Rapid sequence induction:

Rapid sequence induction is a method of achieving rapid control of the airway whilst minimising the risk of regurgitation and aspiration of gastric contents. Intravenous induction of anaesthesia, is swiftly followed by the placement of an endotracheal tube (ETT). Performance of an RSI is a high priority in many emergency situations when the airway is at risk, and is usually an essential component of anaesthesia for emergency surgical interventions. RSI is only required in patients with preserved airway reflexes. In arrested or completely obtunded patients, an ETT can usually be placed without the use of medications.

Patient factors may dictate the need for certain elements of the RSI to be modified or omitted. Contraindications to suxamethonium such as allergy, susceptibility to malignant hyperthermia or hyperkalaemia should prompt usage of an alternative muscle relaxant such as rocuronium. A laryngeal injury contra-indicates cricoid pressure. Unstable cervical spine fractures will require caution in the application of cricoid pressure due to the possibility of exacerbating damage. Controversy exists around cricoid pressure: a systematic review describe both the success and failure of cricoid pressure to prevent aspiration. It is suggested that it is often used inconsistently and applied improperly in all airway management settings; it may impair laryngoscopy view; it may impair the function of the lower esophageal sphincter and it may include movement of unstable cervical spine fractures and esophageal injury.

Preparation:

Preparation is vital, both of equipment and team members – particularly if the team is unfamiliar with the environment or their colleagues. Anticipation of difficult airway and establishing oxygenation plans prior to conducting RSI are essential. A checklist should be used to ensure all equipment is available and in working order, and that the planned sequence of events is shared with all team members. When all checks are confirmed, RSI can then proceed.

<table>
<thead>
<tr>
<th>Adults Rapid Sequence Induction Checklist</th>
<th></th>
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<tbody>
<tr>
<td><strong>Team roles</strong></td>
<td></td>
</tr>
<tr>
<td>Doctor 1: airway and Drugs</td>
<td></td>
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<tr>
<td>Nurse 1: assistant at airway trolley</td>
<td></td>
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<tr>
<td>Nurse 2: cricoid pressure</td>
<td></td>
</tr>
<tr>
<td>Nurse 3: manual in-line control/neck immobilisation</td>
<td></td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>Suction: working and yankaeur is placed under right of pillow</td>
<td></td>
</tr>
<tr>
<td>Ambu-bag: 15 l/min oxygen, PEEP valve</td>
<td></td>
</tr>
<tr>
<td>ETT: correct size – cut appropriately – cuff checked and lubricated</td>
<td></td>
</tr>
<tr>
<td>ETT: one size smaller in packet on top of trolley</td>
<td></td>
</tr>
<tr>
<td>Laryngoscopes: 2 working laryngoscopes with blades</td>
<td></td>
</tr>
<tr>
<td>20ml syringe and cuff pressure gauge</td>
<td></td>
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<tr>
<td>Tube tie/tape</td>
<td></td>
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<tr>
<td>Frova bougie/intubating catheter on top of trolley</td>
<td></td>
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<tr>
<td>Oropharyngeal airway on top of trolley</td>
<td></td>
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<tr>
<td>Capnography set up on ambu-bag and function confirmed</td>
<td></td>
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<tr>
<td>Stethoscope</td>
<td></td>
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<tr>
<td>Ventilator checks complete</td>
<td></td>
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<tr>
<td>Alternative O2 source</td>
<td></td>
</tr>
<tr>
<td>Confirm LMA, 50ml syringe and surgical airway kit within reach</td>
<td></td>
</tr>
<tr>
<td><strong>Drugs</strong></td>
<td></td>
</tr>
<tr>
<td>Demonstrate IV access patent and accessible</td>
<td></td>
</tr>
<tr>
<td>Hypnotic agent: identify syringe – confirm drug and dose</td>
<td></td>
</tr>
<tr>
<td>Opiate: identify syringe – confirm drug and dose</td>
<td></td>
</tr>
<tr>
<td>Muscle relaxant: identify syringe – confirm drug and dose</td>
<td></td>
</tr>
<tr>
<td>Vasopressor: identify syringe – confirm drug, dose and MAP decision point</td>
<td></td>
</tr>
<tr>
<td>Atropine: identify syringe – confirm drug, dose and heart rate decision point</td>
<td></td>
</tr>
<tr>
<td>Sedative infusions: confirm drug and starting infusion rates</td>
<td></td>
</tr>
<tr>
<td><strong>Briefing</strong></td>
<td></td>
</tr>
<tr>
<td>Verbally rehearse failed airway plan</td>
<td></td>
</tr>
</tbody>
</table>
Drugs that are commonly used in RSI:

- Propofol – suppresses laryngeal reflexes and provides better conditions for airway management than other agents.
- Alfentanil
- Rocuronium or suxamethonium may be used (both stored in fridge).
- Rocuronium has a rapid onset and can be antagonised immediately with sugammadex, although the incidence of anaphylaxis may be higher than with other non-depolarising NMBAs. Also, it should be remembered that this does not guarantee airway patency or the return of spontaneous ventilation. If rapid antagonism of rocuronium with sugammadex is part of the failed intubation plan, the correct dose (16mg) must be immediately available.
- Suxamethonium-induced fasciculation increases oxygen consumption during apnoea which may become relevant in the event of airway obstruction.
- Sugammadex (if rocuronium is used) – sugammadex is stored in plan C drawer.
- Metaraminol

Preparation of team members:

Tasks that need to be allocated and performed include:

- Pre-oxygenation
- Intubation
- Assisting the intubator – passing equipment etc
- Drug administration
- Cricoid pressure application (if used)
- Manual in-line stabilisation (if indicated)

A minimum of 2 people are required to fill these roles. Commonly the lead intubator will pre-oxygenate and administer drugs, while the assistant applies cricoid pressure, and passes equipment to the intubator. A third person may be required for manual in-line stabilisation of the neck if cervical spine injury is suspected.

RSI technique:

- **Patient position**: The patient should be positioned appropriately for pre-oxygenation and intubation; this may manual in-line stabilisation, or a semi-recumbent position for pre-oxygenation if respiratory function is impaired by lying supine. In the obese patient, the ‘ramped’ position should be used routinely to ensure horizontal alignment of the external auditory meatus and the suprasternal notch because this improves the view during direct laryngoscopy.

- **Head positioning**: position the patient’s head to facilitate intubation. Provided there are no contra-indications, the correct position for the head is “sniffing the morning air”. The neck is slightly flexed and the head extended. May be made easier by placing a pillow under the patient’s head. This position allows a straight line of vision from the mouth to the vocal cords.

- **IV cannula**: a reliable cannula should be placed, and a carrier fluid should run freely to maximise drug delivery to the central circulation. Alternatively a large syringe of saline may be used to flush medication following administration.
• **Pre-oxygenation**: using a bag-valve-mask device, the patient is ventilated with 100% oxygen. When satisfactory pre-oxygenation has been obtained, and all members are ready to proceed, the chosen medications should be administered and the patient should be observed for evidence of effect.

• When intubating conditions are obtained, either by observing fasciculations (if suxamethonium is used), waiting for an appropriate time period, or by using a neuromuscular monitor, intubation should be performed.

• The laryngoscope is held in the operator’s left hand. At this point, the mouth is inspected for loose teeth or dentures. Brief suction may also be required to clear any debris or secretions from the laryngeal inlet.

• The tip of the endotracheal tube is advanced through the vocal cords and once the cuff has passed through, the tube is secured at this level and the cuff inflated. The cuff is inflated to provide an air-tight seal between the tube and the trachea. (as a guide, the same number of millilitres of air can be used as the diameter of the tube in millimetres, and adjusted later).

• The catheter mount (with closed–suction system) is then attached to the tube and the patient is ventilated using bag-valve-mask device.

• Confirmation of tube placement: correct placement of the tube needs to be confirmed. This should include visual confirmation that the tube is between the vocal cords, bilateral chest expansion, and auscultation and capnography. End-tidal CO2 monitoring helps to verify tube placement. Gold standard is the appearance of a 4 phase capnography waveform for 5 breaths. Absence of exhaled CO2 indicates failure to ventilate the lungs, which may be a result of oesophageal intubation or compromised airway obstruction (rarely, complete bronchospasm).

• Cricoid pressure, if requested by the intubator, is constantly maintained throughout the procedure. It is **not released** until the intubator is happy that the tube is correctly placed. However, in the event of the patient vomiting, **cricoid pressure should be released** as continued pressure may induce oesophageal trauma/rupture.

• Insert slide sheet under patient – from shoulder to just above hip level – to facilitate insertion of chest x-ray plate. Head of bed elevation ≥30° unless there are contra-indications.

Cricoid pressure (may also be referred to as Sellick Maneouvre):

This is applied to protect the airway from contamination during the period between loss of consciousness and placement of a cuffed tracheal tube. Gentle mask ventilation after the application of cricoid pressure and before tracheal intubation prolongs the time to desaturation. If applied correctly, cricoids pressure may improve the view on direct laryngoscopy.

• Performed to prevent gastric distension/regurgitation of stomach contents into the larynx during intubation and induction.

• The cricoid cartilage is identified immediately below the thyroid cartilage (Adam’s apple) where it forms a complete ring at the upper end of the trachea.

• Firm pressure is applied (with thumb and forefinger) on the cricoid. This forces the cricoid ring backwards. The oesophagus is then occluded against the body of the 6th cervical vertebra.

• This manoeuvre is maintained until: (1) the tracheal tube is inserted into the larynx, (2) the cuff is inflated and (3) the person performing tracheal intubation indicates that pressure can be released.

• Cricoid pressure should not be used in cases of active vomiting. If the patient vomits cricoid pressure must be released immediately because of the slight risk of oesophageal rupture.
Potential problems/complications that may occur during intubation:

- **Trauma/bleeding** – all the structures encountered from the lips to the trachea may be traumatised.
- **Regurgitation and aspiration of gastric contents.**
- A tube that is too long may pass into a main bronchus (usually the right), causing the opposite lung to collapse, thereby severely impairing the efficiency of ventilation. This is usually identified by the absence of breath sounds and reduced movement on the unventilated side.
- **Unrecognised oesophageal intubation.** Ventilation may appear adequate, but in fact, the patient is not receiving oxygen and rapidly becoming hypoxaemic. If there is any doubt, the tube should be removed and the patient ventilated using a bag-valve-mask device.
- In certain circumstances, such as acute epiglottitis, laryngoscopy and attempted intubation are contra-indicated because they could lead to a deterioration in the patient’s condition. These specialist skills may be required including the use of anaesthetic drugs or fibreoptic laryngoscopy.
- **Hypotension** - follows induction of anaesthesia because of the direct cardiovascular effects of the drugs given and may be treated with either vasoconstrictors, fluids, inotropes.
- **Reduced cardiac output** - positive pressure ventilation reduces venous return to the heart.
- **Severe hypoxaemia.**
- **Arrhythmias.**

Laryngoscopy grade:

Opposite tomorrow: Mallampati classification based on maximal mouth opening and what structures can be visualised.

**Difficult intubations:** the security of the ET tube must be maintained at all times. The bedside nurse needs to be vigilant in keeping the tube secure.
Failed intubation:

Inability to intubate the patient during an RSI should prompt the usual approach to a difficult intubation, which should be communicated to the team prior to induction.

If the initial intubation attempt is unsuccessful, a best attempt at face-mask ventilation should be performed while preparing either a supraglottic airway, a different laryngoscopy technique or a new operator. Attempts at intubation should be limited, and the persistent risk of regurgitation and aspiration is remembered. Rarely, a surgical airway may be required and equipment for this should be available at every RSI.

Algorithms have been produced by the Difficult Airway Society and are illustrated below:
Key features of Plan A - mask ventilation and tracheal intubation:

- Maintenance of oxygenation is the priority.
- Advantages of head-up positioning and ramping are highlighted.
- Pre-oxygenation is recommended for all patients.
- Apnoeic oxygenation techniques are recommended in high-risk patients.
- The importance of neuromuscular block is emphasised.
- The role of video-laryngoscopy in difficult intubation is recognised.
- A maximum of 3 attempts at laryngoscopy are recommended.
- Cricoid pressure should be removed if intubation is difficult.

Key features of Plan B – maintaining oxygenation: supraglottic airway device (SAD) insertion:

- Failed intubation should be declared.
- The emphasis is on oxygenation via a SAD.
- Second-generation SADs are recommended i.e. I-gels (non-inflatable cuff); size is according to bodyweight. Small/size 3 yellow = 30-60kg; Medium/size 4 green = 50-90kg; Large/size 5 orange= 90+kg
- During rapid sequence induction, cricoid pressure should be removed to facilitate insertion of a SAD.
- Blind techniques for intubation through a SAD are not recommended.

Key features of Plan C – final attempt at face-mask ventilation:

- Failed SAD ventilation should be declared.
- Attempt to oxygenate by face mask.
- If face-mask ventilation is impossible, maintain oxygenation and wake the patient up.
- Declare CICO (can’t intubate can’t ventilate) and start Plan D.
- Continue attempts to oxygenate by face mask, SAD, and nasal cannulae.
Key features of Plan D – CICO – can’t intubate, can’t oxygenate:

- CICO and progression to front-of-neck access should be declared.
- A didactic scalpel technique has been selected to promote standardised training.
- Placement of a wide-bore cuffed tube through the cricothyroid membrane facilitates normal minute ventilation with a standard breathing system.
- High-pressure oxygenation through a narrow-bore cannula is associated with serious morbidity.
- All anaesthetists should be trained to perform a surgical airway.
- Training should be repeated at regular intervals to ensure skill retention.
- Following emergency front-of-neck access the patient will require ENT surgical review.

Emergency front-of-neck access:

A CICO situation arises when attempts to manage the airway by tracheal intubation, face-mask ventilation, and SAD have failed. Hypoxic brain damage and death will occur if the situation is not rapidly resolved.

A cricothyroidotomy may be performed using either a scalpel or a cannula technique. Anaesthetists must learn a scalpel technique and have regular training to avoid skill fade.

Scalpel cricothyroidotomy:

Scalpel cricothyroidotomy is the fastest and most reliable method of securing the airway in the emergency setting. A cuffed tube in the trachea protects the airway from aspiration, provides a secure route for exhalation, allows low-pressure ventilation using standard breathing systems, and permits end-tidal CO2 monitoring.

![Cricothyroidotomy technique: cricothyroid membrane palpable: scalpel technique; ‘stab, twist, bougie, tube’](image)

(A) identify cricothyroid membrane (B) make transverse stab incision through cricothyroid membrane. (C) rotate scalpel so that sharp edge points caudally. (D) pulling scalpel towards you to open up the incision, slide coude tip of bougie down scalpel blade into trachea. (E) railroad size 6 tube into trachea.
Failed intubation, failed oxygenation in the paralysed, anaesthetised patient

CALL FOR HELP
Continue 100% O₂
Declare CICO

Plan D: Emergency front of neck access
Continue to give oxygen via upper airway
Ensure neuromuscular blockade
Position patient to extend neck

Scalpel cricothyroidotomy
Equipment: 1. Scalpel (number 10 blade)
            2. Bougie
            3. Tube (cuffed 6.0mm ID)

Laryngeal handshake to identify cricothyroid membrane

Palpable cricothyroid membrane
Transverse stab incision through cricothyroid membrane
Turn blade through 90° (sharp edge caudally)
Slice coudé tip of bougie along blade into trachea
Railroad lubricated 6.0mm cuffed tracheal tube into trachea
Ventilate, inflate cuff and confirm position with capnography
Secure tube

Impalpable cricothyroid membrane
Make an 8-10cm vertical skin incision, caudad to cephalad
Use blunt dissection with fingers of both hands to separate tissues
Identify and stabilise the larynx
Proceed with technique for palpable cricothyroid membrane as above

Post-operative care and follow up
• Postpone surgery unless immediately life threatening
• Urgent surgical review of cricothyroidotomy site
• Document and follow up as in main flow chart

This flowchart forms part of the DAS Guidelines for unanticipated difficult intubation in adults 2015 and should be used in conjunction with the text.
**Extubation:**

Extubation refers to removal of the ET tube and is the final step in liberating a patient from mechanical ventilation.

At the end of the weaning process, it may be apparent that a patient no longer needs mechanical ventilation to maintain sufficient oxygenation and ventilation. However extubation should not be ordered until it has been determined that the patient is able to protect the airway and the airway itself is patent.

Airway protection is the ability to guard against aspiration during spontaneous breathing. It requires sufficient cough strength and an adequate level of consciousness, each of which should be assessed prior to extubation. The amount of secretions should be considered prior to extubation because airway protection is significantly more difficult when secretions are increased.

Sedation, of course, frequently reduces consciousness and may therefore influence the ability of a patient to be successfully intubated.

**Early extubation has positive advantages for patients:**

- Reduced risk of chest infection or hospital-acquired infection.
- Earlier return to independence.
- Reduced stress for the patient and the family.
- Shorter stay in ICU.

**Assessment prior to extubation:**

- Respiratory function is returning to normal for the patient. There should be no signs of respiratory depression.
- Respiratory rate is < 35 per minute.
- Oxygen saturation is >95%.
- There are no significant signs of respiratory depression.
- Conscious level (GCS >8) and sedation score is adequate.
- Sedation is stopped.
- Enteral feeding is stopped – or stomach decompressed.
- Cardiovascularly stable.
- The patient is warm and well perfused.
- Gag reflex is present: the patient is able to cough effectively and clear secretions.
- Breath sounds are equal and clear.
- CXR is satisfactory.

**Assessing for cuff leak:**

For most patients, a cuff leak does not need to be performed unless risk factors for post extubation stridor from laryngeal oedema are present e.g. traumatic intubation or large ET tube.
Problems that may occur during extubation:

- Laryngeal spasm.
- Regurgitation.
- Vagal stimulation/arrhythmias.
- Trauma.

Problems that may occur following extubation:

- Post-extubation stridor caused by laryngeal oedema.
- Laryngeal stenosis.
- Hoarseness.
- Vocal cord paralysis.
- Aspiration.
- Respiratory failure.

Some patients may require the following after extubation:

All patients should be closely monitored following extubation. Some patients will need early aggressive management with oxygenation and airway clearance so that re-intubation can be avoided.

The following may be needed:

- Nasal High Flow
- Non-invasive ventilation (NIV)
- Regular chest physiotherapy/out-of-hours chest physiotherapy.
- Cough-assist device.
- Bronchodilator therapy/nebulisers.
- Suctioning e.g oropharyngeal suctioning/suctioning via naso-pharyngeal device.
- Diuresis.

Timing of extubation:

- The optimal timing for extubation i.e. daytime versus night-time is unknown.
- Common practice is to extubate patients once successful weaning parameters have been met, provided that appropriate personnel are available.
- In general, this occurs during daytime hours.
- However, while not absolutely contra-indicated, clinicians may perform after hours extubation among selected individuals in whom the risk of reintubation is assessed to be low.
- Extubation of a patient that has been difficult to intubate should be performed with caution. There is a possibility that the patient may need re-intubation if there is a problem with extubation, and this may prove difficult or impossible.
- Authorisation to proceed to extubation is always sought from medical staff.
Extubation procedure:

- Use PPE including full face visor.
- Explain procedure to the patient.
- Aspirate NG tube if this hasn’t already been done.
- Place the patient in an upright position.
- Press the pre-oxygenation button on the ventilator – this allows ventilator to halt during the process of removing the tube. Servo pre-ox key is found under ‘Quick Access’ then select ‘Suction support’.
- Disposable bag for waste products is needed so have this at hand.
- Place an inco pad or alternative protective pad over the patient’s chest (secretions during extubation may soil clothing).
- Suction the oropharynx using a yankeaur suction catheter.
- Suction the ET tube.
- Remove ET tapes and use a 10ml syringe to fully deflate the endotracheal cuff.
- Insert suction catheter down the ET tube, apply suction and simultaneously remove the ET tube.
- Suction the oropharynx again: instruct the patient to cough to clear any residual secretions.
- Apply either nasal prongs or appropriate humidified oxygen therapy. Non-rebreathing masks should only be used very temporarily.
- Apply either nasal prongs or appropriate humidified oxygen therapy. Connect patient to humidified oxygen using facemask, heated hose tubing and air entrainer if oxygen <50% is required. If high flow oxygen is needed then use the Nasal High Flow device.
- Offer oral hygiene following removal of ET tube.
- Dispose of all equipment as per hospital policy.
- The patient may cough more secretions: provide tissues and a mono cup.
- Continue to encourage deep breathing and coughing exercises.
- Liaise with physiotherapist as needed. Remember on-call physiotherapist can be contacted out-of-hours.

Post-extubation management:

- Continue to monitor oxygen saturations.
- Aim for oxygen saturations > 94% or as indicated by medical staff.
- Increase oxygen concentration to maintain target oxygen saturation.
- Obtain ABG 20 to 30 minutes after extubation.
- Observe for hoarseness, respiratory stridor, increase in carbon dioxide level and cardiovascular stability. Check respiratory rate every 15 minutes until stable.
- Continue to liaise with the physiotherapist and medical staff.

Always remember, extubation may fail and it may be necessary to prepare equipment for emergency re-intubation.
**DAS Exubation Guidelines: Basic algorithm**

**Step 1** Plan extubation

**Plan**
Assess airway and general risk factors

**Airway risk factors**
- Known difficult airway
- Airway deterioration (trauma, oedema or bleeding)
- Restricted airway access
- Obstructive OSA
- Aspiration risk

**General risk factors**
- Cardiorespiratory
- Respiratory
- Neurological
- Metabolic
- Special surgical requirements
- Special medical conditions

**Step 2** Prepare for extubation

**Prepare**
Optimise patient and other factors

**Risk Stratify**

- **Low risk**
  - Focused
  - Uncomplicated airway
  - No general risk factors

- **‘At risk’**
  - Ability to oxygenate uncertain
  - Extubation potentially difficult and/or general risk factors present

**Optimise patient factors**
- Cardiovascular
- Respiratory
- Metabolic / Temperature
- Neurovascular

**Step 3** Perform extubation

**Low risk algorithm**

- Safe transfer
- Handover / communication
- Oxygen and airway management
- Observation and monitoring
- General medical and surgical management

**‘At risk’ algorithm**

- Analgesia
- Staffing
- Equipment
- Documentation

**Step 4** Postextubation care

**Recovery or HDU / ICU**

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**DAS Exubation Guidelines: Low risk algorithm**

**Step 1** Plan extubation

**Plan**
Assess airway and general risk factors

**Low risk extubation**
- Focused
- Uncomplicated airway
- No general risk factors

**Step 2** Prepare for extubation

**Prepare**
Optimise patient and other factors

- **Optimise patient factors**
  - Cardiovascular
  - Respiratory
  - Metabolic / Temperature
  - Neurovascular

- **Optimise other factors**
  - Location
  - Skilled help / assistance
  - Monitoring
  - Equipment

**Step 3** Perform extubation

- **Perform Awake Extubation**
  - Preoxygenate with 100% oxygen
  - Suction as appropriate
  - Insert a bite block (e.g. rolled gauze)
  - Position the patient appropriately
  - Antagonise neuromuscular blockade
  - Establish regular breathing
  - Ensure adequate spontaneous ventilation
  - Minimise head and neck movements
  - Wait until awake (eye opening/behaving commands)
  - Apply positive pressure: deflate the cuff & remove tube
  - Provide 100% oxygen
  - Check airway patency and adequacy of breathing
  - Continue oxygen supplementation

- **Deep Exubation**
  - Advanced technique
  - Experience essential
  - Vigilance until fully awake

**Step 4** Postextubation care

**Recovery and follow up**

- Safe transfer
- Handover / communication
- Oxygen and airway management
- Observation and monitoring
- General medical and surgical management

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The technique described for awake extubation is a suggested approach. Practice may vary in experienced hands.
References:


UpToDate: keywords ‘intubation’ and ‘extubation’ [accessed 7 June 2017]