


GREATER SYDNEY AREA HEMS

Aeromedical Operations, NSW Ambulance

# PREHOSPITAL RAPID SEQUENCE INTUBATION MANUAL

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GREATER SYDNEY AREA HEMS

# PREHOSPITAL EMERGENCY ANAESTHESIA MANUAL

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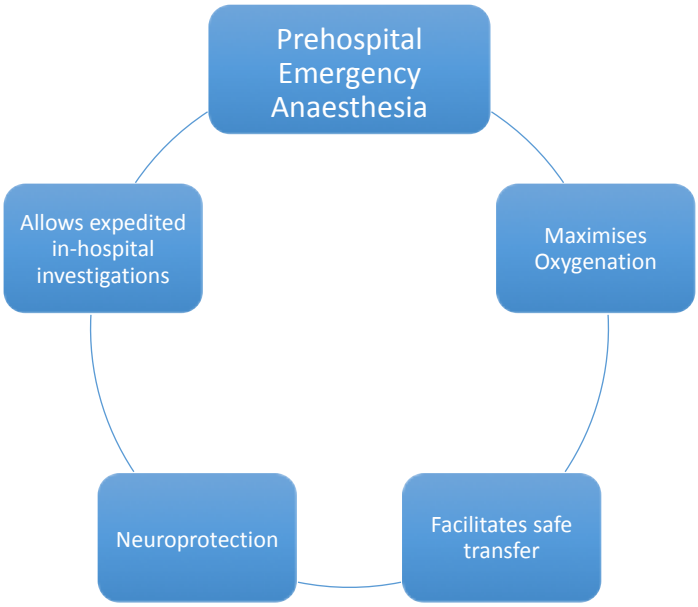
## FOREWORD

This is version four of the Greater Sydney Area HEMS prehospital emergency anaesthesia/rapid sequence intubation manual. It draws on the collective wisdom of all our staff over many years. We thank them all. Sydney HEMS currently perform in the region of 280 prehospital RSIs each year. This manual supports the standard operating procedures (known as clinical practice standard) and online learning for new staff.

The use of drugs (especially paralysis) to achieve definitive airway management, commonly called 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 surgical care. The extra time spent on scene securing an airway (even by skilled clinicians) is one of the greatest controversies in prehospital care[1]. The time spent managing the airway is offset by the time saved during the transport and in-hospital phases of resuscitation as long as it is performed safely and expeditiously. Prehospital emergency anaesthesia scene times of less than 20min are achievable and should be the target during training.




Prehospital emergency anaesthesia is potentially riskier than in-hospital general anaesthesia because of the challenges presented by 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 for as well as the procedures to be followed for prehospital emergency anaesthesia. The underlying philosophy is to promote a pre-planned laryngoscopy strategy for **first look success**. This avoids prolonged and multiple attempts and consequent complications [34]. It aims to ensure a safe standardised technique for prehospital emergency anaesthesia while 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.

Note: This manual describes a system for prehospital emergency anaesthesia; 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 safest and most expedient advanced airway management.

This manual does not describe the training, documentation, currencies and clinical governance framework for prehospital RSI at Sydney HEMS that underpin this practice. This manual is not aimed to be complete manual of prehospital airway management and decision making. No intervention, Bag mask ventilation, laryngeal mask airways and surgical airways may be preferred options in some cases.

## INDICATIONS FOR RAPID SEQUENCE INTUBATION

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 prehospital rapid sequence intubation are:

- Failure of airway patency
- Failure of airway protection
- Failure of ventilation or oxygenation
- Anticipated clinical course / humanitarian reasons
- To facilitate safe transportation

### FAILURE OF AIRWAY PATENCY.

Although simple airway manoeuvres and adjuncts such as positioning, airway suctioning, jaw thrust, oropharyngeal and nasopharyngeal airways, and laryngeal mask airways may be essential initial measures to open and maintain a non-patent airway, these should be regarded as temporising measures. All patient with non-patent airways will require a secure airway at some point in their resuscitation and ideally this should be performed as soon as possible in the prehospital phase provided it can be done safely and expeditiously. The use of laryngeal masks such as the IGEL are not proved in our service outside of cardiac arrest management, and we continue to define definitive airways as ‘cuffed tubes in tracheas’. There is insufficient reassuring information regarding LMA performance in flight transfer of RSI patients to advocate for their use.

### 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 GCS <9 as described by EMST/ATLS[2] or even GCS motor scores (<4) CANNOT be relied upon as the sole indicator of the need for intubation.

### FAILURE OF VENTILATION OR OXYGENATION.

Patients with acute ventilatory failure or failure to maintain adequate oxygen saturation despite supplemental oxygen should be considered for prehospital emergency anaesthesia and intubation. Such patients may have diminished respiratory drive due to head injury or critical chest injuries impairing ventilation. Early intubation is desirable in such patients.

### ANTICIPATED CLINICAL COURSE OR HUMANITARIAN REASONS.

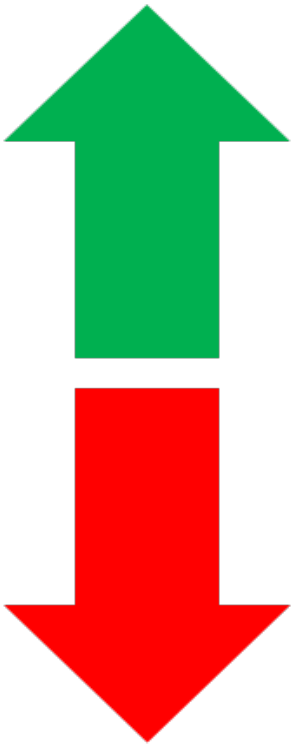
This indication refers to the patient who can be predicted to deteriorate (e.g. head injuries, inhalational burns or high spinal injuries) or where intubation and ventilation will be important in removing the work of breathing in the face of multiple major injuries. In the case of major trauma patients, whose management is certain to include a potentially painful series of procedures and diagnostic evaluations as well as the operating theatre, early anaesthesia and intubation should be considered. Intubation can allow for larger doses of analgesia and amnesics to be safely given.

### 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 patients (e.g. head injury) or those with severe psychiatric disturbance.

## DECISION TO INTUBATE

The decision to induce anaesthesia and perform intubation is a medical team decision taking the following factors into consideration[3]:



### Factors in favour of on-scene RSI

- Impaired airway patency/protection
- Hypoxia/hypoventilation, or hyperventilation in neuroprotection
- Fluctuating/deteriorating conscious level
- Thermal or Neck injury risking airway swelling
- Long transfer with risk of deterioration
- Polytrauma with need for multiple interventions
- Tiring breathing in high spinal lesion
- Combativeness
- Patient threat to team/flight safety
- High analgesia requirement
- Out of hours/understaffed destination

### Factors against on-scene RSI

- Time critical hospital intervention (e.g. haemorrhage control, PCI, clot retrieval)
- Short time to appropriate hospital
- Hostile scene
- Intubation & Rescue airways likely impossible
- More favourable location nearby or enroute
- Mass casualty event with unsurvivable injury

Alternatives to on-scene intubation may include stopping a road vehicle to intubate en route as needed. Team safety of not being restrained in a moving vehicle needs to be considered, as does the space constraints within vehicles. As a general rule, intubation before transport is preferable.

## URGENT COLD INTUBATION

Patients who are in respiratory or cardiac arrest may be intubated without drugs. The “Cold Intubation Checklist” should be used in these cases. ICP paramedics in NSW have access to intubation checklists that are an acceptable alternative checklist.

Paralysis should be considered for patients not in full cardiac arrest to reduce vocal cord movement and coughing with intubation. Circulation times and hence drug onset will be slowed.

Rarely, in periarrest patients, oxygenation is not possible via BVM or LMA until paralysis is given. Paralysis may allow manual ventilations and prevent hypoxic arrest whilst intubation equipment is being prepared.

Surgical airways are acceptable first line airways. They do not always have to be preceded by an intubation attempt.

An LMA (IGEL) can be a good temporising airway when tolerated; and when functioning well can be used as a definitive airway during cardiac arrest management.

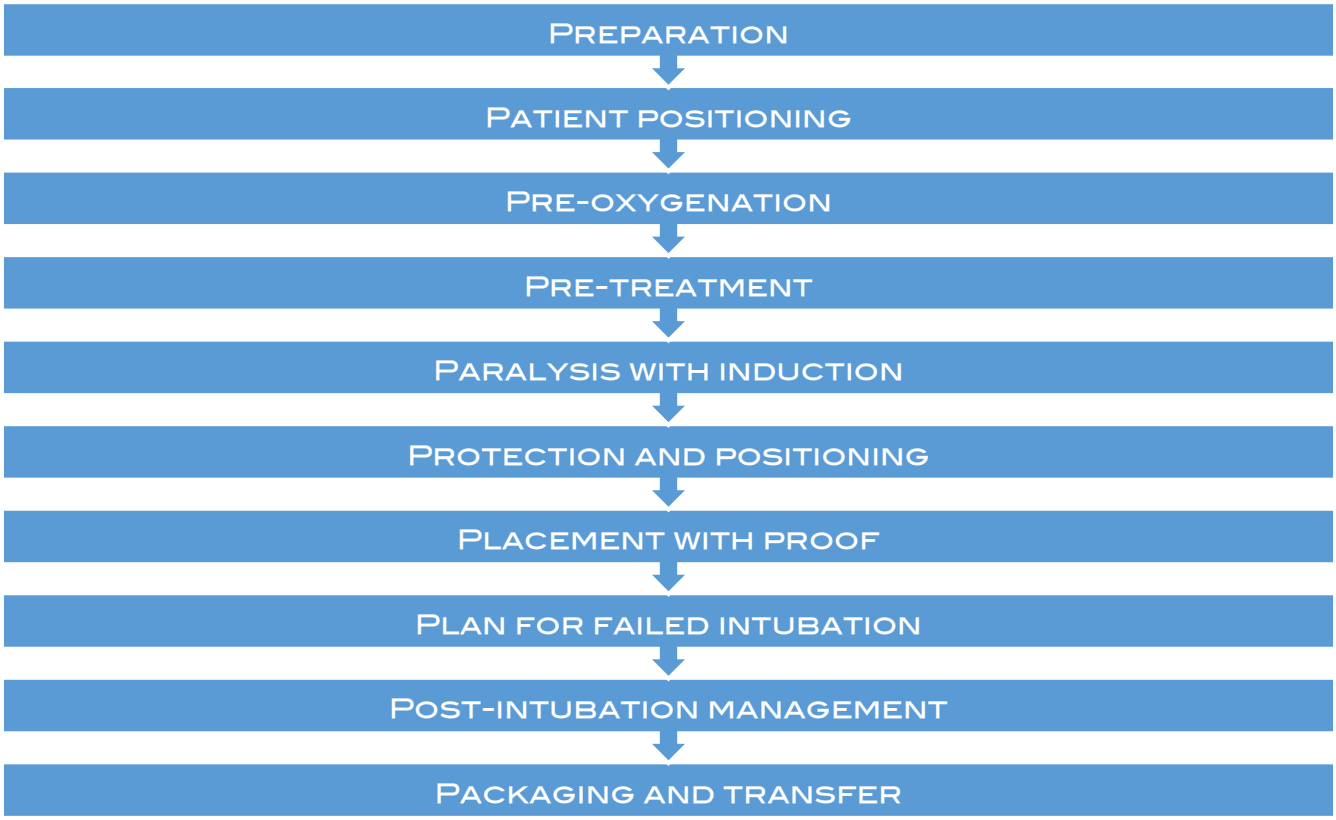
Intubations for patients in cardiac arrest are usually delegated to others on scene. Positioning with the LUCAS mechanical CPR device can be challenging. Blood on the CMAC camera is more likely with compressions. Sedation and paralysis may be necessary when manual chest compressions (LUCAS device) creates muscle tone and/or consciousness. Drug onset will be prolonged. During medical cardiac arrest, the usual considerations for minimising interruptions to chest compressions apply.

**Greater Sydney Area HEMS**
**COLD INTUBATION ACTION CARD**

| |
|---|
| Patient OXYGENATED |
| Patient POSITION OPTIMISED |
| LARYNGOSCOPE tested |
| SUCTION working |
| BOUGIE |
| TUBE and TIE |
| SYRINGE for cuff |
| ETCO2 (waveform or EMMA) |

## STANDARD PREHOSPITAL RAPID SEQUENCE INTUBATION

Tracheal intubation following induction/paralysis is the central component of prehospital emergency anaesthesia. It is divided into ten conceptual and practical stages that follow the decision to intubate (adapted from Ron Walls – Manual of Emergency Airway Management)[4].




### 1. PREPARATION - SELF, TEAM, EQUIPMENT/ENVIRONMENT, PATIENT

Following the decision to intubate, is a team plan on where the intubation is to take place. Rarely are patients intubated where they are found. 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.

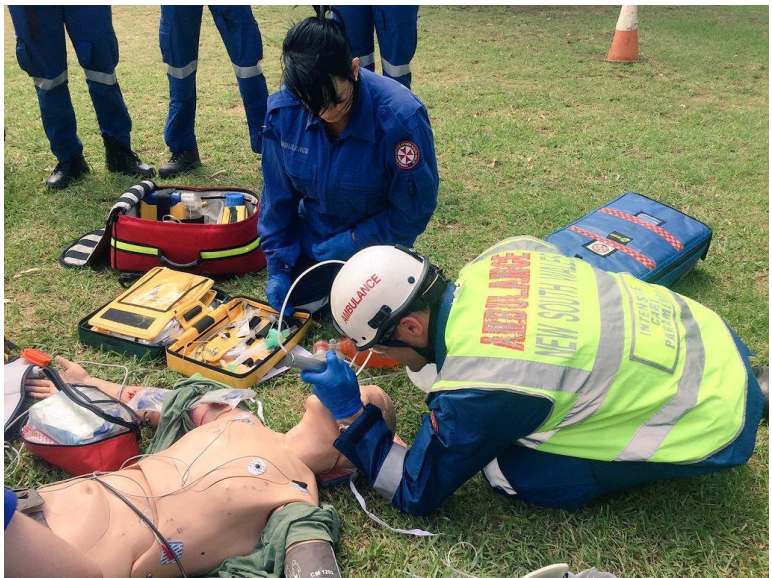
Preparation includes preparation for failure. All patients should have an assessment made as to the likelihood of successful intubation and bag-valve-mask ventilation/surgical airway in the event of failure to intubate. Predicting difficult intubation in prehospital environments is challenging [35] not withstanding gross anatomical abnormalities or deformity due to injury. The factors for and against scene RSI already mentioned should be considered.

Verbalising the Airway Plan is the first step of the RSI checklist.

#### SELF & TEAM

- Early consideration of PPE for self & team - eye wear, masks, gloves, +/- gown etc as appropriate to context.
- Allocate tasks
    - Operator/Laryngoscopist - retrieval team member
    - Airway Assistant / ELM - retrieval team member
    - MILS (Manual In-line immobilisation of cervical spine) - local team under supervision


- 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.
- Optional roles - timing 60 seconds for paralysis and event marking monitor.
- The critical care paramedic is usually responsible for establishing monitoring and the RSI equipment set-up. When they are engaged in scene management/extrication tasks the doctor is expected to be able to fill this role.
- If there are no features (apart from C-Spine immobilisation) to predict a difficult airway and full pre-oxygenation can be achieved 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.
- Paramedics must be up to date for the Prehospital Emergency Anaesthesia Currency to perform laryngoscopy.
- Flight nurses are not sufficiently drilled in our procedures to be intubators - and should be airway assistants the same as non-current critical care paramedics.
- 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 emergency anaesthesia regardless of experience** unless they have previously practiced or drilled our procedure and remain current for the procedure.
- Staff positioning is shown in the picture with in-line cervical immobilisation on the left of the patient keeping the right side clear for the equipment set-up, airway assistant and monitoring.
- Airway Assisting is not a familiar skill to many doctors. Scenario training helps. Assistants need to be familiar with equipment - which is left in the kit dump area unless in use and the patter and two person interaction of the



intubation procedure.

- It is important for ancillary staff to be appropriately briefed on their expected role and actions. The in-line cervical immobilisation 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 - MONITORING, DRUGS, AIRWAY KIT

- The equipment set-up should be **standard and automatic for all prehospital emergency anaesthetics.** The set-up must be drilled and practiced by the medical team in scenario training.

- The standard position for the equipment set-up should be adjacent to the patient's right shoulder at a comfortable height. The site needs careful consideration to avoid having to move equipment once laid out. Avoid intubating in direct bright sunlight as this can adversely affect visualisation of glottic structures – use shade or an assistant to shield the intubator with a blanket during the procedure.

- Monitoring is best positioned with the monitor screen easily visible to the doctor and paramedic. The retrieval service Zoll X-Series 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 - see 'Prehospital Mission Workflow' Clinical Practice Standard.) Ideally monitors allow recording and printing.

- 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 main monitor ETCO2 failure. **$ETCO_2$ monitoring must be used whenever a BVM is applied to a patient whether by face-mask, SGA or tracheal tube.** It is the most important monitor of ventilation and airway patency. Loss of $ETCO_2$ trace indicates a loss of airway patency until proven otherwise (equipment failure/circuit disconnection etc).

- In winch access monitoring consists of finger probe $SpO_2$, EMMA capnometer, and manual bp.

- Oxygen – sufficient oxygen **MUST** be secured for the pre-oxygenation, extrication and transport phases. A minimum of two full CD 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. Potential for fluid soiling during laryngoscopy (blood, gastric contents or pulmonary oedema) should prompt two functioning suction units immediately to hand.

- Keep the wide bore (DuCanto) suction catheter as primary suction.

- The Laerdal unit has a limited battery life - only turn on when checking or actually in use. The fluid chamber is limited in size and liquid levels must not reach the white entrance port. Keep vertical. An extended length suction unit is carried by the team to swap with the vehicle tubing to allow vehicle suction to reach a set up at the back doors of the ambulance vehicle.

- A plastic bag should be ready to accept soiled airway kit.
- The airway kit-dump is designed to stay within the borders of the bag to help protect from wind. Off the ground is safest.
- In busy scene ground level RSIs, equipment bags are best placed around the equipment set-up site as a cordon to prevent interference with the procedure.
- Drugs - predawn medications need to be readied for use - removing all plastic casing.

## PATIENT

- Ideally on a stretcher, positioned for RSI, with clothes removed, monitor applied, oxygen & basic splinting as required and able. RSI should follow the primary survey.
- Intravenous access - two secure IV (or IO) lines are ideally required for all emergency anaesthetics. Failure of induction (total or partial) due to tissued cannulae is not uncommon in prehospital care. BE 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. Even flushed lines can later tissue, especially after movement. An ultrasound guided cannula generally takes longer than an IO.
- The team may plan interventions before or after RSI as dictated by patient and context. The checklist will prompt consideration of haemodynamics (e.g. blood bolus) and oxygenation (e.g. needle decompression/assist ventilate) pre RSI.

## CREW RESOURCE MANAGEMENT ISSUES

- The key to minimising scene times is ensuring SIMULTANEOUS ACTIVITY AT ALL TIMES during resuscitation and nowhere is this more important than during emergency anaesthesia.
- 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 utilised 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.
- Intubation of patients on the ground is much more difficult and only very rarely necessary. If intubating on the ground - a rehearsal of intubator position is essential - see below.
- Prehospital anaesthesia should usually be undertaken when the casualty is in the supine position, with occipital pad, and relatively easy and full access. The ideal position for intubation is on a stretcher or raised platform with 360 º access. A height adjustable ambulance stretcher at the rear of a vehicle is ideal. The momentum after RSI is to then complete post intubation checks and load straight into the vehicle.
- The head of the stretcher should ideally be inclined 10-20 degrees head up with an occipital pad in place, and height adjusted to the operator.
- For bariatric patients, the anatomical positioning of C spine can be hard to judge. Ear to sternal notch RAMPING position should be considered for both oxygenation and intubation benefits.
- If travelling by helicopter an option is with the helicopter stretcher partially loaded in to the side of the AW 139 (stretcher East-West). Be aware of the fixed height of this stretcher, although head up tilt is possible. 360 access is not complete so concurrent activity of splinting etc is more difficult, but the location of monitoring, ventilator and syringe drivers on the bridge is convenient. The fixed height may suit one team member over another.
- Intubation inside an ambulance vehicle (road, rotary or fixed wing) or confined space is more difficult and increases the chances of failure. 360º access to the patient should be obtained where possible. Intubation inside an ambulance may occasionally be necessary in severe weather conditions or threatening crowds and this procedure should be practised by all staff. The extra difficulty of changing position inside a vehicle should be taken into account when deciding on operator.
- 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 emergency anaesthesia.


A second stretcher acts as an excellent work station

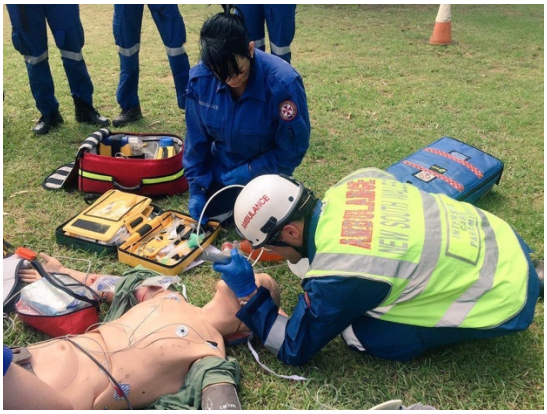
- Complex extrication movements after anaesthesia are often difficult and the focus for management of trapped patients should be on **maintaining oxygenation with rapid extrication** if the airway is compromised, under airway adjuncts, supraglottic airway (SGA) such as the IGEL, or in-situ surgical airway.
- In remote settings such as winch access, patient positioning to allow access and comfortable laryngoscopist position usually involve using natural surroundings +/- the winch basket to get patients off the ground.
- An extrication device provides a good inclined position for intubation in a rescue basket.

Whilst intubating at the back of a road vehicle is our standard approach, rescue basket RSI, loaded into helo or within a road vehicle (e.g. in bad weather) may be best.

## 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 maximise their position for laryngoscopy.
- With height adjustable stretchers the intubator should have stretcher height adjusted to them.
- In non-stretcher situations, consider the best positioning of operator eye to patient larynx. Either and/or both patient and operator may need moving. Video laryngoscopy can partially compensate for difficult positioning.
- If the patient cannot be moved from the ground then operator position is critical and must be practiced in advance in simulation. Kneeling rarely works. You should try these to see which suits you best:
    - ***Kneeling*** – most versatile rough or soiled ground but often difficult to obtain a good view. Most people's body lengths are too long and keep eyes too high.
    - ***Lying Prone*** – gets the eye line right but may put the laryngoscopist at a mechanical disadvantage and needs space behind the casualty.
    - ***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).


Lying - note occipital pad & airway positioning still essential




Kneeling - note lean to left to lower eyeline

Sitting may suit some intubators

## 3. PRE-OXYGENATION

**STANDARD APPROACH - BVM-PEEP-NC with good facemask seal and $ETCO_2$ trace**

- In the majority of missions there will be adequate personnel and oxygen sources to provide standard pre-oxygenation. In our service the standard approach uses a BVM with PEEP valve (default set at 5cm $H_2O$) applied tightly to the patient's face with 2-handed technique with Nasal Prongs running at 10L/min.
- Pre-oxygenation is essential for safe prehospital emergency anaesthesia. It should proceed throughout the preparation phase above. Commonly nasal cannulae are added underneath the Non rebreather bag (NRB)/trauma mask to a second oxygen source during preparation for RSI; and the NRB replaced by a well sealed BVM facemask with PEEP valve for the final preoxygenation at the start of the checklist.


- Use of nasal cannulae and facemask require two Oxygen sources.
- Nasal cannulae as an adjunct to BVM preoxygenation should be used at at least 10lpm [40].
- PreOxygenation is dependent upon an open airway. Two nasopharyngeal airways and an oropharyngeal airway with jaw thrust ("Tripod") 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.
- Studies on healthy volunteers have shown the $FiO_2$ from a well sealed BVM to exceed that of the traditional NRB. A 'leaky' BVM seal is approximate to an NRB. With a leaky BVM facemask, or an NRB, nasal cannulae improve $FiO_2$. A good seal is best [41]. The facemask seal with any required airway opening manoeuvres needs to be continued until laryngoscopy.
- The PEEP valve on the BVM provides some continuous positive airway pressure generated by the flow from the nasal cannulae. In the absence of nasal cannulae flow, the PEEP is only maintained by gas flow during exhalation and is quickly lost during apnoea.

- The $FiO_2$ of BVMs vary by manufacturer and ventilation. Our Orange Laerdal device requires an exhalation cap or PEEP valve to allow $FiO_2$ of 100% with spontaneous ventilation. The Ambu device provides $FiO_2$ 100% for SV.

- Classic pre-oxygenation de-nitrogenates the functional residual capacity so establishing an oxygen reservoir in the lungs, blood and tissues which, if effective, may allow several minutes of apnoea without $O_2$ desaturation and the need to ventilate the patient. This reservoir buys time for laryngoscopy and intubation. The reservoir may be increased by head up positioning and PEEP; but is reduced by patient's chest injuries and hypoventilation.

- In practice most prehospital patients are already on non-rebreather mask $O_2$. At decision for RSI the nasal cannulae are added during set up with the final preoxygenation of BVM-PEEP-NC with good facemask seal completed during the checklist. This incremental style allows for effective preoxygenation in the minute it takes to do the checklist.

- The catheter mount ("goose neck"), HME filter and $ETCO_2$ sensor should always be placed in the breathing circuit to monitor pre-oxygenation. The $ETCO_2$ waveform becomes a the key measure of ventilation, gives early warning of airway obstruction or leak and indicates onset of paralysis following rocuronium administration. Manual facemask ventilation should always generate an $ETCO_2$ trace.

- BVM-assisted ventilations are mandatory when the patient has inadequate spontaneous ventilations. Controlled hand ventilation during apnoea to avoid hypoxia may be considered when patient's physiology and suspected injuries make desaturation during apnoea likely.

- PEEP may reduce venous return in shocked patients during preoxygenation. PEEP related haemodynamic changes require dose reduction of anaesthetic and/or blood transfusion when the patient is "PEEP sensitive". Positive pressure ventilation after intubation will increase this haemodynamic change.

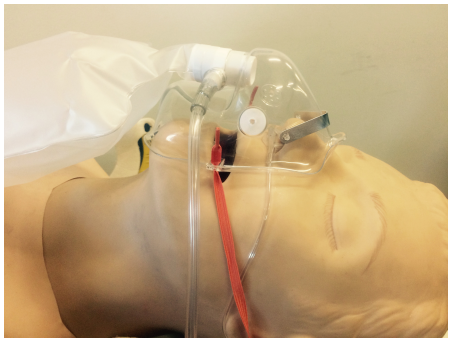
- In patients with severe facial injuries with severe airway bleeding consideration should be given to pre-oxygenation in the lateral position to allow airway toilet with movement to supine position immediately after induction.

- PreOxygenation is an opportunity to consider the patients oxygenation needs throughout the RSI; including use of LMA or facemask ventilation in addition to nasal cannulae flow during apnoea.

- In several cases of trismus, the team has found a small dose of ketamine to be very effective to improve airway and oxygenation.

**AUSTERE ENVIRONMENT APPROACH**

In a small number of missions there will not be adequate numbers of staff or oxygen sources to apply the standard approach. Such missions include winch accessed casualties or remote environments and a tight-fitting non-rebreathing mask with reservoir +/- high flow nasal cannulae may be utilised.



## 4. PRE-TREATMENT

- Combative, agitated or uncooperative patients who need intubation are a particular challenge in the prehospital setting.
- Pre-treatment with small titrated doses of ketamine (10-40mg) to a total of 0.5 -1mg/kg can be very effective in order to facilitate further assessment, monitoring and effective pre-oxygenation of these patients. This has been described as “Delayed Sequence Intubation”[16] by some authors but simply refers to the use of ketamine to sedate a patient in order to facilitate pre-oxygenation for intubation “sedate to preoxygenate”. Controlling the patient for preoxygenation is preferable to pushing on with paralysis is a poorly oxygenated patient.
- Evidence for atropine pre-treatment in paediatrics is lacking and bradycardia may be more related to hypoxia[17]. Atropine is therefore not routinely drawn up for paediatric intubation.
- Fentanyl may have some protective effects against the downstream hypertensive response to ketamine and intubation in haemodynamically stable patients although the clinical significance of this is unknown and the literature is minimal. Its co-administration at induction is an option but tends not to be used by the majority of GSA-HEMS physicians as it may cause delayed hypotension.


- Other pre-treatment regimens such as lidocaine and de-fasciculating doses of paralytics are not well supported by the literature and inevitably delay and complicate standard emergency anaesthesia[18, 19].
- Pre-treatment can also include actions to reduce the impact of the induction & paralysing agents. Hypoxia remaining after airway care should prompt reconsideration of needle pleural decompression pre-RSI, and need for blood products before RSI considered in shock.

## 5. PARALYSIS WITH INDUCTION

- Immediately prior to induction the Emergency Anaesthesia Pre-intubation Checklist should be completed. This challenge-response list identifies and catches common prehospital RSI errors. The team member who completed the kit dump (usually the paramedic) reads out the list and the assistant responds to the challenge as each element is identified and checked. The checklist traps errors, allows everyone to focus on the task in hand, and provides up to a minute of focused preoxygenation. Announcing the start of the checklist to the assembled team can help with CRM and control background noise.
- All drugs should be given into a running line or flushed in with a bolus of crystalloid by one of the retrieval team (usually the doctor).
- IV induction agent. ketamine (1.5-2mg/kg) is the preferred induction agent for prehospital emergency anaesthesia with a much safer haemodynamic profile than available alternatives[20].
- In significantly hypovolaemic patients, a reduced dose of ketamine (0.5-1 mg/kg) is given as requirements are less. Co-administration of blood products should be considered. Signs of hypovolaemia may include: reduced pulse pressure or loss of peripheral pulses, increased respiratory rate, skin pallor, cool skin, and collapsed veins.
- In unconscious peri-arrest patients a muscle relaxant only intubation may be preferred with rocuronium 2mg/kg.
- If the patient is hypertensive initially or at risk from isolated raised intracranial pressure then an alternative agent such as thiopentone may be used. Prehospital status epilepticus or suspected medical intracranial haemorrhage are examples. Fentanyl pretreatment can also be effective but be alert to hypoventilation during preoxygenation, and post intubation hypotension.

- IV rocuronium 2 mg/kg is the preferred muscle relaxant for emergency anaesthesia as it may reduce oxygen consumption compared with suxamethonium and maintains paralysis in case of a need for SGA rescue or surgical airway. The maximum required dose in 200mg in bariatrics. 2mg/kg may provide up to 2 hours paralysis. Onset time is approximately 60s, which is best timed using a team member. Monitoring can be event marked.

- Whilst awaiting full relaxation it is useful to warn bystanders of impending cessation of respiration as this can be disturbing to the uninitiated onlooker.

- Apnoeic oxygenation continues after the cessation of spontaneous respirations provided oxygen is supplied and the airway is open. The patient will need their airway holding open with manual manoeuvres +/- airway adjuncts. Oxygen needs to be delivered by facemask +/- nasal prongs. The mask should not be removed from the patient's face until laryngoscopy after the identification of flaccid jaw tone.

- If $SaO_2$ begins to fall prior to full relaxation then gentle ventilation should be used to maintain oxygenation with $ETCO_2$ waveform scrutinised to ensure effective ventilation. Two person (four handed) BVM is best with adjuncts.

- It is helpful if the use of ventilation during apnoea is discussed in the airway plan. Hypoxic patients, or those at risk of hypoxia during apnoea, as well as the severely acidotic patient may benefit from ventilation.

- Ensure full relaxation.  A common mistake in the enthusiasm to secure the airway is to undertake laryngoscopy prior to adequate relaxation (usually complete at 60 seconds) and the laryngoscopist must ensure full relaxation prior to attempted laryngoscopy by testing jaw tone. Asking an assistant to call out  at 60s can prompt the team to check jaw tone.

- A further period of apnoeic oxygenation occurs during laryngoscopy with the use of nasal cannulae. This practice has been shown to reduce the rates of patient desaturation in prehospital RSI [41].

# Greater Sydney Area HEMS
## Prehospital Emergency Anaesthesia Checklist
v 5.1 May 2024

| | |
|---|---|
| PPE worn | Check |
| Airway Plan Verbalised | Check |
| Haemodynamics optimised | Check |
| Optimal position: Off ground, Occiput elevated, Head up, Shade | Check |
| O2 sufficient = 2 bottles | Check |
| Preox – [BVM inflating, PEEP, Nasal Prongs at 10L] | Check |
| Suction tested – [second suction considered] | Check |
| ECG, NIBP cycling, SpO2, waveform CO2 seen | Check |
| Fluid runs easily | Check |
| BP cuff on opposite arm | Check |
| Spare cannula | Check |
| Drugs and doses | Check |
| Neck stabilised, collar open | Check |
| OPA & NPAs | Check |
| Laryngoscope bright | Check |
| Tube, size *n* | Check |
| Spare Tube | Check |
| Syringe | Check |
| Bougie chosen | Check |
| Circuit: catheter mount (gooseneck), filter, capnograph | Check |
| Tube tie | Check |
| iGel | Check |
| Crike set | Check |

***"CHECKS COMPLETE. ANAESTHETISING AT --/--"***

**Press and hold CMAC Record Button**

**Paediatric Considerations**

**Ear to sternal notch. Gastric tube. Omit Gooseneck. Adhesive tape to secure tube**

## 6. PROTECTION AND POSITIONING

### CRICOID PRESSURE

- **Cricoid pressure is not routinely used in the service.** There is little evidence that even well applied cricoid pressure (Sellick's Manoeuvre) prevents passive regurgitation and aspiration. It is commonly poorly performed. It may reduce tone at the lower oesophageal sphincter[21], impair laryngoscopic view and railroading over a bougie, and cause movement of the cervical spine[22]. If the clinician decides to use cricoid pressure they must ensure the cricoid operator is briefed appropriately and cricoid pressure removed if laryngoscopic view is difficult, or railroading isn't smooth.

- **External Laryngeal Manipulation (ELM)** (or 'bimanual laryngoscopy' or 'BURP backwards upwards rightwards pressure) should be considered part of good two handed laryngoscopy technique. It improves laryngoscopic view[23] and **should be used whenever initial view is suboptimal** as part of the "30 second drills". The laryngoscopist manipulates the laryngeal structures to maximise their view and an assistant can be directed to hold them in position during intubation.

- **The cervical collar should be open and the mandible free of any restrictions for intubation.** The uncleared C-spine is protected in all blunt trauma patients by an assistant holding Manual In-line Stabilisation (MILS). The MILS person stats on the left of the patient, facing the incubator, preventing rotation or sideways movement of maxilla & skull but avoiding the jaw. They forearms should run along the sagittal plane (in line with the patients body) to avoid impeding the laryngoscope handle. The MILS team member may need briefing.

- **Maintaining the neutral position of the C-spine.** In most adult patients, lying supine significant neck extension. This is 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 "Ear to Sternal Notch Position" is strongly preferred.

## 7. PLACEMENT WITH PROOF

- At 60 seconds after muscle relaxant administration, the patient's jaw should be tested for flaccidity and laryngoscopy attempted. **There is always time to perform laryngoscopy gently and carefully.**

- The service is currently using the Storz CMAC Pocket Video Laryngoscope with Mac 4 and Mac 2 blades. The hyperangulated unchanelled D blade in the inter hospital pack is rugged enough for the prehospital environment but rarely indicated, and often distant from RSI location. Interhospital pack flexible scopes should play no role in prehospital intubation.

- Traditional direct laryngoscope with Mac4,2 and straight paeds blade is also available as backup.

- Some ICP Ambulances in NSW now carry McGrath VL device with Mac blades. The CMAC device is preferred.

- The airway assistant needs to be able to reach airway kit, suction, face to retract lip/cheek, and front of neck for ELM but they also need to be able to keep situational awareness (or delegate this) for monitoring and patient. At the side of the patient they are often best placed to assess patient airway positioning. Roles may include all of: retracting cheek, passing suction, ELM and/or occipital lift, passing bougie, reshaping bougie, top end control, feeding ETT, inflating cuff, removing bougie with control, connecting BVM and giving first breaths all whilst watching the video screen to provide confirmatory feedback to the operator. The assistant should be ready to troubleshoot a difficult view with the operator via 30s drills. It is best to leave airway equipment in the kit dump and take out as used so hands are free to perform all these tasks.

**Direct Laryngoscope**

**CMAC Pocket Monitor with Mac 4 DL+VL**

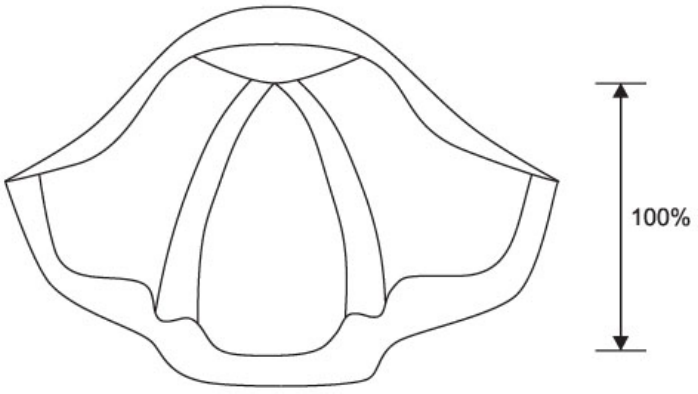
**Mac2**

**McGrath DL+VL**

- The first step of any successful laryngoscopy is to **Open the mouth** to create space for the blade to enter. Dentures may become apparent and are best removed for laryngoscopy.
- **Lead with suction**. Given approximately 30% of prehospital airways require suction [36, 38] it is prudent to expect to need suction. Secretions also threaten the camera lens and screen view.
- The CMAC has a Macintosh shaped blade and as such is used as a traditional Macintosh blade shaped (Direct) Laryngoscope.
- The CMAC screen should be positioned where both team members can see it if necessary. The primary objective is for the operator to perform laryngoscopy and intubate with a direct view, whilst the assistant confirms actions on the screen. ETT depth and cuff inflation are more easily seen on the magnified screen image.
- It has been described that this DL and VL use by the team does not fit well into definitions of DL or VL but is a DL/VL hybrid.
- Reviewing our Sydney HEMS database it is apparent that a larynx lower on the screen is easier to target and intubate than one at the peripheries of the screen [37]. Often an ‘anterior’ larynx appears so because of a sub-glottic blade position, and a ‘lower’ glottis appears with vallecula placement (see pics).

- When using the VL screen, especially when blade tip is below epiglottis, it is possible to be too close and aiming at an anterior angle making bougie and ETT insertion difficult as per hyperangulated blades. Back off the target and accept a <100% POGO view to improve bougie placement.
- Where possible all laryngoscopies should be recorded using the CMAC Pocket record function. Press and hold the record button until it flashes screen. A red dot appears on the screen.
- The **advantage of using DL view** is that the Macintosh laryngoscopy technique is performed better resulting in an improved view, a more direct path to the cords for easier tube placement, and when the video view is lost through secretions and fluids the intubation can continue. Skills are also maintained.
- The laryngoscopist should communicate clearly with the assistant throughout the procedure. It is useful to verbalise the view of the epiglottis and then the cords to the assistant.
- The **POGO score** (percentage of glottic opening) visualised is a useful shorthand (ie POGO 80%, POGO 50%)

- A **bougie** should be used for **ALL** prehospital intubations. Use of an intubating bougie is associated with higher success rates, particularly on first attempt[24]. 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 or slightly curved bougie with coude (angled) tip is easiest to use and the bougie should be pre-shaped prior to use. Bougies often become misshapen in packs and need reshaping before use.
- The bougie should be used naked with the assistant supporting the free end. If intubating as a single operator a preloaded bougie may be needed and like all airway skills needs practising.
- 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.
- 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.
- In the event of a Grade III DL view which does not improve with 30 second drills and is no better on the video screen (if available), a "tactile guided" bougie may be passed under the epiglottis in the midline. Gentle "hold-up" should be felt at around 30 cm and indicates tracheal placement. A bougie in the oesophagus will freely pass into the stomach. A tracheal tube should ONLY BE PLACED if "hold-up" is confirmed when manipulating the bougie. Some instances of false hold up have been described.
- Audit shows that the rare grade IV view is almost always improved by changing patient position (improving head elevation with padding) and operator position (removing patient from ground). Meticulous attention should therefore be paid to optimising these prior to the first attempt. A lack of identifiable structures can also occur from a blade tip that is too deep and has 'gone past' the larynx. Apply anterior life while retracting the blade in the midline to watch for larynx dropping from above.
- 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.




- A constant **patter** of communication flows between the operator and airway assistant during intubation; as the operator says what they can see and the assistant feeds back what they can or cannot see on the screen. Assistant confirmations "Yep - I can see 50% POGO on screen also", and "I have the bougie" allow team working without the operator taking their eyes from the larynx.
- Sometimes the tube will not pass easily along the bougie and catches on the arytenoid cartilage or right vocal cord. Traditional right sided bevels (e.g. paediatric microcuff tubes) need retracting back up the bougie to disimpact from arytenoid then rotated 90 degrees anticlockwise "tip to top" before sliding over bougie into trachea. Parker Tip tubes have their tip sitting on the concave surface of the bougie and hence, if impacted, need retracting from the arytenoid then bougie aligned with the midline of the patient to bring 'tip to top' and allow railroading. Always pull back ETT to disimpact before rotating.

- A smaller size ETT may be needed if arytenoid catch persists.
- To avoid intubating the right main stem bronchus, watch the tube pass into the trachea until the cuff *just* disappears and then immediately noting the length of the tube at the teeth. The upper black line of the Parker tube should still be visible (note black lines are manufacturer dependent and not standardised).
- "Keep the view for $CO_2$". This team dynamic involves the operator maintaining the view with the laryngoscope and holding the ETT after ETT railroad while the assistant inflates cuff, removes bougie to a plastic bag, and attaches bag and ventilates. Fogging is often seen in the ETT whilst the maintained view confirms placement. This needs rehearsal and practice. The advantages are two fold. In the event of $ETCO_2$ monitor failure, the team can confirm tracheal placement visually. Maintaining vision of the cuff position throughout cuff inflation, bougie removal and attaching ventilation reduces accidental extubation at this critical time.
- Laryngoscopy micro skills and common challenges are captured by CMAC videos on the Sydney HEMS website at: https://sydneyhems.com/airway-registry/cmac-videos/
- Cuff inflation should prompt a check of pilot balloon pressure. Immediate cuff leaks are possible from tooth trauma, but also from cuff herniation into the pharynx. Be cautious of repeated cuff reinflations which may represent a slowly migrating cuff.
- Once the tube is in place and the cuff inflated, correct tube placement should be confirmed immediately by waveform capnography. Secure the tube in place. Note depth.
- The appropriate adjunct for paeds tubes is given in the paeds aide memoir. Stylets are preferred for 3.0 & 4.0 tubes. Stylet use should be practiced. Adult intubations with a persistent epiglottis may benefit form a stylet to lift the epiglottis.
- **Tube placement MUST always be confirmed by end tidal $CO_2$ detection**
- A rapidly decreasing or absent $ETCO_2$ trace should prompt checking for cardiac output and evidence of tracheal tube placement. Oesophageal intubation should be the prime suspect. Rarely, extreme bronchospasm in anaphylaxis or ETT blockage (e.g. blood clots) can present with loss of $ETCO_2$ and very high airway pressures/ impossible to bag.

**EMMA (left), Zoll X-Series (right)**


## 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 emergency anaesthesia:

1. Return to 2-person 4-handed BVM ventilation with adjuncts as required (OPAs NPAs) to maintain oxygenation. An LMA may succeed where BVM fails especially with beards. $ETCO_2$ trace confirms ventilations. Consider release of tension pneumothorax with IPPV.
2. Take deliberate steps to identify and rectify the problem causing failure to intubate. Reconsider patient positioning and check equipment ready (camera lens clean) before 2nd attempt.
3. "30 second drills" are so named because they should be easily performed within 30s.

| 30 Second Drills |
|---|
| Use bi-manual laryngoscopy (ELM) |
| Optimise operator position |
| Optimise patient position (small pad under the head with neck in neutral position) |
| Suction where secretions or blood block the view |
| Insert laryngoscope deeply and slowly withdrawn until identifiable anatomy is seen |
| Consider changing laryngoscope, blade size or type |

- The Airway Assistant should use their view of the VL screen to assist the laryngoscopist with attaining best view and both team members should look to the screen if DL view is limited after performing 30s drills.
- The decision to repeat laryngoscopy versus move onto surgical airway in the face of desaturation rests with team view of likelihood of success and time to oxygenation. Persistent attempts to intubate in the face of a desaturating patient are not in the patents best interests.

Common 'actions' on for Grade 3 (epiglottis only) and Grade 4 (tongue only/no laryngeal structures) views.

GRADE IV

- Withdraw laryngoscope and slowly re-insert around the tongue until epiglottis is visualised – "Epiglottoscopy"
- Suctioning of airway secretions or blood
- Provide further head elevation or drop operator eye line
- Deep midline and withdraw watching for larynx dropping from above (VL view best)

GRADE III

- ELM to improve position of laryngoscope tip in vallecula
- Lift up floppy epiglottis directly with blade or styletted ETT
- Reposition airway alignment "ear to sternal notch" (more occipital padding & ramping)
- Guided bougie under epiglottis in midline feeling for gentle "hold-up" at ~ 30cm

- After a second unsuccessful look - An LMA is a temporising measure as it provides little airway protection though if transport times are short by road, and oxygenation is being maintained, it may be appropriate to transport the patient with SGA in place.
- 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 needs to be well drilled in the procedure and confident of success. The most common mistake in performance of surgical cricothyroidotomy relates 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 operator performance. See section below.

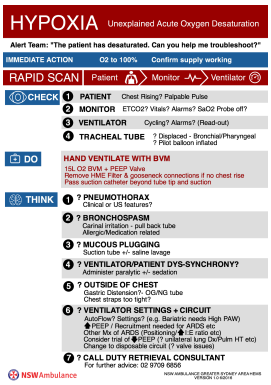
## 9.POST INTUBATION MANAGEMENT

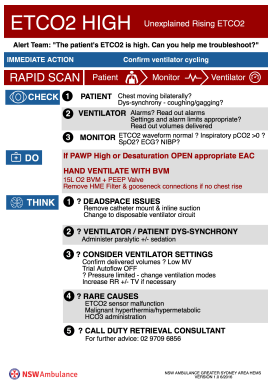
- It is important to avoid a post-intubation lull in tempo and vigilance. This is the time when serious errors are most likely. Problems include accidental extubation, monitoring disconnection, ongoing sedation overlooked, omission of ventilation in the now paralysed patient.
- The team must **remain vigilant** to avoid such errors.
- Watch for post anaesthetic complications such as bradycardia (hypoxia) and hypotension (positive pressure ventilation/over sedation), development of tension pneumothorax and hypo/hyperventilation.
- Consider the following for maintenance of anaesthesia with:
    - Fentanyl for analgesia – loading dose of 50-100mcg followed by infusion or incremental small boluses
    - Midazolam (infusion or 2mg boluses) or ketamine (20mg boluses or 1mg/kg/h infusion) for sedation. Sedation will be needed within 20mins of ketamine induction.
    - Rocuronium after 1-1.5 hours (approx ~50mg every 30 mins in an adult).
    - Opiates, midazolam and ketamine combinations are compatible in one syringe for retrieval.
- Analgesia/sedation should be titrated to avoid signs of noxious stimulation and possible awareness (tachycardia, hypertension, eye watering, sweating, reactive large pupils).
- Overzealous positive pressure ventilation increases intrathoracic pressure, reduces venous return and may reduce cardiac output worsening shock. Low carbon dioxide causes cerebral vasoconstriction and brain ischaemia.
- End-tidal $CO_2$ should be kept within physiological values around 30-35mmHg particularly in head injured patients. Blood $PCO_2$ levels can vary widely from $ETCO_2$. High $ETCO_2$ is to be avoided. Low $ETCO_2$ should prompt review of circulation.
- Ventilation targets of 6-7ml/kg x 16 breaths per min are an appropriate starting point for most adults - paediatric values are given in paeds dosing cards.
- Mechanical ventilation is preferable to 'hand bagging' even for short trips with fewer interruptions to ventilation, controlled pressures, and more consistent minute ventilation. With consistent minute volumes, changes in $ETCO_2$ can reflect changes in cardiac output.
- In some instances (PEEP dependent or respiratory infectious risk) it may be prudent to clamp the tube before disconnecting HMEF circuit to connect or change ventilator.
- If a patient desaturates following intubation and ventilation, (DOPES) displacement of the tube, obstruction 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

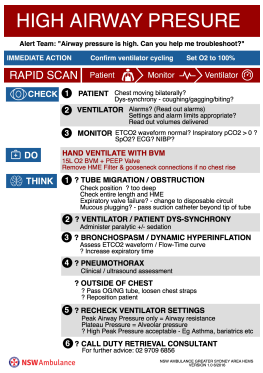
who have had a period of bag-valve-mask ventilation.

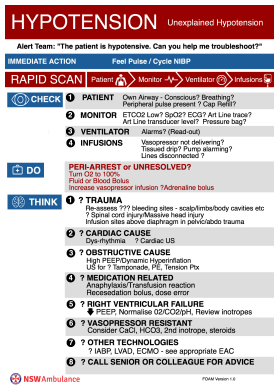
- Intubation is the start of the patients critical care, e.g. neuroprotection will require sedation, analgesia, paralysis, control of sats & $ETCO_2$, head up, no neck restrictions, frequent reassessment of pupils ?hypertonic saline, temperature & blood sugar control. Most of this can be attended to en route.

https://sydneyhems.com/resources/emergency-action-card/



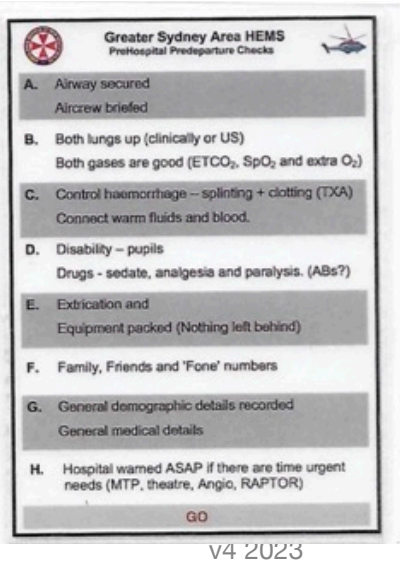




## 10. PACKAGING AND TRANSFER

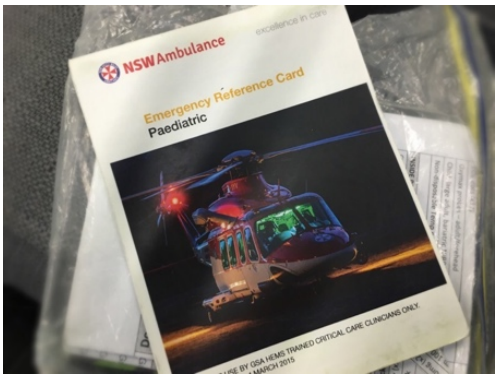
- All tubes and lines must be **absolutely secure** and the tracheal tube should be controlled by a member of the team for all transfers, as the risk of tube dislodgment is highest during transfers.
- All airway connections MUST be secured with **“Push and twist”** technique rather than just being “pushed” together.
- 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].
- Monitoring, ventilator infusions and airway must be visualised and accessible throughout retrieval.
- 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.
- Some members find the Pre departure checklist helpful after intubating to maintain momentum and leave scene.



## SPECIFIC PATIENT GROUPS

### PAEDIATRICS

Prehospital anaesthesia of small children is only rarely required. This service performed RSIs on 77 patients <16y over 4 years (2017-2020). The risk/benefit equation is altered by the increased complexity of the procedure, lesser familiarity, tendency to desaturate much earlier and the dangers of drug dosage errors[32]. Drug doses and equipment sizes are given in the Paediatric Emergency Reference Cards. Paediatric considerations appear the the end of the RSI checklist. The CMAC Mac 4 laryngoscope was being comfortably used down to <1y of age, but since the Mac 2 blade arrived, it is preferred in babies and has performed well down to and including newborns.




**Paediatric Considerations**

**Ear to sternal notch. Gastric tube. Omit Gooseneck. Adhesive tape to secure tube**


Paediatric aide memoir cards are also available on the NSW Trauma app

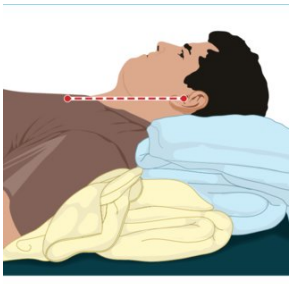
### HYPOVOLAEMIA

Hypovolaemic and/or hypotensive, patients are at risk of decompensation and cardiac arrest during induction and 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.

Reduce the dose of induction agent. A fluid/blood bolus immediately prior to induction should also be considered. In patients who are in extremis, intubation with muscle relaxant only may be necessary.

### BARIATRICS

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 if not well positioned. Consider experience of intubator. Bringing the neck into neutral alignment is essential in these patients. Ramping may be indicated. Pad behind the shoulder blades to bring the sternum horizontal then pad the occiput to create horizontal ear to sternal notch. Raising the back of the bed can have a similar affect (see photo). The neck skin should be uncreased and the face flat. Ramping improves oxygenation AND intubation.



## BURNS

Patients with severe burns are challenging both clinically and psychologically. The airway should be secured early in patients with suspected airway burns. Airway swelling follows direct thermal trauma to the larynx (usually inhaled hot smoke), or systematic inflammatory oedema in TBSA >30% especially after fluid resuscitation commences. Airway swelling, and full thickness burns to the face/neck can make oral intubation impossible. Impending swelling is suspected by stridor and dysphonia. Visible burns or soot deposition in the oropharynx confirm smoke inhalation. Facial burns may arise from 'flash burns' where heat is not conducted to the airway, and intubation is not required for airway swelling. Nasoendoscopy is not feasible prehospitally and any concern for airway burns should prompt intubation.

Standard RSI procedure is followed with a backup ETT of smaller than usual size incase laryngeal swelling impedes ETT railroading.

Inhalational injury occurs when superheated gases in a confined space or very close to the face are breathed in. Lower airway inhalation injury may present as wheeze and lung injury, 100% Oxygen may be indicated with prolonged smoke exposure. Cyanide and other toxins are not identifiable prehospitally. Inability to ventilate may be caused by full thickness burns to the chest requiring on-scene escharotomy.

Adequate sedation and analgesia must be given during and following RSI. Ketamine remains an excellent choice and doses needed may be high. It is suggested that severe full thickness burns of the neck or face can make oral intubation or SGA insertion impossible and a surgical airway may be necessary.

## MANAGEMENT OF MASSIVE REGURGITATION/UPPER GIT HAEMORRHAGE

Continuous pharyngeal soiling is a challenge to preoxygenation and laryngoscopy. Head up positioning for all RSIs may help reduce passive regurgitation in some.

Planning includes: Double suction and team brief. Our Prehospital Laerdal Compact Suction Unit is very effective BUT fills at 330mL and stops working if filter wet so use alternative suction from vehicles/venturi first for large volumes. Preoxygenation in the lateral position may be needed, weighing the risk of rolling a patient increasing internal haemorrhage in trauma.

In the event of continuous soiling of the pharynx utilise continuous suction during laryngoscopy "suction assisted laryngoscopy and decontamination SALAD" with second suction unit to hand. If inadequate place an ETT blindly into the oesophagus and inflate cuff to divert flow. Lateral position intubation can be considered. Surgical airway may be necessary for large volume fluid soiling.

Practising 'SALAD' sims helps familiarise continuous suction laryngoscopy.

## MAXILLO-FACIAL HAEMORRHAGE

Bleeding into the pharynx during laryngoscopy is common. Our service finds approximately 1/3 of prehospital intubations require suction.

Two functioning suction systems should be available and the team brief SALAD techniques above. A blocked Yanker should be removed and the tubing used in preference or via a 6.0 ETT. DuCanto catheters block less frequently. Splinting of the face should follow intubation.

## INFECTIOUS PRECAUTIONS

Good practice includes team PPE with eye protection, facemask and gloves. Type of facemask (N95 or surgical) varies on risk. Gowns may not perform well in the prehospital environment. Reducing contact contamination of surfaces and vehicles is standard. Used airway equipment should be contained but still available for the transport phase. Bougies, laryngoscopes etc should be placed in a plastic bag for onward journey. Bougie removal should be controlled to avoid spreading contamination.

2020 fears of aerosol generation by airway intervention for COVID-19 are largely reappraised by recent literature and airway actions are very likely to be lower risk than exposure by coughing or shouting. N95 masks and eye protection are the mainstay of protection. Face shields cover skin exposure better than goggles, but both may be subject to fogging that impedes laryngoscopy. With meticulous aerosol PPE no overt change to RSI procedure is necessary. Clamping of ETT when changing ventilators can be considered.

## NEAR-DROWNING

A standard operating procedure/clinical practice standard covers near drowning. The pulmonary oedema appearing as froth can obscure the laryngeal inlet at laryngoscopy. Continuous suction may be required during bougie attempts. Positive pressure ventilation before laryngoscopy (BVM ventilations with generous PEEP e.g. >10cm $H_20$) reduces froth and prolongs the window to see the cords. Gastric fluid regurgitation is common. Positioning on a stretcher is preferable as always, and avoiding sand entering BVM and airway equipment is critical.

## AIRWAY INJURIES

Most airway injuries are detected in poly trauma patients following CT scans. Standard prehospital RSI procedure is the mainstay of care. Isolated airway injuries in stable patients are rare in our service. Associated blood vessel and spine injuries need evaluation.

The principles of manipulating an injured airway are avoiding positive pressure ventilation across the damage by facemask or LMA, avoiding placing a bougie or ETT through the defect, avoiding pushing against a transection with a bougie/ETT, being aware of the potential air leaks in the neck e.g. impeding access for surgical airway and chest e.g. tension pneumothorax. Consider placing surgical airways below the injury (tracheostomies).

The most experienced operator should perform laryngoscopy, avoid bag mask ventilation and place the bougie with care (possibly directing the Coude tip posteriorly). A smaller ETT may be required. The aim is to place the cuff of the ETT below the injury. Tension pneumothorax and mediastinum may arise.

With significant tissue loss from open wounds it may be possible to insert an ETT directly into the trachea through the defect after confirming the defect leads to the trachea and is not above the vocal cords.

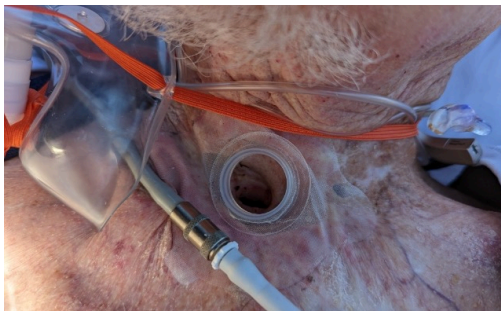
Complex fiberoptic techniques are not appropriate for the prehospital setting where simple techniques are preferred.

## OBSTETRICS

Parturients in whom the funds is above the umbilicus require uterine displacement, manually or by tilt (care in pelvic injuries) for RSI. Gastric regurgitation should be planned for. Permissive hypotension following RSI may not perfuse the placenta.  Low normal $ETCO_2$ is targetted.

## STOMA IN NECK

Rarely we encounter patients whose trachea has been sutured to the front of their neck. This is the only entrance to the trachea and lungs. The airway will not collapse with unconsciousness, nor is there a risk from regurgitation.  The tracheal rings are often identifiable in the stoma, and $ETCO_2$ will not emerge from their mouth/nose. Sedation +/- paralysis may be need to insert an ETT through the hole. Small facemask BVM or LMA facemask are options.



## WINCH ACCESS/REMOTE RSI

A patient is intubated by our team prior to winch extraction on average once every 2.5 months. Performing emergency anaesthesia following a winch primary with no other staff or equipment present on-scene is fortunately uncommon, but clearly can be necessary. 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 emergency anaesthesia 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 which is with the portable ventilator. The monitor is winchable in an equipment winch bag but not routine. Risks and benefits may support basic monitoring with finger probe oxygen saturations, manual BP or pulse checks, and EMMA capnography.

Patient positioning for intubation may utilise natural resources, though placing the patient on the basket edge via our extrication device provides excellent intubation positioning.

Packaging an intubated patient in a rescue basket takes practice. Scenario training is the best way to practise winch RSI & packaging.

## SURGICAL CRICOTHYROIDOTOMY

- There is a subgroup of patients for whom surgical cricothyroidotomy may be the primary means of securing the airway without a preceding attempt at emergency anaesthesia. These include full thickness facial/neck burns where neck and mouth movement is severely limited, massive maxillo-facial haemorrhage and the entrapped patient with airway compromise who cannot be extricated and access is impaired.
- With inability to intubate in prehospital RSI, rarely it is appropriate to allow paralysis to wear off and let the patient wake to pre-anaesthetic status. Most of our patients are intubated for emergent reasons and need their airways securing by another means.
- Front of neck access/surgical airways in young children are fortunately rare but have specific challenges. A needle cricothyroidotomy system is carried. There is concern over high failure rate (40%) and perforation of the posterior tracheal wall (42%)[30]. In infants the cricothyroid membrance is too small so a tracheotomy may be needed - vertically cutting through the anterior part of a tracheal ring. It will bleed and losing control of the trachea is possible, which can be prevented by gaining purchase on the trachea using forceps, sutures or a surgical towel clip. After short training 97% success was achieved in one study using a surgical, as opposed to needle, technique[31]. These factors should be considered when planning for a can't intubate/can't ventilate scenario while preparing for paediatric emergency anaesthesia.

The surgical airway equipment should be removed from its pouch (but kept close) whenever there is concern for a

difficult airway - e.g. Airway trauma, Difficult anatomy, Burns to face and neck and/or airway.

The technique of surgical cricothyroidotomy is based on published literature[33], animal and cadaver simulations as well as service experience. Service experience suggests it can avoid some of the common complications.

The most common challenges encountered when performing surgical airway are:

- Delay in decision-making
- Significant bleeding from the incision (it requires a tactile technique)
- Inability to instrument the incision with unfamiliar equipment in time-critical situations.


## CRICOTHYROIDOTOMY TECHNIQUE - SCALPEL, FINGER , BOUGIE

**Locate**

Locate the crico-thyroid membrane BEFORE emergency anaesthesia in any patient with a predicted difficult airway. The neck must be fully extended, and midline & CTM marked. Verbalise which side you will stand & how to extend the neck (e.g. drop head over end of stretcher). In patients where the anatomy cannot be easily palpated such as obese patients, a long midline longitudinal incision should be made to facilitate accurate identification of the cricothyroid membrane.

**Grip**

The larynx must be firmly secured between the thumb and middle finger to prevent movement during the incision. This laryngeal handshake allows the index finger to locate the cricoid ring and cricothyroid membrane. Any movement of the larynx during the incision must be prevented.

**Incise**

Once the cricothyroid membrane has been located by surface palpation or palpation through a midline longitudinal incision, a stabbing/rocking incision is made through the cricothyroid membrane ensuring the size 22 scalpel is fully inserted.

**Finger**

The incision is then directly probed using your finger. Index finger or little finger is recommended. 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. In the extremely rare setting of a paediatric surgical airway an adult finger may not fit and the bougie can be placed directly through the incision as long as purchase on the trachea is maintained.

**Bougie**

A paediatric bougie is placed alongside the finger though the incision and confirmed to be within the trachea by palpation. Confirmation of intratracheal bougie placement by palpation or hold-up is required before railroading.

**Tube**

A size 6.0 tracheal tube (in adults) is then railroaded over the bougie into the trachea, ensuring the cuff is within the trachea and the cuff inflated. The size 22 scalpel is larger than the size 6.0 tube and the finger dilation ensures the tube will fit. The tube can be cut to reduce the chance of displacement. The tube can be tied, taped, or sutured in position. Check in trachea not bronchus. Inflate cuff generously to seal.

**Confirm**

$ETCO_2$ MUST be used to confirm tracheal placement and continuously monitored to ensure the airway remains patent. In event of cuff leak - inflate more air to seal.

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