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ICON

OXYGEN INSUFFICIENCY

INTRODUCTION:

The drugs used for sedation and analgesia can interfere with a patient's ventilation both by relaxing the airway muscles and suppressing the urge to breathe. The primary risk related to sedation is respiratory complications. Ability to maintain a patent airway is an essential prerequisite for administration of sedation. Airway obstruction can be either total or partial.

ANATOMY & PHYSIOLOGY OF THE RESPIRATORY SYSTEM:

The respiratory system is situated in the thorax, and is responsible for gaseous exchange between the circulatory system and the outside world. Air is taken in via the upper airways (the nasal cavity, pharynx and larynx) through the lower airways (trachea, primary bronchi and bronchial tree) and into the small bronchioles and alveoli within the lung tissue.
The lungs are divided into *lobes*; The left lung is composed of the upper lobe, the lower lobe and the lingula (a small remnant next to the apex of the heart), the right lung is composed of the upper, the middle and the lower lobes.

Mechanics of Breathing

To take a breath in, the *external intercostals muscles* contract, moving the ribcage up and out. The *diaphragm* moves down at the same time, creating negative pressure within the thorax. The lungs are held to the thoracic wall by the *pleural membranes,* and so expand outwards as well. This creates negative pressure within the lungs, and so air rushes in through the upper and lower airways.

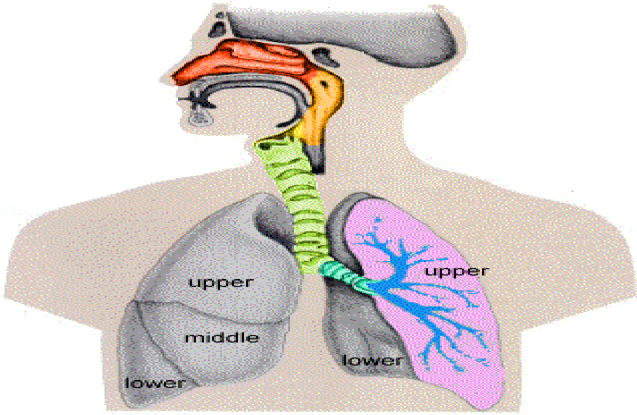
Expiration is mainly due to the natural elasticity of the lungs, which tend to collapse if they are not held against the thoracic wall. This is the mechanism behind lung collapse if there is air in the pleural space (*pneumothorax*).

Physiology of Gas Exchange

Each branch of the bronchial tree eventually sub-divides to form very narrow terminal bronchioles, which terminate in the alveoli. There are many millions of alveoli in each lung, and these are the areas responsible for gaseous exchange, presenting a massive surface area for exchange to occur over.

Each alveolus is very closely associated with a network of capillaries containing deoxygenated blood from the pulmonary artery. The capillary and alveolar walls are very thin, allowing rapid exchange of gases by *passive diffusion along concentration gradients*.
CO_2 moves *into* the alveolus as the concentration is much lower in the alveolus than in the blood, and O_2 moves *out of* the alveolus as the continuous flow of blood through the capillaries prevents

saturation of the blood with O_2 and allows maximal transfer across the membrane.



The heart is the pump responsible for maintaining adequate circulation of oxygenated blood around the vascular network of the body. It is a four-chamber pump, with the right side receiving deoxygenated blood from the body at low presure and pumping it *to* the lungs (the pulmonary circulation) and the left side receiving oxygenated blood *from* the lungs and pumping it at high pressure around the body (the systemic circulation).

The myocardium (cardiac muscle) is a specialised form of muscle, consisting of individual cells joined by electrical connections. The contraction of each cell is produced by a rise in intracellular calcium concentration leading to spontaneous depolarisation, and as each cell is electrically connected to its neighbour, contraction of one cell leads to a wave of depolarization and contraction across the myocardium.

This depolarization and contraction of the heart is controlled by a specialized group of cells localised in the sino-atrial node in the right atrium- the *pacemaker cells*.

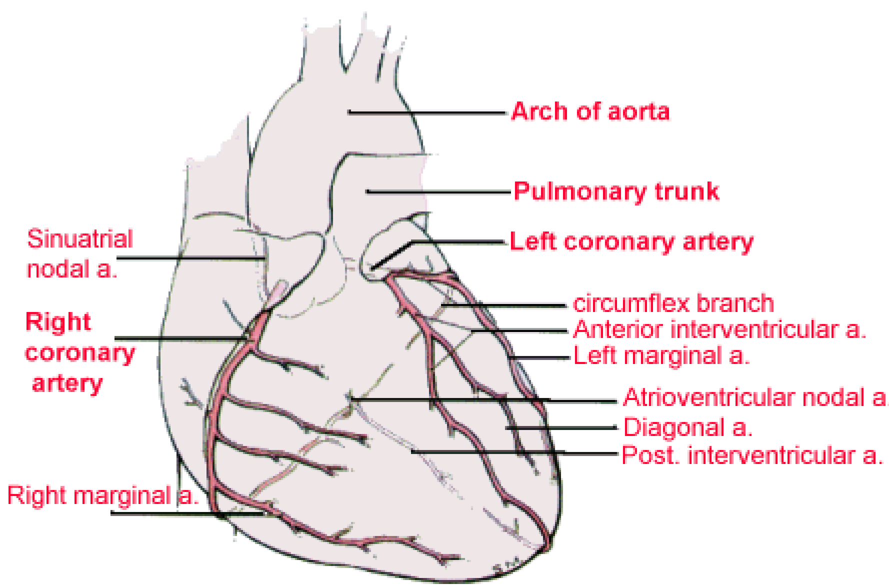
1. These cells generate a rhythmical depolarization, which then spreads out over the atria to the atrio-ventricular node.
2. The atria then contract, pushing blood into the ventricles.
3. The electrical conduction passes via the Atrio-ventricular node to the bundle of His,

which divides into right and left branches and then spreads out from the base of the ventricles across the myocardium.

4. This leads to a 'bottom-up' contraction of the ventricles, forcing blood up and out into the pulmonary artery (right) and aorta (left).
5. The atria then re-fill as the myocardium relaxes.

The 'squeeze' is called **systole** and normally lasts for about 250ms. The relaxation period, when the atria and ventricles re-fill, is called **diastole**; the time given for diastole depends on the heart rate.

The Coronary Circulation



The heart needs its own reliable blood supply in order to keep beating- the coronary circulation. There are two main coronary arteries, the left and right coronary arteries, and these branch further to form several major branches. The coronary arteries lie in grooves (sulci) running over the surface of the myocardium, covered over by the epicardium, and have many branches which terminate in arterioles supplying the vast capillary network of the myocardium. Even though these vessels have multiple anastomoses, significant obstruction to one or other of the main branches will lead to ischaemia in the area supplied by that branch.

DEFINITION:

Oxygenation is the delivery of oxygen to the body tissues and cells.

FACTORS AFFECTING OXYGENATION:

Adequate oxygenation is influenced by many factors including: age, environmental and life style factors and disease process•

1. Age: older adults may exhibit a barrel chest and require increased effort to expand the lungs. Older adults are also more susceptible to respiratory infections because of decreased activity of cilia which normally are effective defense mechanism.

2. Environmental and lifestyle factors:

   Environmental and lifestyle factors can significantly affect clients oxygenation status. Clients who are exposed to dust, animal dander, chemicals in the home or workplace are at increased risk for alteration in oxygen

   Individuals who experience significant physical or emotional stress or who are obese or underweight are also subject to changes in oxygenation status

Disease process:

Diseases that may affect oxygenation include: obstructive pulmonary disease, atherosclerosis heart failure, anaemia

ALTERATION IN OXYGENATION:

Anemia:Hemoglobin transports 99% of oxygen to tissuesDecreased Hb production, increased RBCdestruction, blood loss

Toxic inhalation: decreased binding sites
Carbon monoxide: Increased Metabolic Rate, increased oxygen demand
-Exercise, pregnancy, fever(Prolonged or high fever)

Aging: Structural changes chest wall compliance, elastic recoil, functioning alveoli. Defense mechanisms, cilia function, cough force, immunity

OTHER RESPIRATORY RISK FACTORS:

•Increased age

•Nutrition's

•Cigarette smoking

•Substance abuse
•Exercise

•Environmental pollution

•Stress/anxiety

INDICATION FOR OXYGEN THERAPY:

Any individual with one or more of the following:

- Peri and post cardiac or respiratory arrest
- Hypoxia - diminished blood oxygen levels (oxygen saturation levels of <92%)
- Acute and chronic hypoxemia (PaO_2 < 65mmHg, SaO_2 < 92%)signs and symptoms of shock
- Low cardiac output and metabolic acidosis (HCO_3 < 18mmol/l)
- Chronic type two respiratory failure (hypoxia and hypercapnia

- Despite a lack of supportive data, oxygen is also administered in the following conditions:

- Dyspnoea without hypoxemia
- Post-operatively, dependent on instruction from surgical team
- Treatment of pneumothorax

- Assessment process - difficulty to obtain arterial blood samples
- Clinical conditions in infancy are exclusive although overlaps exist in adolescents

TYPES OF OXYGEN THERAPY:

High concentration oxygen therapy

Up to 60 per cent oxygen results in the reduced risk of hypoventilation and retention of carbon dioxide. High concentration oxygen therapy can have detrimental effects on the respiratory system,

Complication: particularly after prolonged usage, and can lead to respiratory distress due to absorption atelectasis (collapse of alveolus due to blockage).

Low concentration oxygen therapy (controlled oxygen therapy)

Used to correct hypoxaemia by using an accurate amount of oxygen.

Long term oxygen therapy (LTOT)

The provision of continuous oxygen therapy for patients with chronic hypoxaemia. Requirements vary between 24-hour dependency and dependency during periods of sleep. Principally aims to improve symptoms and prevent harm from chronic hypoxaemia.

Chronic hypoxaemia include those with:

- Chronic lung disease
- Congenital heart disease with pulmonary hypertension
- Pulmonary hypertension secondary to respiratory disease
- Interstitial lung disease
- Bronchiolitis
- Cystic fibrosis and other causes of severe bronchiectasis
- Obstructive sleep apnoea and other sleep related disorders

Assessment:

Wherever possible, a set of baseline observations should always be obtained. This should be documented appropriately on relevant.

Method of administration

Considering oxygen requirement and potential for tolerability of the child, delivery methods must be decided (Rationale 4) and potential methods of delivery are listed below.

The selection of an appropriate oxygen delivery system must take into account clinical condition, the patient's size, needs and therapeutic goals (Myers 2002):

- high concentration oxygen is usually delivered via incubator or humidified head box
- for concentrations below 50 per cent, oxygen can be delivered via nasal cannula
- face masks
- re-breathe mask
- humidified oxygen
- wafting
- via nebulisation
- tracheostomy
- nasal cannula
- via a ventilation circuit

Face mask

Supplied in child sizes, but has been found that children do not always tolerate them (Moules and Ramsey 1998). There are two types of face masks dependant on the condition of the child (Woodhams et al 1996):

Simple oxygen mask (variable flow masks)

Vents in the mask allow for the dilution of oxygen (Chandler 2001). High concentrations of oxygen can be safely administered. If low concentration of oxygen (below four litres) required, then there is a risk of a carbon dioxide build up (Bell 1995).

High concentration oxygen masks

Used for emergency situations (Advanced Life Support Group 1997) due to a large reservoir that allows oxygen only to be breathed in by the child. This prevents the inhalation of mixed gases. The approximate oxygen received is 99 per cent (Bell 1995).

Humidified

This can be delivered via a face mask or head box, dependent upon child age/co-operation. Humidified oxygen should be utilised when high percentages of oxygen are required for prolonged periods, and in those with chronic respiratory illness, to prevent drying of the mucosa and secretions (Chandler 2001).

Nasal cannula oxygen does not need to be humidified (Rationale 5).

Wafting

When conventional delivery methods are not tolerated, wafting of oxygen via a face mask has been shown to deliver concentrations of 30-40 per cent with 10 litres oxygen per minute, to an area of 35x32cm from top of the mask.

Wafting via green oxygen tubing has been assessed as appropriate for short term use only, ie whilst feeding.

A standard paediatric oxygen mask placed on the chest can give significant oxygen therapy with minimal distress to the patient (Davies et al 2006).

Via nebulisation

If the child is oxygen dependant, nebulisers should be delivered via oxygen and not air.

Tracheostomy

Oxygen can be delivered via a tracheostomy mask, Swedish nose or headbox. Consider child's individual needs (Rationale 6).

Nasal cannula

Can be used for long-term oxygen use, whilst allowing the child to vocalise and eat. The concentration is often not controlled, resulting in a low inspiratory oxygen concentration.

The use of nasal cannulae can, in the sensitive child, produce dermatitis and mucosal drying (Joint Formulary Committee 2006). Only low flow rates of up to two litres per minute can be given comfortably (Mallet and Bailey 1996) due to inadequate humidification (Jamieson 1999).

Nasal cannula oxygen does not need to be humidified (Rationale 5).

Via a ventilation circuit

Accurate measurement of inspired oxygen is difficult and pulse oximetry must be maintained. Can be delivered at various points throughout the ventilation circuit (Simonds 2007) but always before the humidification unit as oxygen is a cold gas that needs to be warmed and humidified.

Via an Ayres T piece – open ended bag

Used frequently by anaesthetists and experience gives a reliable impression of the state of the lungs. This technique allows manual application of PEEP (positive end-expiratory pressure). It is completely reliant on an effective oxygen source (Advanced Life Support Group 2003).

Bag valve mask

Comes in three sizes: 250mls, 500mls and 1,500mls. The smallest one is ineffective even at birth. Two smallest bags have a pressure limiting valve set at 4.41kPa (45cm H_20) to protect the lungs from barotrauma (damage caused to tissues by a change in pressure inside and outside the body).

The reservoir bag enables the delivery of oxygen concentrations up to 98 per cent. Without the reservoir bag it is not possible to supply more than 50 per cent oxygen

SUCTIONING PROCEDURE

USE OF IRRIGANTS

PURPOSE:

To assist in the removal of bronchial secretions that cannot be expectorated by the

patient spontaneously.

POLICIES/PERSONNEL

1. Suctioning is a shared procedure between Respiratory Care and Nursing

Service.

2. Suctioning is ordered on a prn basis; Respiratory will perform procedure with

respiratory treatments and as often as time allows.

3. RRT 1 AND 2, CRTT 1 AND 2.

EQUIPMENT:

Sub-micron mask

Suction Regulator/Equipment

Suction cannister

Connective tubing

02 flow meter

Resuscitation bag

Sterile suction catheter

Sterile gloves

Sterile cup (if needed)

Sterile H20

Stethoscope

Metered vials of normal saline (for tenacious

secretions) or other irrigant

Water soluble lubricant (for N-T auctioning) Personal Protective Equipment (gown,

goggles, gloves

INDICATIONS:

1. Visible presence of secretions in tube orifice

2. Coarse tubular breath sounds on auscultation

in patient unable to cough or without artificial airway in place.

3. Patient with an artificial airway.

PROCEDURE:

Preparation

1. Review the patient's chart for physician order, and note any indications, contraindications, or potential side effects of therapy ordered. Review the patient's history, physical diagnosis, progress notes, CXR, lab reports (including PFT's and ABG'S) and medications before performing the procedure.

2. Identify patient by comparing hospital and billing numbers on the armband to those on the physicians' orders for therapy.

3. Examine and auscultate patient.

4. Assemble Equipment:

Attach connective tubing to suction regulator/equipment and inlet of suction container. Connect suction machine to vacuum wall outlet. Turn vacuum on,

and occlude tip of connective tubing. If no suction is demonstrated on gauge,

tighten all connections. If still no suction occurs increase vacuum. If still no Cardiopulmonary Services

suction occurs, label machine "defective" obtain another suction machine,

reassemble and retest.

5. Identify patient by verification of name on armband and by verbal questioning.

6. Identify yourself and your department.

7. Inform the patient/family of the procedure and its purpose. Be prepared to

answer any questions about the procedure that the patient may have.

Implementation

1. Wash hands and apply personal protective equipment as indicated (gloves and

sub-micron masks mandated). (gowns, eye protection if splashing is likely to

occur.)

2. Adjust vacuum between -80 to -120mmHg for adults or -60 to -80mmHq for

pediatrics.

3. Position the patient by extending the neck slightly to facilitate entrance into the

trachea (especially for nasotracheal auctioning).

4. Open suction catheter exposing only the connector, attach to connective tubing

and maintain sterility of catheter.

5. Fill sterile box with sterile water, and place a dab of water-soluble lubricant on

sterile envelope if nasotracheal auctioning is to be performed.

6. Check heart rate before, during and after procedure. If tachycardia or

bradycardia occurs discontinue the procedure until it resolves.

7. Place sterile gloves on both hands.

8. Remove suction catheter from envelope maintaining sterile technique. NOTE: coat tip of catheter with lubricant only if nasotracheal suctioning is to be performed.

9. If patient has an artificial airway in place, hyperoxygenate with a resuscitation bag or mechanical ventilator. If patient is receiving oxygen therapy, request several deep breaths before suctioning.

10. Insert the catheter through the nose or endotracheal tube to the point of restriction without applying suction. NOTE: do not aggressively force the tip of the catheter through any obstructions in the nose. Withdraw the catheter and reposition the patient's head and try again.

11. After the restriction has been passed, slowly advance catheter. Ask patient to take deep breaths or watch for inspiration. Pass catheter into trachea.

12. Once catheter has been placed in trachea, slowly withdraw while applying intermittent suction and rotating catheter. Remember: Suction should not be applied for more than 10-15 seconds.

13. Hyperoxygenate the intubated patient or request the non-intubated patient to take several deep breaths.

14. Auscultate the patient's chest; if secretions can still be heard repeat the suctioning procedure (5-10ml of normal saline may be used to loosen tenacious secretions). Before re-suctioning, clear catheter with sterile water.

Follow Up

1. Discard gloves and catheters in an aseptic manner, clear connective tubing with remaining sterile H20 and turn off suction.

2. Return the patient to comfortable position.

3. Discard personal protective equipment and wash hands.

4. Document procedure as per department guidelines.

5. Inform nurse and/or physician of any pertinent request, complaints or reactions to the therapy.

Precautions/Complications,

1. Hypoxia

2. Vagal stimulation: Cardiac arrhythmia

3. Tracheitis Cardiopulmonary Services

General Therapy

Proc7.16

4 Damage to mucus membranes

5: Airway occlusions

6. Sudden death

7. Bleeding disorders

USE OF IRRIGANTS:

1. Saline

2. Sodium Bicarbonate

PROCEDURE:

1. Upon physician order for NaHCO3.

2. Mix irrigant solution utilizing 1:1 or 1:2 ratio of Sodium Bicarbonate to normal saline.

3. Check suction setup for correct functioning.

4. Hyperoxygenate and hyperexpand lungs. Suction as per protocol utilizing 1-5 ml

ofirrigant as needed. Note patient's tolerance

5. Record suctioning procedure as per department guidelines on Respiratory Progress Notes or ventilator flow sheet. Note the amount of sodium Bicarbonate used to suction each patient.