Failed intubation, increasing hypoxaemia and difficult ventilation in the paralysed anaesthetised patient. Rescue techniques for the "can't intubate, can't ventilate" situation

failed intubation and difficult ventilation (other than laryngospasm)

Face mask
Oxygenate and Ventilate patient
Maximum head extension
Maximum jaw thrust
Assistance with mask seal
Oral +/- 6mm nasal airway
Reduce cricoid force - if necessary

1

failed oxygenation with face mask (e.g. SpO_2 <90% with FO_2 1.0)

Call for help

2

LMA™ Oxygenate and ventilate patient
Maximum 2 attempts at insertion
Reduce any cricoid force during insertion

succeed

3

Oxygenation satisfactory and stable. Maintain oxygenation and awaken patient

"can't intubate, can't ventilate" situation with increasing hypoxaemia

Plan D: Rescue techniques for "can't intubate, can't ventilate" situation

or

4

Cannula cricothyroidotomy

Equipment: kink-resistant cannula, e.g. Patil (Cook) or Ravussin (VBM)
High pressure ventilation system, e.g. Manujet III (VBM)

Technique

1. Insert cannula through cricothyroid membrane
2. Maintain position of cannula - assistant's hand
3. Confirm tracheal position by air aspiration - 20ml syringe
4. Attach ventilation system to cannula
5. Commence cautious ventilation
6. Confirm ventilation of lungs and exhalation through upper airway
7. If ventilation fails, or surgical emphysema or any other complication develops - convert immediately to surgical cricothyroidotomy

fail

Surgical cricothyroidotomy

Equipment: Scapel - short and rounded (no. 20 or Minitech scalpel)
Small (e.g. 6 or 7mm) cuffed tracheal or tracheostomy tube

4-step technique:

1. Identify cricothyroid membrane
2. Stab incision through skin and membrane
   Enlarge incision with blunt dissection (e.g. scalpel handle, forceps or dilator)
3. Caudal traction on cricoid cartilage with tracheal hook
4. Insert tube and inflate cuff

Ventilate with low pressure source
Verify tube position and pulmonary ventilation

Notes:
1. These techniques can have serious complications - use only in life-threatening situations
2. Convert to definitive airway as soon as possible
3. Post-operative management - see other difficult airway guidelines and flow-charts
4. 4mm cannula with low-pressure ventilation may be successful in patient breathing spontaneously

5

Difficult Airway Society Guidelines Flowchart 2004 (use with DAS guidelines paper)

Figure 1. *Reproduced by kind permission of the Difficult Airway Society (UK) and available for download at*: www.das.uk.com/files/cvci-Jul04-A4.pdf

Update in
Anaesthesia

Management of the 'can't intubate, can't ventilate' situation

Leonard Pott
Correspondence Email: lpott@psu.edu

Summary

Choose a plan in advance, and practice it thoroughly.

Ensure that everyone is familiar with the plan.

Do not repeatedly try to intubate - allow three good attempts and try an alternative method.

Start cricothyroidotomy BEFORE the patient has hypoxic damage.

If the facilities are not available for a cannula cricothyroidotomy (high-pressure oxygen, kink-resistant cannulas), use the surgical approach.

INTRODUCTION

Even when a patient proves to be unexpectedly difficult to intubate, it is usually not a problem to adequately oxygenate and ventilate the patient using bag-mask ventilation (BMV). Occasionally, and fortunately very rarely, we encounter a patient who is impossible to intubate AND who also cannot be adequately oxygenated. This is the feared 'can't intubate, can't ventilate' situation. The incidence of 'can't intubate, can't ventilate' in patients who are not expected to be difficult intubations is probably around 1 in 10 000 anesthetics. This condition obviously has life-threatening implications and must be resolved within minutes, if not seconds, to avoid hypoxic brain damage or death. The Difficult Airway Society (DAS) has produced a management algorithm, shown in Figure 1.[1]

COMMENTARY ON ALGORITHM

Although the algorithm is intended to be self-explanatory, there are some important points to bear in mind.

BOX 1 – *'failed intubation and difficult ventilation'*

1. Do not persist with intubation attempts. Repeated attempts at intubation will result in bleeding and swelling of the airway structures, which has been shown to increase the risk of complications, even if the patient is eventually intubated. In addition, time is passing which means that the patient will become progressively more hypoxic. Far better to limit intubation attempts to three good attempts, at least one of which should be by the most competent person in the room, and then go onto the next step. Remember, "If at first intubation attempt you do not succeed, repetitive attempts may make the airway bleed."[2]

2. Jaw thrust is very important because it helps lift the base of the tongue from the pharyngeal wall, which is a common site of upper airway obstruction. An oropharyngeal airway will help to achieve this.

3. Likewise, inserting a short nasal cannula (nasopharyngeal airway) bypasses obstruction at the level of the soft palate. This cannula should be long enough to pass beyond the uvula but not long enough to simulate the glottis or even worse, enter the esophagus. The cannula should be passed through the nose and parallel to the hard palate (not directed upwards). The cannula should have a diameter sufficient to provide unrestricted gas flow.

4. Using two hands to hold the mask and an assistant to squeeze the bag may make a significant difference. By using two hands the seal can be optimized and the mandible can be pulled in an anterior direction. This technique is particularly useful in patients with a beard.

5. Cricoid pressure, if not correctly applied, can distort the larynx and make intubation impossible. Release the cricoid pressure on the second intubation attempt. If the intubation proves impossible, reapply cricoid pressure and start bag-mask-ventilation, but if this is also difficult then release the cricoid pressure and check whether there is an improvement.

6. CALL FOR HELP. This is very important! In an emergency situation such as this, you will almost certainly need a second pair of hands to help fetch equipment, or to hold something while you are performing another task. Do not attempt to resolve every problem unaided. In addition, another person will review the situation and may easily spot something that you have overlooked.

Leonard M Pott
Associate Professor of Anesthesiology and Emergency Medicine
Director of Advanced Airway Management
Penn State Hershey Medical Center
Hershey PA
USA

BOX 2 – *'failed oxygenation with face mask'*

1. Attempt the insertion of the laryngeal mask airway (LMA) early. Do not wait until the patient is severely hypoxic and has a significant amount of airway trauma.

2. Always make sure that you have an appropriately sized LMA available before starting any anesthetic induction. You cannot always predict when you will run into difficulties and the equipment for your alternative management strategy should be immediately available.

3. As far as local practice allows, you should ideally be completely comfortable using an LMA. Use an LMA on many of your routine cases who do not necessarily require an endotracheal tube in order to become completely familiar with the intubation technique. The 'can't intubate, can't ventilate' situation is not the time to learn how to insert an LMA!

BOX 3 – *'successful oxygenation'*

1. It is probably best to wake your patient and postpone surgery, because the patient has had a period of desaturation and there is likely to be some degree of airway trauma.

2. Occasionally it will be necessary to proceed with surgery. In this case you need to decide:

   a. Does this patient require general anesthesia or can we awaken the patient and use a regional technique?

   b. Does this patient really need an endotracheal tube for safe anaesthesia? You must consider the risk of aspiration, for example in a woman due to undergo caesarian section.

If you do decide that you must proceed, and that the patient needs an endotracheal tube, then you may consider swapping the LMA for an intubating LMA (Figure 2). Again, you should be familiar with the technique before you even consider it. In some circumstances, for example life-threatening peripartum haemorrhage, analysis of the risks and benefits may lead you to proceed with an LMA.

BOX 4 – *'cannula or surgical cricothyroidotomy'*

Cricothyroidotomy (access to the airway through the cricothyroid membrane) provides access to the trachea BELOW the vocal cords, and is indicated for a supra-glottic obstruction. It is no use for tracheal or bronchial obstruction by foreign bodies or malignant tumours below the upper trachea.

The choice between a cannula cricothyroidotomy and a surgical cricothyroidotomy is very significant for logistic planning and training, and is also rather controversial. This procedure is potentially life-saving and so a more detailed discussion of the alternative techniques is warranted. There are advantages and disadvantages associated with both alternatives, however equipment issues and the unavailability of high-flow or pressurized oxygen make surgical cricothyroidotomy the preferred option in poorly resourced settings.

Figure 2. *The intubating laryngeal mask airway*

Cannula cricothyroidotomy

Advantages

1. This technique is considered less invasive and may be associated with less bleeding.

2. Some cannula techniques are performed with a Seldinger technique, with which anesthesia personnel are very comfortable.

Disadvantages

1. Cannula cricothyroidotomy is a temporary measure that allows oxygenation of the patient, but is inadequate for ventilation and carbon dioxide removal. A tube of 4mm internal diameter or greater is necessary to achieve ventilation. The cannula should be replaced by a definite airway, when the appropriate staff and equipment are avialble - ideally this should be within 10 to 15 minutes.

2. The use of a cannula for the cricothyroidotomy requires specialized equipment which may not be readily available at all locations. It is important that the cannula be kink-resistant, and various cannula are available. Examples are the Ravassin, Patil, Quicktrach and others.

3. Because of the cost of the equipment, the expense of providing stock for multiple locations and sufficient stock for training may prove to be inhibitory.

4. An ordinary intravenous catheter has been used successfully, but must be of a large size (14G) and can very easily kink. It is not recommended except in the most severe emergencies.

5. Because the time for inspiration is limited, adequate tidal volumes can only be achieved with oxygen flow rates of around 20 litres per minute. This may be impossible to achieve where in settings where oxygen is provided by oxygen concentrators. A cannula requires a high-pressure source of oxygen in order to provide adequate flow-rates.

6. High-pressure oxygen, typically 50psi (3 to 4 atmospheres), is potentially dangerous because it can result in barotrauma to the lung, pneumothorax, or subcutaneous emphysema. These conditions can rapidly cause death.

7. To minimize some of the risks of high-pressure oxygen, some form of injector which can limit the pressure, is used (Figure 3).

Figure 3. *A Manujet (VBM Medizintechnik GmbH, Sulz, Germany) high-pressure oxygen injector*

8. This specialized equipment must also be readily available at all locations where a 'can't intubate, can't ventilate' situation may arise. A high-pressure oxygen outlet must also be available, and the two systems must be able to be connected to each other. Staff must be able to prepare the equipment within a few minutes and many studies have shown that this cannot be easily achieved.

9. If a specialized injector is not available, wall oxygen can be used via a flowmeter, using a circuit made from readily available components (Figure 4). A three-way tap is essential to decompress the system and control inflation. By using your finger to occlude the tap opening, the oxygen is directed through the cannula. When the tap opening is not occluded, the oxygen takes the low resistance path and is vented to the environment. Use tubing which does not offer significant resistance, and ensure that all connections fit. This equipment should be pre-assembled and immediately available.

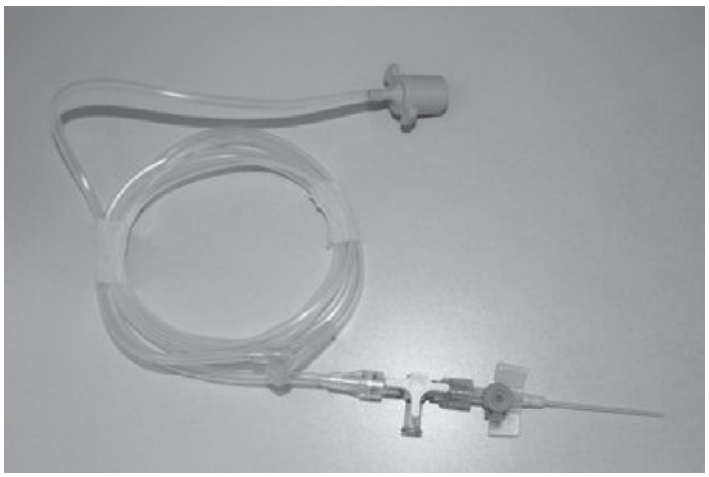

Figure 4. *A. example of an injector constructed using the 15mm connector from a size 5.0 endotracheal tube, an intravenous giving set with the drip chamber cut off, a three-way Luer tap and a large bore (14G) cannula. Note the position of the three-way tap*

10. Adequacy of ventilation is monitored by watching the chest rise and fall, and by the pulse oximetry response. Minute ventilation may be insufficient to avoid hypercapnoea.

11. The oxygen introduced into the patient's lungs must also be exhaled. This cannot be done through the cannula and the intra-thoracic pressure must therefore be released through the mouth. Jaw thrust, or insertion of an oropharyngeal or laryngeal mask airway may be necessary to facilitate expiration. In some cases of 'can't intubate, can't ventilate' the supra-glottic obstruction is complete and then the expired gas cannot be release creating a situation of high intrathoracic pressure and profound haemodynamic compromise.

12. No suction capacity is available.

13. No cuff is available to seal and protect the lower airway from contamination.

Surgical cricothyroidotomy

Advantages

1. Equipment is easily available; a scalpel and a small endotracheal tube are essential. Depending on the technique used, a tracheal dilator, a tracheal hook, and a gum elastic (Eschman) bougie are desirable.

2. Surgeons are usually comfortable with the procedure.

3. Both inspiration and expiration are possible through the endotracheal tube.

Disadvantages

1. Severe bleeding may result from cutting large veins or the thyroid gland.

BOX 5 – *'notes on cricothyroidotomy'*

These techniques are associated with significant complications, and are best avoided by adequate planning and preparation. Complications include severe bleeding, failure to oxygenate, tracheal stenosis, vocal cord damage. If however, the patient is becoming hypoxic and adequate ventilation is not possible, then the diagnosis of 'can't intubate, can't ventilate' should be made early and a cricothyroidotomy performed. Do not allow the patient to be hypoxic for too long.

Although the Difficult Airway Society algorithm only lists two alternative approaches for the percutaneous approach, there are many more available. Examples include the Melker, the Minitrach II, and the Quicktrach. Each has its own particular advantages and disadvantages. See Appendix A for a description of a common technique for surgical tracheostomy.

Table 1. *Factors to consider when choosing between needle and surgical cricothyroidotomy*

	Cannula cricothyroidotomy	**Surgical cricothyroidotomy**
Equipment	Specialized, relatively expensive. Constructed injectors must be pre-assembled	Commonly available
High-pressure oxygen	Required	Not required
Aspiration risk	High	Low
Suctioning	Not possible	Possible
Bleeding risk	Low	High
Barotrauma risk	High	Low

2. It may be difficult to identify the cricothyroid membrane. An incision through the upper tracheal rings, while not ideal, is better than permanent hypoxic brain damage or death.
3. Care must be taken not to lose the tracheal opening before the endotracheal tube is inserted. Use either a tracheal hook, or the handle of the scalpel.

PRE-EVENT PLANNING

1. Chose a particular approach for your institution and prepare adequately. The author's suggestion is the surgical cricothyroidotomy.
2. Make sure the necessary equipment is available at all locations where a 'can't intubate, can't ventilate' situation may arise.
3. Train your personnel. The anesthesia providers, the surgical staff, and all the nursing staff must know where the equipment is kept.

Practise the technique. The incidence of 'can't intubate, can't ventilate' is low, probably around 1 – 2 per 10 000 cases, so experience is difficult to attain, which makes simulation training indispensible. If possible, try to attend an airway management course which demonstrates the technique under the supervision of an expert. Alternatively, and in addition, read a very clear description of the technique in textbooks such as Hagberg,[3] Hung,[4] or Walls[5]. Various alternatives for practice include cadavers, plastic simulation models and animals.

FURTHER POINTS *(Adapted from Reference 2)*

- Repeated attempts at intubation will cause airway bleeding.
- Remember that an elective case can be scheduled for another day.
- Recognize you limitations when dealing with unfamiliar equipment.
- Remember and allow for the risks of aspiration.
- Record all events and timings in detail in the patient's notes.
- Provide a warning for your colleagues embarking on future anaesthetics - fix an ALERT sticker or label to the front of the patient's notes.
- If in doubt – carry the guideline about.

REFERENCES AND FURTHER READING:

1. Henderson J, Popat M, Latto I, Pearce A. Difficult Airway Society guidelines for management of the unanticipated difficult intubation. *Anaesthesia* 2004; **59**: 675-94. Available at: http://www.das.uk.com/guidelines/downloads.html
2. Clore MD. Medico-legal trial lawyer, South Carolina. 2009.
3. Hagberg C. Benumof's Airway Management. 2nd ed. Philadelphia: Mosby Elsevier 2007.
4. Hung O, Murphy M. Management of the Difficult and Failed Airway. New York: McGraw Hill Medical 2008.
5. Walls R, Murphy M, Luten R, Schneider R. Manual of Emergency Airway Management. 2nd ed. Philadelphia: Lippincott Williams Wilkins 2004.
6. MacIntyre A, Markarian MK, Carrison D, Coates J, Kuhls D, Fildes JJ. Three-Step Emergency Cricothyroidotomy. *Military Medicine 2007*; **172**: 1228-30.

Appendix A. *Techniques for surgical tracheostomy*

A brief outline of the surgical technique for cricothyroidotomy (based on Reference 6).

1. Identify the cricothyroid membrane. Find the thyroid cartilage, also known as the 'Adam's apple'. Ensure that you are in the midline by moving the thyroid cartilage from side to side, and by identifying the notch in the superior margin of the cartilage.
2. Run your finger down the thyroid cartilage and palpate the inferior margin. At that point you will feel a depression, which is the location of the cricothyroid membrane. This membrane attaches the thyroid cartilage to the cricoid ring below.
3. Depending on time pressure, clean the neck.
4. Make a vertical incision over the cricothyroid membrane, approximately 3 – 4 cm long. The incision is vertical to avoid damage to underlying vessels and other structures.
5. Cut down to the cartilage, using your finger intermittently to dissect the tissues. There will probably be significant bleeding so palpation of the cartilages is important. Stay in the midline!
6. When the cricothyroid membrane has been identified, make a horizontal 5 mm incision through the lower part of the membrane. Watch the depth of incision to avoid damage to the posterior tracheal wall and the underlying oesophagus.
7. Keep the incision open using your scalpel blade and place a gum elastic bougie into the opening, directing it down towards the chest. Advance the bougie until resistance is felt.
8. Pass the endotracheal tube over the bougie. A size 5.0 tube is usually appropriate. Ensure that the bevel of the endotracheal tube is lined up with the horizontal incision of the cricothyroid membrane before advancing further.
9. Apply gentle pressure and advance the endotracheal tube into the trachea. Gentle rotation of the tube may facilitate entry.
10. When the tube is in the trachea, remove the bougie and inflate the cuff.
11. Ventilate the patient in the normal fashion.