GREATER SYDNEY AREA

HEMS

PREHOSPITAL RSI MANUAL

Version 2.1 Oct 2012

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Foreword

Advanced airway management including rapid sequence intubation (RSI) is a fundamental component of advanced prehospital care. Securing airway patency and protection is an essential skill in caring for the multiply injured patient. It maximises oxygenation of critically injured patients, enables their safe transport to hospital, facilitates neuroprotection as well as rapid in-hospital investigation and definitive care. The extra time spent on scene securing an airway (even by skilled clinicians) is one of the greatest controversies in prehospital care[1]. This time is often offset by the time saved during the transport and in-hospital phases of resuscitation as long as it is performed safely and expeditiously. Prehospital RSI scene times of less than 20min are achievable and should be the target during training.

Prehospital RSI is potentially more risky than in-hospital RSI because of the difficulties of the prehospital environment and therefore every effort must be made to ensure the safety of the procedure. In aviation and military settings it is well accepted, that the higher the acuity of the situation, the greater the need to remove individual procedural preference and the greater the need to adhere to a standard operating procedure.

Aims

This manual describes the indications and procedures to be followed for prehospital emergency anaesthesia. The underlying philosophy is to promote a pre-planned laryngoscopy strategy for First Pass success. It aims to ensure a safe standardised technique for prehospital RSI whilst acknowledging the varied circumstances, environments and pathologies encountered in the prehospital setting. The advice given is derived from the combined experience of a large range of clinicians in prehospital trauma care and is evidence-based where possible. It aims to maximize intubation success at the first attempt thereby avoiding prolonged and multiple attempts and consequent complications. The manual outlines the key theoretical and practical competencies which are assessed in the RSI Clinical Currency.

Note: This manual describes a system for prehospital RSI; however, many of the principles may be translated directly to in-hospital practice, particularly in skill- or resource-limited settings where retrieval team equipment and expertise may be required to provide the most safe and expedient airway management.

Indications for RSI

As with all procedures, the decision to proceed with prehospital RSI must be based on an informed assessment of the risk of the procedure versus the clinical benefits.

The indications for pre-hospital emergency anaesthesia are:

1. **Failure of airway patency**
2. **Failure of airway protection**
3. **Failure of ventilation or oxygenation**
4. **Anticipated clinical course/humanitarian reasons**
5. **To facilitate safe transportation**

1. ***Failure of airway patency*.** Although simple airway manoeuvres and adjuncts such as airway suctioning, chin-lift, oropharyngeal and nasopharyngeal airways may be essential initial measures to open and maintain a non-patent airway, these should be regarded as temporising measures. Such patients will ALL require a secure airway at some point in their resuscitation and this should be considered in the prehospital phase provided it can be done safely and expeditiously.

2. ***Failure of airway protection*.** An unconscious patient with an easily maintained airway and adequate ventilation is still at significant risk of passive regurgitation and aspiration of stomach contents, secretions or blood, particularly if transport times to hospital are prolonged. A patient with an unprotected airway is best defined by their *inability* to prevent aspiration of secretions, blood or vomitus and is indicated by an absence of spontaneous swallowing and/or failure to spontaneously clear blood, saliva or mucous from the oropharynx. Lack of a gag reflex or numerical assessment of GCS (<9) or motor scores (<4) as described by EMST/ATLS[2] CANNOT be relied upon as an indicator of the need for intubation.

3. ***Failure of ventilation or oxygenation*.** Patients with acute ventilatory failure or failure to maintain adequate oxygen saturation despite supplemental oxygen should be considered for pre-hospital emergency anaesthesia and intubation. Such patients may have diminished respiratory drive due to head injury or critical chest injuries impairing ventilation.

4. ***Anticipated clinical course*.** This indication refers to the patient who can be predicted to deteriorate (e.g. head injuries, inhalational burns or spinal injuries) or where emergency anaesthesia will be important in removing the work of breathing in the face of multiple major injuries. In the case of major trauma patients, whose management is certain to include a complex and potentially painful series of procedures and diagnostic evaluations as well as the operating theatre, early anaesthesia and intubation should be considered.

5. ***To facilitate safe transportation*.** A sub-group of patients will require emergency anaesthesia to ensure safe transportation particularly in rotary-winged or fixed-wing aircraft and/or where transport times are prolonged. These patients include agitated or uncooperative head injured patients or those with severe psychiatric disturbance.

Decision to intubate

The decision to induce anaesthesia and perform intubation is made by the TEAM taking the following factors into consideration[3]:

Factors in favour of on-scene RSI	Factors against on-scene RSI
• Impaired airway maintenance and/or protection • Hypoxaemia or hypoventilation, or hyperventilation in patients requiring neuroprotection • Fluctuating or deteriorating level of consciousness • Thermal injury to airway • Penetrating neck injury • Long road or air transfer with risk of deterioration • Polytrauma with requirement for multiple interventions and/or operative procedures • Combativeness • High cervical lesion with diaphragmatic breathing	• Morphology or pathology that may hinder successful intubation (e.g. laryngeal fracture, morbid obesity) • Time critical surgical lesion (e.g. penetrating trauma with shock) • Short distance from most appropriate hospital • Paediatric patients- particularly <5 yo • Hostile environment • Unconducive team dynamics

Urgent Cold Intubation

In certain circumstances it will NOT be appropriate to proceed with full preparation and induction of anaesthesia. Patients who are in respiratory or cardiac arrest or who have agonal respiration do not need a full equipment set-up or checklist run-through (see below) and should be intubated without drugs. If there is residual muscle tone and clear signs of life but the patient is in extremis consideration should be given to intubation using paralysis only.

Standard RSI

Standard intubation or RSI is the central component of prehospital emergency anaesthesia. It is divided into ten conceptual and practical stages (adapted from Ron Walls – Manual of Emergency Airway Management)[4]. The specifics of each phase in prehospital RSI are given below.

1. **Preparation**
2. **Patient positioning**
3. **Pre-oxygenation**
4. **Pre-treatment**
5. **Paralysis with induction**
6. **Protection and positioning**
7. **Placement with proof**
8. **Plan for failed intubation**
9. **Post-intubation management**
10. **Packaging and transfer**

1. *Preparation*

- All patients should have an assessment made as to the likelihood of successful intubation and of successful bag-valve-mask ventilation in the event of failure to intubate. It should be noted that many of the features predictive of a difficult airway, which may be useful in other settings, lack sensitivity and specificity in the prehospital environment and many aspects of a routine pre-anaesthetic assessment are obviously impossible or contra-indicated in our practice[5,6]. It is beyond the scope of this document to describe all aspects of airway assessment (although in practice difficult airways are most commonly encountered in severe burns, morbid obesity, dysmorphic syndromes and massive facial or airway injuries.) Notwithstanding, a predicted difficult airway should be considered in the decision-making process prior to RSI. In the prehospital phase it may be possible to maintain a patent airway and transport the patient but in MOST patients RSI will need to proceed with full preparation for a surgical airway in the event of inability to intubate and ventilate. Assessment for a difficult airway forms part of the RSI checklist. The plan for a difficult airway MUST be discussed prior to induction and a specific "Plan B" verbalised during the preparation phase.

Equipment set-up

- The equipment set-up should be **standard and automatic for all RSIs.** This must be drilled and practiced by the prehospital team in scenario training.
- The standard position for the set-up should be adjacent to the right side of the patient's head as shown in the picture. The site needs careful consideration to avoid having to move equipment once laid out.
- Monitoring is best positioned on the right side of the patient with the monitor screen easily visible to the doctor and paramedic. The Retrieval Service Lifepack 15 multimodality monitor should be applied as soon as practicable after arrival on scene to avoid delays in changing over later in the resuscitation. Monitoring should be attached as early as possible (preferably during the doctor's primary assessment.)
- Monitoring will include SpO_2, NIBP (set cycling interval to 3min), ECG and $ETCO_2$[7]. Automated NIBP readings are preferable to manual ones as they avoid prolonged periods without blood pressure readings and result in earlier detection of hypotension. They also facilitate safe post-intubation sedation particularly in head injured patients. The EMMA capnometer is a backup in case of Lifepack 15 ETCO2 failure.
- Equipment bags are best placed around the equipment set-up site as a cordon to prevent interference with the procedure.

Team positioning needs to be planned and practiced during training.

- Oxygen – sufficient oxygen **MUST** be secured for the pre-oxygenation, extrication and transport phases. A minimum of two full C-size cylinders must be made available. It is essential to prepare this EARLY in the procedure particularly if remote from vehicles.
- Suction – the standard prehospital suction device is the Laerdal LCSU-3 compact portable suction unit. Additional sources of suction include a venturi device (from an oxygen cylinder) or vehicle powered suction. Inadequate or failure of suction is a COMMON REASON for intubation failure particularly in facial injuries where bleeding can be torrential and in these cases you can never have too much suction on hand.
- Intravenous access - <u>two secure IV (or IO) lines are ideally required for all RSIs</u>. Experience has shown that failure or partial failure of induction due to tissued cannulae is much more common in prehospital RSIs and is particularly common when IV lines are placed by staff other than the retrieval team. Be VERY aware of this problem. A bag of crystalloid on a pump set should be attached and checked to be running well prior to drug administration, but stopped in between. If a second IV line cannot be placed easily an IO should be inserted.

Personnel

- Allocate tasks: 3 or 4 person technique depending on need for cervical spine immobilisation.
    - In-line cervical spine control
    - Bi-manual larynogoscopy assistant (External Laryngeal Manipulation (ELM))/Cricoid
    - Airway Assistant
    - Laryngoscopist
- The delegation of roles and appropriate briefing of staff is an essential task. The doctor is responsible for delegation of staff and their briefing but both members of the team must be aware of this procedure.
- The retrieval paramedic is responsible for establishing monitoring and for the equipment set-up.
- If there are no features (apart from C-Spine immobilization) to predict a difficult airway the first attempt at laryngoscopy may be taken by the retrieval paramedic with the doctor becoming the airway assistant and available as second operator if laryngoscopy proves to be difficult. This enables the doctor to maintain the clinical overview of the procedure. All registrars should take a turn at performing laryngoscopy in the prehospital setting during their term and this should be discussed prior to arrival at the scene.
- **If a difficult airway is anticipated or adequate pre-oxygenation is difficult then the physician should perform the laryngoscopy.**
- Non-retrieval service staff **should not perform laryngoscopy for RSI regardless of experience** unless they have previously practiced or drilled our RSI procedure and they are RSI current.
- Staff positioning is shown in the picture with In-line cervical immobilization and OELM assistant on the left of the patient.
- It is important for these staff to be appropriately briefed. The In-line cervical immobilization assistant is positioned on the left of the patient which keeps the right side clear for the equipment set-up and monitoring.
- The In-line cervical Immobilization operator should be briefed to keep their hands away from the mandible and their arms in line with the long axis of the patient out of the way of the laryngoscopist.

Equipment set-up is aided by the printed template.

CRM Issues

- The key to minimizing scene times is ensuring SIMULTANEOUS ACTIVITY AT ALL TIMES during resuscitation and nowhere is this more important than during RSI.
- Always introduce yourselves on arrival and if you can, try to remember the names and designations of staff as you listen to their handover. Most staff are happy to have us there but the service (and the likelihood of our being requested in the future) depends on maintaining good working relationships with on-scene crews.
- It is vital that the on-scene paramedics be involved in the resuscitation. This may well be their only serious trauma case for the year and it is essential to involve them as active participants; always being mindful of their skills.
- Always consider whether other on-scene staff can be utilized for tasks such as splintage, cannulation, setting up fluids or fetching equipment to free up the clinical team to perform tasks only we can perform (such as the equipment set-up or surgical procedures).
- The team need to think several steps ahead and anticipate the need for equipment such as oxygen, suction, a stretcher and the means and route of transport which all of which will be time-consuming if done in a serial fashion.
- There should NEVER be on-scene staff standing around quietly watching – there are MANY things to do at once. Even non-medical staff such as fire crew and police can be utilised to create a cordon, remove curious onlookers or act as a drip stand!

2. *Patient Positioning*

- Ensure adequate access to the casualty. Intubation is RARELY necessary in the position in which the injured person is found. The first task after deciding to intubate is to locate the most appropriate place to perform the procedure.
- Patients should be extricated to a safe environment (facilitated by analgesia, sedation and regional anaesthetic techniques) e.g. to the roadside on an ambulance stretcher.
- Intubation of patients on the ground is much more difficult and only very rarely necessary.
- Prehospital anaesthesia should usually only be undertaken when the casualty is in the supine position with relatively easy and full access. The ideal position for intubation is on a stretcher or raised platform with 360 ^{o} access. (for example on an ambulance or retrieval stretcher with legs retracted (fully down) at the rear of a vehicle. If the team plan to depart to hospital by helicopter then ideally RSI will occur next to the EC145 or inside the AW 139 (with the stretcher fully extended). Experience has shown that intubation <u>inside</u> an ambulance vehicle or confined space is more difficult and increases the chances of failure and therefore 360^{o} access to the patient should be obtained where possible. A temporary airway adjunct may be useful whilst repositioning.
- Positioning the patient just outside the rear of a vehicle has several advantages including access to powered suction, additional lighting and oxygen supplies. A second ambulance stretcher is often available and can be used as an ideal workspace for equipment for an RSI.

A second stretcher is a useful workspace.

- Complex extrication movements after anaesthesia are often very difficult and the focus for management of trapped patients should be on ***maintaining oxygenation with rapid extrication*** if the airway is compromised, using airway adjuncts, LMA or in-situ surgical airway.
- Intubation inside an ambulance may occasionally be necessary in severe weather conditions or threatening crowds and this procedure should be practised by all staff.

Laryngoscopist position

- Direct laryngoscopy is the process of bringing the glottis into alignment with the eyes of the operator and as such the doctor or paramedic performing laryngoscopy must maximize their position for laryngoscopy. If the patient cannot be moved from the ground then some of the

choices include:

- ***Kneeling*** – most versatile rough or soiled ground but often difficult to obtain a good view.
- ***Lying Prone*** – gets the eye line right but may put the laryngoscopist at a mechanical disadvantage.
- ***Left lateral Position*** – provides a good eye line and mechanical advantage and comfort may be improved with padding under the left elbow (such as a SAM splint). These techniques may be best practiced in scenario training.

3. Pre-oxygenation

- Pre-oxygenation is essential for safe anaesthesia and RSI. It should proceed throughout the preparation phase above. Pre-oxygenation de-nitrogenates and establishes an oxygen reservoir in the lungs, blood and tissues and, if effective, will allow several minutes of apnoea without O_2 desaturation and the need to ventilate the patient. Two nasopharyngeal airways and an oropharyngeal airway with jaw thrust ("Tripod" or "supported Tripod" (with jaw thrust) technique) should be used if there is difficulty maintaining an open airway.
- Head injury is NOT an absolute contra-indication to the CAREFUL placement of a nasopharyngeal airway.

Apnoeic Diffusion Oxygenation (ADO)

- Studies have demonstrated that during apnoea (following muscle relaxant administration in RSI), supplying oxygen to a patent airway can significantly prolong safe apnoea time before desaturation occurs[9,10,11,12]. This phenomenon is well described in brainstem death testing protocols where oxygenation can be maintained for long periods without ventilation when oxygen is supplied to apnoeic patients via the tracheal tube. The physiology is relatively straightforward; during apnoea, oxygen is continuously absorbed into the blood from the FRC at a rate of approximately 250mL/min whilst CO_2 continues to accumulate in the blood, only slowly diffusing into the aveoli at a rate of approximately 10mL/min[13]. This differential creates sub-atmospheric alveolar pressure and a net inflow of gas into the lungs of around 240mL/min in the average anaesthetised human, provided the airway is kept patent. If oxygen (rather than room air) is supplied then the oxygen reservoir in the lungs can be maintained for extended periods. In our setting this is best accomplished by administration of high flow oxygen at 15L/min by nasal cannulae just prior to induction (before the pre-RSI challenge/response checklist is completed) and left on until successful tracheal intubation is accomplished. The airway is naturally opened during laryngoscopic attempts and this can be augmented by airway adjuncts or jaw thrust. It is also worth noting that the use of nasal cannulae in addition to NRB or BVM for pre-oxygenation has been shown to significantly increase FIO_2 in spontaneously breathing patients by washing out ventilatory dead space with oxygen in-between spontaneous breaths[14] and thus increases the effectiveness of pre-oxygenation.

- There are 2 alternatives for effective prehospital pre-oxygenation in addition to high flow nasal cannulae.

  A. In a spontaneously breathing patient with adequate ventilation 3-5 minutes of high flow O_2 via a tight fitting non-rebreathing mask with reservoir (in addition to high flow nasal cannulae) is usually adequate and this reduces the number of assistants needed.

  B. If the patient (and number of assistants allows), a bag-valve-mask (BVM) (100% O_2) with a two handed technique may be used. This will tie up 1 or 2 team members during a critical phase of preparation. This is the preferred technique if full oxygenation (SaO2 > 98%) cannot be achieved with a non-rebreathing mask (with high flow nasal cannulae). The gooseneck and ETCO2 sensor can be placed in the breathing circuit to monitor pre-oxygenation.

Circuit with ETCO2 in-line

- If the patient's spontaneous ventilation is inadequate then assisted BVM ventilation will be required.
- In certain critically ill patients, even with effective 2 person assisted BVM ventilation oxygen saturation may remain suboptimal and the intubation may need to proceed anyway, as long as all reasonable measures to correct hypoxia have been instituted. This is a matter for clinical judgement on the part of the team.
- In patients with severe facial injuries with severe airway bleeding consideration should be given to pre-oxygenation in the lateral position to allow airway toilet with movement to supine position immediately after induction.

4. Pre-treatment

- Combative, agitated or uncooperative patients who need intubation are a particular challenge in the pre-hospital setting.
- Pre-treatment with small titrated doses of ketamine (10-20mg) to a total of 0.5 -1mg/kg can be very effective in order to facilitate further assessment, monitoring and then pre-oxygenation of these patients. This has been described as "Delayed Sequence Intubation"[15] or Titrated Ketamine Induction by some authors but simply refers to the use of ketamine to sedate a patient in order to facilitate pre-oxygenation for intubation.
- Compelling evidence for atropine pre-treatment in paediatrics is lacking and the incidence of bradycardia seems to be related more to episodes of hypoxia rather than pharmacological or reflex effects[16]. In children under 8 yrs old atropine (20mcg/kg) may be drawn up in case of bradycardia.
- Other pre-treatment regimens such as fentanyl, lidocaine or de-fasciculating doses of paralytics are not well supported by the literature and inevitably delay and complicate standard RSI[17, 18].

5. Paralysis with induction

- Immediately prior to induction the RSI checklist should be completed. This is a challenge-response list which aims to identify and correct issues prior to intubation.
- The team member who completed the kit dump reads out the list and the assistant responds to the challenge as each element is identified and checked. Whilst it can feel like a long time to read through the checklist, it rarely takes more than 30 secs and it has proved its effectiveness in trapping errors and preventing threats to patients safety.
- All drugs should be given into a running line or flushed in with a bolus of normal saline by one of the team – usually the doctor.
- IV induction agent- Ketamine (1.5mg/kg rounded down to 100mg) is the preferred induction agent with a much safer haemodynamic profile than available alternatives[19].
- In significantly hypovolaemic patients, induction may unmask compensatory vasoconstriction and they should be given a half dose of ketamine (0.5-1 mg/kg) for induction. Blood pressure is often maintained despite significant blood loss in young patients and a reduced pulse pressure with diastolic hypertension should be heeded as a warning sign of hypovolaemia. Other signs of hypovolaemia include increased respiratory rate, skin pallor or mottling, cool skin temperature and

visibly collapsed veins. Be very aware of these secondary signs of hypovolaemia prior to induction.

- In unconscious peri-arrest patients induction drugs may be omitted and a muscle relaxant only intubation performed.
- If the patient is hypertensive initially then an alternative agent such as thiopentone may be preferred.
- IV Suxamethonium (1.5-2mg/kg) or Rocuronium 1.2mg/kg are the preferred muscle relaxants for RSI. High dose Rocuronium has some practical and theoretical advantages over suxamethonium including a better safety profile, longer duration of action, and a longer time till patients suffer oxygen desaturation, though Suxamethonium retains the advantage of a slightly faster onset (45 vs 60sec) and the onset and cessation of fasciculations remain useful indicators of muscle relaxation in most patients. It is worth noting that a small but significant proportion of patients do not fasciculate following Suxamethonium administration especially if the cardiac output is low.
- Whilst awaiting full relaxation it is useful to warn bystanders of impending cessation of respiration as this can be disturbing to the uninitiated onlooker.
- Fluid bolus of 20-30mL (immediately after each drug) to ensure effective central distribution.
- If $Sa0_2$ begins to fall prior to full relaxation then gentle interposed ventilation should be used to maintain oxygenation.
- Oxygenation continues even after the onset of apnoea provided an oxygen gradient is maintained between pharynx and alveoli. The team should ensure that the mask is not removed from the patient's face until the moment of commencement of laryngoscopy, usually marked by apnoea AND the identification of flaccid jaw tone.
- A common mistake in the enthusiasm to secure the airway is to undertake laryngoscopy prior to adequate relaxation (usually present at 45 seconds) and the laryngoscopist must ensure full relaxation prior to attempted laryngoscopy.

• 6. Protection and positioning

Cricoid Pressure

- There is no evidence that even well applied cricoid pressure (Sellick's Manoeuvre) prevents passive aspiration. It is most commonly poorly performed. There is evidence that cricoid pressure may reduce tone at the lower oesophageal sphincter[20], significantly impair laryngoscopic view and cause unwanted movements of the cervical spine[21]. It should no longer be routinely applied to patients undergoing prehospital RSI. If the clinician decides to use cricoid pressure for the RSI they must ensure the cricoid operator is briefed appropriately and cricoid pressure removed if laryngoscopic view is difficult.
- External Laryngeal Manipulation (ELM) has been demonstrated to improve laryngoscopic view[22] and **should be used whenever initial view is suboptimal.** The laryngoscopist manipulates the thyroid cartilage to maximize their view and an assistant can be directed to hold the thyroid cartilage in position during intubation. It is important to recognize the difference between this technique and cricoid pressure.
- The uncleared C-spine should be routinely protected in all blunt trauma patients and this should be performed by an assistant holding the head from the left side of the patient. The Cervical collar **should be open** and the mandible free of any restrictions for intubation.
- In most adult patients lying supine on a stretcher or extrication board causes significant neck extension and this is exaggerated in those with a large body habitus. This should be corrected by placing a folded towel or SAM splint beneath the occiput to maintain a neutral head position. A neutral position reduces stress on the possibly injured cervical spine, improves the patency of the airway and facilitates direct laryngoscopy. If cervical spine precautions are not needed (for example some burns patients or following submersion incidents) the patient should be postioned in the "Ear to Sternal Notch Postion" (ESP) which greatly improves laryngoscopic view.

7. Placement with proof

- Approximately 45-60 seconds after muscle relaxant administration, the jaw should be tested for flaccidity and laryngoscopy attempted. **There is always time to perform laryngoscopy gently and carefully.**
- The tracheal bougie should be used for **ALL** prehospital intubations. Use of an intubating bougie

is associated with higher success rates, particularly on first attempt[23]. It reduces the chance of being unable to pass a tube when the glottis is well visualised and may reduce cervical movement required to perform intubation.

- A straight bougie with coude tip is easiest to use and it should be straightened as far as possible prior to use.
- The bougie should be used naked with the assistant supporting the free end or pre-loaded with 6-8cm of bougie protruding.
- Experienced operators should consider obtaining the minimal acceptable view which allows intubation as this may reduce cervical movement, though this should not endanger the success of the procedure.
- The tip of a bougie is placed a few centimetres into the trachea. It is VITAL that the laryngoscopist maintains their view THROUGHOUT tube passage and the team-work of the airway assistant is essential in this regard.

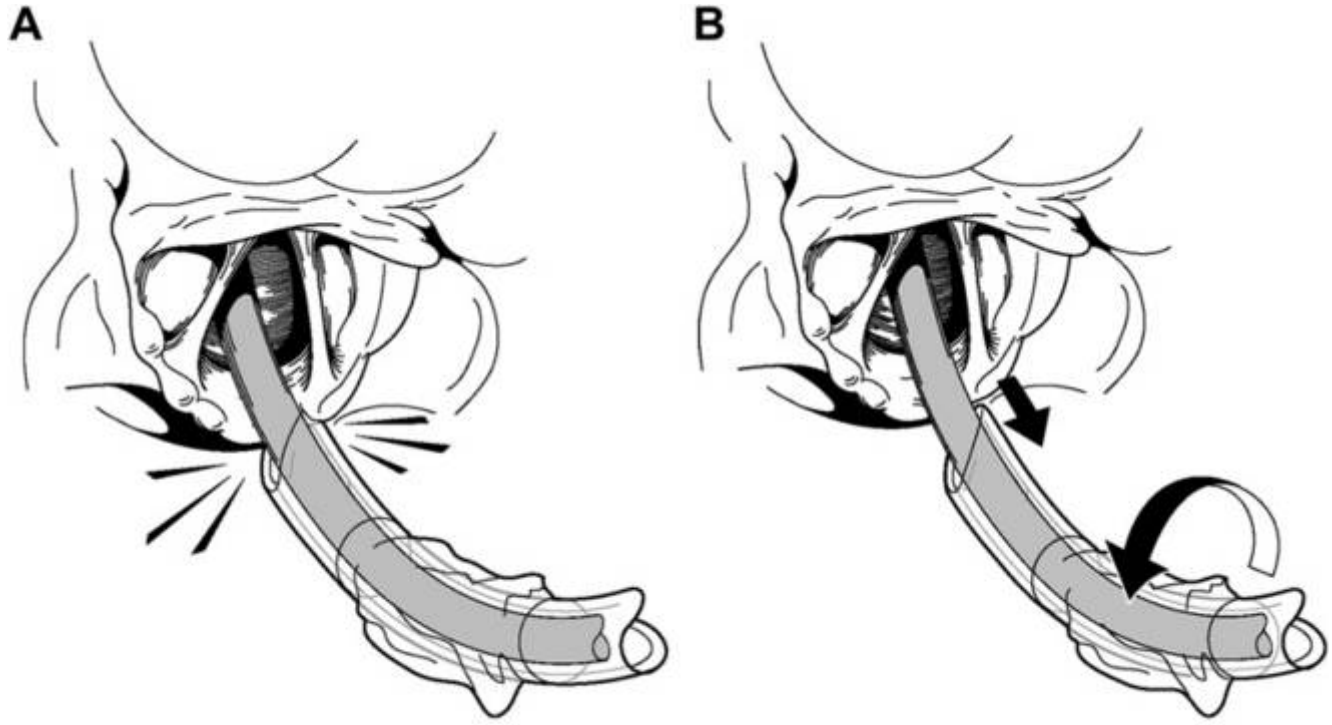
- **The laryngoscopist MUST communicate clearly with the assistant throughout the procedure.** It is useful to verbalize the view of the epiglottis and then the cords to the assistant. The POGO score (percentage of glottic opening) visualised is a useful shorthand.
- Sometimes the tube will not pass easily along the bougie and catches on the arytenoid cartilage or right vocal cord. This can be managed by slow **anticlockwise** rotation of the tube. Alternatively the flip/flop manoeuvre may be used[23]. The tube should be pulled back 2-3cm and rotated (FLIP) 90^0 anticlockwise allowing the tip of the tube to clear the vocal fold and pass through the larynx. In this orientation the tracheal tube blocks the view so as soon as the tip passes through the cords FLOP the tube back 90^0 clockwise and observe the cuff passing through the cords. This should be practiced during scenario work.

- If the tracheal tube is too large it may not pass even with rotation and a smaller tube should be substituted.
- Care must be taken when using a bougie to avoid intubating the right main stem bronchus and this is best achieved by watching the tube pass into the trachea until the cuff *just* disappears and then immediately noting the length of the tube at the teeth. The black line on the tracheal tube should still be visible.
- In bright sunlight it will be necessary to utilise an assistant to provide shade over the patient's head in order to enhance contrast within the airway
- Once the tube is in place and the cuff inflated, correct tube placement should be confirmed immediately.
- Beware the tube that does not look far enough (less that 19 to 20 cm) in and has a small but persistent leak. The cuff may have become displaced outside the cords on inflation leaving just the tip between the cords. In this position the tip can be displaced into the pharynx with the smallest patient movement.

Determination of correct tube placement

- **See the tube passing through the cords**
- **Palpation of tube movement within the larynx and trachea**
- **See the chest expand equally with each ventilation**
- **Auscultation of breath sounds**
- **Absence of epigastric sounds with respiration**
- **End Tidal CO_2 monitoring (waveform or quantitative)**

- Clinical signs alone are not sufficiently reliable in the prehospital environment and **tube placement MUST always be confirmed by end tidal CO_2 detection**.
- Disposable qualitative $ETCO_2$ detectors may be used as a backup in case of failure of waveform or quantitative capnography. These devices undergo a colour change when expired CO_2 passes across their surface. The colour change is from purple (room air) to yellow (4% CO_2). At least 6 tidal volumes should be given before these detectors are used to confirm tracheal tube position[18]. Once tube placement is confirmed it should be secured in place. Particular care must be taken in the paediatric patient and use of Leukoplast (brown tape) is recommended.



A common cause of difficulty when railroading a tracheal tube over the bougie.

***(A)** Tracheal tube tip caught on the right arytenoid as it is being railroaded over the introducer.*

*Corrective manoeuvres: **(B)** Tracheal tube is withdrawn 2 cm to disengage the arytenoids and counterclockwise rotation of tracheal tube 90^0 to orient the bevel posteriorly. The bevel is then facing posteriorly and allows for smooth passage through the glottis.*

8. Plan for failed intubation

- The plan for failed intubation should be discussed by the team prior to intubation.
- Actions on first failed intubation during standard RSI:

1. Return to 2 person bag-valve-mask ventilation with adjuncts as required (supported Tripod) to maintain oxygenation if the patient desaturates.

2. Where an adequate view cannot be obtained a further attempt may be undertaken provided deliberate steps have been taken to identify and rectify the problem causing the failure and that oxygenation can be maintained between attempts. These are the 30 sec drills[25] (so named because they should be easily performed long before a normal pre-oxygenated patient begins to desaturate).

30 sec Drills

- **Release cricoid and use bi-manual laryngoscopy (OELM)**
- **Optimise operator position**
- **Optimise patient position (small pad under the head with neck in neutral position)**
- **Use better suction where secretions or blood block the view**
- **The laryngoscope can be inserted deeply and slowly withdrawn until identifiable anatomy is seen**
- **Consider changing laryngoscope blade size or type**

- The key to the management of failed intubation is early recognition of the problem and not persevering in the face of a desaturating patient. See the discussion of Failed Intubation.

9. Post Intubation Management

- It is important to avoid a post-intubation lull in tempo and vigilance. This is the time when serious errors are most likely. It is possible for the tube to become dislodged, monitoring to become disconnected, ongoing sedation to be forgotten and no one remember to bag-ventilate the now paralysed patient. The team must remain vigilant to avoid such errors.
- Be very aware of post RSI complications such as bradycardia (hypoxia, suxamethonium) and hypotension (over sedation), development of tension pneumothorax and inadequate or hyperventilation.

- Commence maintenance of anaesthesia with:
  - **Morphine or fentanyl for analgesia**
  - **Midazolam for sedation**
  - **Rocuronium for long acting muscle relaxation**

- Anaesthesia should be extended using Morphine and Midazolam which should be repeated at regular intervals in ~2mg boluses titrated to avoid signs of awareness (tachycardia, hypertension, eye watering, sweating, symmetrical pupil dilatation). Fentanyl is an appropriate alternative.
- Further muscle relaxant Rocuronium should be administered at a dose of 0.6mg/kg (~50mg) every 30-40 minutes.
- Overzealous positive pressure ventilation (particularly in hypotensive patients) by increasing intrathoracic pressure and reducing venous return may reduce cardiac output. Six to eight breaths per minute at tidal volumes of approximately 8-10ml/kg may be adequate to maintain oxygenation without impairing cardiac output[27].
- End-tidal CO_2 should be kept within physiological values around 30-35mmHg particularly in head injured patients.

somewhere in the breathing circuit, **pneumothorax** and equipment failures such as malassembly or malfunction should be sought.

- Gastric decompression with an orogastric tube should also be considered particularly in children and in patients who have had a period of bag-valve-mask ventilation.

10. Packaging and Transfer

- All tubes and lines must be **absolutely secure** and the tracheal tube should be controlled by a member of the team for all transfers, as the risk of tube dislodgment is highest during transfers.
- Careful observation of PR, BP, presence or absence of sweating, lacrimation and pupil size and their reaction is required throughout transfer to detect under-sedation.
- Full monitoring should be maintained throughout transfer (the minimum standard is continuous SpO_2, intermittent NIBP, continuous ECG and continuous waveform $ETCO_2$ [7].
- Directed observations of the patient from observing skin colour, chest movement and pattern of respiration, following the circuit from the patient to the ventilator and noting monitoring and alarms should be repeated every few minutes.
- Full documentation should be carried out and a copy given to the receiving hospital.

RSI CHALLENGE/RESPONSE CHECKLIST

Greater Sydney Area HEMS
RSI challenge-response checklist

Patient position optimised	Check
O2 sufficient = 2 bottles	Check
Preoxygenation – [Nasal Prongs considered]	Check
Suction tested – [second suction considered]	Check
Monitor: ECG, NIBP, SpO2, waveform CO2	Check
IVI / Drugs	
Fluid connected, runs easily	Check
BP cuff on contralateral arm, BP seen	Check
Spare cannula in	Check
RSI drugs prepared, doses selected	Check
Intubation Equipment	
BVM	Check
OPA & 2 NPAs	Check
Laryngoscope tested	Check
Tube size chosen, cuff tested	Check
Alternate Tube	Check
Syringe	Check
Bougie	Check
Circuit: catheter mount (gooseneck), filter, capnography	Check
Tube tie	Check
Team Brief	
C-Spine immobiliser briefed – Collar open	Check
ELM / Cricoid assistant briefed	Check
Difficult laryngoscopy plan briefed	Check
LMA	Check
Crike set	Check

'Failed' Laryngoscopy

Failed intubation "algorithms" are often used in anaesthetic and emergency practice[28] and whilst it is essential that the team has a specific plan for failed intubation this will often be dependent on the patient position, the presence of other injuries (such as chest or facial trauma) and the skills of the operator. As such we present the important issues and encourage the team to think about and discuss the plan for a failed intubation for each case. This forms part of the pre-RSI checklist.

- The essential recovery action is to maintain oxygenation of the patient.
- BVM ventilation with 2 person technique and full airway adjuncts – guedel and 2 nasopharyngeal airways (Supported Tripod) should be the reflex fall-back position.
- If ventilation is not possible then, in most patients, LMA insertion will be the most appropriate technique. The Laryngeal Mask Airway (LMA) is a temporising measure as it provides no airway protection though if transport times are short and oxygenation is being maintained it may be appropriate to transport the patient with LMA in place.
- For a subgroup of patients *insertion* of an LMA is likely to be impossible. These patients include those with restricted mouth opening (burns, facial trauma) or where there is obstruction or distortion of the airway.
- Patients with significant chest wall injuries may be impossible to *ventilate* with the LMA due to the high pressures needed and this can often be predicted during patient assessment.
- The surgical cricothyroidotomy will be the primary mode of securing ventilation and the airway in some patients listed above and the final step in a "can't intubate/ can't ventilate" situation. As such the team need to be well drilled in the procedure and confident of success. The most common mistake in performance of surgical cricothyroidotomy relate to a delay **making the decision** so that by the time the procedure is performed there has been significant hypoxia and the enhanced stress of falling oxygenation impairs the performance of the procedure.
- There is a subgroup of patients for whom surgical cricothyroidotomy may be the primary means of securing the airway without a preceding attempt at RSI. These include full thickness facial/neck burns where neck movement is severely limited, massive maxillo-facial haemorrhage and the entrapped patient with airway compromise who cannot be extricated and access is impaired.
- A simple surgical technique for performing cricothyroidotomy is described below and experience suggests it may avoid some of the common complications.
- Rarely it is appropriate to allow paralysis to wear off and let the patient wake to pre-RSI status. Most of our patients are intubated for emergent reasons and need their airway securing by another means.
- In children less than 8 yrs old needle cricothyroidotomy may enable oxygenation without ventilation for a 10-20min window, but the lack of a satisfactory fall back position (like surgical cricothyroidotomy) is an important consideration in the decision making process regarding paediatric RSI.

Specific Populations

Paediatric RSI

Prehospital anaesthesia of small children is only rarely required. The risk/benefit equation is altered by the increased complexity of the procedure, tendency to desaturate much earlier and the dangers of drug dosage errors[29]. Where intubation is needed the anaesthetic doses and equipment sizes should be calculated independently by each team member and results compared. The paediatric dosage "cheat" sheets are helpful in these calculations.

Hypovolaemic patients

Hypovolaemic, and particularly frankly hypotensive, patients are at risk of decompensation and cardiac arrest during induction and immediately following positive pressure ventilation. This may relate to loss of vasomotor tone, peripheral vasodilatation, reduced venous return, increased intrathoracic pressures or complications such as tension pneumothorax. The warning signs of compensated hypovolaemia have been discussed in the section on induction. The advice to reduce the dose of induction agent in such patients is reiterated here. A fluid bolus immediately prior to induction should also be considered. In patients who are in extremis, intubation with suxamethonium only may be necessary.

Obese Patients

Patients with large body habitus present many problems for resuscitation not least of which is a tendency to desaturate earlier as well as a more difficult airway. The most experienced intubator should make the first attempt at laryngoscopy. Such patients tend to lie supine with significant neck extension in a cervical collar which can make intubation impossible. This problem is also commonly seen in patients with motorcycle leathers or other bulky clothing under them. A pad under the occiput to bring the neck into neutral alignment is essential in these patients.

Burns

Patients with severe burns are challenging both clinically and psychologically. The airway should be secured early in patients with suspected airway burns. Patients with airway burns have a high risk of developing airway swelling which can make subsequent oral intubation impossible. The signs of airway burns include stridor, dysphonia, odynophagia, visible burns or soot deposition in the oropharynx, presence of full thickness facial or neck burns and the presence of inhalational injury. Inhalational injury occurs when superheated gases form in a confined space or very close to the face and are breathed in. This can make preoxygenation and ventilation difficult and consideration should be given to preoxygenation in the sitting position prior to induction. Inability to ventilate may be caused by full thickness burns to the chest requiring on-scene escharotomy. Most patients are completely alert despite severe burns and adequate sedation and analgesia must be given during and following induction of anaesthesia. Ketamine remains an excellent choice for such patients and doses needed may be high. As discussed above, severe full thickness burns of the neck or face can make oral intubation or LMA insertion impossible and a surgical airway may be the primary mode of securing the airway in such patients.

Winch Primaries

Though performing an RSI following a winch primary with no other staff or equipment present on-scene is fortunately uncommon, it has certainly been performed in this service. The challenges are many. The increased difficulties include very limited oxygen supplies, difficult environment or terrain, need for stabilisation during the winching procedure where capacity for monitoring or intervening are extremely limited and of course the fact that only 2 personnel are present. If prehospital information suggests the possibility of a winch primary requiring RSI the clinical team must brief their plan, equipment to be winched, lines of communication and the extrication plan in detail. In addition to the usual equipment packs, oxygen should be winched using the winching bag. The LifePack 15 is cumbersome in winching situations and basic monitoring with oxygen saturation monitoring, manual BP or pulse checks and EMMA capnometry is recommended. Scenario training is the best place to practice this challenging contingency.

Surgical Cricothyroidotomy

The surgical airway equipment should be removed from its pouch when it is anticipated that an airway will be particularly difficult. For example:

- Airway trauma
- Difficult anatomy
- Burns to face and neck reducing jaw movement
- Possible airway burns

The technique of surgical crico-thyroidotomy is based on published literature[30], animal and cadaver simulations as well as service experience. It is rapid and reliable. It aims to address several problems which may be seen in the prehospital setting which make some other techniques less appropriate. The most common challenges encountered when performing surgical airway are:

- Delay in decision-making
- Significant bleeding from the incision
- Inability to instrument the incision with unfamiliar equipment in time-critical situations.

It is a one person technique which relies on sense of touch rather than visualisation of structures and which is applicable to any situation requiring surgical access to the airway in patients older than 8yrs.

Technique

Locate
The crico-thyroid membrane must be located with certainty prior to commencing the procedure. This should be done prior to RSI in any patient with a predicted difficult airway and is assisted by physically marking the neck with pen or marker. In patients where the anatomy cannot be easily palpated such as obsese patients, those with significant neck soft tissue or a short neck, a long midline longitudinal incision should be made to facilitate accurate identification of the crico-thyroid membrane.

Grip
The larynx must be firmly secured between the thumb and middle finger to prevent movement during the incision. The index finger should be used to locate the cricoid ring and crico-thyroid membrane. Any movement of the larynx during the incision must be prevented.

Incise
Once the crico-thyroid membrane has been definitively located by surface palpation or palpation through a midline longitudinal incision, a “stabbing/rocking incision is made through the crico-thyroid membrane taking care to avoid injuring the posterior wall.

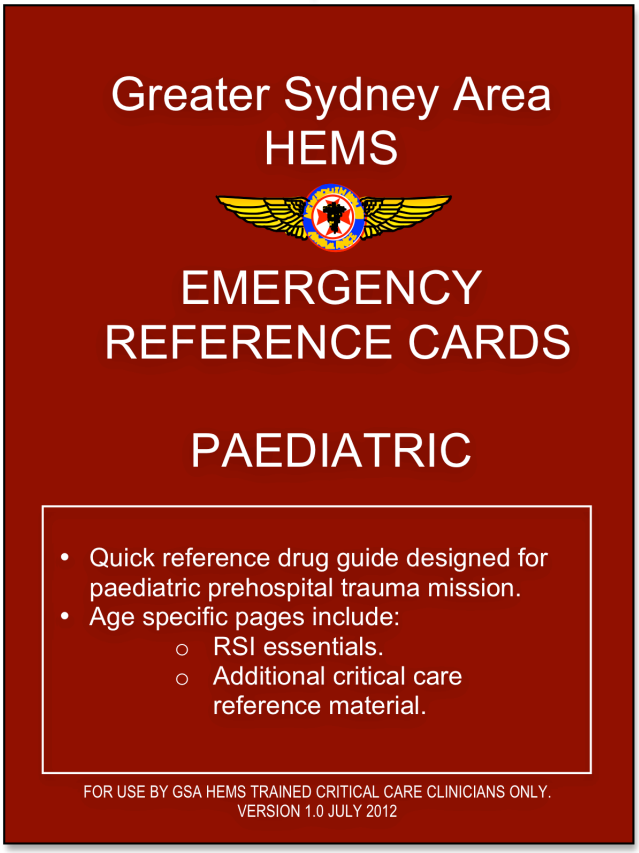
Finger
The incision is then directly probed using the small finger of either hand. The finger performs several important roles: as a highly sensitive probe and dilator and definitively confirms tracheal position prior to insertion of the bougie and tube. The tracheal rings MUST be felt before proceeding further.

Bougie
A paediatric tracheal bougie is then placed alongside the little finger though the incision and confirmed to be within the trachea by palpation.

Tube
A size 6.0 tracheal tube is then railroaded over the bougie into the trachea, ensuring the cuff is within the trachea and the cuff inflated. The tube can be cut short to reduce the chance of displacement. The tube can be tied and taped in position.

Confirm
ETCO2 MUST be used to confirm tracheal placement and continuously monitored to ensure the airway remains patent. Sudden loss of ETCO2 suggests displacement of the tube or device related failure

Paediatric Dosing Booklet



PAEDIATRIC Emergency Reference Card – GSA HEMS.

NEWBORN – 4kg

Rapid Sequence Induction

ETT Size - 3		ETT Length-10cm	
Laryngoscope blade	Miller 1	iGel size – N/A	
		DOSE	VOLUME
Ketamine (10mg/mL) *REDUCE INDUCTION DOSE IN SHOCK*			
Induction (2mg/kg)		8mg	0.8mL
Sedation (0.5mg/kg)		2mg	0.2mL
Sux	2mg/kg 50mg/mL	8mg	0.2mL
Rocuronium	1.2mg/kg 10mg/mL	5mg	0.5mL
Morphine	0.1mg/kg 1mg/mL	0.4mg	0.4mL
Midazolam	0.1mg/kg 1mg/mL	0.4mg	0.4mL

All doses are IV/IO

GSA HEMS 2012

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