



Emergency Medicine Society of South Africa

PRACTICE GUIDELINE

EM015B

**RAPID SEQUENCE INTUBATION:
SUPPORTING MATERIALS**

This Practice Guideline sets out the evidence behind the algorithms for Rapid Sequence Intubation in the emergency environment (Practice Guideline EM015).

Excluding the cover page, this Practice Guideline is **27** pages.

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Responsible committee member: Prof Lee Wallis

(This Guideline was written and produced by Dr Mike Wells, who acknowledges extensive input from Dr Lara Goldstein, Mr Martin Botha, Dr Walter Kloeck and Dr Heike Geduld)

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Acknowledgements

This material has been adapted from many sources including the online practice guidelines of the American College of Emergency Physicians (ACEP).

A special mention must be made of the following sources:

1. Walls RM, Murphy MF. Manual of Emergency Airway Management. Third edition 2008. Wolters Kluwer / Lippincott, Williams & Wilkins. Philadelphia.
2. Kovacs G, Law JA. Airway Management in Emergencies. 2008. McGraw Hill. New York

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Definition

Rapid sequence intubation (RSI) is defined as a technique where:

a potent sedative or induction agent is administered intravenously followed in rapid sequence with a paralyzing dose of a quick-acting neuromuscular blocking agent;

for the purpose of creating optimum conditions to facilitate tracheal intubation and to minimize the adverse physiological effects of airway manipulation.

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Introduction

Securing an airway is one of the most important procedures in emergency medicine. One of the first tasks of any clinician managing an acutely unstable patient is to secure the airway. In most circumstances, emergency clinicians use rapid sequence intubation (RSI) to accomplish this task. RSI is an important technique for airway management in both adult and paediatric patients in the Emergency Centre (EC) and falls within the domain of Emergency Medicine practice.

Rapid sequence intubation (an Emergency Medicine procedure) is clearly distinguished from rapid sequence induction (an anaesthetic procedure):

- Rapid sequence intubation is a procedure in which the end result is the safe and effective execution of tracheal intubation in an emergency setting.
- Rapid sequence induction is the method of initiating anaesthesia in a patient at risk of aspirating gastric contents during the anaesthetic.

RSI incorporates a rapidly acting sedative agent (i.e. an induction agent such as etomidate, ketamine or propofol) and a neuromuscular blocking agent (i.e. paralytic agent such as suxamethonium or rocuronium) to create optimal intubating conditions and enable rapid control of the airway. RSI presupposes the patient is at risk for aspiration of stomach contents and incorporates medications and techniques to minimize this risk. Use of RSI also helps to mitigate the potential adverse effects of airway manipulation.

There is overwhelming evidence that RSI in the EC is safe and effective when performed by trained individuals. Any physician working in the EC should acquire the skills and proficiency required to perform RSI.

Why should RSI be used in the EC?

- RSI is not dependent on patient co-operation, and can be performed expeditiously
- Muscle relaxation improves conditions for laryngoscopy and intubation
- Drugs used in RSI control the adverse physiological effects of intubation
- RSI has a very high success rate in experienced hands

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The American College of Emergency Physicians recognizes the role of RSI in modern emergency care and supports the following principles:

- *Physicians performing RSI should possess training, knowledge, and experience in the techniques and pharmacologic agents used to perform RSI.*
- *Neuromuscular blocking agents and appropriate sedative and induction agents should be immediately available in the EC and accessible to all physicians who perform RSI in the EC.*
- *Quality review and patient monitoring should be addressed when policies about RSI are developed in the EC.*

Paediatric RSI

Paediatric RSI differs from that used in the adult in only a few minor respects. These differences will be highlighted in the protocol with text boxes.

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Current and recent controversies in RSI

Should RSI be performed by non-anaesthetists?

Yes – the evidence is overwhelming that RSI is within the domain of Emergency Medicine and is safe to be used by individuals that have been appropriately trained.

Should RSI be performed in children, infants and neonates?

Yes – the evidence is consistent that RSI improves intubation conditions and intubation success in patients of all ages, including neonates.

Are anaesthetic induction agents appropriate for RSI in the EC?

Yes – they are better than sedative agents; their onset of action is much more rapid and they are more effective at blunting unwanted physiological responses to intubation.

Is cricoid pressure necessary?

We don't know – the evidence supporting the use of cricoid pressure is fairly limited and there is more and more evidence emerging about the damaging effects of this manoeuvre. It is acceptable to omit the use of cricoid pressure in RSI. It is also acceptable to use cricoid pressure, as long as it is released if it interferes with bag-mask ventilation or laryngoscopy.

Is etomidate safe to be used?

We don't know – there is concern about the adrenal suppression arising from the use of etomidate, but little good evidence to show that it increases morbidity or mortality. Most experts still advocate the use of etomidate in all but the overtly septic patient. It is still acceptable to use etomidate for RSI.

Should cuffed tubes be used in children?

Yes – there is ample evidence to show that cuffed tubes in children are at least as safe, and possibly safer, as uncuffed tubes. The use of cuffed endotracheal tubes is appropriate in children over the age of 1 year as long as cuff pressures are monitored carefully. Preliminary evidence suggests that cuffed tubes are also safe in neonates and infants.

Is premedication necessary before RSI?

No – the routine use of atropine in children as a premedication has been abandoned. The use of lignocaine and fentanyl for cerebral and cardiovascular protection has not been well established and should not be part of routine treatment. There may be a role for these agents under certain circumstances.

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Indications

See Intubation algorithm (EM015).

Rapid sequence intubation (RSI) is the standard of care in emergency airway management for intubations not anticipated to be difficult, and for potentially difficult intubations in uncooperative patients. This procedure should be employed for all intubations in the EC unless there is a specific contraindication or compelling reason to use an alternative technique.

Multiple large prospective observational studies confirm that the implementation of RSI has led to improved success and decreased complication rates for emergency intubation.

Paediatric RSI

The indications for adults and children are exactly the same.

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Contraindications

There are no absolute contraindications to RSI, although there may be absolute contraindications to using one or more of the individual pharmacological agents. The Emergency Physician should exercise extreme caution using RSI in the following situations:

- If a cricothyroidotomy (as a rescue surgical airway) is deemed to be impossible
- When intubation is considered to have a negligible chance of success

RSI is specifically not contraindicated for the following conditions, although caution exceeding that exercised for a routine RSI is advised:

- Penetrating injuries of the neck
- Blunt trauma to the neck
- Maxillofacial trauma with high grade facial skeleton fractures

RSI is not indicated in patients in cardiac arrest.

Paediatric RSI
RSI is specifically not
contraindicated in children of any
age.

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Performing Rapid Sequence Intubation

See RSI algorithm (EM015).

Infection control

All practitioners involved in RSI should give careful consideration to infection control measures. Standard precautions should be observed and must include gloves, mask and eye protection.

Preparation

Airway assessment

There is no specific evidence to support the method or utility of assessing a patient to identify a potentially difficult airway in the EC, prior to commencing RSI. It is nonetheless recommended that a rapid, formal assessment of the airway be performed, which would consist of at least the following components:

Paediatric RSI

There is no validated airway assessment tool for use in children. The most important aspect of airway assessment in children is to evaluate the anatomy of the facial skeleton, mouth and tongue. Developmental or congenital abnormalities (e.g. Pierre-Robin sequence or Down syndrome) may make laryngoscopy and intubation more difficult.

The MMAP system:

- **Mallampati score** (patient seated if possible)
- **Measurements** (measured by the patient's fingerbreadths)
 - Thyromental distance – minimum 3 fingerbreadths
 - Mouth opening – minimum 3 fingerbreadths
 - Jaw protrusion – minimum 1 fingerbreadth (1cm)
- **Atlanto-occipital extension**
- **Pathology** in the airway causing airway obstruction or distortion of the airway

The LEMON system:

- **Look externally** (facial trauma, large incisors, beard or moustache, and large tongue)
- **Evaluate the 3-3-2 rule** – laryngoscopy might be difficult if
 - The inter-incisor (mouth opening) distance is <3 fingers
 - The hyomental distance (between the tip of the jaw and the beginning of the neck, under the chin) is <3 fingers

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- The thyromental distance (between the thyroid notch and the floor of the mandible (top of the neck)) is <2 fingers
- **Mallampati** (Mallampati score ≥ 3)
- **Obstruction** (presence of any condition that could cause an obstructed airway)
- **Neck mobility** (limited neck mobility).

If a potentially difficult airway is suspected then the risks and benefits of RSI should be carefully weighed-up and alternative airway management strategies considered.

Positioning

If cervical spine trauma is suspected then appropriate precautions should be followed at all times (see below).

The patient should be positioned in such a way to permit optimal conditions for laryngoscopy:

- The bed should be at an appropriate height, with the middle of the patient's head at the level of the doctor's umbilicus
- The patient's head should be as close of possible to the top of the bed
- The patient's head and neck should be positioned in the "sniffing position" by positioning a pillow or blankets behind the head until the tragus of the ear is at the same horizontal level as the sternum. This position is also useful for obese patients.

Paediatric RSI

Children should be positioned with the same end-point in mind: the external acoustic meatus should be at the same horizontal level as the sternum. This is more often achieved by placing a ± 5 cm thick pad under the child's torso. The rest of the positioning remains the same.

Drug & equipment (see checklist (EM105))

Drugs

Drug doses should be determined based on the patient's weight, age, co-morbidities as well as physiological status. The drugs should be appropriately diluted (if necessary) and the syringes should be labelled. The person who will be administering the drugs should be briefed on the procedure (it is perfectly acceptable for an assistant who is not a doctor to administer the medications under the doctor's supervision). The following drugs should be procured and prepared before commencing RSI:

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- Induction agent
- Neuromuscular blocking agent (paralytic)
- Topical anaesthetic agent (lignocaine in spray form)
- Atropine or glycopyrrolate for symptomatic bradycardias during and after RSI
- Vasopressor agents (phenylephrine or ephedrine) for hypotension during and after RSI
- Sedative agent to be administered after RSI has been accomplished
- Paralytic agent to be administered after RSI has been accomplished (if required)
- Reversal agents for non-depolarising neuromuscular blocking agents (neostigmine and glycopyrrolate), if they have been used

Important note:

Reversal agents for non-depolarising agents are NOT effective early after their administration. These agents will only be useful to shorten the duration of the paralysis and not to completely reverse it.

Equipment

Full resuscitation equipment should be available before commencing RSI (see previous EMSSA guidelines on resuscitation equipment). All equipment should be checked to ensure that it is in working condition and that the method of operation is clearly understood.

The following equipment (including backup devices) should be prepared, checked and immediately available during the RSI:

- Laryngoscope with a variety of blade sizes and blade shapes.
- Suction with an atraumatic rigid suction tip.
- Appropriately sized endotracheal tube (ETT) (7.0mm to 7.5mm for women and 8.0mm to 8.5mm for men is usually suitable) in which the cuff has been checked. A range of larger and smaller sizes must be immediately available.
- A stylet should be used routinely and be loaded into the ETT before the first intubation attempt unless a bougie is used. The stylet should be straight with a 30° hockey-stick bend just proximal to the cuff (although some laryngoscopists prefer a more uniform gently curved bend; either is acceptable according to personal preference).
- A bougie (gum-elastic bougie or other type) must be immediately available.
- A stethoscope of adequate quality.

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- A confirmatory device (ideally an end-tidal carbon dioxide (ETCO₂) device, but oesophageal detector devices may also be used) to assist in the verification of correct tube placement.
- Tape or adhesive plaster or commercial device to secure the ETT once position and depth have been confirmed.
- Bacterial filter and heat-moisture exchanger device.
- Resuscitation bag (self-inflating bag)¹.
- Oropharyngeal airways of various sizes.
- Rescue supraglottic airway devices (laryngeal mask airway or laryngeal tube airway) in a variety of sizes.
- Equipment and instruments for the placement of an emergency surgical airway.

Paediatric RSI

The list of equipment for children is much the same, with a couple of additions and some minor differences:

Reference material for weight estimation and equipment size guidelines should be available in the resuscitation room. The appropriately sized equipment should be used – this should be guided by the use of reference material (e.g. the Broselow tape, the PAWPER tape system). Endotracheal tube size determination should be guided by length and not by other methods. Rescue equipment should also be available in sizes appropriate for children.

Monitoring devices

The following monitoring devices should be used routinely:

- Continuous oxygen saturation monitoring.
- Continuous heart rhythm (3-lead electrocardiogram) monitoring.
- Continual non-invasive blood pressure (NIBP) monitoring at 3 minutes intervals during and for 15 minutes after the RSI. The NIBP cuff should be of an appropriate size and positioned on the patient's arm (unless impossible, in which case it should be positioned on the patient's ankle).

¹ "Ambu-bag™" / "Resuscitation bag" / "Self-inflating bag" / "Bag-valve-mask" / "Resuscitator" are terms that are often used interchangeably for the same device.

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Personnel

In addition to the person performing the intubation at least one, and preferably two, assistants are required. If manual in-line axial stabilisation (MIAS) of the cervical spine is performed, this should be by an additional person, if possible. The assistants should be given specific directions as to their role in the procedure, and briefed as to the position of the cricoid cartilage if cricoid pressure is to be used.

For example:

- Assistant 1 – hold the ETT; retract the right side of the mouth to facilitate tube insertion; inflate ETT cuff; attach ETCO₂ or other confirmatory device; secure tube
- Assistant 2 – Apply cricoid pressure or external laryngeal manipulation; support the head if the head is elevated during laryngoscopy
- Assistant 3 – manual inline stabilisation of the cervical spine

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Performance of RSI

Positioning of patient, physician and personnel

- The patient should be positioned as previously described in a position to permit optimum laryngoscopy.
- The physician should be at the head of the bed, standing comfortably upright with the equipment within easy reach without moving.
- If MIAS is applied, the assistant must provide stabilisation from below (see below).
- One assistant should be positioned close to the patient's head at the right side of the physician and the other should be on the left side at the level of the patient's chest.

Premedication and preloading

Premedication

There is no good evidence to support the routine administration of any premedication as part of RSI in the EC. Agents that have been used include lignocaine, fentanyl, atropine, esmolol and defasciculating medications.

- Lignocaine – there is limited evidence of efficacy of lignocaine in patients with raised intracranial pressure and less supporting evidence for use in status asthmaticus. The use of lignocaine may be associated with hypotension following RSI. It may be considered in haemodynamically stable patients with raised intracranial pressure at a dose of 1.5mg/kg at least 3 minutes before intubation.
- Fentanyl – there is some evidence that fentanyl may attenuate unwanted physiological responses to intubation in high doses, but at the risk of hypotension. The other benefit of fentanyl is that it provides some degree of analgesia and sedation that extends after the RSI. Fentanyl should be administered in haemodynamically stable patients with raised intracranial pressure or in patients with underlying cardiovascular disease at a dose of 1 to 3µg/kg at least 3 minutes before intubation.
- Atropine – there is no role for the routine administration of atropine except when a patient receives a second dose of suxamethonium.

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Paediatric RSI

As with adults, there is no indication to routinely use any premedication in children. Atropine dose 0.01mg/kg – minimum dose 0.1mg.

Atropine premedication should be considered for RSI in neonates and may be considered for RSI in children. The adult dose is 1mg (maximum dose 3mg); 0.5 mg for cardiac patients.

- Defasciculating medications – there is no role for the use of defasciculating agents in RSI in the EC.

Preloading

Adequate fluid preloading may prevent the hypotension that may occur during RSI as a side effect of medication administration, neuromuscular blockade and positive pressure ventilation. All patients, unless specifically contraindicated, should have a crystalloid fluid bolus of 10ml/kg immediately prior to RSI.

Preoxygenation (preoxygenation checklist)

Preoxygenation is an essential and mandatory component of RSI and should occur before the administration of the induction agent. This should be done using a system that delivers an F_iO_2 approximating 100%:

- A non-rebreather facemask (**NB** - a partial rebreather facemask will deliver an F_iO_2 of only around 60%).
- A bag-valve-mask device with an inflated (never fully collapsed) reservoir
 - Gentle manual assistance (compressing the bag) synchronised to the patient's breathing may facilitate the opening of the duck-bill valve and decrease the work of breathing.
- A non-invasive CPAP ventilation system.

Paediatric RSI
Although a flow-inflating bag is ideal in children it is seldom available in the ED. Gentle manual assistance is required for the spontaneously breathing child.

Positive pressure ventilatory assistance may be required to assist hypoxic patients achieve adequate oxygenation and denitrogenation in the preoxygenation period.

Preoxygenation may be achieved in two ways:

- Tidal breathing (or assisted ventilation) for 3 to 5 minutes with a device that delivers a high F_iO_2 .
- Five vital capacity breaths over a 1 minute period (as long as the oxygen reservoir is of adequate size and the mask fits tightly). This technique is less effective than the first.

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Induction agent

See Drugs section (EM015) for full pharmacological information.

The induction agent should be administered only once all equipment and personnel have been readied, premedication agents have been administered (and allowed time to work) and the patient is adequately preoxygenated. It should be administered as a bolus

injection. The dose of the induction agent should be adjusted in critically ill, hypotensive or hypovolaemic patients. The choice of agent depends on the patient and the clinical scenario and the following agents are recommended for RSI in the EC:

Paediatric RSI

Exactly the same agents may be used in children as in adults, generally based on the same per kilogram dosage. Ketamine is generally the first choice agent for most indications.

- Etomidate is the first choice of induction agent for most clinical scenarios as it has the least negative effect on patient haemodynamics of all the induction agents. Despite the controversy about adrenal suppression there is enough evidence to support its ongoing use in the EC. It should probably be avoided in overtly septic patients.
- Ketamine is an excellent induction agent in adults and children for medical and trauma cases. It is specifically *not* contraindicated in patients with raised intracranial pressure.
- Propofol is a good induction agent but may cause significant hypotension. It should be used with caution in hypotensive patients and patients with cardiovascular disease.
- Thiopentone is a good induction agent and offers excellent cerebral protection but may also cause significant hypotension following administration.
- Midazolam is NOT a good agent for RSI and should be used only if no better agent is available. It is a sedative agent and not an induction agent.

See Table for recommended induction agents in different clinical scenarios.

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| | Clinical scenario | First choice agent | Alternative agent |
|--------------------------|---|--------------------|-----------------------|
| Trauma or medical | No brain injury / CVA - haemodynamically stable | Etomidate | Propofol, thiopentone |
| | No brain injury / CVA - shock | Ketamine | Etomidate |
| | Brain injury / CVA - haemodynamically stable | Etomidate | Thiopentone, propofol |
| | Brain injury / CVA - shock | Etomidate | Ketamine |
| | Profound shock | Ketamine | None |

Paralytic agent

The paralytic agent should be administered immediately after the induction agent. There are three options for neuromuscular blockade as part of RSI:

- Suxamethonium is the first choice paralytic agent for RSI in the EC unless there are specific contraindications to its use. The most beneficial dose is 1.5mg/kg in adults, 2mg/kg in children and up to 3mg/kg in infants.
- Rocuronium may be used for RSI at a dose of 1mg/kg if suxamethonium cannot be used.
- High dose vecuronium (0.2 to 0.3mg/kg) may also be used as a third choice agent, but has a longer onset of action and duration of action than the other agents.

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Manual inline axial stabilisation (MIAS) of the cervical spine

Whenever trauma to the cervical spine is suspected, appropriate measures to protect the patient from new or aggravation of neurological injury must be employed.

Paediatric RSI

Do not neglect MIAS in children.

During or before the preoxygenation phase of the RSI the following process must be followed in trauma patients in whom cervical spine injury has not been excluded:

- Stabilisation of the cervical spine must be maintained at all times.
- The patient must be positioned supine, appropriately for spinal protection:
 - Children should have a pad under the torso to maintain a neutral spine position.
 - Adults should have a pad under the occiput to maintain a neutral spine position.
- The head blocks and cervical collar must be removed while simultaneously instituting MIAS:
 - This procedure should be performed by a trained individual.
 - The MIAS should be performed from below, with the stabiliser's hands placed alongside the patient's face and head in order to control the movement of the head and neck.
- During laryngoscopy the person maintaining MIAS should provide feedback to the laryngoscopist with respect to excessive movement of the head and neck.
- Once successful intubation has been confirmed the MIAS may be released simultaneously with the reapplication of the cervical collar and other immobilisation devices.

Cricoid pressure

The use of cricoid pressure during RSI in the EC is controversial. The consensus of expert opinion at this point in time is that cricoid pressure should be applied after the patient has lost consciousness after the administration of the induction agent and continuously

Paediatric RSI

Cricoid pressure should be avoided in children as it increases the difficulty of laryngoscopy and bag mask ventilation.

maintained until the cuff has been inflated and the position of the ETT has been confirmed to be correct. This guideline is subject to the following provisos:

- Cricoid pressure should not be used if the assistant is not trained and experienced with the procedure.

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- Cricoid pressure should immediately be released and not reapplied if:
 - There is any difficulty in bag-mask ventilation.
 - A supraglottic airway device is inserted.
 - There is any difficulty with laryngoscopy, including if external laryngeal manipulation is required (which cannot be performed while maintaining effective cricoid pressure).
 - The patient vomits.
- The doctor may also elect not to make use of cricoid pressure at all during the RSI.

Laryngoscopy (best look)

Once the induction and neuromuscular blocking agents have been given, interposed positive pressure ventilations should be avoided except in patients at risk of developing hypoxaemia (children, pregnant patients and patients with lung injury or lung disease) or if the oxygen saturations drop below 92%.

The laryngoscopist should assess the state of muscle relaxation 60 seconds after the administration of the paralytic agent. Once the patient is sufficiently relaxed, laryngoscopy should be performed with a strategy for optimising the chances of successful tube placement at the first attempt.

Paediatric RSI

The technique of laryngoscopy is the same in children. Either a curved or a straight blade of appropriate size may be used (check the reference material for information on size). Beware of passing the blade too deeply – this may lead to a confusing view of the hypopharynx with no landmarks detectable.

The first attempt

- The patient and laryngoscopist should be optimally positioned.
- The correct size blade should be used - a size 3 curved blade is appropriate for most adults.
- Suction should be used to clear secretions and / or blood to permit clear vision of the larynx.
- The blade should be advanced under direct vision until the tip is in the vallecula (or lifting the epiglottis with a straight blade).
- The handle should be lifted along its axis without the blade levering or rocking against the patient's teeth or gums.
- If the larynx is not well visualised then the following manoeuvres are recommended (if permitted by considerations of cervical spine protection):

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- The head should be lifted with the laryngoscopist's right hand while watching for an improved view of the cords – if so then the head should be supported by an assistant while the tube is inserted.
- External laryngeal manipulation should be performed with the laryngoscopist's right hand while watching for an improved view of the cords– if so then the larynx should be maintained in position by an assistant while the tube is inserted.
- Two hands may be used on the laryngoscope handle to improve view.
- The bougie may be used on the first attempt even if no difficulty is anticipated. If the first attempt at laryngoscopy shows a less-than-ideal visualisation, the decision to use the bougie should be made early. The bougie should therefore be readily available (on the patient's chest) for every attempt at laryngoscopy.
- If the tube has not been successfully inserted before the oxygen saturations drop to 90% then the laryngoscope must be withdrawn immediately and bag-mask ventilation initiated. If bag-mask ventilation is unsuccessful then a rescue supraglottic airway should be inserted and additional assistance should be procured.

The second attempt

After the first attempt at laryngoscopy the physician should evaluate the reason for the failed attempt and consider how to improve the chances of success at the second attempt. The factors to contemplate include:

- Adjusting the positioning of patient or physician.
- Changing the size or type of blade.
- Considering different or additional agents if the intubating conditions were not ideal.
- Using a bougie if it was not used on the first attempt.

Ensure that the patient is adequately preoxygenated before the second laryngoscopy is attempted. Repeat the laryngoscopy process in order to visualise the cords. If the tube is not successfully passed before the saturations drop to 90%, then bag-mask ventilations should be resumed without delay.

The third attempt

No more than three efforts at intubation should be attempted during RSI. The third attempt should not be a reattempt at laryngoscopy but should be either:

- Performed by a different (and preferably more experienced) person.

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- Performed using an alternative intubation technique such as with the Airtraq™, the light wand, a fiberoptic video system or the intubating laryngeal mask airway.

If this attempt fails then the patient may either be ventilated with a supraglottic airway device or a bag-valve-mask until additional expertise arrives or until a surgical airway is inserted.

Tube placement

Once the vocal cords have been adequately visualised then the ETT (or the bougie) should be introduced. The tube should be observed passing through the cords and inserted such that the cuff is just deep to the cords. The cuff should be inflated with just enough air so that there is no leak around the tube (estimation of cuff inflation

pressure by palpating the pilot balloon is not reliable). Cuff pressures should ideally be measured and should be less than 30cmH₂O. If a cuff pressure gauge is not available, the cuff should initially be inflated with a volume of air equal to the tube size (e.g. 7ml for a 7mm internal diameter tube), and thereafter adjusted to a volume that is just sufficient to prevent an air leak during ventilation. The stylet should be withdrawn and the position of the tube confirmed

Paediatric RSI

If a cuffed tube is used in a child then the pressure of cuff inflation should be measured, and should be less than 20cmH₂O.

Confirmation of tube placement

The position of the tube must be confirmed to be within the trachea and not the oesophagus by the following techniques:

- Clinical examination
 - Visualising the ETT passing between the vocal cords.
 - Listen for the absence of borborygmi in the stomach with a single ventilation; wait for the person auscultating to be ready before ventilating.
 - Listen for appropriate breath sounds in both

Paediatric RSI

Normal breath sounds in children may be heard in the abdomen, and borborygmi from an incorrectly sited tube may sound like breath sounds. The use of capnography or a CO₂ detector device is mandatory in children.

The depth of insertion of the tube is very important in children: the average depth from teeth or gums can be determined from reference material.

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lung fields. It is often difficult to confidently distinguish between correct and incorrect tube placement with auscultation alone.

- EC ultrasound may be used to assess tube position, pleural sliding and diaphragmatic movement.

and

- An additional means of excluding oesophageal intubation
 - Expired CO₂ detection by means of capnography (which remains the gold standard technique) or by a colorimetric CO₂ detector.
 - A commercial oesophageal detector device.

Once endotracheal intubation has been confirmed and the cuff has been inflated then the cricoid pressure may be released (if it was applied).

The correct placement of the ETT in terms of depth should be evaluated by a chest radiograph as soon as practically possible: the tip of the tube should be in the mid-trachea well above the carina at about the level of the fourth thoracic vertebra (T4).

Securing the ETT

The endotracheal tube should be safely secured by means of adhesive tape or cotton tape as soon as correct placement has been confirmed. The depth of the tube to the maxillary incisors or maxillary gums should be noted and recorded. Part of securing the airway includes appropriate restraint of the patient's head as well as the tubing connecting the ETT to the ventilator. An antimicrobial filter / heat-moisture exchanger should be installed. The tubing from the ventilator to the endotracheal tube should also be secured appropriately.

Paediatric RSI

Securing the tube can be difficult in children and adhesive plaster generally works best. The head should be well secured as small amounts of flexion and extension can result in significant movement of the tip of the tube.

Small volume attachments (filters etc.) should be used to minimise dead space.

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Post RSI management

Positioning

After the position of the tube has been established the patient should be positioned in a 30° head-up position unless spinal immobilisation is required or if the patient is hypotensive. The head up position should be established by elevating only the head section of the bed and not by placing the patient in a reverse-Trendelenberg position. This will decrease the risk of aspiration of regurgitated stomach contents (which can occur even with a correctly placed cuffed endotracheal tube).

Sedation and analgesia

Appropriate sedation and analgesia following RSI is often poorly managed in the EC. Sedative agents should be administered immediately after the ETT has been secured and the patient connected to the ventilator since the duration of action of most induction agents is <10 minutes and the onset of action of most sedative agents is >5 minutes. Induction agents (with the exception of ketamine) have no analgesic properties and adequate analgesia needs to be administered if appropriate to the clinical scenario. The doctor must pay adequate attention to ensure that adequate sedation and analgesia is administered.

Agents that may be used for sedation include:

- Midazolam can be administered either as an infusion or intermittent boluses.
- Propofol can be administered as an infusion (but preferably avoided in children).
- Ketamine administered as an infusion (useful for its analgesic properties as well).
- Other newer agents such as dexmedetomidine may be useful.

Analgesic agents that can be administered after RSI include:

- Morphine administered as an infusion or as intermittent boluses.
- An infusion of short or ultra short acting opioids (fentanyl, alfentanil, remifentanil).
- Ketamine administered as an infusion.

Neuromuscular blockade

The routine use of long-acting neuromuscular blocking agents is not recommended, but may be required under certain circumstances. These agents should generally be avoided in patients with possible intra-abdominal haemorrhage, and with fixed cardiac output states. Paralytic agents that may be useful post RSI include:

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- Vecuronium
- Pancuronium

Ventilation

Under normal circumstances, RSI should not be performed unless there is a ventilator available to provide mechanical ventilation, although it might not always be necessary to ventilate every patient. Ventilation should always incorporate lung-protection strategies in all ages and categories of patients. The following initial ventilator settings should be appropriate for most patients following RSI:

Paediatric RSI

Ventilation in children should follow the same guidelines. A ventilator that is approved for use in children should be used.

- Mode – SIMV (synchronised intermittent mandatory ventilation).
- Tidal volume – 6ml/kg (based on ideal body weight).
- Ventilation rate – 12 breaths per minute for adults and 20 to 60 per minute for children / infants / neonates.
- PEEP (positive end expiratory pressure) – 5 to 10 cmH₂O.
- PIP (peak inspiratory pressure) – ideally no more than 30 cmH₂O.
- F_iO₂ (fraction of inspired oxygen) – 100%.
- I:E (inspiratory time: expiratory time) ratio – 1:2

Blood gas analysis must be performed once ventilation has been established and the ventilator settings adjusted accordingly, if required.

Haemodynamic monitoring and management

During RSI there are several major physiological changes that may have significant negative haemodynamic consequences which may in turn impact negatively on patient outcome:

- Decreased heart rate as a side effect of medications used in the RSI.
- Depressed myocardial contractility from premedication and induction agents.
- Peripheral vasodilatation from medications and muscle paralysis.
- A reduction in cardiac output caused by a drop in venous return as a result of positive pressure ventilation.

These changes in haemodynamic status can be partially offset by appropriate fluid preloading, but may need additional management especially after the initiation of positive pressure ventilation. For

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this reason continuous haemodynamic monitoring is essential during and for 15 minutes after the conclusion of the RSI. Significant decreases in heart rate should be treated with intravenous atropine after ensuring that the bradycardia is not as a result of hypoxaemia. Significant decreases in blood pressure should be treated with one or more boluses of a vasopressor agent such as phenylephrine or ephedrine.

Adjuncts

After the ETT has been secured, an oropharyngeal tube should be inserted (to function as a bite-block and to facilitate oral hygiene). An orogastric tube should also be inserted as soon as is practically possible.

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TRAINING

The Emergency Medicine Society of South Africa acknowledges that there is no internationally accepted consensus guideline for the training of doctors in the performance of RSI and there is no procedure in South Africa for the credentialing or accreditation in RSI. The guideline adopted by EMSSA is therefore as follows:

- Any doctor working in an EC should be competent to perform RSI or should be working under the supervision of a doctor who is experienced in RSI
- Training in the performance of RSI should include the following components
 - an appropriate course in airway management which incorporates both theoretical and practical instruction on RSI
 - simulated intubations on a variety of manikins
 - supervised intubations in the EC
- Training should be considered as incomplete until the doctor is satisfied with his own skills and has demonstrated his proficiency in the procedure in a variety of patients and clinical situations.

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CONTINUOUS QUALITY IMPROVEMENT

Each institution in which RSI is performed should have a written quality program in place in order to oversee the training, performance and review of this procedure. This program should be updated on a regular basis and must include, *inter alia*, the following components:

- A written protocol for the performance of the procedure
- A written checklist for drugs and equipment required for the procedure
- A written guideline for the training or training-requirements for practitioners performing the procedure
- A system for the review of the indications of each procedure performed
- A system for the review of outcomes of the procedure and the patients in whom the procedure was performed
- A system for ongoing training and education based on periodic review of the performance and outcomes of the procedure.

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