Airway Management

One of our most important tasks is to manage the patient's airway. There are multiple tools we use for this, and we will examine each of them.
They can be divided into a few categories:

- Supplemental oxygen devices
- Masks (face or laryngeal)
- Endotracheal tubes and laryngoscopes to help place them
- Emergency rescue devices

Supplemental oxygen devices take a few forms, such as nasal cannulas or loose-fitting masks, but all do only one thing: they increase the amount of oxygen delivered to the lungs with each breath. They do not allow for any sort of external assistance with ventilation nor do they allow airway pressure to be adjusted.

Nasal cannulas (the "prongs" that enter the nose and deliver oxygen) are typically used with flows of two to six litres per minute, although the upper limit is not hard-and-fast when they are used for brief periods with humidified oxygen. This can occasionally come in handy on patients too anxious to tolerate a mask. It is possible to monitor respiration automatically by a simple modification to the nasal cannula: before placing the cannula on the patient, take a 16-gauge IV catheter and insert it so that it pierces the plastic tubing and enters one of the prongs, then remove the needle and safely discard it. The catheter remains in the cannula for the duration of the case, and you can attach the tubing from the gas analyzer to it for an estimate of how often respiration is occurring.

Cannulas provide an inspired oxygen concentration (FiO_2) of up to about 40%. To give patients a higher concentration of oxygen, you need a mask; two types are available. A simple mask consists of an oxygen supply line and a face mask with two open ports that allow patients to breathe air if they inhale faster than oxygen is supplied. This lets the FiO_2 reach about 60%, since it provides a little external reservoir (the mask itself) that can fill with oxygen.
To increase FiO_2 further, a nonrebreathing mask is required; this mask involves a system of valves and a reservoir bag that can fill with oxygen during exhalation and between breaths.
The valves ensure that all inhaled gas comes from the reservoir bag, which fills directly from the oxygen supply line. To use a nonrebreather mask, you need very high (15 lpm) flows so that patients can't drain the bag completely when they breathe in.
The next step on our list is a snugly fi tting face mask attached to a self-inflating (Ambu) bag or an anesthesia machine's breathing circuit. This can provide almost 100% oxygen, limited only by a bit of rebreathing, and allows the anesthesiologist to ventilate the patient simply by holding the mask firmly on the face and squeezing the bag to force air into the lungs.
When an anesthesia machine is used for this, its automatic pressure limiting (APL, or "pop-off") valve must be closed first to allow positive pressure in the system. This sounds a bit complicated but is actually very handy. The mask can fi rst be placed on the patient with the valve open, allowing oxygen to fi ll the lungs while the monitors are placed prior to induction; after induction, we simply close the valve to mask-ventilate the patient until we are ready to intubate.
For most surgeries, we intubate the patient for two reasons:
First and most obvious is the need to maintain ventilation; a patient who has received muscle relaxants is unable to breathe, as is a patient who is anesthetized to stage 4.
Second is the need to defend the airway against secretions and aspiration. Awake patients who accidentally inhale a bit of foreign matter cough vigorously until it is cleared; anesthetized patients fail to do so.
Bits of secretions (or worse, aspirated vomit) can then be spread throughout the lungs by positive-pressure ventilation, turning a localized problem into a much larger one.

Let's look more closely at how we intubate because it's one of the most critical skills in anesthesia; even those interns who do not choose anesthesiology as a career will find good airway management skills a valuable asset.

AIRWAY ASSESSMENT

The difficult airway is the single most important cause of anaesthesia-related morbidity and mortality—up to 30% of deaths attributable to anaesthesia are associated with inadequate airway management.

• Most catastrophes are due to unexpected diffi culty or poor planning in patients with known difficulty.
• Airway assessment has traditionally focused on detecting difficult direct laryngoscopy and tracheal intubation.
• Predicting difficult mask ventilation, LMA placement, and other rescue techniques is equally important.
• Intubation is: Difficult in ~1:50 cases.
• Impossible in ~1:2000 cases (increasing to ~1:300 for emergencies).
• Facemask ventilation is difficult in ~1:20 cases and impossible in ~1:1500.
• Rescue techniques fail in ~1:20 cases.
• Patients with multiple predictors of diffi culty or risk factors for rapid hypoxaemia (e.g. pregnancy, obesity, children) need great care.

History

- Congenital airway difficulties (e.g. Down's, Pierre Robin, Klippel–Feil syndromes).
- Acquired airway diffi culties (e.g. pregnancy, diabetes, rheumatoid arthritis, ankylosing spondylitis, acromegaly, Still's disease).
- Iatrogenic problems (e.g. cervical fusion, oral/pharyngeal radiotherapy, laryngeal/tracheal surgery, TMJ surgery).
- Reported previous anaesthetic problems, e.g. dental damage or severe sore throat. Check anaesthetic notes, med-alerts, and possibly databases.

Examination

- Adverse anatomical features, e.g. small mouth, receding chin, high arched palate, large tongue, bull neck, morbid obesity, large breasts.
- Acquired problems (e.g. head/neck burns, tumours, abscesses, radiotherapy injury, restrictive scars).
- Mechanical limitation—reduced mouth opening and anterior temporomandibular movement (e.g. TMJ damage, quinsy, postradiotherapy), poor cervical spine movement.
- Poor dentition, e.g. anterior gaps, rotten/sharp/loose/protruding or awkwardly placed teeth.
- Orthopaedic/neurosurgical/orthodontic equipment (e.g. surgical collar, halo traction, external fixator, stereotactic locator, dental wiring).
- If using the nasal route check the patency of the nasal passages.

• NB: facial hair may hide adverse anatomical features.

Predictive tests

Laryngoscopy requires a clear line of sight from the upper teeth to the glottis. It entails mouth opening, extension of the upper c-spine, and moving the tissue within the arch of the mandible out of the way. Most tests of difficult laryngoscopy check one or more of these capacities.

Problems with predictive tests:

- Low specifi city and positive predictive value. Large numbers of false positives. Generally <5% of patients with features 'predicting' difficult laryngoscopy prove difficult.
- Sensitivity is often <50%, i.e. >50% of diffi culties are not predicted. Studies that have developed predictive tests often quote higher sensitivity and specificity than found in routine practice.
- Combining tests increases the specifi city (i.e. reduces false positives) but decreases sensitivity (i.e. misses more of the difficult cases).

• Definitions of 'difficulty' vary widely. Although the laryngeal view described by Cormack and Lehane is frequently used, it correlates only moderately with measures of difficulty with intubation. Modifications have therefore been proposed

Interincisor gap (II gap)

• The distance between the incisors (or alveolar margins) with the mouth open maximally.
• Affected by TMJ and upper c-spine mobility.
• <3cm makes intubation difficulty more likely.
• <2.5cm—LMA insertion will be difficult.

Protrusion of the mandible

- Class A—able to protrude the lower incisors anterior to the upper incisors.
- Class B—lower incisors can protrude to, but not beyond, the upper incisors.
- Class C—lower incisors cannot protrude to the upper incisors.

Classes B and C are associated with increased risk of difficult laryngoscopy.

Mallampati test

Examine the patient's oropharynx from opposite the patient's face while the patient opens their mouth maximally and protrudes their tongue without phonating.

- Faucial pillars, soft palate, and uvula visible. (Class 1)
- Faucial pillars and soft palate visible—uvula tip masked by base of tongue. (Class 2)

• Only soft palate visible. (Class 3)
• Soft palate not visible. (Class 4)

Class 3 and 4 views (i.e. when there is no view of the posterior pharyngeal wall) are associated with an increased risk of diffi cult laryngoscopy. This test is prone to interobserver variation. Used alone it correctly predicts about 50% of difficult laryngoscopies and has a false positive rate of >90%.

Extension of the upper cervical spine

• When limited (<90^0) the risk of difficult laryngoscopy is increased.
• Movement may be assessed by:
    • Flexing the head on the neck, immobilising the lower c-spine with one hand on the neck, then fully extending the head. Placing a pointer on the vertex or forehead allows the angle of movement to be estimated.
    • Placing one finger on the patient's chin and one finger on the occipital protuberance and extending the head maximally.
    • With normal c-spine mobility the finger on the chin is higher than the one on the occiput. Level fingers indicate moderate limitation. If the finger on the chin remains lower than the one on the occiput there is severe limitation.

Thyromental distance (Patil test)

The distance from the tip of the thyroid cartilage to the tip of the mandible, neck fully extended:
• Normal >7cm; <6cm predicts ~75% of diffi cult laryngoscopies.
• Combined Patil and Mallampati tests (<7cm and Class 3–4) increases specificity (97%) but reduces sensitivity (81%).

Sternomental distance (Savva test)

The distance from the sternal notch to the tip of the mandible, neck fully extended and mouth closed.
• <12.5cm associated with diffi culty (positive predictive value 82%).

Wilson score

Five factors—weight; upper c-spine mobility; jaw movement; receding mandible; protruding upper teeth. Each scored from 0–2 (subjectively normal to abnormal).
• A total score of ≥2 predicts 75% of diffi cult intubations; 12% false positives.

Predictors of difficult mask ventilation

Mask ventilation requires the ability to cover the mouth and nose with a facemask and produce a seal while maintaining an open airway.
Predictors of difficulty:
• Age >55yr
• Body mass index >26kg/m 2
• History of snoring
• Beard
• Absence of teeth
(The presence of two of the above factors has a >70% sensitivity and specificity.)
• Facial abnormalities
• Receding or markedly prognathic jaw
• Obstructive sleep apnoea
• Mallampati Class 3–4.

How to Intubate

We're going to look first at how to intubate with a traditional laryngoscope and a Macintosh blade, and will subsequently discuss alternate airway devices. Let me also preface this section by saying that you will not learn to intubate solely from reading this or any book; it is a skill learned only through practice. Reading this will, however, help you to become proficient much more quickly as an experienced anesthesiologist guides you through your first intubations.

1) The **first step is to position** the patient properly, so as to allow for an easy view and good mechanical advantage while performing laryngoscopy. Too low and you'll be bending over to see
where you're going; too high and you won't be able to use your full strength, as we'll discuss in a moment. The **optimal height** has the patient's head around the height of your flexed elbows.
The patient's head should also be on a foam pillow and angled back, as if looking up; the resultant pose has been termed the "sniffing position," or drinking from a full pint glass and makes laryngoscopy easier.

2) The patient is now **preoxygenated** as described above, and anesthesia is induced with one of the IV medications you have learned about.
3) When The fasciculations seen with succinylcholine are evident, or you have waited the appropriate time per non-demolarising muscle relaxant, you're ready to intubate.
4) Open the mouth using a scissoring motion with your dominant hand (i.e., pushing the upper teeth with your index finger and the lower teeth with your thumb), then insert the laryngoscope gently with your nondominant hand, being careful to avoid the teeth. Gently advance the laryngoscope into the oropharynx, then push it away from you, bringing the lower jaw and tongue with it.
This part of the procedure is so counterintuitive that it deserves special mention. Most new trainees doing their first DL (direct laryngoscopy) are tempted to try a levering motion, both because of the laryngoscope's shape and because the proper technique requires a surprising amount of force, particularly when intubating large adults. **Do not use a levering motion with the laryngoscope!**
The metal laryngoscope is stronger than the teeth (if you've ever bitten down on a fork, you know what metal on teeth feels like) and you can easily damage the teeth by attempting to lever off of them. This is one of the most common malpractice claims in anesthesiology.

How do you get sufficient force to do a DL in a large adult, then? The answer lies in proper technique. Since the laryngoscope fits easily in one hand, it's easy to view it as a hand tool and attempt to move it only by moving one's arm. This is inefficient, and usually works well only when a fairly large trainee is trying to intubate a small patient. How would you move a large object at home? Would you only push with one arm, or would you set your arms and then lean against the object to enlist the help of your powerful back and leg muscles? The same thinking applies here. Place the laryngoscope carefully, then use your whole body's muscles to lift the lower jaw and tongue; you'll be surprised how much easier the DL becomes.

Back to the DL. We're pushing the laryngoscope away with our entire body's force, producing a beautiful view of the oropharynx, but so far we aren't seeing vocal cords. That's normal at this stage. Using a scooping motion, place the laryngoscope blade deep into the oropharynx and slowly withdraw it while pushing the handle away from your body. You should see the epiglottis pop down suddenly. That's how you know that you are in the vallecula and therefore correctly positioned.
At this point, pushing the laryngoscope vigorously away from yourself (and remembering what we said about biomechanics a moment ago) should give you a view of the vocal cords.
Without relaxing your arm and without taking your eye off the airway, have your assistant hand you the endotracheal tube that you previously styletted and tested. Place it through the vocal cords, then ask the assistant to pull the stylet out as you advance the tube further. You will want the tip of the tube to be about 1–2 cm above the carina. Inflate the cuff gently, attach the tube to the breathing circuit (always holding the tube with one hand), and test to ensure that you're in the trachea. Once you've confirmed placement, turn on the ventilator, turn on whichever inhaled agent you're planning to use, and secure the tube with tape.

Let's step back for a second, to where we talked about ensuring you're in the trachea. How do you do that? The first step is to watch the tube enter the trachea; just as sports players watch the ball at all times, you should watch the tube continuously while inserting it. The second step, after inflating the cuff, is to give the patient a breath with the ventilation bag and listen to the stomach with your stethoscope; a bubbling sound means that you are in the oesophagus. If you hear nothing, listen over the lungs. It is critical that you listen to both sides when doing so because it is easy to place the tube into a mainstem bronchus—almost always the right, because it forms a smaller angle with the trachea than the left mainstem does. The CO_2 tracing on your gas analyzer provides further proof that your tube is in the trachea since gas exchange happens only in the lungs.

The 8 P's of intubation

P-reparation
P-reoxygenation
P-osition
P-remedication
P-ut to sleep
P-aralyse
P-lace the tube
P-lacement verification