Extubation and emergence

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Abstract

Emergence and extubation are a time of increased risk in all anaesthetics, with more complications occurring then than at induction and intubation. The majority of problems are airway related due to airway obstruction, hypoxia, aspiration, airway trauma or post-obstructive pulmonary oedema. Other problems include a delayed recovery of consciousness, cardiovascular instability and delirium. Prompt identification and treatment of the underlying cause is essential to prevent serious morbidity and mortality. The Difficult Airway Society published extubation guidelines in 2012. These guidelines provide a step-wise approach to extubation in a four-stage approach encompassing planning, preparation, performing and then post-extubation care. The planning phase is aimed at identifying the patients in whom extubation is a higher risk procedure, based on the presence or absence of risk factors and clinical assessment. Preparation includes optimization of the patient and the environment prior to extubation. The performing stage is a guide to maximize the success of the extubation process, while the post-extubation care is aimed at ensuring that safe and appropriate care is ongoing.

Keywords Airway; emergence; endotracheal; extubation; monitoring

Royal College of Anaesthetists CPD Matrix: 1C01, 1C02, 2A01, 3A01

Learning objectives

After reading this article, you should be able to:

- recognize and manage the problems associated with extubation and emergence
- assess a patient's readiness for extubation
- describe a structured approach for safe tracheal extubation
- identify risk factors for failure of extubation

Emergence is defined as the point in the process of recovery from general anaesthesia at which spontaneous respiration, airway reflexes and consciousness are re-established. The majority of significant problems at this time are airway related; in fact, more airway problems occur at emergence and extubation than at induction and intubation. Despite this, emergence and tracheal extubation have traditionally been a relatively neglected topic in airway discussion, teaching and training. To try and overcome this, the Difficult Airway Society (DAS) published guidelines for management of tracheal extubation in 2012.[1] These guidelines highlight the potential problems associated with emergence and extubation and provide a strategic, step-wise approach to extubation.

Problems occurring at emergence

The common problems encountered at emergence are summarized in Box 1.

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Airway obstruction

The most common cause of upper airway obstruction at emergence is laryngospasm. Other less common causes include laryngeal oedema, trauma, haemorrhage and vocal cord paralysis/dysfunction. Laryngospasm is the sustained closure of the vocal cords resulting in partial or complete airway obstruction. The most common trigger is the presence of blood, secretions or surgical debris in the airway, with spasm more likely to occur if the patient is in a light plane of anaesthesia. Treatment involves opening and clearing the oropharynx, applying continuous positive airway pressure (CPAP) with 100% oxygen, followed by deepening of anaesthesia with propofol and/or paralysing with suxamethonium 1 mg kg^{-1} intravenously. If the intravenous route is not available, suxamethonium can be administered via the intramuscular (2–4 mg kg^{-1}), intralingual (2–4 mg kg^{-1}) or intraosseous (1 mg kg^{-1}) routes.

Post-obstructive pulmonary oedema

Post-obstructive pulmonary oedema (POPO) is a complication that occurs secondary to upper airway obstruction at emergence and has an incidence of approximately 1 in 1000 anaesthetics.[2] Often referred to as negative pressure pulmonary oedema, POPO is caused by the huge negative intrathoracic pressures generated by the patient to try and overcome the obstruction. Consequently, fluid is pulled out of the vasculature down the negative gradient created. Symptoms and signs of POPO usually develop immediately after extubation and include respiratory distress, haemoptysis and bilateral radiological changes consistent with pulmonary oedema. The majority of patients improve within 24 hours with supportive treatment (including oxygen therapy and CPAP). For those patients who fail to improve

Problems occurring at emergence

- Airway obstruction
- Post-obstructive pulmonary oedema
- Hypoxia
- Aspiration
- Airway trauma
- Delayed recovery of consciousness
- Delirium
- Cardiovascular disturbance

Box 1

Please cite this article in press as: Foulds L, Dalton A, Extubation and emergence, Anaesthesia and intensive care medicine (2018), https://doi.org/10.1016/j.mpaic.2018.06.001

quickly, consideration should be given to early re-intubation and positive pressure ventilation. If the cause is due to biting on the tracheal tube, deflating the cuff can help relieve the obstruction. Traditional measures used to treat pulmonary oedema such as diuretics, nitrates and opiates, have no place due to the different pathophysiological processes involved.

Hypoxia

The causes of early postoperative hypoxia are multiple and include airway obstruction, hypoventilation, ventilation/perfusion mismatch, diffusion hypoxia, shivering and a decrease in cardiac output. If not treated promptly, hypoxia may progress to brain damage, cardiovascular dysfunction and ultimately death. The key to management is rapid, effective administration of oxygen combined with methodical assessment of the patient to determine the underlying cause. Pre-oxygenation should be considered a vital step at emergence, as it is at induction, to maximize pulmonary oxygen stores. Furthermore, administration of oxygen therapy should be the default in all patients during transfer and in the recovery room as this has been shown to decrease the incidence of early postoperative hypoxia.

Aspiration

Aspiration can be defined as the inhalation of material (e.g. gastric content, blood) into the airway below the level of the true vocal cords. Over one-third of aspirations occur at extubation.[3] The clinical consequences of pulmonary aspiration range from no sequelae to severe pneumonitis and acute respiratory distress syndrome (ARDS). Aspiration was the single biggest cause of death as a result of airway complications in the RCOA 4th National Audit Project (NAP4).[3]

The anaesthetic technique should be modified accordingly in patients with risk factors for aspiration, both at induction and emergence. If aspiration is suspected, position the patient in the head-down position to limit pulmonary contamination and suction any contaminants from the oropharynx. This should be followed by administration of 100% oxygen, rapid sequence induction, tracheal intubation and ideally tracheal suction before commencement of positive pressure ventilation. The most effective measures to protect against aspiration at emergence include reducing the volume of gastric contents by suctioning through a gastric tube and ensuring the patient is awake with adequate return of airway reflexes prior to extubation. Routine antibiotics are not indicated following aspiration. However, if the patient develops clinical signs of infection then they should be prescribed.

Airway trauma

Airway trauma encompasses a wide range of airway threatening issues that can be caused by surgical or anaesthetic interventions. Any surgery around the airway can cause trauma and therefore problems following extubation, with bleeding, haematoma formation and oedema the most common causes of airway compromise. Less common issues include vocal cord paralysis (after vagal or recurrent laryngeal nerve damage) and tracheomalacia. Anaesthetic causes of airway trauma relate to use of airway adjuncts (including supraglottic airways), laryngoscopy, intubation, use of intubation aids such as stylets or bougies, pharyngeal suctioning and nasogastric tube insertion. While minor laryngeal trauma is common and rarely has serious consequences, significant damage can occur. The American Society of Anesthesiologists Closed Claims analysis showed that the vast majority of lower airway and oesphageal injuries were associated with difficult intubation, while laryngeal injury occurred after routine intubation in 80% of the cases reported.[4] Repeated laryngoscopy attempts increases the incidence of trauma and morbidity, therefore multiple laryngoscopy attempts should be avoided. Additionally, procedures such as pharyngeal suctioning and bougie insertion should be carried out under direct vision wherever possible. The use of prophylactic steroids may be beneficial in reducing complications due to oedema. A high index of suspicion is essential and if the airway is likely to be at risk postoperatively then advanced extubation techniques, or a decision not to extubate immediately, should be considered. In the event of airway threatening extratracheal haematoma, prompt removal of the skin clips and neck decompression can be life saving.

Delayed recovery of consciousness

Residual drug effects: problems may arise at emergence and in the early postoperative period due to the residual effects of pharmacological agents. Many drugs used in anaesthesia have effects on conscious level and respiratory drive. The effects of these drugs on the patient and the patient's ability to eliminate them can vary, resulting in a patient whose recovery can be significantly delayed. For example, opioids and benzodiazepines may delay recovery of consciousness after anaesthesia and used together can have a pronounced effect on respiratory depression, producing hypercapnia and coma.

Inadequate reversal of the effects of neuromuscular blocking drugs (NMBD), also known as postoperative residual curarization (PORC), may in severe cases mimic unconsciousness in the conscious patient or cause hypoventilation, hypercapnia and coma. Even minimal residual paralysis causes unpleasant symptoms of diplopia and generalized weakness for the patient and increases the risk of aspiration, upper airway obstruction and hypoxaemia.[5] The 5th National Audit Project concerning Accidental Awareness Under General Anaesthesia (NAP5) recently reported that 18% of cases of awareness occurred during the emergence phase of anaesthesia.[6] Almost all of these cases were as a result of PORC and caused distress to the patients involved. PORC is largely preventable through the use of a nerve stimulator, allowing correctly timed delivery of appropriate reversal agents with maintenance of anaesthesia until a patient is fully reversed. The AAGBI guidelines on standards of monitoring during anaesthesia and recovery recommend that a peripheral nerve stimulator is mandatory for all patients receiving NMBD and ideally a quantitative device should be used to more accurately assess the train of four ratio.[7]

Non-pharmacological causes causes must also be considered in the differential diagnosis and can be classified into metabolic abnormalities, respiratory failure and neurological events. As part of the initial assessment, it is imperative to check the patient's temperature and capillary blood glucose to exclude hypo/hyperglycaemia and hypothermia, as these are easily reversible causes of a depressed conscious level. This should be followed by a full clinical examination, with particular attention to respiratory and neurological systems, appropriate blood tests and

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