Emergency intubation is typically performed in clinically unstable patients, and in environments that are less well controlled than operating theatres. Emergency nurses often assist emergency intubation processes and care for patients intubated by pre-hospital personnel, so it is vital that they and other emergency department (ED) staff understand the risks associated with misplaced intubation and the recommended techniques for the early detection of this phenomenon. This is particularly true of oesophageal intubation, which can be fatal.

Incidents of undiagnosed pre-hospital oesophageal intubation have been estimated at between 6 and 14 per cent of attempted intubations (Nolan et al 2005). These are not limited to patients attended by paramedics and other pre-hospital practitioners; missed oesophageal intubation can also occur, and prove fatal, in theatre (Daily Mail 2006, Thomas and Cooper 2002).

These incidents occurred despite the attending clinicians’ having reported hearing breath sounds on auscultation. This is not unusual. Caplan et al (1990) note that anaesthetists report the presence of breath sounds in 48 per cent of such cases.

As a result of their findings, the Royal College of Anaesthetists has published formal recommendations on the use of capnography (Association of Anaesthetists of Great Britain and Ireland 2000).

ENDOTRACHEAL TUBE PLACEMENT

The European Resuscitation Guidelines recommend that correct endotracheal (ET) tube placement should be confirmed by clinical assessment, usually chest auscultation, and by secondary devices (Nolan et al 2005) such as oesophageal detection devices (ODDs) or end tidal carbon dioxide (EtC02) detectors.

These devices should be considered part of the primary confirmation of ET tube placement. In neonates, infants and children, EtCO2 detectors are preferred, while use of ODDs is limited to in children who weigh more than 20kg (Nolan et al 2005).

The most commonly used clinical method for confirming correct placement is by observing the presence of chest movement and breath sounds.

Table 1.

<table>
<thead>
<tr>
<th>Signs</th>
<th>Methods</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest movement</td>
<td>Observation and palpation to check whether</td>
<td>Chest wall movement can occur with oesophageal intubation due to gastric</td>
</tr>
<tr>
<td></td>
<td>chest movements are symmetrical. Lack of</td>
<td>distension</td>
</tr>
<tr>
<td></td>
<td>chest movement can be a feature of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>hyperinflated chests, for example in patients</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with asthma</td>
<td></td>
</tr>
<tr>
<td>Breath sounds</td>
<td>Bilateral auscultation to check breath sounds</td>
<td>Breath sounds can be transmitted to the thorax from the oesophagus or</td>
</tr>
<tr>
<td></td>
<td>and detect right main bronchus intubation</td>
<td>stomach</td>
</tr>
<tr>
<td>Epigastric sounds</td>
<td>Listening for sounds associated with</td>
<td>Ventilation before intubation can cause gastric distension</td>
</tr>
<tr>
<td></td>
<td>ventilation transmitted to the epigastrostom</td>
<td></td>
</tr>
<tr>
<td>Water droplets in</td>
<td>Looking for droplets of condensed water</td>
<td>Can be present even in cases of oesophageal intubation</td>
</tr>
<tr>
<td>tube</td>
<td>vapour in the tube</td>
<td></td>
</tr>
<tr>
<td>Gastric contents in</td>
<td>Looking for the presence of gastric contents</td>
<td>Gastric contents can be present in the trachea because of previous</td>
</tr>
<tr>
<td>tube</td>
<td>in the tube</td>
<td>aspiration</td>
</tr>
</tbody>
</table>

Adapted from O’Connor and Swor (1999), and Ramez (2001)
ET tube as it is passed through the vocal cords, followed by chest auscultation. Other methods, described in Table 1, are used less frequently.

CONFIRMING CORRECT TUBE PLACEMENT
Oesophageal detection devices and EtCO₂ detectors, used on their own or in combination, can confirm the correct placement of ET tubes.

Oesophageal detection devices
The ODD was the first product developed for detecting oesophageal intubation and is used before ventilation is started.
There are two types: those with self inflating bulbs (Fig. 1) and those with 50ml syringes (Fig. 2).

End tidal carbon dioxide devices
These measure the concentration of carbon dioxide in the breath at the end of exhalation. They can be used only after ventilation tubes are in position, which greatly increases the risk of gastric inflation.
They can be: capnographs (Fig. 3), which record carbon dioxide concentrations both numerically and as traces over the respiratory cycle; capnometers, which record concentrations only numerically; or colorimetric devices, which show different carbon dioxide concentrations as different colours.
Capnographs and capnometers:
■ Are classified as ‘mainstream’ devices, which are used mainly in critical care, or ‘sidestream’ devices, which are more common in resuscitation environments, depending on how they collect air samples.

In these, both the bulb and syringe are attached to the end of the ET tube and both are designed to create a high pressure suction that will cause the oesophagus, but not the cartilage strengthened trachea, to collapse, thereby identifying oesophageal intubation.
Oesophageal detection devices have been researched widely. Bozeman et al (1996) demonstrate a 100 per cent success rate in using ODDs to confirm ET tube placement during cardiac arrest. They are inexpensive, require no calibration and can be used even in poor lighting.
Oesophageal detection devices are not suitable for use in children weighing less than 20kg however, and can give false negative results in obese or pregnant patients and those with hyperinflated chests, caused by asthma for example (Bozeman et al 1996).
Table 2. A combined approach to ensure correct endotracheal (ET) tube placement

- Confirm ET tube placement with oesophageal detection device (ODD) before ventilating the patient, then attach colorimetric EtC0₂ detector.

- If ODD and EtC0₂ detector indicate successful intubation, continue ventilating the patient. If capnograph available, maintain EtCO₂ detector at between 34-38mmHg. Check both hemi-thoraces to ensure equal bilateral air entry.

- If ODD indicates correct placement but colorimetric EtC0₂ detector indicates possible oesophageal intubation, remove tube immediately.

- If colorimetric EtC0₂ detector indicates correct placement but ODD indicates possible oesophageal intubation, remove tube immediately.

- Listen to both hemi-thoraces for breath sounds.

- If breath sounds are present and ODD indicates correct placement, continue ventilating the patient.
  - Note that colorimetric EtC0₂ detectors can produce ‘false negatives’ in patients with low perfusion, such as those with cardiac arrest.

- If two out of three tests are successful, ET tube placement is correct.

- Remove tube immediately.

- Confirm correct placement only after ventilation has started.

- Ensure ventilation is effective by reducing risk of hyperventilation, which can adversely affect outcomes in patients who have had cardiac arrest (Aufderheide et al. 2004) or head injury (Davis et al. 2004), or hypoventilation (Helm and Fischer 2005).

- Sidestream EtC0₂ detectors are increasingly being incorporated into transport monitors and defibrillators, allowing better management of critically ill or injured patients by giving beat-by-beat monitoring and preventing hyper- or hypoventilation.

- Colorimetric devices:
  - Are ideal for using immediately after emergency intubation because they are small and light, and require no calibration.
  - Should be operated in good light so that colour changes can be noted accurately.
Smaller, paediatric EtCO₂ detectors are available for children weighing less than 15 kg to minimise the effect of the dead space added by the device. There can be problems with EtCO₂ detectors however. Bozeman et al (1996) suggest for example that they have a sensitivity of only 70 per cent for identifying correctly placed ET tubes during cardiac arrest, mainly because of patients’ difficulty in these circumstances to exhale carbon dioxide.

Combined approach

No device or clinical observation can detect misplaced ET tubes with 100 per cent certainty (Nolan et al 2005), particularly during periods of low perfusion such as during cardiac resuscitation. Capnographs and capnometers offer the most effective method of monitoring and detecting misplaced tubes but they are expensive, bulky and, because they require a lot of power, can rapidly deplete batteries. Nevertheless, the use of capnographs and capnometers outside intensive care units is becoming increasingly common, particularly to prevent hypo- or hyperventilation.

A combined approach, based on the findings of traditional observational techniques, ODDs and colorimetric EtCO₂ detectors, offers the safest method of confirming ET tube placement.

Table 2 builds on this combined approach and is sufficiently robust to be applied in any environment where emergency intubation takes place, whether or not capnographs or capnometers are available.

CONCLUSION

Emergency intubation is frequently performed in emergency departments, so practitioners need to be aware of the recommended techniques for confirming correct ET tube placement. Relying solely on chest auscultation for identifying oesophageal intubation should be discouraged, and secondary confirmation devices should be made available for use during emergency intubation.

This process can be facilitated by the availability of lightweight capnographs and capnometers, either incorporated into transport monitoring equipment or defibrillators, or as stand alone, hand held units.

References


Endotracheal intubation

LORNA McINULTY has compiled this self assessment questionnaire (SAQ) to test your knowledge of issues pertaining to endotracheal intubation.

To answer the questions in this SAQ, you will need to refer both to your own practice and to an article by Nick Castle published last month in Emergency Nurse. Once you have answered the questions, you may want to check them by reading the article again.

1. Capnography refers specifically to
   a) Measurement of exhaled carbon dioxide on a digital monitor [ ]
   b) Measurement of both oxygen and carbon dioxide on a digital monitor [ ]
   c) A wave form produced as a patient breathes in and out [ ]
   d) Measurement of carbon dioxide displayed in wave form [ ]

2. Capnography can be used in all but which one of these scenarios:
   a) Emergency intubation [ ]
   b) A mass casualty situation involving inhalation of toxic fumes [ ]
   c) Ventilatory monitoring in theatre [ ]
   d) Routine investigation of patients with asthma or chronic obstructive pulmonary disease [ ]

3. Oesophageal detection devices can be used in children who weigh more than
   a) 10kg [ ]
   b) 20kg [ ]
   c) 30kg [ ]
   d) 50kg [ ]

4. Oesophageal detection devices are most helpful in patients who
   a) Have asthma [ ]
   b) Are obese [ ]
   c) Are children weighing less than 20kg [ ]
   d) Are fasted, healthy patients undergoing general anaesthesia [ ]

5. The abbreviation, EtCO₂, stands for
   a) Endotracheal carbon dioxide [ ]
   b) End tidal carbon dioxide [ ]
   c) Exhaled tidal carbon dioxide [ ]
   d) End testing carbon dioxide [ ]

6. Which statement is true? Capnography differs from pulse oximetry in that it
   a) Measures both oxygen and carbon dioxide [ ]
   b) Shows changes immediately [ ]
   c) Can be used only in patients who are intubated [ ]
   d) Requires an anaesthetist to be present at all times [ ]

7. Carbon dioxide can rise in all but which one of the following situations:
   a) Hyperventilation [ ]
   b) Hypoventilation [ ]
   c) Fever [ ]
   d) Hypercatabolic states [ ]

8. What percentage of pre-hospital patients are estimated to have unrecognised oesophageal intubation?
   a) Between 1 and 2 per cent [ ]
   b) Between 5 and 10 per cent [ ]
   c) Between 6 and 14 per cent [ ]
   d) More than 20 per cent [ ]

9. To confirm endotracheal tube placement, the European Resuscitation Council recommends
   a) Auscultation of chest and epigastrium [ ]
   b) Auscultation combined with pulse oximetry and blood gas analysis [ ]
   c) Auscultation combined with either an oesophageal detection device or end tidal carbon dioxide monitor [ ]
   d) The use of an end tidal carbon dioxide monitor only as the gold standard [ ]

10. Which of these wave forms indicates a normal capnograph?
    a) [ ]
    b) [ ]
    c) [ ]
    d) [ ]

Brain stretcher

This activity took me 3 _ 3 minutes to complete. Now that I have completed it, I think my knowledge of the subject is:
   Excellent [ ]
   Good [ ]
   Satisfactory [ ]
   Unsatisfactory [ ]
   Poor [ ]

As a result of this, I intend to:
   ____________________________
   ____________________________
   ____________________________
   ____________________________

Lorna McInulty is a lecturer in nursing at the University of Salford.

The answers to this SAQ will be published in the next issue of Emergency Nurse and later this month on the Emergency Nurse website, at www.nursing-standard.co.uk/emergencynurse/, where you can also access a copy of the article, Castle N (2007) Endotracheal tubes: early detection of oesophageal intubation. Emergency Nurse. 14, 10, 22-25.