Critical incidents: the respiratory system

James Palmer

Abstract

A critical incident is an event that causes harm, or could cause harm if allowed to continue without intervention. The respiratory system and the circulatory system are areas of anatomy and physiology that can lead most rapidly to the greatest harm. Minor critical incidents are common but troublesome, major ones can lead rapidly to hypoxaemia, brain injury and death. The introduction of pulse oximetry and capnography led to a marked fall in the frequency of such incidents in the late 1980s; better training and availability of special equipment have helped to maintain this fall. The sharing of information by reporting systems such as the Australian Incident Monitoring Study (AIMS) has disseminated information about potential problems more widely, and the improved designs of anaesthetic machines and equipment have contributed to a reduction in hazards. Despite these improvements, risks still remain; only intelligent assessment, preparation, and planning as well as continued training for such events can minimize the severity and frequency of their occurrence. High standards of monitoring in the perioperative period, and a willingness to seek help reduce the chance of an adverse event. This article deals with events related to the respiratory system including airway injury, airway obstruction, inadequate ventilation, aspiration, laryngospasm, bronchospasm, pulmonary oedema, and pneumothorax. Difficult intubation is dealt with elsewhere.

Keywords Airway injury; airway obstruction; bronchospasm; critical incident; dental damage; laryngospasm; pneumothorax; pulmonary oedema; respiratory complication

Learning objectives

After reading this article you should be able to:

- classify the main types of critical incidents that affect the airway
- list ways in which the commonest incidents can be avoided
- draw up a plan to minimise risk during anaesthesia.

The respiratory system is as essential to anaesthesia as to the functions of oxygenation and ventilation. The delivery of inhalational anaesthetic agents and the control of ventilation as well as humidification, filtration, and phonation, are all dependent on an intact and functioning respiratory system. Since reliable records have existed the majority of adverse incidents in anaesthesia have been respiratory, reflecting the speed at which life-threatening hypoxaemia can occur. The number of these adverse incidents only decreased in the 1980s; change documented by the American Society of Anesthesiologists (ASA) Closed Claims Analyses in 1990, 1999, and 2006. These useful resources assess the value attributed to each type of injury by the American legal system, but do not illustrate minor incidents which are better looked at in some form of anonymous incident reporting system such as the Australian Incident Monitoring Study (AIMS). The closed claims analyses well demonstrate the dramatic reduction in costs from severe injury and death that followed the initial voluntary use, and subsequent enforcement by minimum monitoring standards, of pulse oximetry and capnography. However, the majority of critical incidents go unreported either because they are addressed appropriately (e.g. laryngospasm), or because they are deemed 'expected' (e.g. sore throat). As a consequence, they may never be recorded at all, leading to a tendency to accept them as unavoidable, an unacceptable situation in this author's view. Critical incident reporting must be open, anonymous, straightforward, and universal; only in an open and blame-free culture can we hope to address the minor but still important event as much as we do the severe and life-threatening.

One could choose to classify critical incidents in a number of ways; anatomically, mechanistically, functionally (relating to each function of the system in turn), or by frequency. The anatomical classification is simple and memorable and for that reason is used here. For the purposes of this article the respiratory system is considered to extend from the patient through the breathing circuit to the gas supply; however, despite the high numbers of critical incidents related to difficult intubation and oesophageal intubation (36% of all ASA closed claims events leading to death or brain injury) and their consequent high litigation costs, these topics are dealt with elsewhere and will not be covered here.

Oro-dental damage

This occurs more commonly than is realized and ranges from minor abrasions to lips, gums or tongue (10–20% of all anaesthetics), to chipping or dislodgement of teeth and dental prostheses (about 1 in 1000 anaesthetics). Care when performing laryngoscopy and suction, and the use of a roll of swabs as a molar 'bite block' can help reduce injuries inflicted by bruxism during emergence. The Guedel airway prevents biting on an indwelling airway, but is a common cause of injury to the incisor teeth.

Nasal and nasopharyngeal injury

Epistaxis is not uncommon during passage of tracheal or nasogastric tubes and can have deleterious effects on view at laryngoscopy as well as being unpleasant for the patient. Nasal polyps and adenoidal tissue can be dislodged by tracheal tube passage and the turbinates can also suffer injury in the same way. Preparing the nose with vasoconstrictors such as cocaine, xylometazoline or phenylephrine/lidocaine topical solutions, softening the tube by placing it in warm water well before use, and selecting small tube

James Palmer *FRCA is a Consultant Anaesthetist at the Salford Royal NHS Foundation Trust, Manchester, UK. Special interests are the difficult airway, neuroanaesthesia, and day case anaesthesia. Conflicts of interest: none declared.*

sizes will all reduce these complications which made up 5% of all claims in the 1999 ASA closed claims study.

Larynx and pharynx

The most common injury in this area is 'sore throat' (20–30% of all anaesthetics). This is a very loose definition ranging from trivial discomfort in the immediate postoperative period, to hoarseness and pain persisting (and even extending to dysphagia) for weeks. Although local anaesthetic gel on airway devices does not appear to help, using smaller tracheal tubes, gentle laryngoscopy, careful inflation and monitoring of tube cuff pressure (using a proprietary gauge), and the correct positioning and inflation of laryngeal masks and other supraglottic airways all reduce the frequency of this complication. Tracheal tube cuffs of a high volume low-pressure variety are preferred, and pressures within the cuff held below 30 cm H_2O. The corresponding figure for laryngeal mask cuffs is 50 cm H_2O. In the situation where the patient has no operative pain sore throat can be a significant cause for complaint, and, in those who use their voice professionally, litigation. The more serious end of the spectrum is vocal cord or arytenoid dislocation caused during intubation, superior laryngeal nerve injury from over inflation of a laryngeal mask, and perforation of the pharynx (especially easy in the presence of a pouch) potentially leading to fatal mediastinitis. Repeated blind suctioning of the pharynx in an inappropriate manner with rigid suckers (Yankauer) is particularly likely to result in pharyngeal or uvular injury. Laryngeal injuries made up 30% of all airway claims in the ASA closed claims study, the pharynx and oesophagus nearly 40%, the nose, trachea and temporomandibular joint the remaining 30%. Airway obstruction at the cricoid ring can occur if cricoid pressure is applied too firmly, and compression of the thyroid cartilage or trachea occurs if the same manoeuvre is applied in the wrong place. Either of these can lead to failure to ventilate the lungs or to intubate the trachea. Late onset airway obstruction from oedema can occur if bleeding has occurred into the soft tissues of the neck after, for example, central venous cannulation, neck dissection, or trauma.

Laryngospasm

In terms of frequency this is relatively rare (9 per 1000 in adults, 28 per 1000 in children[1]), but alarming when it occurs and requires prompt recognition and treatment to avoid severe hypoxia or negative pressure pulmonary oedema. Laryngospasm is prolonged glottic closure (mediated by the superior laryngeal nerve) provoked by light anaesthesia at induction or emergence sometimes in conjunction with silent reflux, mucus on the larynx, blood, laryngeal instrumentation, surgical stimulus (especially anal or cervical dilatation), movement of the head in an intubated patient, or a combination of several factors.

It is more common in those with ongoing or recent respiratory infections, smokers, and those with reflux, and it tends to be seen more with irritant volatile anaesthetic agents such as isoflurane and desflurane. Obese patients are more likely to obstruct their airway and have reflux so are at increased risk.

Management is based on the use of 100% oxygen applied with a close fitting facemask and continuous positive airway pressure (CPAP) during ongoing emergence or deepening of anaesthesia, but may require administration of doses of propofol, intravenous lidocaine, small doses of succinylcholine, doxapram, reinduction, reintubation, and even bilateral superior laryngeal nerve block. Painful pressure on the so-called 'laryngospasm point' just below the external auditory meatus produces improvement possibly by accelerating emergence, but is postulated to operate through links between parotid sensory innervation and the superior laryngeal nerve. Should hypoxaemia supervene and the patient is near arrest, then the widely held belief is that the laryngospasm will stop before hypoxic damage occurs. In this situation, or if there is any doubt about the diagnosis, it may be safer to perform cricothyrotomy to allow oxygenation. In this circumstance it is essential that a large cannula be used and expiratory times are as long as possible to minimize the potential for barotrauma, pneumothorax, or surgical emphysema.

Blood clots (the so-called 'coroner's clot'), throat packs, unforeseen airway masses, vocal cord haematoma or palsies, and laryngeal or pharyngeal oedema can all mimic laryngospasm.

Trachea

Tracheal injury (including perforation) is caused by many of the same factors as affect the laryngopharynx, and is minimized by the use of smaller tubes and the same avoidance of unnecessary force and speed. Tracheal intubation, even when cuff pressures are carefully monitored, can still lead to early ulceration followed by granulomata or interarytenoid webs after only a few days intubation. Sudden tracheal obstruction can occur if an anterior mediastinal mass compresses the trachea following induction leading to hypoventilation and hypoxaemia. Prompt proning of these patients can open the airway, but is unlikely to be considered if the diagnosis is not made.

Airway fires are dealt with in another article but are a potentially fatal hazard of laser surgery.

Bronchial tree

Bronchospasm and mucus plugging are the most frequently occurring events, but foreign bodies may be aspirated from the breathing system, and injury may occur from clumsy placement of double lumen tubes or bronchial blockers. Bronchospasm may occur due to instrumentation of the airway at light planes of anaesthesia, is more common in asthmatics and smokers, but can be an early sign of anaphylaxis. 'Pseudo-spasm' can occur when accidental endobronchial intubation occurs or when the bevel of a tracheal tube abuts the tracheal wall. Increased care in tracheal tube placement and fixation (especially when repositioning the patient) and the use of tracheal tubes with a Murphy 'eye' minimize this possibility. Those patients at risk of mucus plugging require physiotherapy, nebulized saline and bronchodilators prior to surgery and the use of humidified gases and oxygen during and after the procedure. Should plugging occur, directed suction using a bronchoscope may be used to remove it, but 'bagging' and non-directed suction with, or without, saline lavage is often adequate. Smaller calibre tubes are more likely to block and if mucus plugging is likely then choosing a larger tube may be wise despite their own inherent risks. Treatments for bronchospasm include deepening anaesthesia, bronchodilators (administered via a tracheal tube or intravenously), and the use of halothane, sevoflurane, ketamine, or magnesium.