AIRWAY MANAGEMENT OUTSIDE THE OPERATING THEATRE

E. Hodgson

This review is intended to assist anesthesiologists in assessment and intubation of patients in venues other than the operating room (OR). Rapid assessment to identify patients at risk of failed intubation and oxygenation is essential to avoid a potentially disastrous emergency “Can’t Intubate, Can’t Ventilate” scenario. The equipment and drugs required for intubation may need to be taken to the venue where intubation is required as they may not be as freely available as in the OR. Extubation of the previously difficult airway needs to take place in a similar venue and with similar drugs and equipment available as when intubation was performed.

Introduction

Anesthesiologists are considered the airway management experts of the medical profession. In addition to airway management during general anaesthesia, anesthesiologists are regularly called upon to intubate patients in areas outside the operating theatre, including the intensive care unit (ICU), emergency room and hospital wards. The situation in these areas may be less well controlled than in the operating room (OR). Assessment and decisions have to be made rapidly.

Classification

Intubation may be required for the following groups of patients (1):

1. Moribund patients who are deeply obtunded - require rapid intubation with minimal assessment and no requirement for sedation or muscle relaxation.
2. Semi-elective intubation - These patients often have neuromuscular or CNS pathology which is slowly deteriorating but have no cardiorespiratory compromise. A full airway assessment and routine intubation, similar to that performed in the OT may be carried out.
3. Emergency intubation - These patients may have a variety of pathologies including:
   a. Airway obstruction from tumor, trauma or infection.
   b. Primary pulmonary pathology including pneumonia, acute respiratory distress syndrome (ARDS) and lung contusion.
   c. Multiple organ failure including cardiac or renal failure with pulmonary edema and cardio-respiratory failure secondary to ARDS or systemic inflammatory response syndrome (SIRS).
   d. Severe CNS pathology including head injury, subarachnoid haemorrhage and stroke leading to progressive central hypoventilation and failure of airway protection.
4. Reintubation due to unplanned extubation or tube failure.

Airway Assessment

An airway that is obstructed by tumour, infection or trauma may be obvious and require immediate surgical intervention. Assessment of the intact airway has been formalised by the ASA difficult airway algorithm, which was last revised in 2003 (2). The basis of the assessment is evaluation of factors that may hinder the displacement of the soft tissues of the mouth and neck and thus obscure the laryngoscopic view of the airway. The full assessment requires evaluation of 11 features but should take less than 2 minutes with regular practice.
1. **Teeth**
   a. Large/missing upper incisors - Will obscure the view at laryngoscopy with missing teeth causing the laryngoscope to slip into the resulting gap.
   b. Anterior protrusion of the upper incisors ("Buck teeth") - Will further obscure laryngoscopic view.
   c. Voluntary protrusion of the mandible anterior to the maxilla “Upper lip bite test” (S) - Inability indicates the presence of temporomandibular joint dysfunction.

2. **Mouth**
   a. Mouth opening–The inter-incisor gap needs to be >3cm to allow insertion of a laryngoscope.
   b. Mallampati score (S) - This 4 point score grades the size of the tongue in relation to the pharynx.
   c. High arched palate - Indicates limited space for laryngoscope insertion.

3. **Jaw**
   a. Thyromental distance (S) - Should be at least 5cm. Mandibular hypoplasia limits space for tongue displacement.
   b. Mandibular compliance–The soft mylohyoid muscle may be hardened by infection, malignancy or previous radiotherapy so that it cannot be displaced by compression.

4. **Neck**
   a. Short, thick neck - Both factors limit neck mobility and thus the ability to assume the optimal "sniff" position of neck flexion and atlanto-occipital extension. A neck circumference of >40cm as well as the presence of dorsal neck folds should raise awareness that extension may be limited (S).
   b. Sternomental distance in full extension (S) - This quantifies neck mobility and should be >11cm
   c. Certain conditions are associated with cervical spine instability, most commonly after trauma (S), especially with an associated head injury, but also in rheumatoid arthritis (S) and other disorders associated with ligament laxity and osteoporosis. These patients require manual inline stabilisation with careful intubation to minimise neck movement.

Airway assessment will allow patients to be divided into three groups (S):

1. **Anticipated difficult laryngoscopy**
   - **The 4 Ds**
     - Distortion
     - Dentition
     - Disproportion
     - Dysmobility
   OR
   - LEMON (S)
     - Look externally
     - Evaluate 3 3 2:
       - Inter-incisor gap > 3 fingers
       - Thyromental distance > 3 fingers
       - Thyroid to floor of mouth >2 fingers

Mallampati
Obstruction (snoring / stridor)
Neck Mobility

2. **Anticipated difficult mask ventilation**
   - **BONES**
     - Beard
     - Obesity
     - No Teeth
     - Extremes of age
       (Infant / Elderly)
     - Snores

3. **Anticipated difficult cricothyrotomy**
   - **Fixed flexion deformity of C-spine**
   - Tissue obstruction – obesity, oedema, inflammation

Approach after assessment (S):
1. **Rapid sequence induction WITH muscle relaxation**
   - If no difficulties are anticipated sedation and muscle relaxation may be used in securing the airway.
2. **Sedation only (Quick Look)**
   - With 1-2 difficulties anticipated sedation (inhaled or intravenous) may be used in securing the airway but muscle relaxants should be avoided
3. **Awake intubation / tracheostomy**
   - With all three interventions deemed difficult, the airway should be secured awake if possible.

**Equipment**

After patient evaluation the necessary equipment for intubation should be obtained and checked. This equipment should comprise a self-inflating resuscitation bag capable of delivering 100% oxygen, suction, functioning laryngoscope with a variety of blades, gum-elastic bougies and/or airway
exchange catheters and drugs including adrenaline, atropine and/or glycopyrrolate, sedatives and muscle relaxants.

Each ICU / ED should have a difficult intubation kit with airway devices for an unanticipated difficult laryngoscopy and cricothyrotomy. If such a kit is only available in the OR a separate kit should be available for use outside the OR containing at least three LMAs and a cricothyrotomy kit.

An airway resource cart found in an OR will have a wider variety of equipment that will not be appropriate for storage in other hospital departments. In an urgent, rather than an emergency situation, equipment that could be obtained from the airway resource cart could include a retrograde intubation kit, fibreoptic bronchoscope or percutaneous tracheostomy kit. A comprehensive list of recommended contents has recently been published by the South African Society of Anaesthesiologists (12).

**Patient**

The patient should have adequate IV access established, as hypotension is a common consequence of intubation especially in the hypovolaemic patient. A non-particulate antacid such as sodium citrate should be administered if available and an antiallouge such as glycopyrrolate (0.2-0.4 mg) given intravenously
1. Forward flexion of the neck
2. Extension at the atlanto-occipital joint

Patients who have assumed a position that provides greatest airway patency should be left in this position. Adequate access to the head should be obtained.

**Pre-oxygenation**

The patient should be preoxygenated for at least 3 minutes or 8 vital capacity breaths in 60 seconds. This assures not only denitrogenation of the functional residual capacity but saturation of the blood and tissues of the fast compartment, resulting in prolongation of the time to desaturation (14, 15). This may be vital in critically ill patients who have markedly reduced cardiorespiratory reserves.

**Sedation and paralysis**

Patients with a more than one of the risk factors identified above: difficult laryngoscopy, mask ventilation or cricothyrotomy, should have the airway controlled awake either with a fibreoptic scope, retrograde intubation, blind technique (either orally or nasally), or by tracheostomy, either surgical (open) or dilatational, according to the ASA guidelines (2).

The majority of patients will, however, be most easily intubated using a rapid sequence induction. Etomidate, in a dose of 0.2-0.4 mg/kg, is the induction agent of choice as it causes minimal cardiovascular depression (16). Up to 90% of patients can be intubated using etomidate as a sole agent but the success rate when succinylcholine is added improves to 99% in a pre-hospital setting (17).

Suppression of adrenal function may occur with etomidate (18) but is less dangerous than the immediate cardiovascular depression associated with other agents such as propofol and thiopentone, especially in inexperienced hands (19).

Succinylcholine has the advantage of rapid onset and offset but has a number of disadvantages, the most serious of which include complete apnea which may fail to resolve before fatal desaturation and fatal hyperkalaemia which may arise after prolonged immobility (e.g. reintubation), spinal cord injury or burns (20). Rocuronium is the only non-depolarising relaxant which provides and onset time approaching that of succinylcholine. However, in the doses required (0.6-1 mg/kg), the duration of action exceeds 45 minutes making a “Can't intubate, Can't ventilate” situation invariably fatal (21).

Rapid reversal of the neuromuscular block caused by rocuronium can be achieved by administration of the cyclohexidin, sugammadex, which rapidly inactivates rocuronium by irreversible binding, resulting in complete block resolution within 90sec of administration (22). This may become a very useful drug in the management of emergency intubation after commercial release.

**Cricoid Pressure**

Critically ill patients are likely to be at risk for aspiration. While the role of cricoid pressure in the prevention of aspiration during rapid sequence induction has been questioned (23), it remains the only intervention that may limit this complication. ICU nurses may, however, be less familiar with the application of cricoid pressure than their colleagues in OT and may require coaching prior to the intubation (24).

**Failed intubation**

Persistent attempts at laryngoscopic intubation
should be avoided. Intermittent oxygenation by means of a facemask with continued application of cricoid pressure should be performed before significant desaturation (below 96%) \(^{(25)}\). Visualization of the larynx may be improved by changing the size and type (Macintosh to Miller) of laryngoscope blade and externally manipulating the larynx using the BURP (backward, upward, rightward pressure) manoeuvre \(^{(26)}\). Should intubation unexpectedly prove difficult no more than three attempts should be made before resorting to a failed intubation drill as described in the ASA difficult airway algorithm \(^{(2)}\).

**Confirmation of successful intubation**

The most certain confirmatory test of successful endotracheal intubation is visualization of the tube as it passes through the vocal cords. Clinical signs of tube misting and auscultation may be useful but are not reliable \(^{(27)}\). Visualization may not always be possible and other confirmatory tests have been employed. The most widely used in the OT is capnography as the trachea is the only orifice that produces carbon dioxide. Unfortunately many ICUs do not have capnographs. Colorimetric indicators are available but may be too sensitive and will detect low levels of carbon dioxide in the airway algorithm \(^{(2)}\). Other methods are thus necessary to confirm successful intubation. Visualization of tracheal rings and carina using a fibroptic scope is very reliable but the scope may not be readily available \(^{(27)}\). Both the self-inflating bulb and trans-illumination with a lightwand have been used but neither is superior to auscultation. Auscultation is substantially inferior to capnography \(^{(31)}\). Direct visualization with a laryngoscope or fibroptic scope thus remains the gold standard with capnography showing sustained carbon dioxide production the most useful confirmatory test.

**Extubation**

Removal of the endotracheal tube should take place under the same conditions and with the same care as at intubation \(^{(32)}\). Extubation is NOT a function of recovery room nurses and any complications that arise from extubation in the recovery room are the sole responsibility of the anesthesiologist who conducted the anesthetic \(^{(33)}\). The practice of leaving an intubated patient in the recovery room while starting the next case is fraught with difficulties as it may result in a complicated extubation at the same time as a difficult intubation, with disastrous consequences. In conclusion and in the words of Ron Walls, “A difficult airway is prepared for, a difficult intubation is experienced.”\(^{(34)}\) With meticulous attention to detail, the need to experience a difficult intubation should be minimised, both in and outside the operating theatre.

**References**

15. Benumof JL: Preoxygenation: best method for both