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# Airway management in post anaesthetic care

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Some patients recovered in the post anaesthetic care unit (PACU) will require airway management and close monitoring to prevent any post operative complications. Ineffective airway management will lead rapidly to hypoxaemia, and will ultimately compromise patient care. This article discusses physiological principles and monitoring of airway management in the PACU, an understanding of which is essential when providing appropriate care for patients emerging from anaesthesia.

## Introduction

The recent National Audit Project (NAP4) into major complications of airway management in the UK, conducted jointly by the Royal College of Anaesthetists (RCOA) and The Difficult Airway Society (DAS), has highlighted the incidence of airway complications during emergence and recovery from anaesthesia (Cook et al 2011). A large proportion of the events identified by the audit, during a one-year period, occurred during emergence or recovery from anaesthesia.

Davey and Ince (2004) describe airway management as the cornerstone of effective post anaesthetic management. Maintaining the airway is vital as the patient's life depends upon it (Dolenska et al 2004). Ineffective airway management will lead rapidly to hypoxaemia, organ failure and ultimately death. Most patients experiencing a general anaesthetic will be recovered in the post anaesthetic care Unit (PACU), and will require airway management and close monitoring to prevent post operative complications. It is essential that adequate standards of care are maintained in order to prevent serious complications (AAGBI 2009). Intubated and ventilated patients' care is complex and it is important that any complications arising can be diagnosed and managed accordingly, in order to provide individualised care.

This article discusses physiological principles and monitoring of airway management in the PACU, an understanding of which is essential when providing appropriate care for the intubated or ventilated patient and those emerging from anaesthesia. The Health Professions Council (HPC) requires that all registrants

understand the key biological, physical and clinical concepts relevant to their profession (HPC 2008). Concepts affecting a patient's airway will be discussed, as they affect most patients visiting the PACU.

## Physiological Principles

### Airway

An inadequately maintained airway may result in hypoxaemia (Robinson & Hall 2007). Of primary concern is airway obstruction, of which there are several causes. Younker (2008) states that central nervous system depression resulting from drugs such as opioids, is the primary reason for airway obstruction post anaesthesia. The tongue falling back against the posterior pharyngeal wall (Davey & Ince 2004), foreign bodies, teeth, crowns and throat packs all pose a threat of airway obstruction to the unconscious patient. The latter was highlighted in an audit conducted into critical incidents (NPSA 2007).

Obstructions not only reduce the intake of air into the respiratory system, but also create a more turbulent flow of air in the trachea and upper airway. This turbulence disturbs the laminar airflow required in the lower respiratory tract to facilitate efficient exchange of gases (Davis & Kenny 2006).

Partial airway obstruction is characterised by noisy breathing, such as inspiratory stridor, expiratory wheeze or a crowing noise. Complete obstruction is characterised by a 'see-saw' chest movement and silence (Jevon 2008). Head tilt and chin lift, as well as jaw thrust and the lateral 'recovery' position, can be utilised to prevent many physiological obstructions (Yentis et al 2009). A laryngoscope and McGill forceps can be

utilised to remove any foreign bodies causing an obstruction (Jevon 2008) in unconscious patients. All patients must be observed on a one-to-one basis until they have regained airway control (AAGBI 2009).

### Breathing

Breathing facilitates gas exchange, supplying oxygen to the tissues and eliminating waste products, such as carbon dioxide ( $\text{CO}_2$ ), which are released at a cellular level (Hatchett 2007). Drugs depress the respiratory centre, causing hypoventilation, a fall in blood pH (Marieb & Hoehn 2010) and an increase in arterial partial pressure of carbon dioxide ( $\text{PaCO}_2$ ), resulting in respiratory acidosis.

Respiratory acidosis is characterised by an increase in  $\text{PaCO}_2$ , low pH and an increase in plasma bicarbonate ( $\text{HCO}_3^-$ ). There are many causes of respiratory acidosis, for example: depression of the central nervous system by drugs, airway obstructions, laryngospasm and chronic obstructive pulmonary disease (COPD), all of which will cause an increase in  $\text{PaCO}_2$ . Respiratory acidosis can cause tachycardia, vasodilation, coma and cardiac arrest (Aitkenhead et al 2007). Its diagnosis is essential in managing the patient's airway and breathing.

Pain significantly restricts respiratory movements in patients who have had high abdominal or thoracic surgery (Davey & Ince 2004), as does fatigue and hypothermia (Jevon & Ewens 2007). The ability to cough and clear secretions is also reduced, increasing the risks of airway obstructions. The shivering, pain and anxiety which result from hypothermia all increase cellular metabolic rate, thereby increasing global oxygen consumption and increasing →

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respiratory demand (Evans 2004). The primary treatment for breathing problems is oxygen therapy (Younker 2008). However, oxygen therapy may cause airway complications, by thickening secretions within the respiratory tract (McArthur-Rouse & Prosser 2007), and as a result, its effects should be monitored. Oxygen is a drug requiring a prescription, and can cause detrimental effects on patients suffering from COPD. In these patients oxygen therapy increases PaCO<sub>2</sub> and reduces hypoxia, thereby reducing the patient's respiratory drive (Davey & Ince 2004).

### Circulation

One function of the circulatory system is to provide cells with oxygenated blood (Hudsmith 2004). Oxygenation of blood is the role of the respiratory system. Thus, changes in blood oxygenation, will affect the respiratory system. An inefficient circulatory system will increase the demands on the patient's respiratory system.

Hypovolemia is a common postoperative problem (Younker 2008) possibly due to patients being starved pre-operatively. It can result in hypotension (Hudsmith 2004) as well as hypovolemic shock (Marieb & Hoehn 2010) and is characterised by inadequate tissue perfusion and cellular hypoxia (Berry 2005). Hypovolemia and hypotension cause a reduction in pulmonary blood flow resulting in an imbalance in the ventilation:perfusion ratio. Alveolar dead space within the lung increases, and as a result CO<sub>2</sub> concentrations within the blood remain high which increases respiratory drive (Pinnock et al 2009).

Ventilatory control would not be possible without the circulatory system. Control is regulated by chemoreceptors which respond to changes in the chemical composition of blood (West 2008). Located on the ventral surface of the medulla, the chemoreceptors are stimulated by positively charged hydrogen ions (H<sup>+</sup>) from CO<sub>2</sub> diffused into the cerebral spinal fluid (CSF) from the cerebral blood vessels (West 2008). An increase in H<sup>+</sup> concentration stimulates ventilation. This increase in respiratory drive is initiated by respiratory acidosis.

The effects of the patient's circulation on the respiratory system are complex and its stability needs to be achieved before extubation is attempted (Younker 2008).

### Monitoring of the airway

Close monitoring of respiratory function is required to provide appropriate treatment (Jevon & Ewens 2007) and should be continued until the patient has recovered from anaesthesia (AAGBI 2002). Monitoring is used to supplement clinical observations and is considered essential to the safe conduct of anaesthesia (AAGBI 2007). However some respiratory conditions, such as respiratory acidosis, cannot be clearly diagnosed by observation. Accurate blood gas monitoring is required.

### Clinical observations

A clinical observation of your patient should be performed before checking other sources of monitoring, and should be a trusted source of monitoring. Respiratory rate and depth should be monitored, as it can be an early warning sign of deterioration. This parameter is not observed frequently enough by practitioners (McArthur-Rouse & Prosser 2007).

The airway should be assessed for stridor, indicating obstruction. Bilateral chest movement and auscultation of the chest indicate the presence of breathing (Jevon & Ewans 2007). Tracheal tug, a downward displacement of the thyroid cartilage during inspiration, as well as paradoxical or 'see-saw' breathing is evident in patients with partial or complete obstruction. The absence of cyanosis and the presence of peripheral perfusion will indicate a functioning circulatory system and adequate gas exchange. Pulse oximetry and blood pressure are mandatory forms of monitoring, which are required for all patients visiting the PACU (AAGBI 2002).

### Pulse oximetry

The pulse oximeter provides incremental measurements of SpO<sub>2</sub> allowing the early detection of hypoxaemia which would not be possible via clinical observation alone (Wright 2003).

Misinterpretation of pulse oximetry data is common in practice, as highlighted in a literature review (Walters 2007). Due to the nature of the oxyhaemoglobin dissociation curve, SpO<sub>2</sub> levels below 85% cannot be interpreted accurately via plethysmograph (Yentis et al 2009). Pulse oximetry is essential in providing a rudimentary method of warning practitioners of poor gas exchange however, it is not always accurate.

### Blood pressure

Blood pressure is a measurement produced by cardiac output and vascular resistance, and can aid in the diagnosis of hypovolaemia and resulting hypotension (McArthur-Rouse & Prosser 2007). Both conditions place increased demands on the respiratory system due to a resulting imbalance in the ventilation:perfusion ratio. Blood pressure can be measured both invasively and non-invasively, the former providing a more frequent measurement. Fluid dynamics can cause errors of up to 70% when using invasive monitoring and non-invasive measures are thought to provide a more accurate mean pressure (Hatfield & Tronson 2008).

### Electrocardiogram (ECG)

An ECG provides a graphical representation of the electrical activity of the heart (Al-Shaikh & Stacey 2007) and facilitates the management of the circulatory system. It is essential in diagnosing cardiac disorders and reduced cardiac output (Jevon & Ewans 2007). Lead II, as defined by Einthoven's triangle, is often used for continuous monitoring during anaesthesia and intensive care (Yentis et al 2009).

In some young healthy patients a regular breathing rate can cause sinus arrhythmia. The heart rate increases during inspiration due to stretch receptors in the lungs sending impulses which inhibit the cardio-inhibitory centre in the medulla oblongata. The heart rate then decrease during expiration. This condition is considered normal (Pinnock et al 2009).

### Temperature

Monitoring of the patient's temperature is required throughout the perioperative phase (NICE 2008). Shivering caused by hypothermia increases the cellular

## *Pharmacological agents administered perioperatively may have an effect on the patient's respiratory centre*

metabolic rate, which determines global oxygen consumption, and consequently increases the demand on the respiratory system (Evans 2004).

### **Blood gas analysis**

Blood gas sampling allows analysis of PaO<sub>2</sub> and PaCO<sub>2</sub> and the acid/base balance of the intubated patient (Hatchett 2007). Continuous sampling provides an assessment of interventions, such as oxygen therapy and fluid management, to counteract the effects of hypovolaemia on the respiratory system. Haemoglobin levels can be monitored to ensure levels greater than 10g/100ml of blood, allowing reduced demands on the respiratory system by providing oxygen to tissues (Davey & Ince 2004).

### **The intubated and ventilated patient**

A patient that is both intubated and ventilated may be unable to self-ventilate, or maintain their own airway. This may be due to respiratory depressant drugs or muscle relaxants (McArthur-Rouse & Prosser 2007). In the author's experience most intubated and ventilated patients are cared for in the intensive care unit (ICU).

### **Ventilation**

The primary objective of ventilation can be considered to be the homeostasis of PaO<sub>2</sub> and PaCO<sub>2</sub> (Pinnock et al 2009). Intermittent positive pressure ventilation (IPPV) increases intra-thoracic pressure, reducing venous return and cardiac output. The functional residual capacity (FRC) is reduced by 20% in anaesthetised patients, increasing the risk of hypoxaemia (Pinnock et al 2009). Ventilation may be therefore be required in order to provide adequate gas exchange.

### **Monitoring**

In addition to the mandatory monitoring required for the recovery of patients, ECG, airway pressure and airway gases should also be monitored (AAGBI 2007). Monitoring of airway pressure is mandatory and can indicate mechanical obstruction or disconnection of the circuit (Al-Shaikh & Stacey 2007). Capnography, a form of airway gas monitoring, provides a graphical

display of CO<sub>2</sub> levels, indicating gas exchange and a patent airway (Yentis et al 2009). The patency of the endotracheal tube (ETT) tube should be monitored closely, suctioning regularly to prevent sputum retention and ensure patency (Jevon & Ewans 2007).

Minimal alveolar concentration (MAC) and cerebral function monitoring (CFM) provide the practitioner with an indication of the patient's level of consciousness and thus the ability to maintain their own airway. MAC should be monitored during the administration of inhalation agents. The term 'MAC awake' is used to describe the point at which patients no longer respond to command, suggesting loss of consciousness (Yentis et al 2009).

Respiratory acidosis or alkalosis, diagnosed via blood gas analysis, indicates hypoventilation or hyperventilation, suggesting that a change in the set respiratory rate of the ventilator is required (Yentis et al 2009).

### **Extubation**

The use of an ETT provides the patient with a patent, protected airway, the removal of which is the responsibility of the anaesthetist (AAGBI 2009). The Glasgow Coma Scale, used to assess a patient's level of consciousness, can also be used as a tool to assess a patient's ability to maintain their own airway. A score of 10 and above is required for extubation to be attempted. All PACU staff should have knowledge of the Glasgow Coma Scale. A spontaneous breathing trial should be conducted before extubation is attempted (Lancaster 2007). Hospital guidelines and policies on extubation should be followed, as there are no nationally agreed criteria (Yunker 2008). Appropriately trained post anaesthetic care practitioners may remove supraglottic airways, as long as an anaesthetist is immediately available (AAGBI 2009).

### **Suction**

Suction can be used to ensure a clear airway. This can be undertaken in the upper airway with a yankeur sucker, preferably under direct vision. A suction catheter can

be used through the ETT to remove secretions below the cuff of intubated patients (Lancaster 2007). Care needs to be taken when suctioning. Excessive use may lead to trauma and oedema. Irritation of the vocal chords may lead to laryngospasm (Davey & Ince 2004).

### **Complications**

The NAP4 national audit identified obstruction as major airway complication in PACU (Cook et al 2011). Laryngospasm is a serious airway complication which occurs as a result of reflex contractions of the pharyngeal muscles (Lancaster 2007) and can be caused by a foreign body near the vocal chords or glottis (Yunker 2008).

Treatment involves removal of the stimulus and administration of 100% oxygen utilising positive end expiratory pressure via a mapleson C circuit. Re-intubation following the administration of a muscle relaxant may be required in extreme cases (Davey & Ince 2004). Heliox has been found to ease respiratory distress during laryngospasm, removing the need for re-intubation in post operative patients (Reuben & Harris 2004).

The surgery itself may pose a threat of airway obstruction, e.g. head and neck or ENT surgery (Leeper & Peel 2003). External pressure on the trachea due to a haematoma or swelling following neck surgery, can contribute to airway obstruction (Davey & Ince 2004).

### **Pharmacodynamics**

Pharmacological agents administered perioperatively may have an effect on the patient's respiratory centre. Opioids reduce both the rate and depth of breathing, and this is brought about by the desensitisation of chemoreceptors to CO<sub>2</sub> (Pinnock et al 2009). Muscle relaxants, not fully reversed, reduce tidal volume, causing hypercarbia and hypoxia (Davey & Ince 2004). Inhalation agents cause ventilatory depression, reducing tidal volume and increasing PaCO<sub>2</sub>, however isoflurane will increase the respiratory rate in the absence of opioids (Aitkenhead et al 2007). Naloxone, used to reverse opioid administration, has also been used to ➔

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increase respiratory drive without reversing analgesia (Yentis et al 2009).

## Discharge criteria

Patients must be fully conscious, able to maintain their own airway and displaying adequate respiratory effort and oxygenation, before discharge from the PACU can be considered (AAGBI 2002). Postoperative pain must be under control; patients must be normothermic and displaying a stable cardiovascular state before being discharged to the ward. A ward handover explaining perioperative complications and postoperative care instructions must be conducted upon discharge (Davey & Ince 2004).

## Conclusion

Patients in the perioperative environment require a great deal of care. At the forefront of this care is airway management. Postoperatively, airway management is affected by a number of concepts. An understanding of respiratory physiology is necessary in order to understand how various factors affect homeostasis, the patient's airway and the ability to breathe.

Clinical observations and supplementary, mandatory monitoring are used to assess the influence that these concepts place on a patient's ability to maintain their own airway and to breathe spontaneously. Control and monitoring of these concepts facilitates homeostasis, good airway management and a successful recovery.

## References

- Al-Shaikh B, Stacey S 2007 **Essentials of anaesthetic equipment** London, Churchill Livingstone
- Aitkenhead AR, Smith G, Rowbotham DJ 2007 **Textbook of anaesthesia** Oxford, Churchill Livingstone Elsevier
- The Association of Anaesthetists of Great Britain & Ireland 2002 **Immediate postanaesthetic recovery** London, AAGBI Available from: <http://www.aagbi.org/sites/default/files/postanaes02.pdf> [Accessed February 2012]
- The Association of Anaesthetists of Great Britain & Ireland 2009 **Guidance on the provision of anaesthesia services for post-operative care** London, AAGBI Available from: [www.rcoa.ac.uk/docs/GPAS-Postop.pdf](http://www.rcoa.ac.uk/docs/GPAS-Postop.pdf) [Accessed February 2012]
- Berry RD 2005 Management of shock in trauma **Anaesthesia and intensive care medicine** 6 (9) 308-10
- Cook TM, Woodall N, Frerk C 2011 **Major complications of airway management in the UK: Report and findings March 2011** London, The Royal College of Anaesthetists and the Difficult Airway Society Available from: <http://www.rcoa.ac.uk/index.asp?PageID=1089> [Accessed February 2012]
- Davey A, Ince CS 2004 **Fundamentals of operating department practice** London, Greenwich Medical Media
- Davis PD, Kenny GN 2006 **Basic physics and measurement in anaesthesia** London, Elsevier, London
- Dolenska S, Dalal P, Taylor A 2004 **Essentials of airway management** London, Greenwich Medical Media
- Evans TW 2004 **Respiratory management in critical care** London, BMJ Publishing Group
- Hatchett R 2007 Interpreting arterial blood gas results **British Journal of Cardiac Nursing** 2 (11) 520-23
- Hatfield A, Tronson M 2008 **The complete recovery room book** Oxford, Oxford University Press
- Health Professions Council 2008 **Standards of proficiency: Operating department practitioners** London, HPC
- Hudsmith J 2004 **Core topics in perioperative medicine** London, Greenwich Medical Media
- Jevon P 2008 Maintaining an airway **Nursing Standard** 22 (26) 35-7
- Jevon P, Ewans U 2007 **Monitoring the critically ill patient** Oxford, Blackwell Science Ltd
- Lancaster L 2007 Extubation after cardiac surgery: A practical guide **British Journal of Cardiac Nursing** 2 (6) 265-70
- Leeper DJ, Peel AL 2003 **Handbook of postoperative complications** Oxford, Oxford University Press
- McArthur-Rouse F, Prosser S 2007 **Assessing and managing the acutely ill adult surgical patient** Oxford, Blackwell Publishing Ltd
- Marieb EN, Hoehn K 2010 **Human anatomy and physiology** San Francisco, Pearson Benjamin Cummings
- National Patient Safety Agency 2007 **Anaesthesia: Safety improvement through partnership** London, NPSA Available from: [www.npsa.nhs.uk/corporate/news/anaesthesia/](http://www.npsa.nhs.uk/corporate/news/anaesthesia/) [Accessed February 2012]
- National Institute for Health and Clinical Excellence 2008 **Inadvertent perioperative hypothermia: The management of inadvertent perioperative hypothermia in adults** London, NICE Available from: <http://www.nice.org.uk/nicemedia/pdf/CG65NICEGuidance.pdf> [Accessed February 2012]
- Pinnock C, Lin T, Smith T 2009 **Fundamentals of anaesthesia** London, Greenwich Medical Media
- Reuben AD, Harris AR 2004 Heliox for asthma in the emergency department: a review of the literature **Emergency Medicine Journal** 21 (2)131-35
- Robinson N, Hall G 2007 **How to survive in anaesthesia** Oxford, Blackwell Publishing
- Walters PT 2007 Pulse oximetry knowledge and its effect on clinical practice **British Journal of Nursing** 16 (21) 1332-39
- West JB 2008 **Respiratory physiology: the essentials** Baltimore, Lippincott Williams & Wilkins
- Wright J 2003 Introduction to pulse oximetry **British Journal of Perioperative Nursing** 13 (11) 456-60
- Yentis SM, Hirsch NP, Smith GB 2009 **Anaesthesia and intensive care A-Z** London, Elsevier Ltd
- Yunker J 2008 Care of the intubated patient in the PACU: The 'ABCDE' approach **Journal of Perioperative Practice** 18 (3) 116-20

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