3. NC + Non-rebreather
+
5. NIPPV: CPAP
2. Venturi mask
up to 50%
4. HFNC
6. Intubation
@emdocsdotnet

Low-flow devices

Nasal cannula

- A thin tube, often affixed behind the ears
- Used to deliver oxygen directly to the nostrils from a source connected with tubing.
- This is the most common method of delivery for home use and provides flow rates of 2 to 6 liters per minute (LPM) comfortably,
- Standard flow rates for oxygen through nasal prongs or nasal catheters are 0.5–1 L/min for neonates, 1–2 L/min for infants, 1–4 L/min for older children. Recommended Methods of Oxygen Delivery
- Allowing the delivery of oxygen while maintaining the patient's ability to utilize his or her mouth to talk, eat, etc.

Low-flow devices

Nasal cannula

Indications

- Low to moderate oxygen requirement
- Mild respiratory distress
- Long term oxygen therapy

Contraindications

- Poor efforts, apnea, severe hypoxia
- Mouth breathing Nasal Prongs

Low-flow devices

Simple Oxygen Face Mask

A plastic oxygen mask that covers the nose and mouth and is utilized when delivering oxygen concentrations ranging from 30% - 60%.

*Naturally occurring room air is 21% and a higher percentage is often essential for medical treatments.

*Depending on the mask size, it offers a self-contained reservoir of 100 to 200 ml of additional gas and requires a flow of oxygen of 5 - 6L/min to avoid CO2 accumulation within the face mask.

*The mask has exhalation ports to allow carbon dioxide to escape as well as mixing delivered oxygen with room air.

Low-flow devices

Simple Oxygen Face Mask

Indications

- High FiO2 requirement >40%

Contraindications

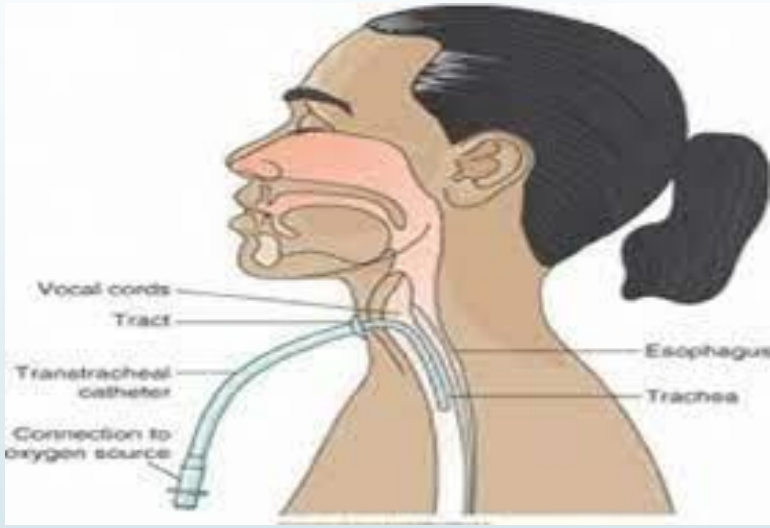
- Poor respiratory efforts
- Apnea
- Severe hypoxia Masks

- High FiO2 without intubation
- Suitable for spontaneously breathing patients with severe hypoxia
- Can be used during nebulization
- No increased risk of airway obstruction or gastric distension

Low-flow devices

Transtracheal catheters

- Used in chronic maintenance therapy and represent a method of oxygenation in which a catheter is surgically inserted through the anterior neck to deliver oxygen directly to the trachea.
- By bypassing the upper airway, oxygen delivery is closer to the alveoli, bypassing the dead space in the upper airway and allowing for chronic use of lower amounts of oxygen without reducing the amount of supplemental oxygen delivered to the lungs.



Low-flow devices

Non-rebreathing masks (reservoir bag)

- A reservoir bag is an attachment to an oxygen administration device that allows for the concentration of oxygen and thus increased percentage administration.
- By allowing the collection of 100% O2 in a reservoir bag, the patient may receive a higher concentration of oxygen by reducing the percent of inhaled gas made up of atmospheric oxygen.

Low-flow devices

Oxygen Box (Head box)

- Used in bed bound infants not intubated
- Made of Plexiglass
- 10-12 lit/min
- High FiO2 without intubation
- Suitable for spontaneously breathing patients with severe hypoxia
- No increased risk of airway obstruction or gastric distension

High-flow devices

High flow nasal cannula (HFNC)

- CPAP, BiPAP
- High-flow nasal oxygen therapy (HFNO)
- Ventilators

High-flow devices

CPAP, BiPAP

- **Continuous positive airway pressure, or CPAP**, is a mask that delivers continuous positive pressure to the patient. It is a form of positive airway pressure ventilator.
- It applies mild air pressure on a continuous basis to keep the airways continuously open who are able to breathe spontaneously on their own.
- Similarly, **bilevel positive airway pressure or BiPAP** is also positive pressure delivered via mask but has an inhale and an exhale pressure set at differing levels.

CPAP, BiPAP

- Hold the mask gently against the child's face, checking that the nose is fully enclosed by the cushion and the mouth is clear.

- Pull the headgear over the head and move the middle strap down until it sits across the middle of the back of the head.

- Keeping your hand on the frame to maintain correct headgear position, bring the lower headgear strap behind the back of the neck.

- Attach the lower headgear strap by holding the tab and hooking the quick-release clip onto the mask.

- If necessary, adjust the straps by removing the Velcro® and gently tightening the headgear straps until comfortable. Do not overtighten.

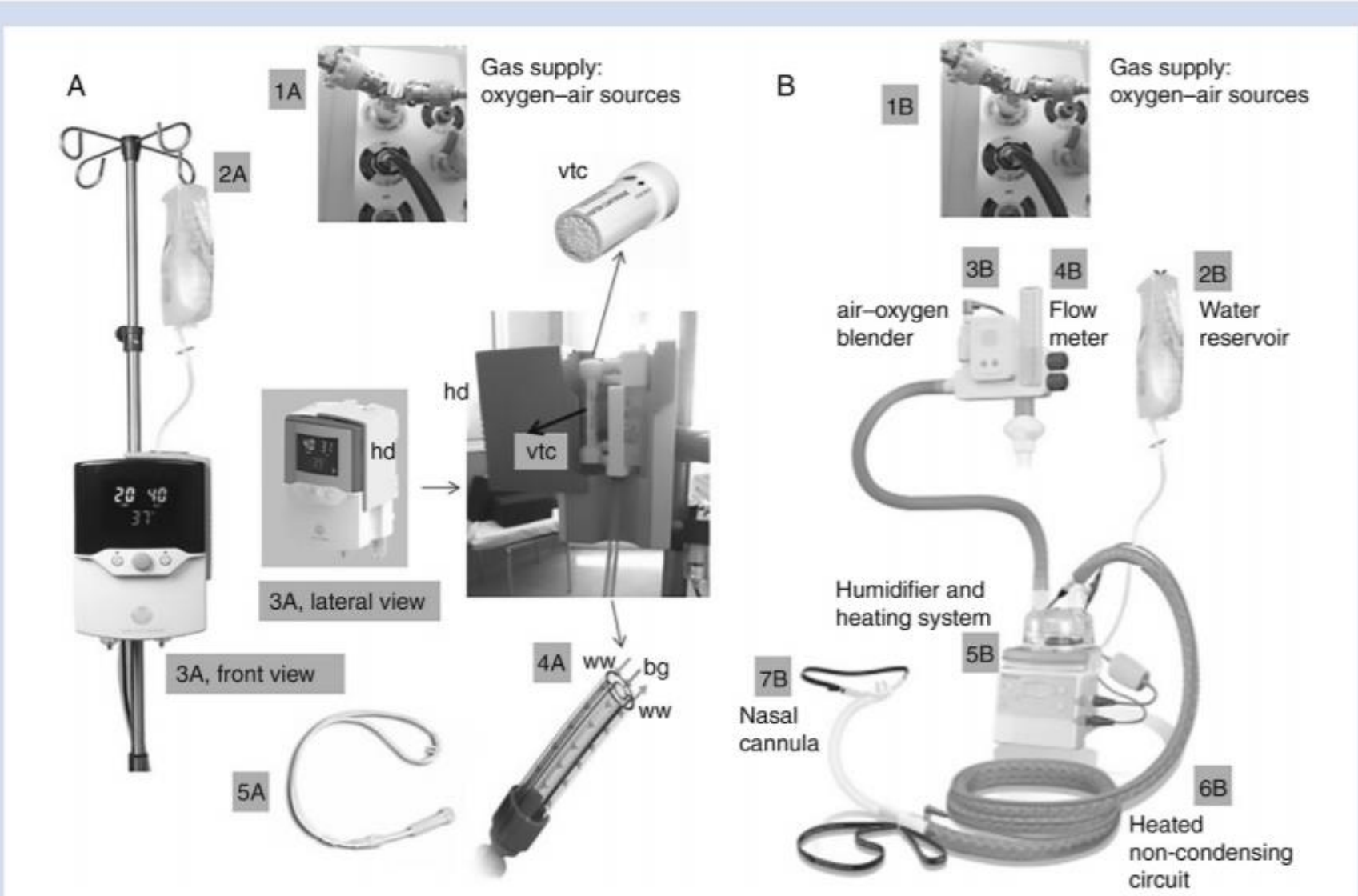
- Connect one end of the air tubing to the swivel and the other end to the airflow device.
- Turn on the airflow device.

Picture from: https://www.respshop.com/cpap-masks/nasal/resmed-pixi-pediatric-cpap-nasal-mask-p-419.html

High-flow devices

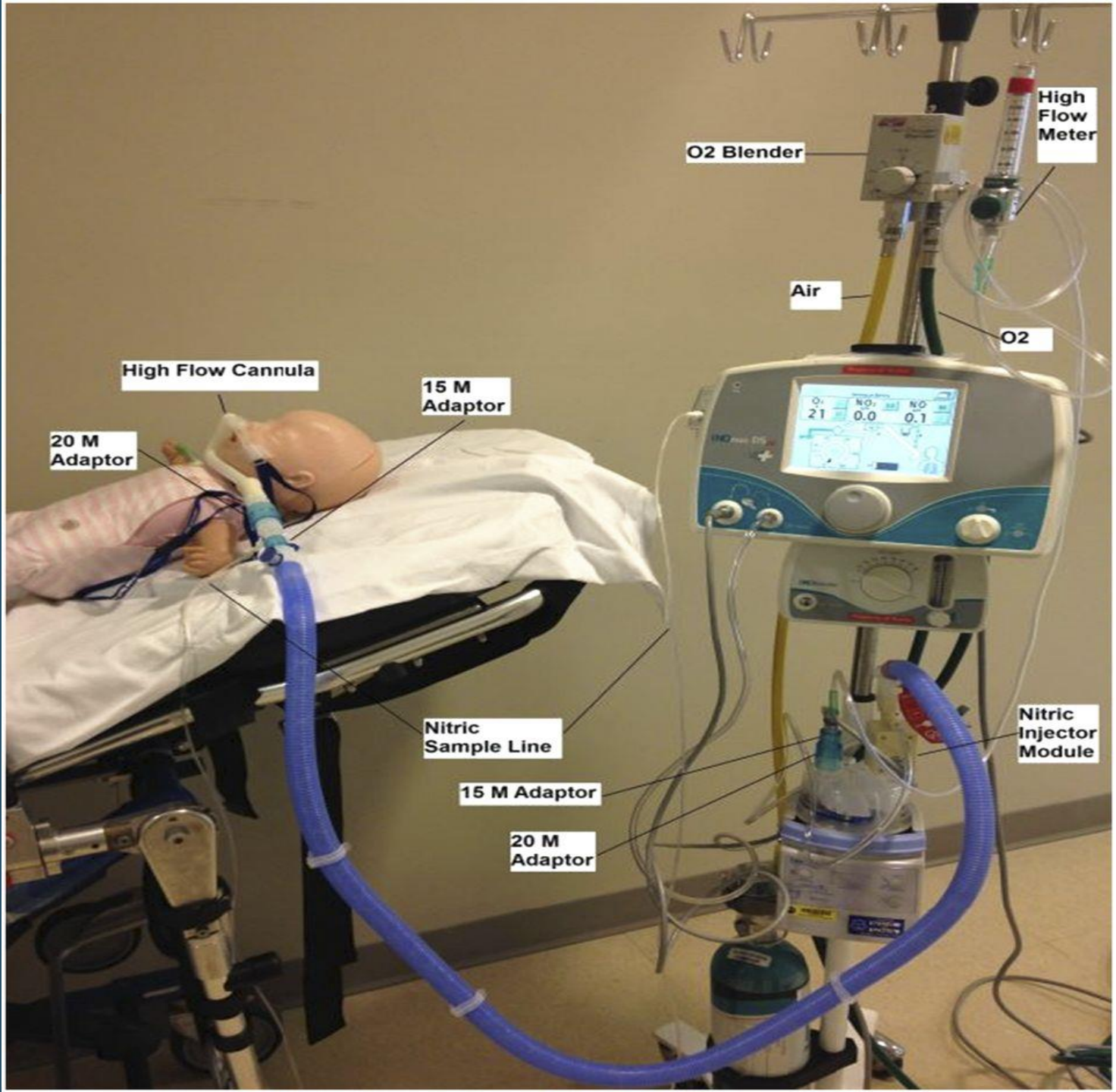
High flow nasal cannula (HFNC)

- It is a nasal cannula with the capability of humidifying oxygen and capable of flow rates that exceed the inspiratory pressure of the patient.
- This setup allows delivery of 100% Fi02 while maintaining the patient's ability to utilize the mouth to talk, eat, etc.
- HFNC may also be used to lengthen times of apnea in preparation for intubation.



High-flow nasal oxygen therapy (HFNO) is an innovative high-flow system that allows for delivering up to 60 litres min-1 of heated and fully humidified gas with a FIO2 ranging between 21% and 100%.

From: Renda T, Corrado A & Iskandar G. (2018). High-flow nasal oxygen therapy in intensive care and anaesthesia. British Journal of Anaesthesia, 120(1).

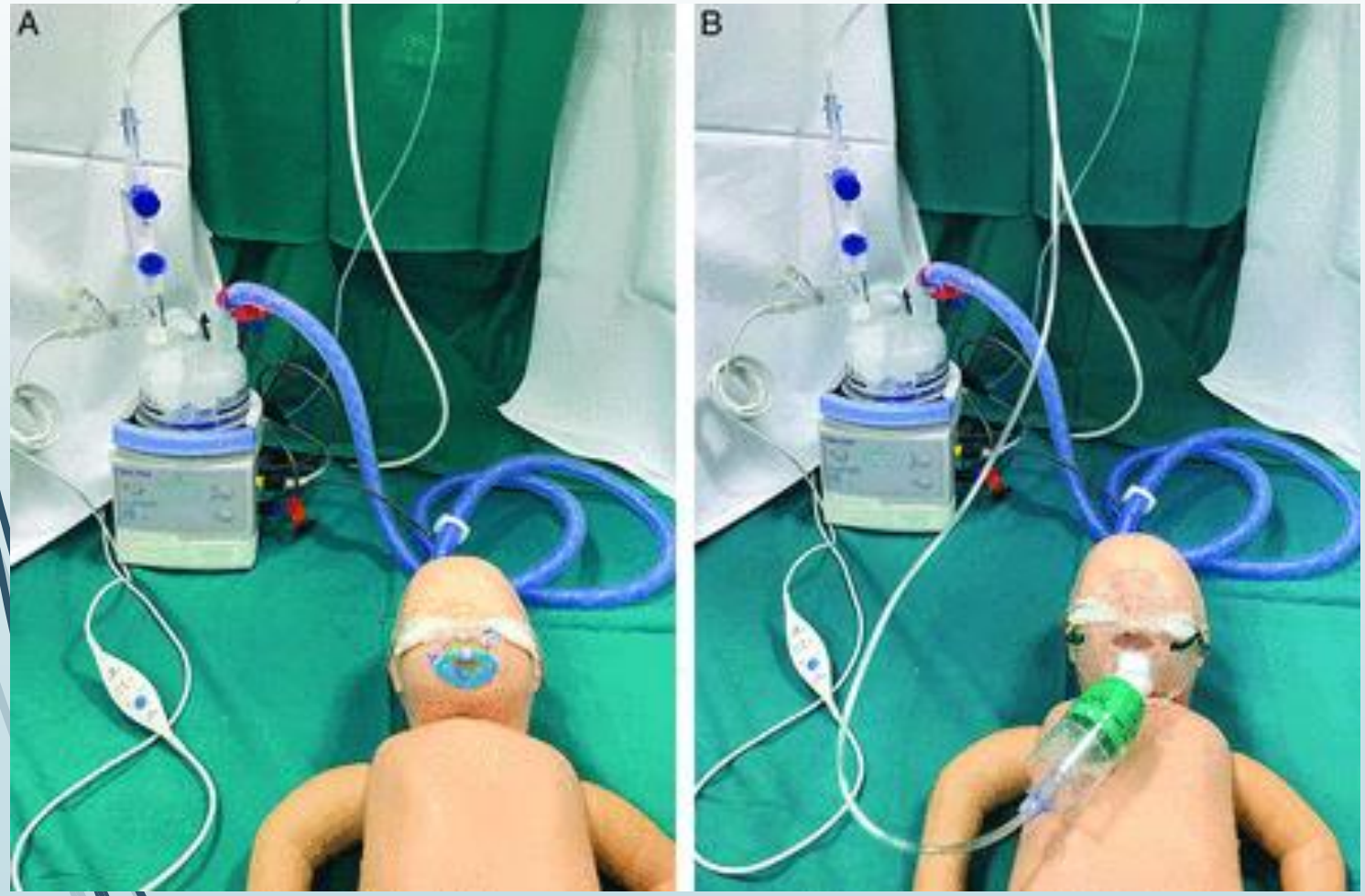


High flow nasal cannula (HFNC)

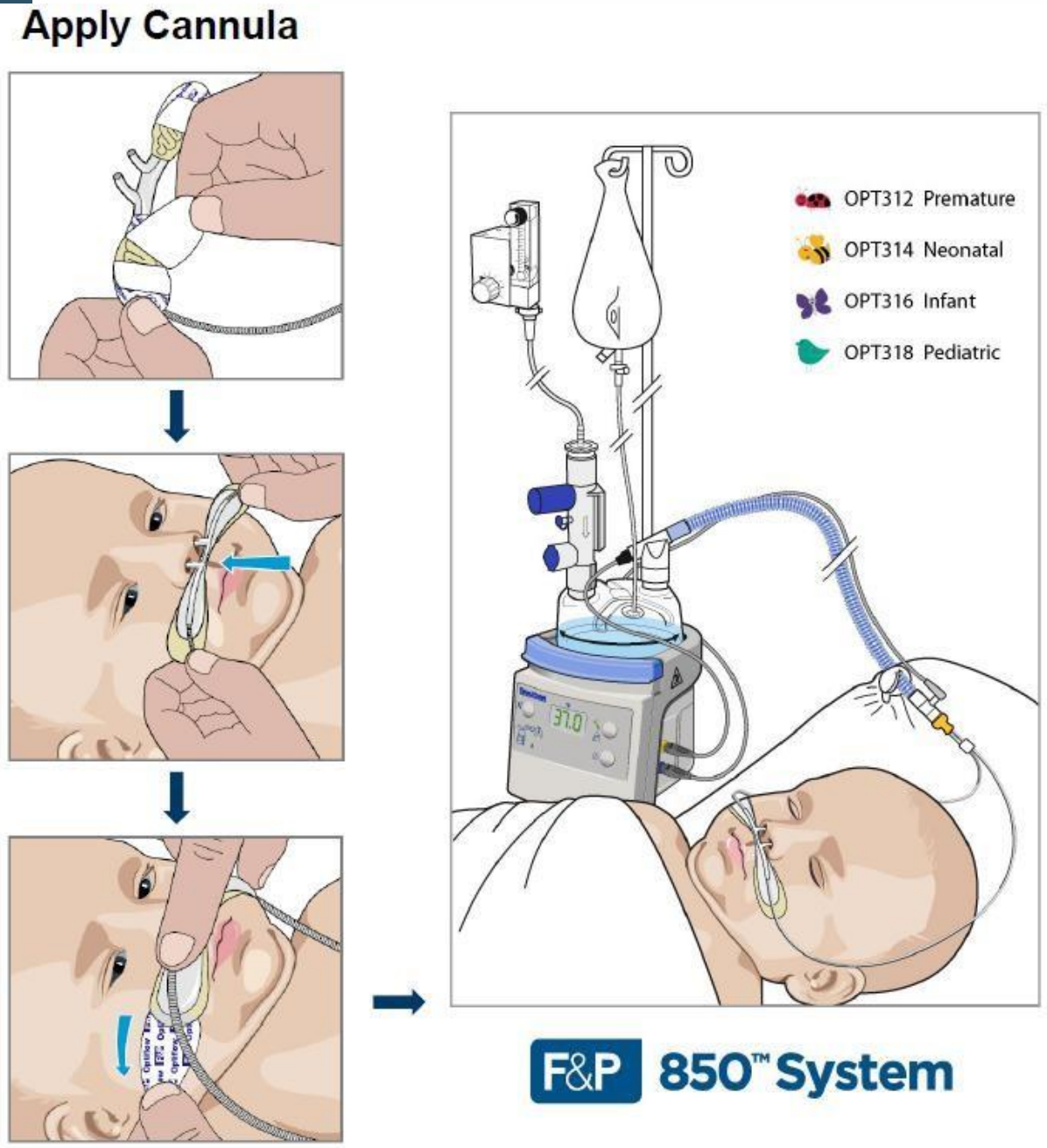
Picture From:
https://pediatrics.aappublications.org/content/141/1_MeetingAbstract/735

High-flow devices

High flow nasal cannula (HFNC)



Picture From:
http://rc.rcjournal.com/content/63/7/886



High flow nasal cannula (HFNC)

Picture From:
http://rc.rcjournal.com/content/63/7/886

High-flow devices

Ventilator

- It is machines that breathe for a patient, either through a tracheostomy or endotracheal tube.
- The ventilator can have oxygen delivery titrated to specific patient needs and delivered through positive pressure.
- Endotracheal tubes possess the added advantage of occluding the airway, thus preventing aspiration of blood, secretions, etc., in patients unable to protect their own airways.

High-flow devices

Ventilator

Picture From: https://percussionaire.com/applications/nicu-picu-care

Sources of Delivery of Oxygen

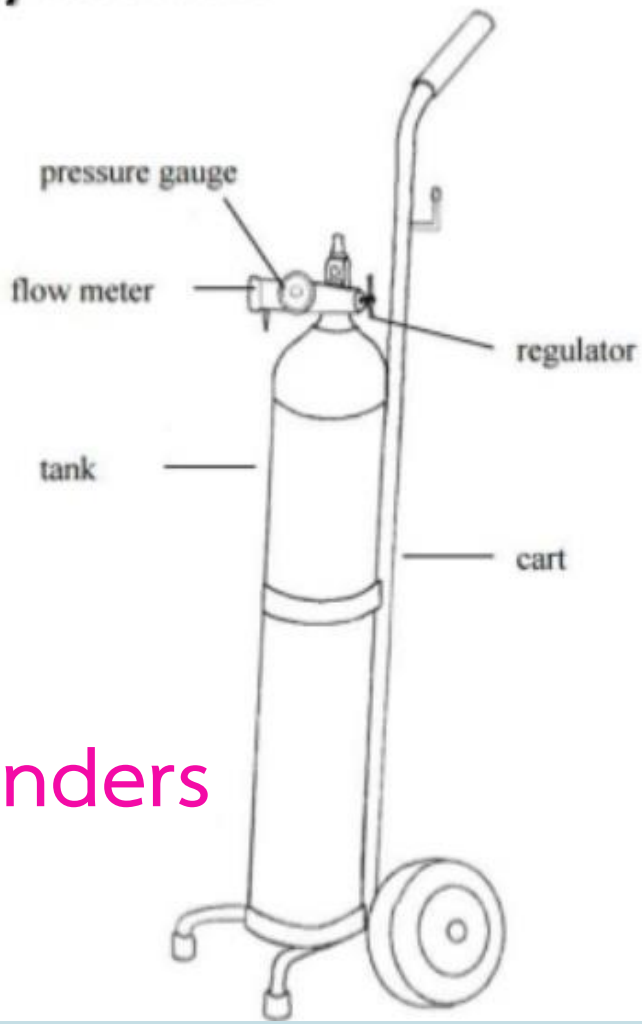
1. Oxygen cylinders

https://www.leeoxygen.com/

2. Central piped oxygen

https://www.istockphoto.com/photo/oxygen-flow-meter-plugged-in-the-green-outlet-on-hospital-wall-medical-equipment-gm1195282355-340656933

Parts of Cylinder

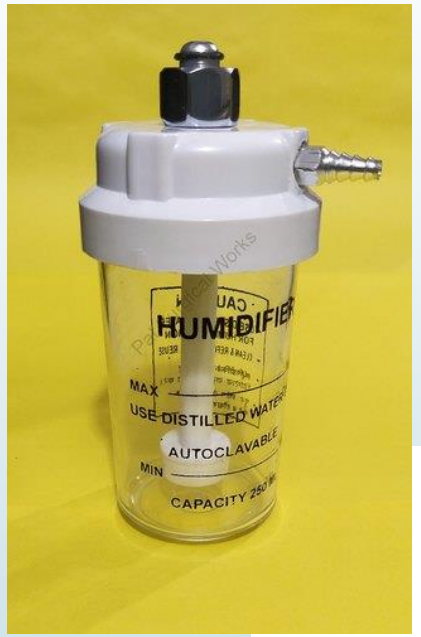


Oxygen cylinders

Humidification

Why Humidification?

- Cold, dry air increases heat and fluid loss.
- Medical gases including air and oxygen have a drying effect. Mucous membranes become dry resulting in airway damage.
- Secretions can become thick and difficult to clear or cause airway obstruction.
- In asthma, the hyperventilation of dry gases can cause bronchoconstriction.



Humidification

Indications

1. Patients with thick copious secretions
2. Non-invasive and invasive ventilation
3. Nasal prong flow rates of greater than 2 LPM (under 2 years of age) or 4 LPM (over 2 years of age)
4. Facial mask flow rates of greater than 5 LPM
5. Patients with tracheostomy Humidification

Potential complications

CO2 Narcosis: This occurs in patients who have chronic respiratory obstruction or respiratory insufficiency which results in them developing hypercapnea (i.e. raised PaCO2). In these patients the respiratory centre relies on hypoxaemia to maintain adequate ventilation. If these patients are given oxygen this can reduce their respiratory drive, causing respiratory depression and a further rise in PaCO2 resulting in increased CO2 levels in the blood and CO2 narcosis.

Pulmonary Atelectasis

Potential complications

Pulmonary oxygen toxicity: High concentrations of oxygen (>60%) may damage the alveolar membrane when inhaled for more than 48 hours resulting in pathological lung changes.

Retrolental fibroplasia (also known as retinopathy of prematurity) An alteration of the normal retinal vascular development, mainly affecting premature neonates (<32 weeks gestation or 1250g birthweight), which can lead to visual impairment and blindness.

Substernal pain-due: characterized by difficulty in breathing and pain within the chest, occurring when breathing elevated pressures of oxygen for extended periods.

Mechanism of Oxygen Toxicity

1 Continuous exposure to supra-physiologic concentrations of O2

2 State of hyperoxia develops

3 Large influx of reactive O2 species (ROS) are produced

4 Disrupts the balance between oxidants and antioxidants

5 ROS may readily react with surrounding biological tissues, damaging lipids, proteins, and nucleic acids Mechanism of Oxygen Toxicity

Diagnosis of oxygen toxicity

Symptoms	Signs
• Substernal chest pain • Inspiration pain • Sore throat • Non-productive cough • Dyspnea • Nasal congestion • Fatigue • Nausea and vomiting • Headache	• Fever • Rales on auscultation of lung field

Investigation of oxygen toxicity

Chest X-ray	• Extended exposure leads to increasing diffuse shadowing throughout both lungs.
Pulmonary function Test	• Decreased vital capacity • Changes in expiratory function and lung elasticity.

Oxygen toxicity

Bronchopulmonary Dysplasia (BPD)	• It is a chronic lung disease. • More common in infants with low birth weight and those who receive prolonged supplemental oxygen. • Causes necrotizing bronchiolitis and alveolar septal injury, with inflammation and scarring. This results in hypoxemia. O2 toxicity in Pre-Term LBW Babies!
Retinopathy of Prematurity (ROP)	• Very premature babies are more susceptible. • An alteration of the normal retinal vascular development, mainly affecting premature neonates (<32 weeks gestation or 1250g birth weight), which can lead to visual impairment and blindness. O2 toxicity in Pre-Term LBW Babies

Monitoring the Progress of Children on Oxygen

1. Children receiving oxygen should be monitored clinically at least twice a day by pulse oximetry.
2. At least once a day a child who are clinically stable (have no emergency signs and SpO2 >90%) should be discontinued from oxygen for 10-15 min and carefully examined for changes in clinical signs and SpO2, to determine whether supplemental oxygen is still required.
3. Children should not be discharged until their SpO2 has been stable at 90% or more while breathing room air for at least 24 hours , until all danger signs have resolved and until appropriate home treatment has been organized.

WHO, ‘Oxygen therapy for children: a manual for health workers’, 2016

Let's watch the this clip…

Thank you

Do not forget to do hw.