Session 4: Infraglottic Airway Rescue

Format: PowerPoint (Session 4); videos for each technique: Cannula; Scalpel-Bougie; Scalpel-Finger-Bougie

Aims:
1. Explain three parts of Andrew Heard’s CICO algorithm (aligned with workstations 1-3) of Session 5

Duration: 20 minutes

Documents and resources: PowerPoint, videos

Venue: Seminar room

Notes to accompany PowerPoint slides

Slide 1

In this presentation we will focus on Infraglottic Airway Rescue.

Infraglottic Airway Rescue is commenced when a CICO situation is declared. We have covered the definitions and criteria for declaring CICO in the session on Supraglottic Airway Rescue.

Infraglottic Airway Rescue specifically refers to rescue techniques performed across the anterior surface of the neck via the cricothyroid membrane or the trachea - that is - below the larynx. Other terms you will be familiar with include cricothyroidotomy, surgical airway and transtracheal tracheal airway.
This topic is also presented in Part 3 of the EdWISE E Learning module by the same name. This is available at www.edwise.edu.au

A key message of this session is that we must have an emergency plan for infraglottic rescue. That means being familiar with a workable algorithm, its associated procedures, the specific equipment required to undertake it and the roles of the team.

This session will focus on these aims focussing on an approach developed by Dr Andy Heard and his team from Western Australia.

Implementing this plan also means we must recognise and declare CICO appropriately. And that the team must be aware of its roles and be able to quickly mobilise resources for infraglottic rescue while supraglottic rescue is occurring. To address these aims we will also present two additional algorithms. Firstly a Transition algorithm to guide us with recognition and declaration of CICO and secondly a team-based algorithm which shows both supraglottic and infraglottic rescue. These algorithms were developed by members of the RHCE CICO Course Working Party.
Research conducted by this team suggests anaesthetists are generally, more comfortable with and successful at cannula based techniques. The Western Australian training model involves a structured, algorithmic approach to infraglottic rescue. Depending upon our ability - in any given situation - to palpate neck anatomy it may involve one or more of three primary procedures: cannula cricothyroidotomy, scalpel/bougie or scalpel/finger/cannula technique.

**Procedure 1** - the Cannula Cricothyroidotomy or tracheotomy technique is suggested as the first line method IRRESPECTIVE OF whether neck anatomy is palpable or not easily palpable.

**Procedure 2** - the Scalpel bougie technique - is suggested if the cannula technique fails AND the neck anatomy is easily palpable. It uses a scalpel to perform a stab incision into the trachea to permit a bougie to be inserted via which ventilation can be delivered with a manual resuscitation bag.

**Procedure 3** - the Scalpel - Finger - Cannula - technique - is suggested if cannula cricothyroidotomy has failed and either the neck anatomy is not palpable or scalpel bougie attempts have failed. A scalpel is used to make an extended, superficial vertical incision, down to the strap muscles. The fingers are then used to blunt dissect down to the cricothyroid membrane or trachea at which point a cannula is inserted.

After a device is inserted into the trachea the goal is to oxygenate and stabilise. A Jet oxygenation technique is used if a cannula is in place. If a bougie is in place oxygenation will occur via a manual resuscitation bag or anaesthetic circuit.

Once the patient has been stabilised a secondary technique is used to insert a cuffed tube. A Melker conversion kit is recommended if a cannula is in place. If a bougie is in place an endotracheal tube can be railroaded over it.

**Slide 6**

We will present these techniques in the following order
Cannula Cricothyroidotomy or tracheostomy is suggested as the first line technique when a CICO is declared. The aim of this procedure is to cannulate airway through the cricothyroid membrane or trachea, choosing the most easily palpable entry point. Let’s view a demonstration of the cannula cricothyroidotomy technique.

http://www.vimeopro.com/johnmackenzie/cant-intubate-cant-oxygenate/page/1
Password: CICO

Let’s walk through the equipment that you will need for cannula cricothyroidotomy. This comprises

- A 14G luer lock non-safety cannula. We recommend the ‘Insyte’ brand.
- A 5ml non-luer-lock syringe
- A source of sterile saline or water to be drawn up into the syringe. This will allow better visualisation and provide tactile feedback of the aspiration of air - but if this is not immediately available then the technique should proceed without it!
- A suitable oxygen delivery system. Three systems are commercially available: the Manujet™, ENK™ and RAPID-O2 Oxygen Insufflation Devive™ (formerly known as the Leroy system). We will discuss these shortly.
- A high-pressure oxygen source. The Manujet™ is connected to a standard O2 pin system and the other devices are connected to an O2 flowmeter.
Delivery of adequate oxygen flows through cannulas requires low compliance oxygen tubing connected to the appropriate high-pressure oxygen source. It also requires specific ‘jetting’ techniques to safely deliver adequate oxygen. These techniques may be critical to the survival of the patient in the interim before a definitive airway is secured. They are not difficult if you and the team are prepared.

Jet oxygenation

You are trying to achieve 2 things with jet oxygenation in the CICO scenario:
1. Provide oxygen
2. Prevent/improve airway and alveolar collapse
A variety of devices are available including the Manujet™ Jet Oxygenator (or Sanders injector); ENK™ device and Rapid O2 Oxygenation Insufflation Device (formerly known as the Leroy device)

**Manujet**: The Manujet is connected to a high-pressure oxygen source such as wall or cylinder oxygen via a pin connection. The pressure regulator on the Manujet™ device allows adjustment of pressure. This feature is not available on the Sanders™ Injector – which always delivers oxygen at 4 bar (or 4000 cm of water). If the device allows pressure adjustment, the pressure should be set to 1BAR (or 1000 cm of water). This reduction in pressure reduces flows to more manageable levels. 1 Bar delivers 250 mls/sec.

A lever when depressed by the operator delivers oxygen at the inspiratory pressure dialed on the regulator. We should test this quickly by depressing the lever to ensure gas is delivered. We should hear a hiss sound and feel gas expelled from the end of the tubing. Before depressing the lever remember to hold the Manujet™ leur connector otherwise it can flick forcefully and causing an injury.

It is important to understand that i) oxygen flows from this device at the set pressure whenever the operator depresses the lever, and ii) this device does not have venting mechanism To allow excess intrathoracic pressure to escape. Thus, if the lever is depressed for long periods or without adequate pauses, and the patients upper airway is completely obstructed then pressures will increase very quickly. Gas trapping and barotrauma will likely ensue.

**ENK and Rapid O2**: The ENK™ and Rapid-O2™ devices are commercially available low-compliance oxygen tubing circuits that connect at one end to the oxygen nipple of a standard oxygen flowmeter, and at the other end to any luer-lock compatible connection such as a cannula. They have thumb/finger holes that allow some expiration of gas in between jetting. Once connected to the high-pressure oxygen source the flows should be turned to maximum, which is usually 15L/min. This will deliver 250 mls/sec during jet oxygenation, assuming all the holes are occluded during inspiratory flow.

**Technique**: We recommend the same oxygenation technique whether using a jet ventilator, the ENK device or a Leroy or Rapid-O2 configuration. This technique can fail if not performed correctly and has the potential to cause barotrauma; for example - pneumothorax, or pneumomediastinum. It is therefore important to use the safest effective jet oxygenation technique possible to avoid these complications. Here are some tips:

**Check your settings**

The Manujet™ should be set at 1.0 Bar (i.e., infant setting, in the Yellow Zone). The ENK™ and Rapid-O2™ devices should be connected to O₂ at 15 litres per minute.
Administer the first breath over 4 seconds

This approach will achieve two outcomes: it will deliver oxygen and may help prevent alveolar collapse or re-expand the lungs. This is important as at this point the lung volumes may be reduced and require re expansion to ensure a rapid response from the first jet. A 4 second jet at the pressures and flows recommended will deliver approximately 1000mls (i.e., 250 mls per sec). Observe chest movement to confirm that oxygen is being delivered to the lungs.

The rate-limiting step for the frequency of safe jet oxygenation is the patency of the expiratory pathway. Always keep in mind that oxygenation, rather than ventilation is important in the emergency scenario. We are not trying to control the CO2 initially; therefore, infrequent jets (breaths) of a known volume are preferable.

**Subsequent jets (breaths) should only be given when needed.** Observe the improvement in oxygen saturation and wait until the oxygen saturation has dropped by 5% from the maximum achieved with the initial jet. Using this objective trigger for subsequent jetting should avoid excessive jetting and decrease the risk of barotraumas.

**Subsequent jets (breaths) should be delivered over a 2 second duration.** This approach should provide adequate oxygenation and gas exchange while minimising the risk of barotrauma. Wait again for a peak and subsequent 5% fall in saturation before delivering subsequent breaths. If there is no saturation reading for whatever reason, it is safe to insufflate 500 mls every 30 seconds if using a 14g cannula and Rapid-O2™ or ENK™ even in complete upper airway obstruction. If using a Manujet™ or Sanders™ injector, this will need to be disconnected from the cannula between jets (breaths) to allow expiration.
**Slide 13**

Jet oxygenation

*IF jetting with the manujet, and there are no signs of expiratory flow*

**THEN** disconnect the manujet to allow some expiration through the cannula (taking care to not inadvertently remove the cannula). This is to ensure hyperinflation causing reduced venous return does not occur.

The Leroy and ENK allow expiration through the cannula and do not require disconnection.

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**Slide 14**

Jet oxygenation

*IF there is no saturation reading for whatever reason*

**THEN** it is safe to insufflate 500 mls every 30 seconds if using a 14g cannula and Rapid - O² (Leroy) / ENK (Or disconnected Manujet) even in complete upper airway obstruction.

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Be suspicious of absent chest wall movement. Failure of initial chest rise may be due to either i) kinking or displacement of the cannula or, ii) equipment failure or disconnection.

Recheck the cannula position by saline aspiration and recheck of oxygen connections and oxygen delivery to the device.

Do not continue to jet until cannula position is confirmed, as jetting through a displaced cannula will create subcutaneous emphysema.

Desist immediately if surgical empysema appears.

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If after 20 seconds there is no response or improvement in oxygen saturations despite chest movement, a second jet of 2.0 seconds duration should be administered.
We should maximise expiratory flow through the patient’s airway. An obstructed upper airway can be improved with the usual manoeuvres to open it such as jaw thrust, chin lift or LMA insertion.

**Only jet oxygenate whilst watching for chest wall rise and fall to monitor inspiration, and more importantly, expiration.** This gives a better indication of whether the expiratory pathway is obstructed. This situation could lead to ‘stacking’ of jetted breaths and, in turn, increased risk of barotrauma.

The scalpel-bougie technique
The scalpel-bougie technique is suggested if the cannula cricothyroidotomy or tracheotomy fails and there is palpable neck anatomy. It involves the use of a scalpel to produce a small triangular hole in the cricothyroid membrane (or trachea), through which a bougie is inserted.

If the bougie has a hollow lumen (such as the Frova™ brand) it can be used to oxygenate the patient until a definitive airway is secured. This is achieved by connecting a Rapifit connector whereupon we can ventilate via a standard manual resuscitation bag.

Once the patient is re-oxygenated we proceed with a secondary technique then railroad a size 6 endotracheal tube (ETT) over the bougie and oxygenate using a standard manual resuscitation bag. If the means of oxygenation via the bougie is not immediately available, we should proceed directly to railroading the ETT over the bougie.

This is the equipment that you will need to have ready to perform a Scalpel – Bougie technique.

- A size 10 blade scalpel is recommended as it will be at least as wide as the Frova™ Bougie
- Green gauze to remove blood
- A hollow bougie
- A ‘Rapifit™’ or equivalent connector to allow a standard circuit or self inflating bags to connect to the bougie
- A size 6mm internal diameter endotracheal tube
- A 10 ml syringe to inflate the cuff
- A manual ventilation bag for ventilation
The scalpel-finger-cannula technique is suggested when cannula cricothyroidotomy or tracheotomy has failed and there is no palpable neck anatomy. This technique can also be attempted if the scalpel-bougie technique has failed. It utilises the equipment used for the two other techniques, which we are labelled Kit 1 and Kit 3 in this presentation. It involves the use of a scalpel to make a midline, approximate 8cm vertical incision if possible, followed by blunt dissection with the fingers of both hands to identify the airway. A 14G cannula is then inserted into the airway and the patient re-oxygenated.
Initial re-oxygenation of the patient via one of the cannula-based infraglottic rescue techniques may be life saving, but it is likely that the patient will subsequently require a definitive cuffed airway for both airway protection and ventilation.

We recommend the use of the Melker™ conversion kit as it utilises the existing 14G cannula for a wire-guided seldinger technique to insert a size 5 cuffed tube.

The Melker™ kits come pre-packaged and will contain – a guidewire to pass down the cannula; a dilator that sits within the tracheal tube; a cuffed size 5.0 tracheal tube; a scalpel to enlarge cuts in the skin and tissues as needed and a syringe for inflating the cuff of the tube. We recommend using a size 10 scalpel blade rather than the blade presented in the kit as this limits the depth of insertion of the blade required protecting against posterior wall damage.

Let's now place these techniques within the broader context of the infraglottic airway rescue algorithm.

Firstly let's look at the decision to declare and commence CICO, or Transition. The NAP4 audit found that attempts at infraglottic rescue were often suboptimal and there was a high incidence of failure. Contributing to this were technical factors, poor decision-making and disorganisation. We have created this list to remind us of factors placing us at risk of failure if we have not prepared for them.
This Transition Algorithm assists with recognition and declaration of CICO.

The key points are:

1. The cue for infraglottic rescue is a CICO situation. This is declared when a ‘best’ attempt at each of the three supraglottic rescue lifelines has failed and saturations continue to fall.

2. We should mobilise resources for infraglottic rescue when 2 of the 3 supraglottic rescue lifelines have been tried and failed.
This CICO Team Emergency Protocol guides team members' roles and resource allocation. These are shown in blue to the right of the WA algorithm.

Team roles: Team members should be clear on their roles. We suggest:

- If enough senior people are available it is worthwhile allocating team leader to direct the intervention using the algorithm as a guide.

- A proceduralist to attempt the cannula cricothyroidotomy. The person attempting the infraglottic airway technique should be the most skilled at this procedure available. They should also be the person who is in the best frame of mind to attempt the task. By this we mean that the primary airway doctor, who has initially encountered difficulty and then failed to oxygenate the patient via supraglottic rescue techniques, will likely be highly stressed. In this state they may be less capable of successfully performing infraglottic rescue, even if they are the most experienced or skilled person present. In this case they may be better suited to one of the other roles.

- A second proceduralist must persist with attempts to oxygenate the patient via the three supraglottic lifelines: bag mask ventilation, laryngeal mask airway or endotracheal intubation. This may deliver some oxygen to the patient and buy them some time. Ideally this person would also have an assistant.

- A team member to assist with supraglottic airway rescue.

- A team member to assist the infraglottic airway rescue by preparing the equipment for the cannula technique and handing it to the proceduralist.

- A second assistant should prepare the equipment for jet oxygenation. The cannula cricothyroidotomy may not be successful. Having equipment ready to attempt the next technique will save time and reduce stress. The second assistant should then prepare the equipment for the scalpel-based techniques as well as ensuring that the cardiac arrest trolley is present.

- Someone should record the events. If a spare person is available he or she should scribe as the event unfolds. This person could also cross check activity against the algorithm, keep track of time and report back to the team.

- All team members should feel empowered to voice concerns and verbalise ideas in a productive and useful manner. This will be difficult but especially important in such a stressful situation.