Assessment & Treatment of Neurotoxicity

Lecture 9: Snake Bite Management Course

Introduction

- This lecture relates mostly to patients with neurotoxicity
- However, it is also relevant to any patient with
  - Shock
  - Hypoxia
  - Severe bleeding or anaemia
  - Coma from any cause
- It relates to **A** & **B** of resuscitation

Identification of Neurotoxicity

- This is expected from bites by
  - Kraits
  - Cobras & king cobra
  - Some seasnakes

Neurotoxicity (1)

- Demonstration (or demonstration video)

- Cranial nerves to voluntary muscles are **ALWAYS** the first affected:
  - III, IV, VI (eyes)
  - V (mouth-opening)
  - VII (most facial muscles)
  - IX, X (swallow & gag, speech)
  - XI (accessory muscles of respiration)
  - XII (tongue)

Neurotoxicity (presynaptic)

Mild ptosis

Severe facial muscle paralysis

Neurotoxicity (2)

- Respiratory muscle assessment:
  - RR, depth of inspiration/tidal volume
  - SpO2 (& cyanosis)
  - accessory muscles - maximal inspiration
  - intercostals - inspiration & expiration (cough)
  - diaphragm - inspiration
  - abdominals - expiration (cough)
  - percussion & ascultation - crepitations (may not be heard if very weak inspiration)
  - respiratory function tests -
    - PEFR meter or blow into sphygmomanometer (expiration)
    - incentive spirometer (inspiration)

Neurotoxicity (3)

- Truncal (abdominal & back) muscles:
  - walk, sit
  - lift head & shoulders off pillow
- Limbs:
  - upper & lower
  - distal & proximal
- Care assessing mental state/level of consciousness - cannot use Glasgow Coma Scale when paralysed (devised for head injury):
  - eye-opening, vocalisation, motor function
  - most useful indicator = ability to obey commands

Basic Respiratory Physiology (1)

- Oxygen content of air is 21%
- O_2 is exchanged for CO_2 in the alveoli
- In people with normal lungs, respiratory drive depends more on the CO_2 level than the O_2 level
- Respiratory rate decreases with increasing age up until about 12 yrs of age
- There is a certain amount of dead space in the respiratory tract - inflow & outflow of air must be greater than this if these gases are to be exchanged & removed
- Tidal volume, T_v,is the volume of gas inhaled & exhaled in each breath, 7-10ml/kg at rest (larger in infants, smaller in large adults)
- Minute volume, M_v, is the amount of gas moved in & out of the lungs in a minute - ie respiratory rate, RR x T_v

Basic Respiratory Physiology (2)

- During spontaneous breathing the respiratory muscles produce a negative pressure in the chest, expanding the lungs & sucking air in
- The respiratory muscles include:
  - The diaphragm (inspiration)
  - The intercostal muscles (inspiration & expiration)
  - The accessory muscles, especially in the neck (inspiration), but also the external chest muscles (expiration)
  - The abdominal muscles (forced expiration)
- The upper airway consists of the structures from the lips to the vocal cords
- The lower airway consists of the structures from the vocal cords to the alveoli, where gas exchange occurs

Basic Respiratory Physiology (3)

- Anything which narrows the upper airway
  - Increases the energy required to move air in & out of the lungs (so very weak respiratory muscles may be unable to overcome this extra resistance
  - Causes the noise known as stridor on inspiration, provided that enough respiratory muscles are strong enough (ie. a patient with neurotoxicity, a partly obstructed airway & weak respiratory muscles may not have stridor)
  - Reduces the tidal volume
  - May lead to both a fall in blood, & so cellular, O_2 levels & a rise in blood, & hence cellular, CO_2 levels - both leading to cellular acidosis, which is detrimental to the function of all cells

Basic Respiratory Physiology (4)

- Upper airway obstruction can be due to
  - Coma or neurotoxicity causing weak upper airway muscles, especially causing the tongue falling back in a supine patient
  - Fluids accumulating ion the upper airway such as saliva, blood, vomit
  - Swelling of the soft tissues of the upper airway
- A completely obstructed upper airway may lead to paradoxical breathing, where
  - the stomach is pushed out & the chest is sucked in by the diaphragm
  - opposite to what is seen in a normal breathing pattern

Basic Respiratory Physiology (5)

- Anything which:
  - weakens the respiratory muscles:
    - severe exhaustion or neurotoxicity
  - or causes a reduced conscious state:
    - severe hypoxia or shock
    - intracranial bleeding
    - hypoglycemia or excessive sedation
  - may lead to:
    - an inability to overcome the extra resistance of a partly obstructed upper airway
    - a reduction in tidal volume
    - reduced O_2 levels & increased CO_2 levels in the blood
    - a loss of swallow reflex, & hence a risk of aspiration of fluids into the lungs

Oxygen Therapy

- Supplemental oxygen should be given to any patient with:
  - Respiratory distress
  - Neurotoxicity
  - Pulmonary aspiration
  - Evidence of low blood oxygen levels
  - Coma
  - Shock

Effectiveness of Administered Oxygen

- The concentration/percentage of oxygen delivered by any method (in addition to the 21% already present in air) depends on:
  - the flow rate
  - the patient's:
    - respiratory rate
    - tidal volume (a lower todal volume means more dilution with expired gas)
    - peak inspiratory flow rate
  - the presence of a partial upper airway obstruction

Methods for Administering Oxygen

Method	Flow rate l/min	Approximate Inspired Oxygen Percentage
Nasal prongs	1-3	23-28
Hudson mask	4-6	30-50
Venturi mask	2-8	23-40
Non-rebreather mask	10-15	50-70
Bag-valve-mask	10-15	70-85
Intubation	5-20	30-100

Basic Airway & Breathing Management

Objectives

- We will discuss:
  - General principles of airway management
  - Airway & breathing problems in snakebite
  - Airway assessment & non-invasive management
  - Ventilation assessment & manual ventilation

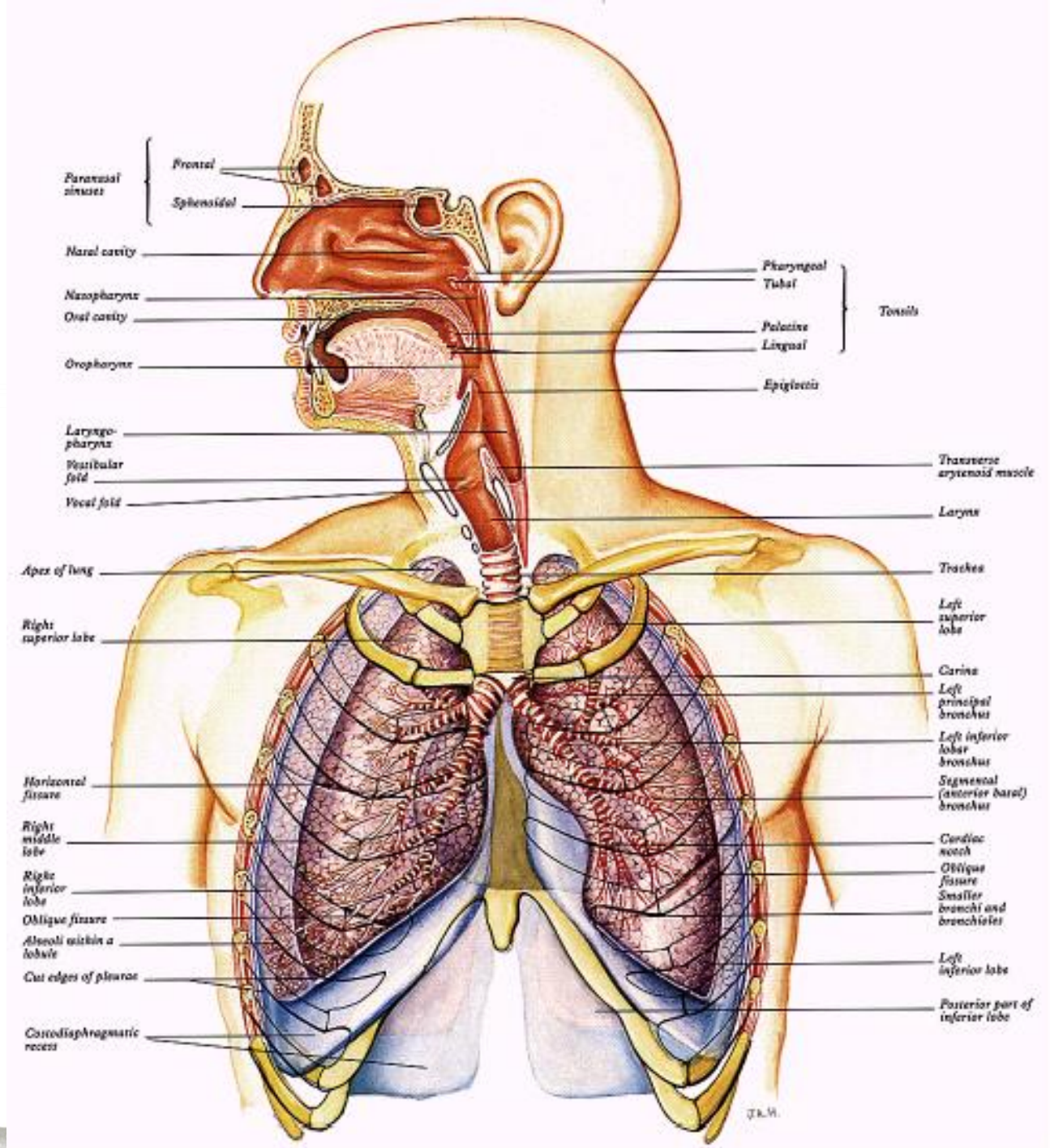
General Principles (1)

- Purpose of air flow
  - absorption of oxygen
  - removal of carbon dioxide

- Requirements
  - a patent (open & preferably protected) airway
  - ventilation (breathing - moving air in & out of the lungs)
  - functioning alveoli
  - perfusion of (blood flow to) alveoli, (cardiac output, patent pulmonary vessels)

General Principles (2)

- **Avoid** complications (eg aspiration, hypoxia) from snakebite if possible
- **Important to do the basics well**
- Frequent reassessment is essential
- Any patient with airway or breathing problems should be transferred safely to a health centre or regional hospital where they CAN be managed
- Always know
  - why you are performing any intervention
  - check the outcome
  - look for adverse effects


Paranasal sinuses
Frontal
Sphenoidal
Nasal cavity
Nasopharynx
Oral cavity
Oropharynx
Laryngo-pharynx
Vestibular fold
Vocal fold
Apex of lung
Right superior lobe
Horizontal fissure
Right middle lobe
Right inferior lobe
Oblique fissure
Alveoli within a lobule
Cut edges of pleurae
Costodiaphragmatic recess
Pharyngeal
Tubal
Palatine
Lingual
Tonsils
Epiglottis
Transverse arytenoid muscle
Larynx
Trachea
Left superior lobe
Carina
Left principal bronchus
Left inferior lobar bronchus
Segmental (anterior basal) bronchus
Cardiac notch
Oblique fissure
Smaller branchi and bronchioles
Left inferior lobe
Posterior part of inferior lobe

Hypoxia & Hypercarbia

- Oxygen is required for all organs to function normally
  - brain - coma, irreversible damage within 3-5 minutes (sooner in children)
  - heart - hypotension/shock, bradycardia
  - kidneys - acute renal failure
  - liver - acute hepatic failure
  - bowel - leakage of bacteria into circulation, septicemia
- Carbon dioxide retention causes
  - acidemia - organ dysfunction, if severe
  - dilatation of cerebral blood vessels - raised intracranial pressure
  - hyperkalemia - exchange of K^+ for H^+

Airway & Breathing Problems (1)

- Upper airway obstruction
  - progressive weakness of muscles of the pharynx & neck leading to upper airway obstruction
  - voluntary motor cranial nerves/muscles
    - face, mouth, tongue, throat
  - occurs before weakness of the muscles of ventilation/breathing
  - hypoxia, hypercarbia
  - loss of ability to swallow

Airway Workshop: Upper Airway Model

Advanced Airway Management: Cut-away Model

Airway & Breathing Problems (2)

- Respiratory (breathing) failure:
  - progressive weakness of respiratory muscles (smaller intercostal muscles first):
    - intercostal muscles
    - accessory muscles (neck & shoulder)
    - diaphragm
    - abdominal muscles
  - hypoxia, hypercarbia, collapse of lung segments
  - loss of cough

Airway & Breathing Problems (3)

- Pulmonary (into the lungs) aspiration (inhalation) of saliva, vomit, or blood due to:
  - loss of swallow & gag reflex & retention of saliva in pharynx
  - ?excess saliva production
  - vomiting
  - spontaneous bleeding of gums
  - loss of cough reflex (power, not sensation is lost)
  - supine posture
  - oral food or fluids

Assessing the Airway

- Is the patient maintaining their airway?
- Is the patient protecting their airway?
- Is there:
  - stridor (usually will NOT occur because it requires reasonable respiratory muscle strength)
  - cyanosis
  - weakness of the facial muscles
  - pooling of secretions
  - loss of swallow, slurred or weak speech
  - paradoxical (“rocking boat”) movement of the abdomen & chest
  - any air movement at all

Hypersalivation & Cranial Voluntary Muscle Paralysis - ? Atropine Use

Opening the Airway

- Body position:
  - left or right lateral
- Simple airway manoeuvres:
  - jaw thrust
  - chin lift (to the neutral position)
- Gentle suction of mouth & pharynx
- Simple upper airway devices:
  - Guedel airway (preferred)
  - nasopharyngeal airway (bleeding risk, better tolerated)

Yankeur Sucker

Guedel's Airways: Oropharyngeal

Nasopharyngeal Airway

The Protected Airway

- The airway is not protected (from aspiration of saliva, blood or vomit) if
  - absent gag & cough reflexes
  - saliva pooling in the mouth
- If the patient is not protecting their own airway then endotracheal intubation is the ideal management
- The laryngeal mask airway is a good alternative

Reducing the Risk of Aspiration

- Position the patient in the left or right coma/recovery position - allows secretions to drain forwards, not backwards
- They require continuous 1:1 nursing
- Frequently gently suction the mouth of any vomit, saliva or blood
- Reduce excessive saliva production with atropine IV
  - 0.3-0.6mg/4-6 hrs adult
  - 0.01-0.02mg/kg/4-6 hrs child
  - will usually cause a mild-moderate tachycardia (warn the patient)

Assessing Breathing

- Are they ventilating?
  - note the rise & fall of the chest
  - is there misting of the oxygen mask if there is no oxygen flow?
  - lack of air movement may be due to airway obstruction, or hypoventilation
- Is it sufficient for good oxygenation?
- Is there
  - cyanosis or hypoxia
  - loss of ability to cough
  - evidence of aspiration
  - Note: weak breathing muscles may not be able to overcome a partly obstructed upper airway

Improving Breathing

- Opening the airway can improve air flow/reduce resistance to air flow
- Oxygen
- Manual/assisted ventilation
  - mouth-to-mouth - 16% oxygen, tiring, infection risks
  - Ambubag/BVM - up to 100% oxygen, tiring to hold mask for long periods
- IV antibiotic if aspiration & fever

Manual Ventilation (1)

- Bag/Valve/Mask ventilation
  - BVM has 2 bags
    - a ventilating bag
    - a reservoir bag - improves FiO_2 when supplemental O_2 is used
  - can use room air (21% O_2)
  - adequate ventilation may be all that is required
    - supplemental O_2 may or may not be required
    - depends on presence of aspiration or pre-existing lung disease

Bag-valve-mask Ventilation: 2-Person

Manual Ventilation (2)

- Respiratory rate, RR = breaths/minute
- Tidal volume, TV = volume of each breath
- Minute volume, MV = RR x TV
- Adult - RR=12/min., TV=7ml/kg (MV=5litres/min. for 70kg adult)
- Child or infant - RR=15–25/min.,TV=8-10 ml/kg
- Ventilating bag volume varies with brand & size (neonatal - 250ml, paediatric - 500ml, adult - 2000ml)

Manual Ventilation (3)

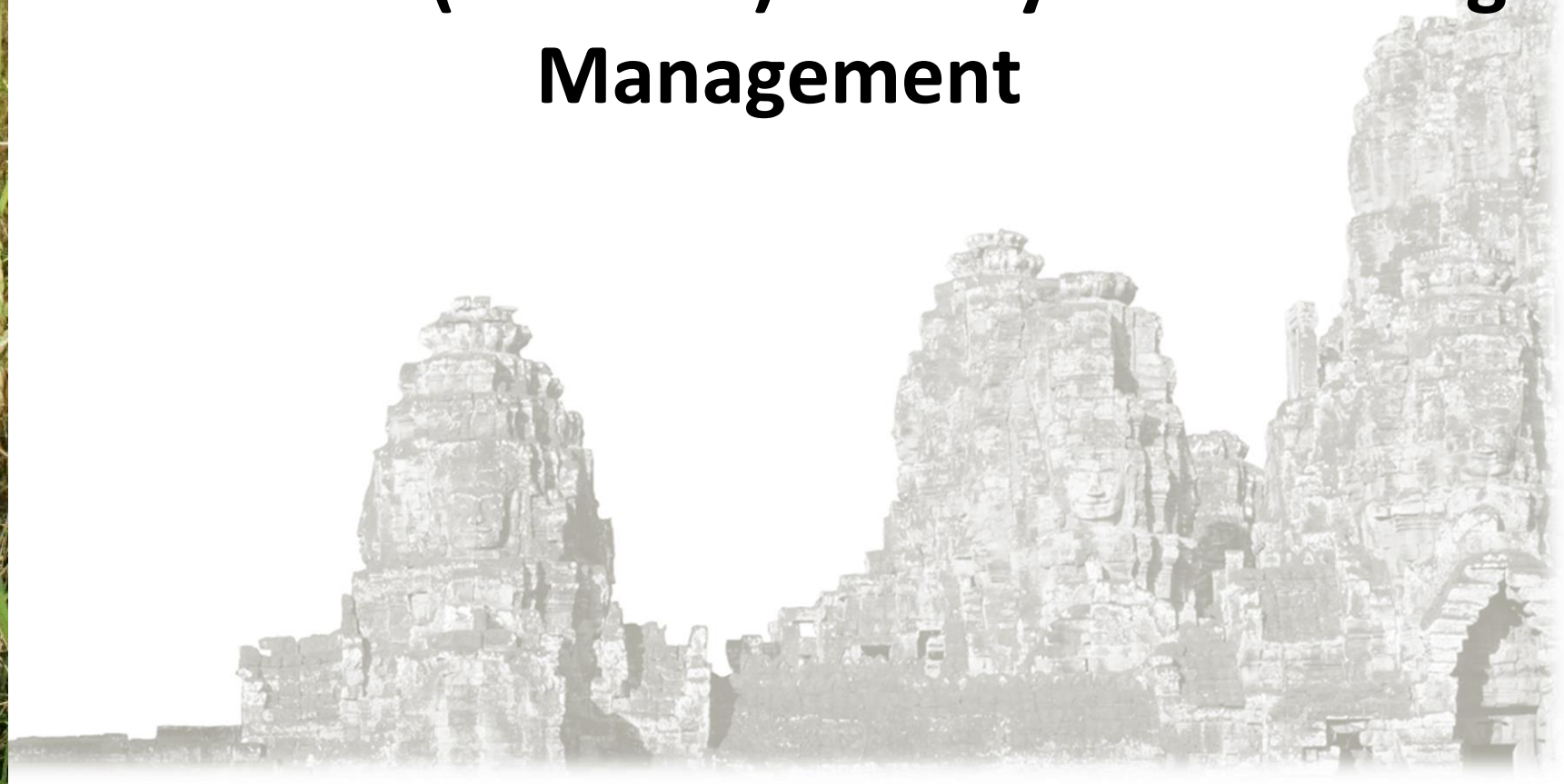
- Mask
  - size – must be appropriate for the patient (4-5 for average adult)
  - seal – may be difficult if bearded, small chin, no teeth, etc.
- Also need to maintain the airway
  - simple airway manoeuvres – jaw thrust, chin lift
  - upper airway devices – Guedel/oropharyngeal
- Technique
  - requires practice
  - monitor the effectiveness of what you are doing
  - change as necessary

(Almost) Successful Basic Airway Management

Summary: Basic Airway Management

- The most important aspects of managing a snakebite patient are:
  - assessing and managing the airway
  - assessing and managing the breathing
  - continually reassessing both
  - ensuring adequate vital organ oxygenation

Advanced (Invasive) Airway & Breathing Management



Objectives

- Cover techniques where equipment is placed into the laryngopharynx &/or the trachea
- Discuss the appropriate use of various airway management techniques in envenomed patients
- Will be followed by 2 practical sessions

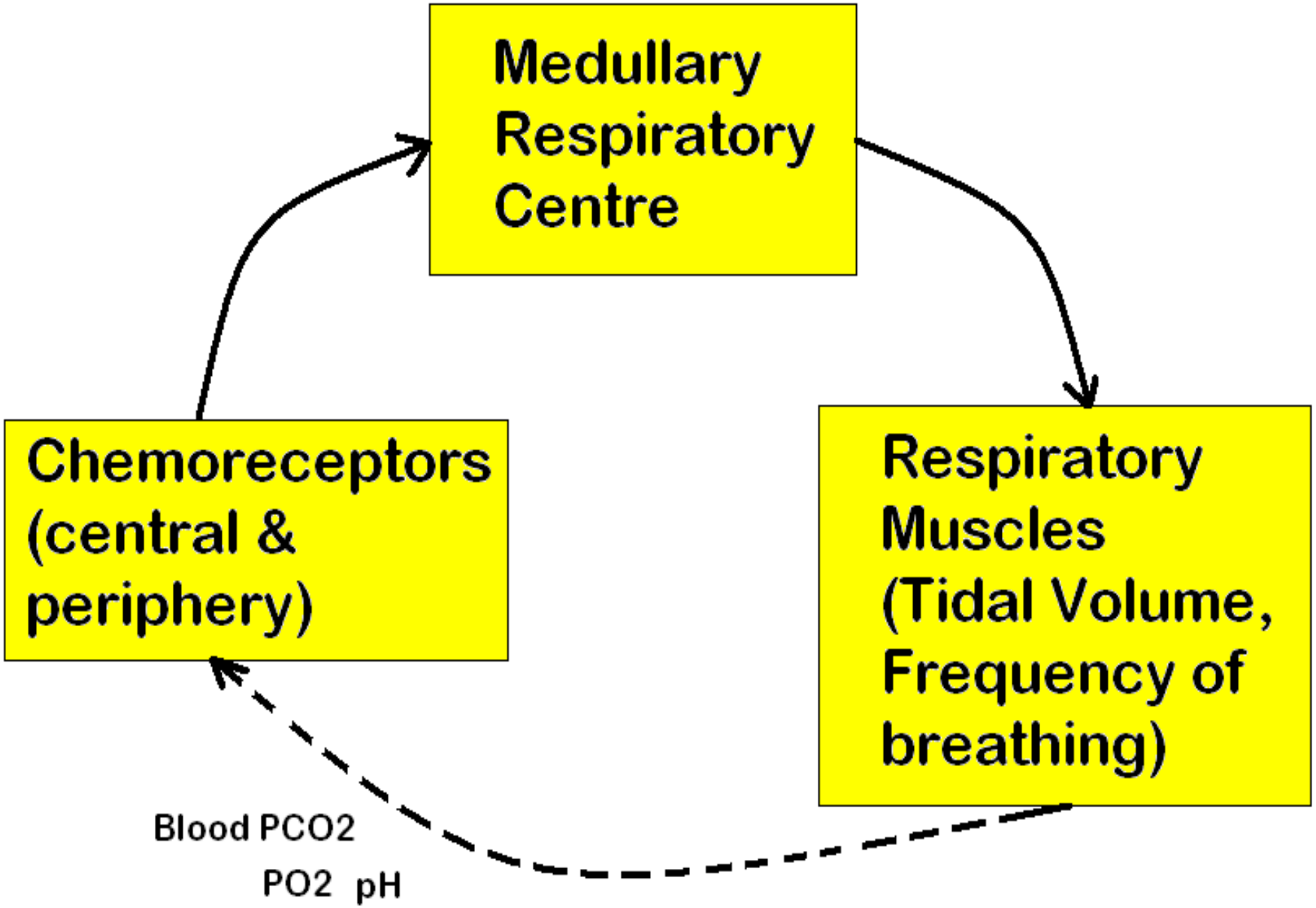
Procedures in Medicine (1)

- For every one you must know
  - Indications
  - Contraindications
  - Advantages
  - Disadvantages
  - Requirements
  - Details
  - Complications
  - Aftercare

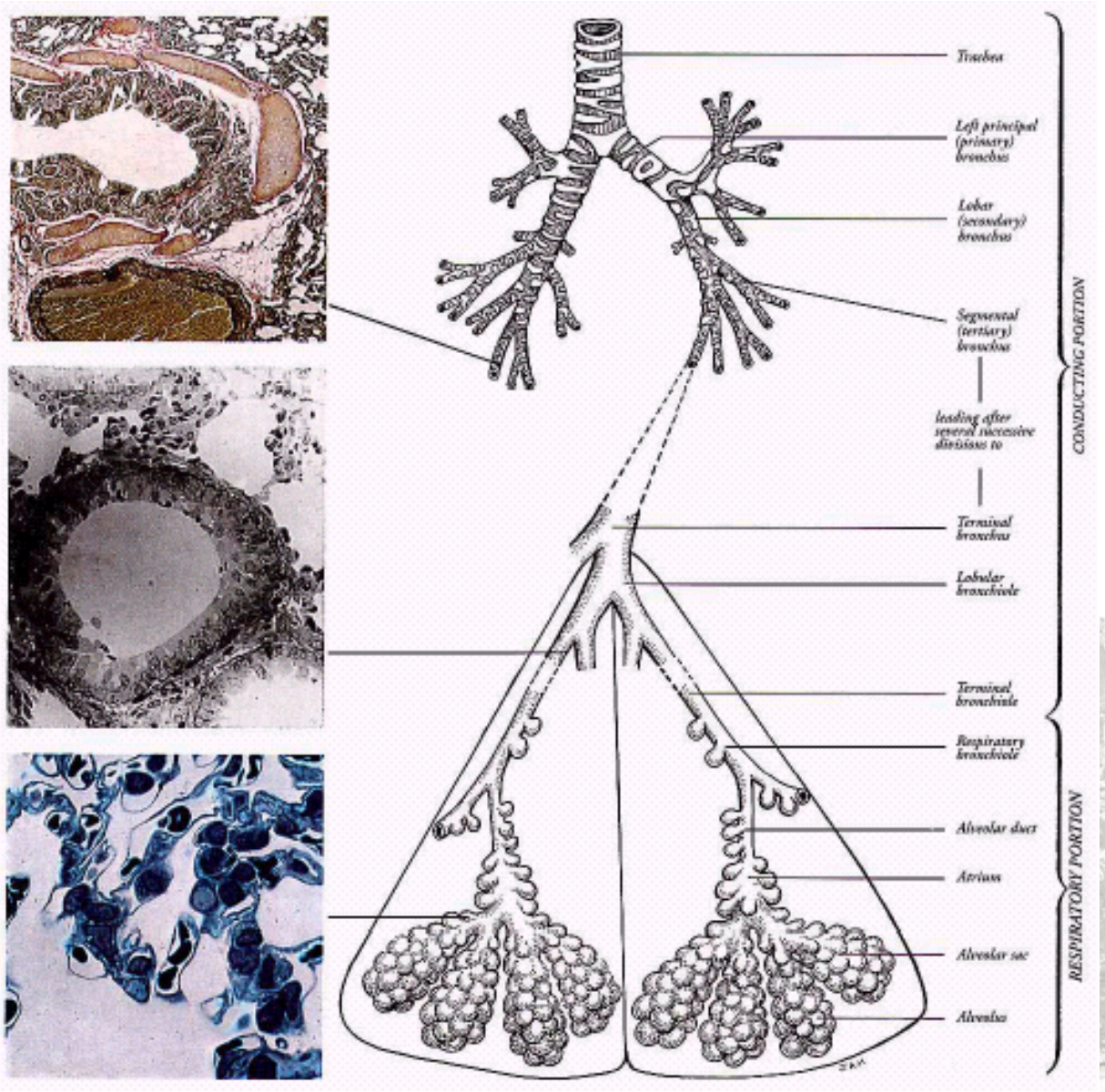
Procedures in Medicine (2)

- When preparing for a procedure you must prepare **PaYED**
  - **Pa**tient & relatives
  - **Y**ourself & other staff
  - **E**quipment, including monitoring
  - **D**rugs

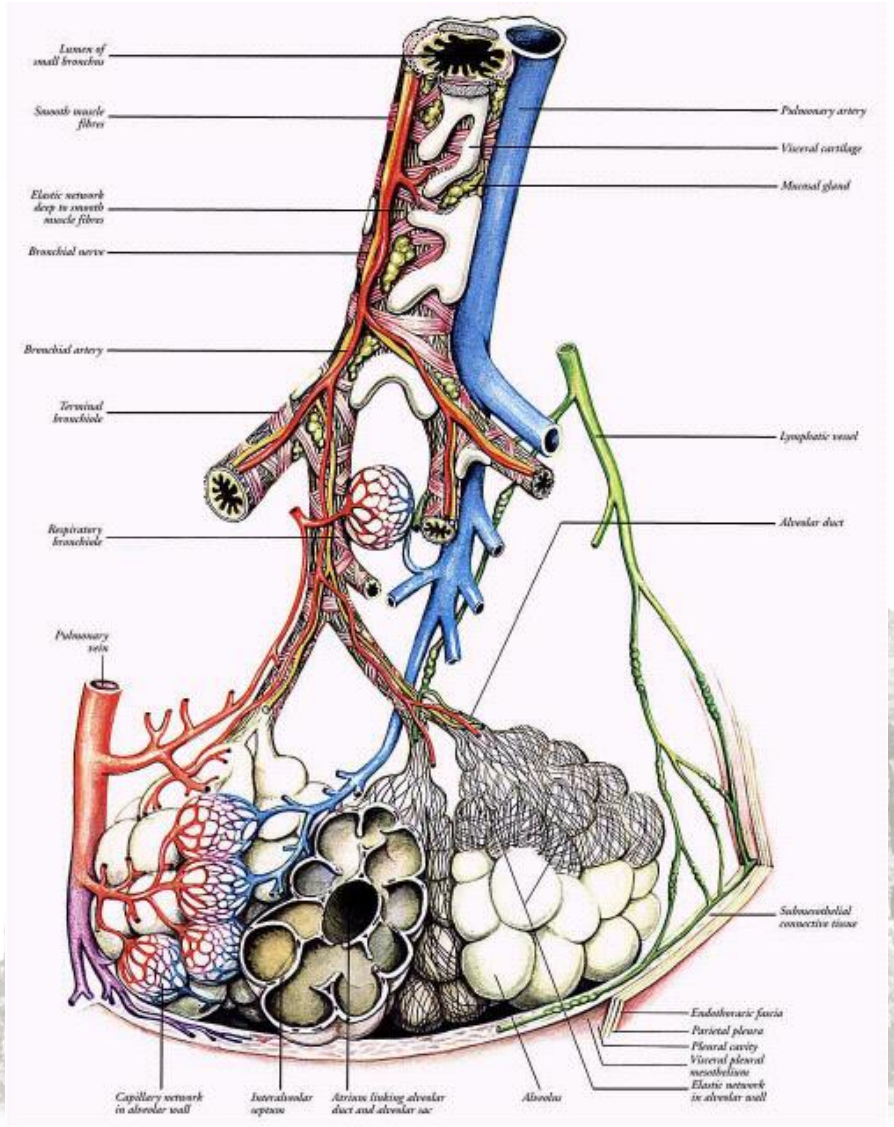
VENTILATORY CONTROL BY FEEDBACK LOOPS



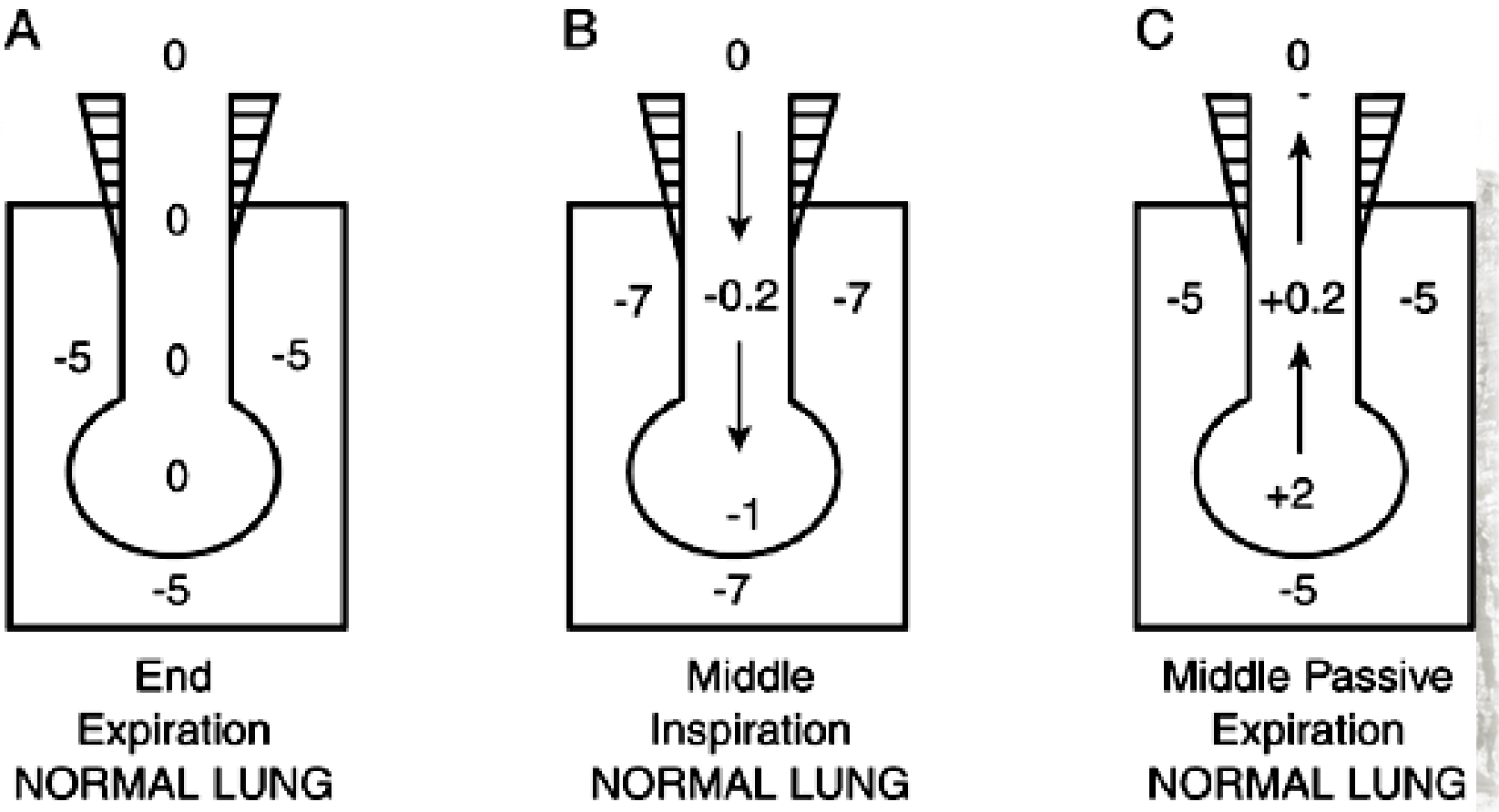
Respiration in the lungs



Respiration in the lungs



Spontaneous Ventilation



Invasive Airway Management

- Endotracheal tube (ETT)
  - cuff in trachea, the airway is almost 100% protected
- Laryngeal Masks (strictly speaking is an UPPER airway device):
  - no cuff in trachea, the airway is NOT 100% protected
  - newer devices are safer & easier to use
  - newer devices have a port for a 14G orogastric tube & other safety features

Endotracheal Intubation (1)

- Advantages
  - Both maintains & protects the airway (with the cuff in the trachea)
  - Relatively secure
  - Allows for mechanical ventilation

- Disadvantages
  - Technical skill & equipment is required & is not always available
  - In some cases it may be technically very difficult
  - Patient must be adequately sedated to tolerate the tube insertion & presence
  - The procedure is associated with some potential complications

Endotracheal Intubation (2)

- Indications
  - Airway protection - eg can't swallow, pooling saliva
  - Airway obstruction - eg. paradoxical breathing
  - Increase oxygenation - PaO_2<60mmHg
  - Increase/manipulate ventilation - $PaCO_2$>60mmHg (despite best available non-invasive respiratory support)
  - Muscular paralysis/apnoea (patient is not breathing)

Endotracheal Intubation (3)

- Contraindications
  - A simpler procedure will suffice
  - Non-starved patient, if an elective procedure (relative CI)
  - Likely difficult intubation, no-one skilled enough to perform procedure

Endotracheal Intubation (4)

- Complications (a long list!)
  - Dental injury
  - Mucosal injury & bleeding
  - Globe injury
  - Inducement of vomiting & aspiration
  - Oesophageal intubation & death
  - Damage to vocal cords
  - Late tracheal stenosis, esp. in children
  - RMB intubation - hypoxia, lung collapse
  - Pneumothorax
  - Tracheitis, pneumonia

Endotracheal Intubation (5)

- Patients with neurotoxicity deteriorate gradually:
  - identify those patients who will require intubation **before** they deteriorate to the point that they need immediate intubation
  - intubated ‘semi-electively’
  - prepare & check equipment, drugs, assemble staff so intubation occurs in a planned, orderly, controlled manner
- Require a **rapid sequence intubation** to reduce the risk of pulmonary aspiration since:
  - not starved
  - vomiting or gastric stasis
  - increased oral secretions

Rapid Sequence Intubation

- Everything ready:
  - **Pa**tient, **Y**ourself & Staff, **E**quipment, **D**rugs
- Pre-calculated drug doses - midazolam, fentanyl ideal; less ideal are morphine, diazepam, ketamine
- Fast-acting muscle relaxant (suxamethonium) - may not be needed in a fully paralysed patient
- Pre-oxygenation, monitor SpO2
- Cricoid pressure - Sellick's manoeuvre
- **ALWAYS** check & confirm ETT tube position - cuff or black line JUST through cords
- Secure tube well
- Special considerations in children

Confirming ETT Position

- Visualisation passing though cords
- End-tidal CO2 monitoring
- Visible equal chest expansion
- Air entry in both axillae, not in stomach
- Palpate ETT pass under fingers
- Palpate cuff as inflated in trachea
- Fogging of tube on expiration
- Oesophageal detector device
- Ease of ventilation
- Maintenance of oxygenation
- CXR

Laryngeal Mask Airways

- Delivering air into the laryngopharynx & hold it open
- Require relatively normal anatomy to work effectively
- Require less skill & training to insert
- Some may have a ‘cuff’ in the oesophagus (oesophagus is distensible; does not prevent aspiration), or OGT port
- In envenomed patients, they are a “second best” to an endotracheal tube
- Indications:
  - patient not maintaining & protecting own airway
  - hypoventilation, hypoxia or aspiration
  - endotracheal intubation is not possible (skills or equipment) & patient’s airway is not able to be maintained by other means
  - “failed airway” drill

Mechanical Ventilation

Mechanical Ventilation (1)

- Role - to provide adequate gas exchange until the envenomation can be definitively treated & the patient has recovered ability to ventilate - from the lungs to the cells
- Unless they have co-morbidities (eg. COAD), or complications (eg. aspiration), envenomed patients will have normal lungs & be easy to ventilate
- Record & monitor position of ETT & adequacy of ventilation, oxygenation
- **Never leave this to the relatives!!!!!!!!!!!**
- **Always sedate & give analgesia:**
  - often have upper limb power still
  - ETT is uncomfortable, frightening
  - especially children
  - then need to control ventilation - don't leave it to the patient

Mechanical Ventilation (2)

- Modes of ventilation:
  - **volume-driven** ventilator - the **pressures achieved** determined by the patient's **lung compliance,** & **volumes** & **times** set
  - **pressure-driven** ventilator - the **tidal and minute volumes** depend on the patient's **lung compliance** as well as on the **pressures** & **times set**
  - **pressure** or **volume** driven ventilation - ventilate the patient with the lowest pressures that achieve adequate tidal volume (and minute ventilation)

Mechanical Ventilation (3)

- Mandatory & Triggered breaths:
  - Mandatory breaths:
    - delivered at a set frequency, regardless of the patient's respiratory effort
    - useful if the patient is not making any respiratory effort
  - Triggered breaths are:
    - triggered by the patient's respiratory effort.
    - good for keeping the ventilator 'coordinated' with the patient's own breathing

Mechanical Ventilation (4)

- Initial ventilator settings - chosen depending on the patient's size & clinical problem
- **Rate (breaths/minute) x tidal volume (volume of each breath) = minute ventilation (minute volume), ie. R x TV = MV**
- **Tidal volume at rest - 7-10ml/kg** (1/10th of blood volume)
- Adult - Rate 12/min. x volume ~500ml = 5-6 litres/min
- Child or infant - Rate 15–30/min. x 10 ml/kg tidal volume
- Start with an FiO_2 of 100%; reduce to <60% in LESS THAN 12 hours (O2 toxicity)
- I:E ratio of 1:2 (assuming normal lungs)

Mechanical Ventilation (5)

- Positive End Expiratory Pressure (PEEP)
  - airway pressure occurring at the end of expiration during positive pressure ventilation.
  - the ‘resting’ pressure in the circuit, between breaths
  - increasing the PEEP increases the end expiratory volume of the lung (residual volume)
  - eg. 5-7 cm H2O
  - keeps more alveoli open for more of the respiratory cycle; may improve gas exchange & reduce shunt
  - risk of accumulating air within lungs - “auto-PEEP’

Mechanical Ventilation (6)

- Look at the effect of the ventilator settings chosen
  - check that the airway pressures (mean & peak) are not too high
  - check a blood gas
    - Is the PaO_2 adequate (should the FiO_2 be reduced or increased)?
    - Is the $PaCO_2$ acceptable (should the minute ventilation be increased or decreased)?
  - close monitoring & adjustment of ventilator settings as needed is at least as important as the initial settings

Mechanical Ventilation (7)

- Avoiding complications, death of intubated & ventilated patients:
  - **Always check A & B in a ventilated patient if BP drops**
  - over-intubation/right main bronchus intubation is VERY common, especially in children; calculate correct depth, check expansion & air entry, CXR!
  - UL weakness develops after airway obstruction & respiratory failure - the patient cannot swallow or breathe, but can still pull out their tube, especially children
    - **secure** tube well!
    - **sedate** all patients (morphine/diazepam)
  - **explain** to patients what is happening
  - **monitor** patients **every second**
  - sedation allows better control of oxygenation & ventilation

Mechanical Ventilation (8)

- Gastric tube:
  - All intubated patients need a gastric tube to:
    - reduce the risk of gastric distension and gastro-oesophageal reflux, & the risk of aspiration (can occur, even with an ETT)
    - make ventilation easier by reducing intraabdominal pressure
    - monitor fluid losses
    - watch for any upper GI blood loss
  - Often done by the least experienced doctor, & done traumatically, causing upper airway bleeding, often leading to inappropriate management, eg giving blood products - so insert carefully
  - The better alternative is to ALWAYS use an OGT, not a NGT
  - Also avoids the problem of sinusitis from prolonged nasogastric intubation

Mechanical Ventilation (9)

- ETT removal - do it once ONLY:
  - ptosis is resolving
  - obeying commands & fully awake (sedation off)
  - able to protrude tongue
  - can sit up on own
  - can take deep inspiration
  - can breathe for several hours on T-piece without difficulty
  - mouth suctioned
  - **Then essential to monitor patient even more closely - be ready to re-intubate**

Recovery after Mechanical Ventilation

Management of Mechanical Ventilation (1)

- Nursing care
  - frequent turns of all patients with neurotoxicity - reduce pressure areas & atelectasis
  - always use humidifier in circuit long-term
  - regular nebulisation - saline or salbutamol
  - gentle suctioning of mouth & ETT (use STERILE catheter!)
  - maintain suction, oxygen availability
  - Amubag/BVM at bedside
  - intubation equipment nearby
  - know where the closest ventilator is

Nursing the Ventilated patient

Management of Mechanical Ventilation (2)

- Additional treatment:
  - fluids
  - sedation
  - stress ulcers: H_2antagonist
  - physiotherapy
  - nasogastric feeding
  - stringent care of the paralyzed patient: turns
  - regular airway suctioning & nebulizing

Management of Mechanical Ventilation (3)

- Monitoring:
  - oxygen saturation, SpO_2
  - end-tidal carbon dioxide, $ETCO_2$
  - blood pressure, BP
  - heart rate, HR
  - urine output, UO
  - temperature, T
  - potential infections:
    - chest
    - urine
    - wounds

Management of Mechanical Ventilation (4)

- Laboratory investigations:
  - pH
  - PaO_2
  - $PaCO_2$
  - K^+
- CXR:
  - initially
  - whenever any sign of deterioration, eg. worsening oxygenation, fever, chest signs

Complications of Mechanical Ventilation (1)

- Equipment:
  - malfunction or disconnection
  - contamination - nosocomial pneumonia
  - loss of O_2 supply
- Pulmonary:
  - atelectasis
  - pneumonia
  - diffuse lung injury
  - barotrauma
  - oxygen toxicity
  - ARDS

Complications of Mechanical Ventilation (2)

- Circulation:
  - reduced cardiac output
  - reduced splanchnic blood flow
  - increased intracranial pressure
  - fluid retention
- Others:
  - gut distension
  - mucosal ulceration
  - muscle weakness
  - sleep disturbances
  - psychiatric complications
  - pressure areas

Supportive Care of the Ventilated Patient

- Patient sedation, analgesia
- Maintenance fluids & orogastric or IV feeding
- Urinary catheter & fluid balance
- Hourly vital signs recording (& act on abnormalities)
- Turns to reduce atelectasis & pressure areas; chest physiotherapy
- Local tissue injury care

Good Airway & Breathing Management - just in time!

…Leads to Great Clinical Outcomes

Summary - Key Points

- The most important aspects of managing a snakebite patient are:
  - assessing & managing the airway
  - assessing & managing the breathing
  - continually reassessing both
  - ensuring adequate vital organ oxygenation
- Anticipate complications
- Monitor closely, reassess frequently
- Promptly act on & treat deterioration & complications