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The 4th National Audit Project of the Royal College of Anaesthetists and Difficult Airway Society



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It is increasingly recognised that major airway events, including those with poor outcome, may occur on Intensive Care Units (ICUs). NAP4 (the 4th National audit project of the Royal College of Anaesthetists and Difficult Airway Society) examined major complications of airway management in NHS hospitals in the UK for a period of one year, during anaesthesia, in ICU or in the Emergency Department (ED). Events were defined as 'A complication of airway management that led to death, brain damage, the need for an emergency surgical airway (needle, cannula, open cricothyroidotomy or tracheostomy), unanticipated ICU admission or prolongation of ICU admission'.

A registry of these major airway management complications was established. Appropriate ethical and regulatory clearance was achieved. The process of notification, submission and case review were carefully controlled to ensure high quality data acquisition, data management and maintenance of patient, clinician and institutional confidentiality.

An expert review panel examined each submitted clinical report. The panel incorporated representatives from all specialties involved in the project. Case review was a structured process. Contributory or causative factors were identified. The degree of harm caused was formally graded. Airway management was classified as good, poor or mixed.

Details are reported in the original papers (Cook et al. 2011a, b) and in a full report (Cook et al. 2011c), which includes several chapters dedicated to ICU and complications of tracheostomy. This article a portion of data from ICU.

NAP4 and ICU

Overall there were 184 cases – 133 from anaesthesia, and 15 from the ED. There were 36 reported events from ICU (20% of all reports to NAP4): 18 resulted in death and four in persistent neurological injury (combined rate 61%). Fourteen percent of anaesthesia cases and 33% in the ED led to death or brain damage.

Seventeen ICU Events (47%) Occurred in Obese Patients.

There were four cases of unrecognised oesophageal intubation, resulting in three deaths. Capnography was not used.

Ten events involved failed intubation (including re-intubation after inadvertent ex-tubation), resulting in five deaths. Of these ten patients only six patients had a Supraglottic Airway device (SAD) used in an attempt to rescue the airway. Five events deteriorated to CICV.

Eighteen cases involved accidental airway displacement: 14 of a tracheostomy (seven deaths and four patients with brain damage) and four of a tracheal tube (no deaths). Capnography was not in use in 13 of these cases and in five, its use was unclear. Obesity was prominent in both groups but particularly with tracheostomy cases. Airway rescue with a SAD was attempted in only four of these patients.

There were 12 attempts at placement of an emergency surgical airway (33% of all ICU cases) of which three completely failed (25%): Four died

and one suffered brain damage as a result of the event. Three were in obese patients. Five cannula cricothyroidotomies were attempted, three failed. Seven tracheostomies were performed (two after cricothyroidotomy) and in at least six the airway was rescued.

Two cases described failed placement during planned tracheostomy: One surgical and one percutaneous.

The most frequent causal and contributory factors, were patient-related (e.g. obesity, recognised difficult airway) (69% of cases), followed by education and training (58%), judgement (50%), equipment and resource (36%) and communication (31%). Positive factors were identified in 54%.

Case Review

Nearly half of reported events (46%) occurred outside 'office hours' when the first medical attendant was a trainee who would not necessarily have advanced airway skills: 31% of anaesthesia events occurred 'out of hours'.

Unrecognised Oesophageal Intubation

There were four cases, of unrecognised oesophageal intubation, leading to two deaths and perhaps contributing to a third. Two intubations were performed by relatively junior trainees and later proved to be straightforward. Both were performed without capnography. In a third case, an unintubated, obese patient suffered a cardiac arrest in the CT scanner.

Laryngoscopy was difficult and intubation required two attempts and the use of a bougie. Tracheal tube position was checked by observation and auscultation, but capnography was not used.

Resuscitation was unsuccessful. After death, fiberoptic bronchoscopy identified the tracheal tube in the oesophagus.

Failed Intubation

There were ten cases of failed intubation or re-intubation after accidental extubation. Several patients with anticipated difficult airways, had intubation delayed until the patient was in extremis, exacerbating an already difficult problem. In others potential difficulty was not recognised. When difficulty was recognised failure to establish a back-up plan in patients at risk of difficult intubation was observed. Finally, some plans were established but equipment or skilled staff were not available to carry the plan out when difficulty arose.

Rescue techniques failed frequently. Although most difficult airway algorithms include cannula cricothyroidotomy as part of the management of the 'can't intubate, can't ventilate' (CICV) scenario, in this group of patients, the failure rate was high.

Accidental Extubation

Inadvertent displacement of a tracheostomy occurred in 14 patients (leading to half of all cases of death and brain damage on ICU) and of a tracheal tube in four (no deaths). Displacement occurred most frequently on movement or during routine care. Capnography was rarely used. The method of fixation of tracheostomies was not consistent. Often, patients whose tracheostomies became displaced were obese, implying that tracheostomy tubes are not always long enough or of appropriate design for such patient's anatomy. Standard tracheal tube displacement occurred in several patients when they and either coughed or attempted self-extubation when waking during a sedation hold. There was a lack of a systematic approach to management of these events: Extubation plans and training were judged lacking. In several cases recognition of extubation was markedly delayed, even until cardiac arrest.

Tracheostomies and tracheal tubes become dislodged at all times of day or night and attending staff did not always have the knowledge to deal with the problem in a measured way. Attendance by only junior trainees was common in out-of-hours cases. Routine rescue techniques (e.g. placement of a SAD) were not always used during management of the airway event. Staff reporting these incidents did not always know what airway equipment or manoeuvres were (e.g. BURP, Combitube), suggesting a deficiency of training in advanced airway skills.

Problems During Transfer

Three patients suffered adverse events directly related to transfer to or from the ICU: All died or sustained brain damage.

Discussion

Methodological considerations (Cook et al. 2011a) suggest that up to 75% of relevant anaesthesia events may not have been reported to the project: As ICU had considerably less local reporters it is possible that even more events may have been missed. Despite this, reports from ICU

account for a disproportionate number of adverse airway incidents, with ICU the source of one fifth of all events and more than half of all cases of death or brain damage. Events on ICU were more likely than those in anaesthesia to lead to permanent harm, including death.

During anaesthesia there were 19 reports of airway complications leading to death or brain damage from 2.9 million anaesthetics. In ICU using NHS Hospital Episode Statistics (HES) data we estimate 48,000 patients received advanced respiratory support and there were 22 reports of death or brain damage. This represents a 60- to 70- fold higher incidence of such events in ICU compared to anaesthesia. Even though there is possible error in this calculation it reinforces the message that airway complications occurring on ICU are an important problem.

The cases raise concerns that junior staff (particularly trainees without anaesthetic backgrounds) without the experience or skills to deal with airway complications, are resident as the only medical staff on ICUs out-of-hours.

Reporters noted a lack of equipment on several occasions. Reviewers noted that the breadth of equipment used to manage airway compromise was considerably narrower than in theatres. Rescue techniques were not always used when indicated and when used, failed more often in ICU than anaesthesia; these factors may be related.

A major concern was lack of anticipation and planning for difficult cases. Planning has several phases:

- Recognition of potential difficulty;
- Formation of a strategy (plan A, B, C, etc.);
- Confirmation that the equipment to perform these plans is immediately available;
- Confirmation that appropriately skilled and experienced staff are immediately available; and
- Communication of these plans at staff handovers.

Finally, and perhaps most importantly, although continuous capnography is a standard of care in the operating theatre (AAGBI 2007) it has not been widely adopted in ICU. Failure to use capnography likely contributed to 17 cases of death or brain damage, as a result of failure or delay in recognising displaced or misplaced airway devices. This included three oesophageal intubations and 14 tube displacements, accounting for 77% of ICU deaths. Use of capnography would likely have prevented or reduced the extent of patient harm in these cases.

Recommendations

• Capnography

Capnography should be used for all intubations and for all patients with tracheostomies or tracheal tubes who are being mechanically ventilated in ICU. Staff should be appropriately trained in its use and interpretation, especially identification of airway obstruction or displacement.

• Airway Equipment

Difficult airway trolleys including a flexible fibroscope must be available in all ICUs and their contents should be familiar to staff.

• Intubation Planning

An intubation checklist (equipment, drugs, personnel, preparation, etc.) should be available and should include strategies for dealing with difficult intubation and the 'can't intubate, can't ventilate' situation.

• Back-up plans

Algorithms must be available for the management of accidental tracheostomy and tracheal tube displacement. These should identify the necessary equipment and skills for carrying out the plan.

• Cricothyroidotomy

Training in needle cricothyroidotomy and emergency tracheostomy is required for intensivists.

• Staffing

Trainee medical staff should be proficient in simple emergency airway management. Appropriate senior staff with advanced airway skills also need to be available at all times.

• Patient Movement and Transfer

Moving patients within the ICU or for transfer may cause airway complications. Staff should be trained to prevent, recognise and manage such complications.

• Education/Training

Intensive care trainees need airway training, including basic airway management and knowledge of appropriate algorithms. All intensive care unit staff should be familiar with interpretation of capnography waveforms. Airway complications should be audited and discussed at morbidity and mortality meetings with learning points implemented.

- **Tracheostomy Tube Design**

There is a need to consider re-design of tracheostomy tubes for obese patients to reduce the risk of displacement complications. Senior organisations and manufacturers should address this need.

- **Teamwork**

Working together as a team and involvement of senior staff are vital in the successful management of airway problems in the ICU. Communication between teams is, and will remain, a vital part of safety.

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