



**Additional information for trainees to underpin
power point presentations**

Trainer's notes to guide presentation

**PACU Breathing : ANAESTHESIA AND SURGERY
Learning and Teaching Resource**

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Presentation : Anaesthesia & Surgery

The combination of drugs, anaesthetic agents and techniques used in general anaesthesia may profoundly interfere with normal respiratory homeostasis in the fit adult. If the adult is elderly, with a history of respiratory disease and is overweight the perianaesthetic risk of respiratory dysfunction increases.

- Elderly people had less efficient respiratory drive, stimulus to breathe and the respiratory muscle is weaker. Hypoventilation is a risk – and opioids should be used with care.
- Smoking causes the airways to be irritable. Bronchospasm is more likely in these patients. Asthma, COPD, lung fibrosis all create risks reducing lung compliance, raising airway resistance, filling up alveoli and making ventilation more difficult.
- Obesity creates the risk of shutting down basal areas of the lung if the patient is in Trendelenberg position

Any operation where the patient is immobile for extended lengths of time risks airway closure and VQ ratio mismatch as the pulmonary blood flow fails to match healthy open alveoli. Surgery on the abdomen or the thorax leaves pain incisions which may cause the patient to hypoventilate in the post anaesthetic period.

General anaesthesia employs a mixture of drugs/agents which impact on normal respiratory function. Induction and maintenance agents [volatiles and opioids and hypnotics] can cause respiratory depression where the respiratory centre fails to respond to CO₂ stimulus to breathe this may result in hypoventilation. Muscle relaxants weaken the intercostal muscle action in raising the rib cage on inspiration. Hypoventilation can ensue.

The anaesthetist will prepare an individual patient plan considering all the above factors in order to safeguard respiratory function intra and post operatively. He will consider the following points:

- a. type of anaesthesia : is general anaesthesia [GA] appropriate or dangerous for the high risk individual with respiratory problems? If surgery is low risk, short in nature then spinal, epidural or local block may be employed with the patient awake.
- b. if GA is necessary and the patient is high risk, then assisted ventilation with endotracheal intubation will be necessary
- c. monitoring : all patients have routine ECG, SaO₂, blood pressure and ETCO₂ monitoring. High risk patients will have an arterial line in situ and ABG monitoring.
- d. anaesthetic drugs [volatiles, opioids] all depress the respiratory centre / muscle relaxants impair respiratory excursion : while this is not a problem intraoperatively if the patient's breathing is controlled on IPPV – this can be a problem when he self ventilates back in PACU. Has the patient any history of respiratory disease which may make breathing difficult.
- e. pain control – balanced analgesia using a mixture of nerve block, opioid, NSAID will ensure smooth pain control lasting into the post anaesthetic period. Which combination will suit the patient's needs?
- f. prepping the patient : those with a history of respiratory problems should be properly investigated : CXR, bronchoscopy : AGB's : pulmonary lung function tests : CT scan : MRI.

General anaesthesia drugs and agents:

Induction and maintenance agents used in GA impact on the respiratory system by their action on the respiratory centre and intercostal muscles.

Induction Drugs

Thiopentone : [induction agent] may cause respiratory depression, apnoea, laryngo and bronchospasm.

Diprivan : [induction agent and TIVA] : used extensively in day surgery due to its fast elimination. Propofol is a powerful respiratory depressant and is used for induction and maintenance [TIVA-total intra venous anaesthesia] to calibrate its administration and allow the patient to regain consciousness promptly after the procedure.

Used as induction agents both the above drugs are safe in that they patient will be tubed and ventilated during the procedure. They can have a lingering affect post operatively in conjunction with other anaesthetic drug mixes.

Ketamine : actually boosts cardiac output [increases HR]. Myocardium oxygen requirements increase.

Benzodiazepines [i.e. midazolam / sedative] Often used when the patient is nervy and difficult to settle. Midazolam remains in the body for a long time and may need reversal with flumazenil. It can potentiate the long lasting effect of the anaesthetic cocktail in leading to delayed return to consciousness with resulting loss in airway protective mechanisms and also contribute to respiratory depression.

Maintenance drugs

Triad of anaesthesia = [hypnotic, narcotic and muscle relaxants] ensure patient is settled during the procedure.

Hypnotic = Volatile agents :

Halothane, Enflurane, Isoflurane, Sevoflurane, Desflurane

These are hypnotic solutions which maintain the patient in the unconscious state.

All the volatile agents depress the respiratory centre and reduce sensitivity to carbon dioxide stimulus to breathing.

Respirations may become slow and shallow. Mild residual hypoxaemia may last hours or days into the post operative period dependent on the nature of surgery, post operative pain and co-existent lung disease.

Narcotic = Opioid drugs

Morphine, Fentanyl, Alfentanyl, Remifentanyl, Sufentanyl

Opioids are given to analgesic patients who experience painful stimuli even when unconscious. Increments of analgesia are given throughout the surgery as increased heart rate and blood pressure signify increased sympathetic reaction to pain. These drugs differ in their time of action but all are powerful respiratory depressants. Morphine is the gold standard of opioids. Typically opioid overdose causes the patient to drop his respiratory rate and depth – as they become more somnolent the tidal volume and rate diminish – resulting in hypoventilation, rising carbon dioxide levels and hypoxia. The airway is unprotected as muscle tone is lost and obstruction may occur.

Muscle relaxants :

Vecuronium, Atracurium, Mivacurium

Suxamethonium : short acting relaxant given for intubation

Are given to relax smooth muscles and enable surgery, also to settle patient on the ventilator and to ensure that minimal doses of other anaesthetic drugs are given.

The long acting muscle relaxants do not depress the respiratory centre but may cause, or contribute to hypoventilation if not reversed properly. The reversal agent is neostigmine [given with glycopyrrolate to prevent bradycardia]. Failure to properly reverse muscle relaxants leads to mild to severe residual paralysis where the patient does not have muscular control over his breathing. This is an emergency and neostigmine should be given stat.

Anaesthetic Gases:

Nitrous Oxide Is given along with the volatile agents as a gas to ensure patient is pain free. N₂O however displaces oxygen in the lungs and supplemental oxygen is given to all patients to help diffuse the nitrous from the lungs.

Oxygen : is always administered as it is essential for myocardial cell function. Lack of it leads to ischaemia, weakens the muscle with maybe fatal results

Effects of anaesthetic technique on respiration : Artificial ventilation [IPPV] may be employed in long, complex where the patient may be at risk of hypoxia. If patient is ventilated for a long period, surfactant is lost and alveoli collapse. Again over long use of IPPV reduces the Functional Residual Capacity and the oxygen reserve held in the lungs at the end of quiet respiration is diminished.

Effects of surgical intervention on respiration : Pain. Surgery is painful in the intra as well as post operative period. Nociceptors work all through. If the balanced analgesia plan is not effective, SNS activated, increase in HR, BP. Most importantly pain [especially chest or abdominal pain] around the incision site discourages patients from deep breathing – an essential part of respiratory recovery

The anaesthetist has much to balance in ensuring his plan will protect respiratory function throughout the procedure.

Management of breathing intra-operatively

- **Induction** : from the moment of induction [gas or intra-venous method] the patient is unconscious and breathing impaired. The airway is secured [for complex, long surgery ETT is the choice, for all other procedures LMA / supra-glottis device is used. The patient is hand ventilated until set up on a ventilator – or allowed to breathe spontaneously.

- **Choice of technique : assisted breathing / spontaneous ventilation** : dependent on the risk factors, the patient will be mechanically ventilated or breathe spontaneously.
- **Monitoring** : again appropriate for patient. Complex, long cases for high risk patient will require invasive monitoring and ABGs.
 For routine cases : SaO_2 will provide a real time indicator of Hb saturation.
 Capnography : real time indicator of efficiency of ventilation : end tidal CO_2 : how well lungs are expelling CO_2 .
 Ventilator observations : routine check on MV / airway pressures to ensure ventilation adequate
 BP / HR / ECG / CVS monitoring important : inadequacy of respiration will lead to CVS compensation
- **Management of patient's breathing / maintenance phase** : The anaesthetist delivers bolus doses of opioid/hypnotic to maintain the patient unconscious during the operation. If ventilated this ensures that the patient does not 'fight' the ventilator [i.e. try to take own breaths]. Signs of a lightening level of consciousness, or pain are observed by elevation of HR and BP as sympathetic responses to both.
- Monitoring of SaO_2 , ETCO_2 [and ABG's if arterial line in situ] provide essential information about the patient's oxygenation and ventilation. If the ETCO_2 is elevated, this equates with PaCO_2 and infers that the patient is retaining CO_2 . This can be corrected by delivering a greater volume of oxygen and air via the ventilator. If the SaO_2 falls and the Hb is not fully saturated with oxygen the ventilator settings can be adjusted to deliver a greater volume of gas, or higher concentration of oxygen [FiO_2]. Patients colour is noted. Cardio-vascular information [HR, BP and ECG] provide essential information about the patient's comfort – and can denote cardio-vascular compensation if breathing inadequate.
- During the intra-operative period the patient is static, lying immobile, supine on the table / or in reverse Trendelenberg position. The effect of this stasis on the lungs means that parts of lung can shut down [atelectasis]. Usually the lung apices are the easiest to ventilate – they receive the gas first. If the patient is put in reverse Trendelenberg, the lung bases can be compressed especially in the obese patient leading to collapse of basal alveoli. Pulmonary perfusion of the

alveoli is impaired also. The lung bases are best perfused – the apices worst. So we have a VQ [ventilation perfusion mismatch]. In normal activity, moving around all the time ensures that the air sacs are kept open and that perfusion serves the entire lung fields.

- Prolonged intubation and ventilation also means that surfactant is destroyed. This protein normally helps to keep the air sacs open by reducing surface tension. Again loss of alveoli.
- **Reversal of anaesthesia**
Volatile agents are turned off at the end of the surgery. If the anaesthetist has dovetailed analgesia and sedative drugs to wear off by the end of surgery the patient should wake and extubation [removal of LMA] can take place. From here on the patient must resume control of breathing. Careful observation is essential to ensure that he is able to take adequate breaths for alveolar ventilation. If the patient fails to wake, deep breathe sometimes a reversal agent is given : dopram, narcan to reverse the effect of anaesthetic drugs. Even while the patient is self ventilating it must be remembered that it can take hours for the full effect of these drugs to wear off. The longer the surgery, the longer the recovery.
- **Residual effects of anaesthesia/surgery in post anaesthetic period**
 - The combination of drugs, position, IPPV and surgery together may have a residual effect in the immediate post anaesthetic period.
 - Thoracic/abdominal surgical procedures require excellent pain control of the patient will be wary of deep breathing post operatively.
 - The effect of alveolar closure due to several factors [loss of surfactant, position, stasis, IPPV, VQ mismatch, secretions, hypoventilation] can contribute to atelectasis or partial closure of areas of the lung

- The impact of volatiles and opioids on the respiratory centre results in diminished rate and depth of respirations – resulting in delayed return to consciousness and hypoventilation. Airway obstruction is a high risk associated with ongoing unconscious state
- Muscle relaxants generally weaken intercostal muscles – and if reversal inadequate can cause residual paralysis – a respiratory emergency
- If the patient is elderly, has a history of respiratory disease or obese, the risk of respiratory complications increases. Smokers, those suffering from COPD have increase risk of secretions which cause irritable airways, possibility of spasm and may block the airway/alveoli.



Trainer's notes on power point presentations

Breathing : Anaesthesia and Surgery

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Trainer's notes : Anaesthesia and Surgery

These notes are intended as advice for trainers [or mentors] delivering the presentation to students.

This presentation follows the normal patient pathway through anaesthesia [from pre-assessment to reversal of general anaesthesia]. This provides a logical structure for slides. The aim here is to understand how the anaesthetist thinks especially with regard to risk management, and how he safeguards respiratory function.

Slides 3-6 : Estimating risk to respiratory function is key to safeguarding breathing intra-operatively. Slide 5 states general risks of surgery/anaesthesia and slide 6 adds on patient specific risks.

7: Anaesthetic plan : this could open discussion on the variety of choices the anaesthetist has in planning anaesthetic and monitoring. Need to emphasise the point that the greater the risk, the more complex will be the monitoring and the more likely the choice of general anaesthesia and use of endo-tracheal intubation.

10-14 : Stages along the way to setting up patient in theatre : pre-oxygenation / induction / airway control / hand ventilation. Emphasises the dramatic change post induction in the patients airway/breathing and the necessity to secure the airway and hand ventilate patient until attached to ventilator.

15 : The patient is now in theatre set up on ventilation ready for the 'maintenance phase' of general anaesthesia.

16 : General aims of care during this phase.

17 : Students should have general understanding of how volatiles delivered – also that Nitrous Oxide is given [as this can cause diffusion hypoxia] in the post operative phase.

18: Monitoring – emphasis how much anaesthetist relies on monitored information in theatre. CVS signs are vital not just to assess cardiac performance but to inform anaesthetist that patient may be in pain, with resultant lightening of conscious level [from raised sympathetic nerve activity / tachycardia/hypertension]. At which point he may increase volatiles, give analgesia.

19: Ventilator observations are taken and together with patient vital signs inform the anaesthetist that ventilation settings may need adjustment.

20/21: Reminder of the principle of the Triad of Anaesthesia. This should be familiar by now! Slide 22 outlines how the three different drug groups used in the Triad may impact on breathing.

23-28: Specific information on drug groups : hypototics, narcotics and muscle relaxants and how they impact on normal respiration. The information is general and not too detailed to serve as an introduction to this subject. Nitrous oxide included here as part of anaesthetic mix.

30: Reminder of the effects of **prolonged ventilation** on breathing when patient spontaneously breathes in PACU. Important to stress that all these factors [drugs, position, IPPV] **contribute** to hypoventilation, atelectasis in the recovery room. These are the background processes that may result in hypoxia. Emphasise the fact that in normal daily activity we are constantly changing position – sitting, lying, standing, turning, bending etc – all the time ensuring that all alveoli remain open, and that blood flow is brisk and serves all areas of the lungs. Contrast now with lying immobile – VQ ratio disturbed, lung stasis and alveoli shut down.

31-32: Reversal time : this phase of general anaesthesia could be compared to a plane landing. Just as taking off and landing are risky times in air flight – so landing/reversal is the same in anaesthesia. Think of the patient, waking and taking over control of his own respirations. Will his respiratory centre be alert to stimulate breaths? – will they be adequate in volume? Will his intercostal muscles be strong enough to inspire enough air for adequate alveolar ventilation? Will he be

in pain and unable to deep breathe? Ideally all the above boxes should be ticked with perfectly planned anaesthesia : however, often surgical time is shorter than planned and the patient is still well deeply unconscious.

33 Sometimes it is necessary to give reversal drugs : narcan/dopram. Effective but rather an unpleasant way of waking! Famously anaesthetists wave a vial of either over the patient to encourage him to wake without actual administration!

34: Important to emphasise always that anaesthetist should not leave patient until PACU staff are satisfied that the patient is breathing well and that they accept full responsibility.

35: Reminders of the residual risks to breathing into post anaesthetic phase.