THE NORTHERN HOSPITAL

RAPID SEQUENCE INTUBATION

The "Pale Blue Dot", Planet Earth, photographed from Apollo 17, Lunar mission 1972, (NASA).

"In the beginning God created Heaven and Earth..."

Genesis 1:1

"My God, it seemed so fragile in that great back abyss, I could cover the whole of it with just the end of my thumb"

Michael Collins

"One planet, one experiment"

Edward O. Wilson

Ever since the dawn of human consciousness, we have pondered our place in the Universe. From the very moment when the historical record opens, in approximately the mid-third millennium B.C it is clear that Homo sapiens of all cultures considered itself to truly be the crown of all of creation. Genesis, records that Heaven and Earth were created on the first "day". The rest of the Universe followed afterwards. From the very beginning it was assumed that Earth was the center of the Universe, the Sun and planets all revolved around it, as did the stars. The limit of the Universe was the final "crystalline sphere" of the heavens, and outside of this physical world lay the empyrean, (or Paradise, Nirvana, El Dorado, the Elysian Fields Xanadu) a place outside of time and of space, the place of God. This thinking became fossilized within unalterable religious dogma. There was one Earth, it lay at the very center of everything, and the crowning glory of creation was humanity. By the First century A.D the brilliant Astronomer Claudius Ptolemy struggled mightily to understand the Universe and to try and find a logical scientific explanation for it. He devised a complex series of crystalline spheres that rotated around the Earth, and contained all the known heavenly bodies. The Ptolemaic system, though incorrect of course, nonetheless did actually describe reasonably well the observed movements of the stars and planets (which at that time were considered to be a "wandering" type of star). This Earth centered view of the Universe tied in well with later religious dogma, which adopted the Ptolemaic system and embellished it within medieval religious notions - the prime mover of the celestial spheres was simply, God, and there the standard model of the Universe stood for well over a millennium.

Then after untold centuries of assumed supremacy of the Earth in its place in the Universe, a Polish Astronomer, in 1543 made a quite shocking, (and heretical) claim that the Earth was ***not*** *the center of the Universe with the publication (prudently, just before his death) of his "On the Revolutions of the Celestial Spheres". At the time Copernicus's theory was widely held in derision and strongly suppressed by the Church. But amoung the learned and educated classes, his theory did not die, and in 1632, Copernicus finally had his champion in the person of Galileo Galilei, who published his famous "Dialogue Concerning the Two Chief World Systems", which promptly got him sent to the Inquisition, courtesy of his great friend Pope Urban VIII. But Galileo went even further than removing the Earth from the center of the Universe. He turned the newly invented telescope to the stars themselves and found that the "wandering stars" were in fact other worlds, like the Earth itself. Not only was the Earth not the center of the Universe, it was not even the only world that existed! In the early Seventeenth century Johannes Kepler, working with Tycho Brahe's observations, worked out mathematical laws that governed the movements of the planets. The mechanism of the "Prime Mover" (read God), had been discovered! But even worse was to come for religious dogma in the early*

Eighteenth century when Isaac Newton, published the "Principia" that contained his laws of gravity. Now not only was the Earth not central, but God did not even drive it, nature did! For two hundred years things rested again, until the monumental discoveries of Edwin Hubble in the early Twentieth century. By his discoveries, the truly unimaginable scale of the Universe became apparent. It was not unchanging but expanding, we orbit a rather "ordinary" star, of which there are countless billions of others. Our solar system resides in the periphery of a great spiral galaxy, the Milky Way, and that there are untold billions of other galaxies. All of a sudden the Earth seemed like a very, very, very insignificant place!

In the mid Twentieth century, the next obvious question began to be asked. If the Earth is no big deal in the scheme of the Universe, then is life itself no big deal as well- even intelligent life? Is the Earth merely one of an unimaginably large number of other planets possibly many of those with life as well! In 1961 Frank Drake, an Astronomer of the National Radio Astronomy Observatory in Green Bank, West Virginia sought to look into this question seriously. He organized a meeting of every serious scientist in the world who was interested in the question of intelligent extraterrestrial life - there were 12 of them! For the agenda of the meeting he came up with his intriguing and now very famous Drake Equation - essentially a probabilistic argument used to estimate the number of extraterrestrial civilizations that might exist within a galaxy (the Milky Way in this case of course) and was technologically advanced enough to communicate with us. The formula he came up with contained seven variables multiplied together, these being: stars in the Milky Way/ rate of new star formation, the fraction of sun-like stars, the fraction of stars that have planets, the number of planets residing in the star's habitable zone, the fraction of potentially habitable planets where life does actually arise, the fraction of planets with life that evolves an intelligent species, the percentage of the total life time of the planet that is inhabited by the intelligent species; or $\boldsymbol{N = N^* \times f_s \times f_p \times ne \times f_i \times f_c \times L}$

Of course the figure one arrives at is highly speculative as we are totally ignorant of most the values of the Drake equation, but its utility lies in at least defining ***what we need to know.*** *In 1961 only the first value was known, and at that time the prospects of discovering or even beginning to work on the other parameters, seemed extremely remote. However in the late Twentieth century, somewhat unexpectedly, a new golden age of Astronomy suddenly emerged as if from nowhere. Geoffrey Marcy, Michel Mayor and Didier Queloz, the new Galileos, discovered the first extra solar planet orbiting a sun like star, 51 Pegasi b in 1995. Since that time over 2000 extra solar planets have been discovered, with many more to come. In the 21st century, astonishingly we now find ourselves on the threshold of discovering the next three terms of the Drake equation! In the 1980s it was speculated the number of planets with life in our galaxy, given the unimaginably large number of stars in it, would be substantial, the magisterial Carl Sagan, even suggesting a figure of up to one million! And yet nagging doubts remained about this optimism, perhaps best summed up in the famous quote of the Nobel Prize winning nuclear physicist Enrico Fermi, "So where is everybody?!" In other words, if intelligent life is abundant in the galaxy, why have we not seen any evidence for it! Astrophysicists and a new breed of "Astrobiologists" are attempting to answer this question, and it seems that within the parameters of the original Drake equation are very many subcategories of contingencies that must happen for even just another Earth like planet to exist - let alone one with life on it, let alone one with complex metazoan life on it.*

It seems our Sun is a "high metallicity" type Sun. In other words enough of the higher elements must exist within the proto-solar system in order for rocky planets like the Earth to

form. This immediacy put serious constraints on the types of Solar Systems that are suitable for life. Irregular galaxies, and elliptical galaxies are relatively metal poor when compared to Spiral galaxies (of which the Milky Way is one). Perhaps our Sun is not such an ordinary star after all. Our Solar System appears to be unusual in many ways compared to others. Our gas giants, orbit far out, whilst in many other systems they are very close to their parent star, thus destroying or seriously affecting any smaller inner rocky planets. Additionally Jupiter acts a cosmic shield to us, absorbing the impact of rogue comets, that would otherwise sterilize the face of the Earth with their impacts. Perhaps the arrangement of our Solar system is odd. The Earth is unusual in its especially large moon, in comparison to is parent planet. The large size of the Moon stabilizes both the Earth's tilt and orbit around the Sun, which otherwise would have far more unstable seasons and weather, far more hostile to the evolution of life. Perhaps the Earth is unique in the type of moon it has. The Earth itself appears unique or at least special. It is not tidally locked to its Sun, meaning its weather is uniform around the planet and mild, it has an internal abundance of heavy radioactive elements which heat the core and drive tectonic plates, which continually alters geography which in turn, drives speciation and the diversity of life, a major protector against mass extinction events. It also has a protective ozone layer and magnetic field which protects life from the Sun's fierce radiation. Of the thousands of planets thus far discovered only a handful come anywhere close to being "Earth like". Perhaps the earth is a highly unusual kind of planet. Even if life became established in the form of microorganisms, there appears to be quantum leaps that need to occur before complex metazoan (i.e multicellular) life evolves. For the first 3 billion years life was unicellular. Metazoan life seems to be a significantly difficult achievement. The enigma of the Cambrian explosion is another event difficult to explain. Even the contingency of meteor impact that cleared the way for the rise of a different type of animal could play a role. Pure luck that the Earth is not still dominated by reptiles and dinosaurs. Earth's ecosystems are remarkably homeostatic over hundreds of millions of years. Perhaps the Earth is unusual or even unique in this situation, one critically important for the allowing the conditions for live to evolve over many billions of years. So far the search for another (truly) Earth like planet has pretty much come up empty - however the epic and noble search does continue in hope.

For most of its history humanity assumed that the Earth was unique, as was life itself, and of life, the crowning glory was Homo Sapiens, made in the "image of God". By the Twentieth century the Earth had been relegated to a minor and insignificant speck of dust - a very lonely place - in a terrifyingly immense and Godless Universe. We now attempt to answer one of the most important questions of life - Are we alone in the Universe? If not then all agree this would be a most profound discovery - perhaps the greatest of all time. But on the other hand - if it were to be shown that life is unique to the Earth - this would perhaps be an even more profound insight still! It seems we are coming full circle. Far from being an "insignificant" speck of dust, perhaps the Earth is the unimaginably rarest jewel in the Universe, and even if not centrally placed, truly the crown of all creation, just exactly as our ancestors believed. Indeed this gives even greater poignancy to the sentiments of Michael Collins, "My God, it seemed so ***fragile*** *in that great back abyss, I could cover the whole of it with just the end of my thumb", but even greater again to those of Edward O. Wilson, "****One planet, one experiment****"*

When we prepare for a rapid sequence induction, we must recall mother Earth herself, the conditions for life must be perfect in every possible way!

RAPID SEQUENCE INTUBATION

Introduction

Ideally all patients should be fasted before anaesthesia/ intubation.

If the stomach is not empty when consciousness is lost, the patient may regurgitate gastric material that may be aspirated into the lungs causing a chemical and infective pneumonitis as well as airway obstruction (Mendelson's syndrome).

Rapid Sequence Intubation (or Induction) (RSI) is a technique that attempts to minimise the risk of aspiration during the anaesthetic induction of unfasted patients.

A newer technique termed **Delayed Sequence Intubation (DSI)** has been developed to **optimize preoxygenation** in unstable/ hypoxic patients.

See separate document for Delayed Sequence Intubation

The **4 classically described** essential features that distinguish **RSI** from *elective* intubation of *stable* and *fasted* patients include:

The essential features that distinguish RSI from elective anaesthesia of fasted patients include:

- Pre-oxygenation.
- The rapid delivery of predetermined doses of drugs, (as opposed to a "titrate to effect" approach).
- The use of cricoid pressure (now controversial)
- Following paralysis, intubation occurs without prior mask ventilation.

Rapid sequence induction requires careful preparation and good assistance.

There should be a standard approach to RSI performed in the ED that all staff are familiar with. A useful aid to this is the provision of a standardized check list.

There should be a clear plan of action, should intubation be unsuccessful at the first attempt. The "Vortex" method is one such approach.

See also separate documents on:

- **ETT Position (in Critical Care Folder).**
- **Capnography (in Critical Care Folder).**
- **Pulse Oximetry (in Critical Care Folder).**
- **Airway Assessment (in Critical Care Folder).**

- **Intubation - Failed (in Critical Care Folder).**

Pathophysiology

Oxygenation consumption:

The lungs contain approximately 79% nitrogen and 21% oxygen.

At the end of a normal expiration there is a volume of air remaining in the lungs called the **functional residual capacity (FRC).**

The FRC has several physiological functions including acting as an **oxygen reserve** on which the patient depends **when they are not breathing.**

The normal FRC is **30 ml/kg** in the adult.

Oxygen consumption during apnoea is approximately 250 mL/minute (or 3 mL/kg per minute) in healthy patients.

In a healthy **preoxygenated** patient the safe apnoea time is up to **7-8 minutes**, compared to just **1 minute** if they were **breathing room air.**

In very unwell patients, however, critical desaturation may occur almost immediately even with preoxygenation.

Gastric acidity:

The more acidic the gastric fluid, the greater the lung damage will be on aspiration.

Based on animal studies, as little as **25 ml** of gastric fluid with a **pH less than 2.5** can cause severe pneumonitis.

Acid causes a loss of surfactant, and pneumonitis can develop within hours.

The patient will become dyspnoeic, tachypnoeic, tachycardic, hypoxic and may develop bronchospasm.

Indications

The indication for an RSI is any patient who requires intubation but is not adequately fasted.

Adequately fasted is generally taken to mean a minimum of **4 hours** since the last intake of solid food.

Contraindications

RSI is **not** recommended in patients with:

- Grossly abnormal upper airways
- Impending upper airway obstruction.

For these situations options include:

- Various awake techniques, using local anaesthesia and fibreoptic assisted intubation.
- Inhalational anaesthesia or short acting IV induction agents without paralysis
- Awake tracheostomy under local anaesthesia and sedation.

Features of an RSI

- Pre-oxygenation:
  - ♥ This is the process of administering oxygen to a patient prior to intubation, so as to extend the period of safe apnoea.
- The rapid delivery of predetermined doses of drugs:
  - ♥ This involves the rapid sequential administration of an anaesthetic induction agent followed by a paralytic agent, in distinction to a more measured "titrate to effect" type of approach that is possible in elective intubation of fasted and medically stable patients.
- The use of cricoid pressure:
  - ♥ This is now a somewhat controversial issue.

    It was designed to stop passive regurgitation and lung aspiration in the unconscious patient.

    It is however contraindicated in active vomiting, where its application may result in oesophageal rupture. If active vomiting occurs then cricoid pressure is released, and the patient turned to the side and suctioned.

    If incorrectly applied it may hinder the laryngeal view.

    As a **separate issue** cricoid pressure may bring an anterior larynx into better view, though this is better achieved by **external laryngeal manipulation applied by the intubator**. This can be done by the intubator directing the hand of the person applying cricoid pressure, (so that cricoid pressure is not lost by changing of operators and enabling the intubator to then intubate with the larynx now in view).
- Following paralysis, intubation occurs without prior bag - valve - mask ventilation:

- ♥ Avoiding bag ventilating the patient (when possible) helps to ensure that the stomach is not inflated and so increasing the risk of aspiration.

- ♥ **In some situations however the benefits of ongoing ventilation to avoid apnoea and hypoxia will outweigh the risk of aspiration.**

Technique

Rapid sequence intubation requires careful preparation and good assistance.

There should be a standard approach to RSI performed in the ED that all staff are familiar with. A useful aid to this is the provision of a standardized check list.

There should be a clear plan of action, should intubation be unsuccessful at the first attempt. The "Vortex" method is one such approach

Staff Preparation:

Ensure adequate staff assistance, including ideally:

1. **Intubator:**

   - When faced with a particularly difficult airway, and when time allows, recruit the assistance of the most senior/ experienced staff member.

     In the event of a failed airway, another person may take on the role of the airway proceduralist and role re-allocation must be clearly communicated to the team.

2. **An airway Nurse assistant**

3. **One person for cricoid pressure**

4. **One person to give drugs**

5. A "Scribe" to record the procedure:

   - The scribe should also call out the **oxygen saturation values**, every 30 seconds, (or more frequently as necessary).

6. In the case of suspected/ possible cervical spine trauma, an extra staff member will be required to provide manual in-line immobilization.

Difficult/ combative patients may require additional staff members to restrain the limbs of the patient.

The **Team Leader** may perform one of the above roles if necessary, but ideally this should be a separate and stand alone role.

Equipment Preparation:

Prepare all necessary equipment:

Ensure:

1. Oxygen:
   - Supply is functioning
   - Connected to the BVM
   - Nasal prongs connected and turned on (to assist apnoeic oxygenation).
2. Suction:
   - Ensure this is *functioning* and *turned on* and easily *accessible.*
   - Often this is placed between mattress and bed beside the head of the patient, for quick access.
3. Pillow(s):

   Sniffing position:

   - For placement under the occiput in adults, (where there is no concern about cervical spine injury). This is especially helpful in establishing the "sniffing" position, (i.e necked flexed and head extended position), to optimize visualization of the laryngeal cords.

   Ramping:

   - For obese patients **multiple pillows** will be required to optimize the patient sniffing position ever further. The upper thoracic spine will need to be elevated in addition to the cervical spine (see also Airway Manoeuvres document).
4. The anaesthetic machine, or circuits are connected and functioning.
5. Monitoring:
   - The **end tidal capnography** device is ready:
     - ♥ Verify function with a test breath
     - ♥ A disposable colorimetric device should also be available, in case of failure of the waveform device.

     Note that capnography is now considered the mandatory gold standard for confirmation of ETT position.

- Continuous ECG monitoring
- Blood pressure cuff in place:
    - ♥ This should be placed on the **opposite arm** to that which is receiving the drug administration (to avoid automatic inflation at the critical moment), or if this not possible, at least (momentarily) deactivated/ deflated at the time of drug administration.

6. Laerdal Bag (or similar non-rebreather device) is assembled with **PEEP valve** attached and functioning without leaks.

7. Endotracheal tube is selected and the cuff has been gelled and tested:
    - As a general rule, a size **7.5 ETT** with stylet is suitable for most adults.
    - A size **7.0 ETT** is suitable for smaller females, and a size **8.0 ETT** is suitable for larger males
    - Test the balloon by filling with 10 cc of **air** with a syringe

8. Laryngoscope is assembled (i.e blade attached) and the **light has been checked.**

    Blades can be:
    - **Macintosh (curved):** Size 3 or 4 for adults
    - **Miller (straight):** Size 3 or 4 for adults

9. Ensure the ready availability of rescue equipment:
    - Adjunctive airways:
        - ♥ Oral airway/ Nasopharyngeal (two of these).
    - Extra ETTs, (including **one size smaller**).
    - Introducer (stylet):
        - ♥ Stylets should not project beyond the end of the ETT.

          They are placed inside the ETT tube for rigidity.

          Bend it 30 degrees into a “hockey stick”, starting at proximal end of cuff (i.e. straight to cuff, and then 30 degree bend).
    - Bougie

- Laryngeal Mask (appropriate size available).
- Spare laryngoscope (with light checked).
- **Difficult intubation tray** on hand, in particular where difficulties are anticipated:
    - ♥ **Video laryngoscopes**
    - ♥ **Cricothyroidotomy kits:**

      Consider the need for a '*Double Set Up*" - i.e opening the surgical airway equipment and having a designated trained operator (if available) to perform a surgical airway if required.

10. A defibrillator should be readily available:
    - Pad placed on patient if high risk

Patient preparation:

1. Explanation (as appropriate and where possible).
2. Optimal patient positioning:
    - Pillow(s), (or specifically designed "ramping" devices if required and if available).
    - Bed height: Patient's head level with operator's lower sternum.
    - Trendelenburg down (consider when an increased FRC is desirable).
3. Feel for the position of the cricothyroid membrane:
    - In cases of possible difficult intubation, it is a good idea to actually mark out the position of the cricothyroid membrane on the patient.

Drug Preparation:

1. Insert an IV cannula, and ensure it is *patent, functioning well* and *secured.*
    - A second IV cannula is ideal, and should always be considered.
    - An IV **fluid bag** should be primed and **connected** to an IV access.
2. Calculate to **exact dose** and **draw up** and **label** the induction agents:

   Induction agents include:

- Propofol: 1-2 mg/kg IV (**Less** in unwell/ hypotensive patients).
- Fentanyl: 1.5 - 3 micrograms/kg IV
- Ketamine: 1- 2 mg/kg IV (4mg/kg IM)
- Midazolam: 0.1 - 0.3 mg/kg IV
    - ♥ Midazolam is not usually recommended for RSI, but some practitioners use low doses of midazolam in combination with fentanyl for a modified RSI in shocked patients or frail elderly /unwell patients.
- Thiopentone 5 mg/kg IV (**Less** in unwell/ hypotensive patients).
    - ♥ Now uncommonly used.

Paralytic agents include:

- Suxamethonium: 1 - 1.5 mg/kg IV (4 mg/kg IM if in *extremis*).
- Rocuronium. 1 - 1.2 mg/ kg IV

See also Appendix 1 below.

3. Prepare drugs that will be required following the RSI:

Prepare infusion for ongoing sedation/ anxiolysis and analgesia following RSI:

- The most commonly used sedative agent is a **propofol** infusion, (this is now preferred over midazolam infusion, where sedation can take much longer to wear off).
- The most commonly used analgesic agents include **fentanyl** and **morphine** infusions.
- Some **bolus doses** may be required in addition to these background infusions.

Ensure also availability of muscle relaxants which may be required:

- The most commonly used muscle relaxants, if required, include vecuronium and rocuronium.

Often **repeat doses of muscle relaxants** are used while the patient is in the ED, in order to facilitate interventions and investigations, while in the ED.

In the ICU sedation only is preferred in the longer term, as prolonged use of muscle relaxants (> 48 hours) can lead to myopathy.

A sedation scale, such as the **Richmond Agitation - Sedation Scale** should be used to target appropriate levels of sedation. [5]

4. Standard resuscitation drugs available:

    - These need not necessarily be drawn up, but should be readily available, e.g. **atropine, adrenaline, metaraminol.**

Preoxygenation:

If the patient has adequate respiratory drive and breaths **100% oxygen for 3 minutes** at normal tidal volumes, most of the nitrogen in the FRC will be replaced with oxygen.

Around 450 mls of oxygen is present in the lungs when breathing air. If a patient breathes 100% oxygen for 3 minutes this can increase to around 3000 mls and act as a significant reservoir of oxygen during the apneic period of sedation/ paralysis.

Alternatively (*in patients who can cooperate*), the patient can take **8 maximal exhalations and inhalations,** breathing 100 % oxygen. This method can reduce the preoxygenation time to approximately 60 seconds.

Preoxygenation extends the duration of safe apnea, defined as the time until a patient reaches a saturation level of 88% to 90%, to allow for placement of a definitive airway

Ideally this allows for up to 7 minutes of apnoea before the patient becomes hypoxic and so if intubation is impossible the patient should have return of spontaneous respiration before they become hypoxic.

Optimizing preoxygenation:

In practice the inability to maintain a complete seal or to provide adequate maximal oxygen flow rates mean that 100 % oxygen cannot be effectively provided. In addition critically unwell patients, particularly lying flat, are likely to have reduced FRC values.

Patients may develop atelectasis and pulmonary shunt, reducing their ability to oxygenate their haemoglobin.

Additionally metabolic demands will be high, increasing the consumption of what oxygen they do have available

These factors combined will significantly reduce the time to desaturation in a sedated/ paralysed and apneic patient.

Steps to optimize preoxygenation include:

1. Increase available FiO_2:

    - Use **high flow oxygen at 15 litres/min** delivered by a **tightly** applied bag-valve-mask system with **PEEP valve at 10 cm** of water attached.

Note that a tight seal must be achieved with the mask, which usually requires a 2 handed technique (with another operator bagging as required). A bag valve-mask device that simply hovers above the patient's face will only provide an *ambient* FiO_2).

An oral airway and bilateral nasopharyngeal airways can also help optimize the patient's airway.

- Alternatively a **NIV - CPAP** circuit may be used

- **Apnoeic oxygenation:**

  Ongoing provision of oxygen to the hypopharynx, (and hence ultimately to the lungs), may further prolong the time to desaturation by minutes.

  The proposed mechanism is *passive* flow of gas due to oxygen absorption in the alveoli during the period of apnoea, providing there is a patent airway.

  This further oxygen may be delivered via the application of **nasal prongs** with continuous oxygen flowing at **15 liters/ min** (less in children). The nasal prongs are applied prior to bag-valve-mask preoxygenation and are supplied by a separate oxygen flow meter.

  Most patients can tolerate nasal prong flow rates of 15 litres/ min, but if they can't, the flow can be reduced back to a comfortable level as required.

  The prongs remain in situ during bag-valve-mask preoxygenation as well as during the period of induction and paralysis.

  After the ETT has been placed, the nasal prongs can be removed.

2. Increase the FRC:

   - Place the patient head up 30 degrees.

   - If spinal precautions are required, then the bed can be tilted in a *reverse* Trendelenburg position.

3. Recruit alveoli:

   This will reduce atelectasis dead space and improve V/Q mismatch.

   it can be achieved by:

   - Provide **positive end expiratory pressure (PEEP)** by have the bag-valve-mask PEEP valve set to **10 cm of water.**

- Alternatively the NIV - CPAP circuit can be used (though reduced conscious state / vomiting will limit this technique) with a pressure setting of 10 cm water.

In general terms:

- Where the SaO_2 is > 95 % use:
  - ♥ A **non-rebreather face mask** with a good seal at 15 L/min O_2 (will provide high FiO_2 with limited entrainment of air).
- Where the SaO_2 is < 95 % use:
  - ♥ A tightly fitted BVM system with **PEEP valve at 10 cm** of water attached with nasal prongs at 15 litres /min and airway adjuncts as required (oral/ bilateral nasopharyngeal airways).

  Or

  - ♥ A NIV CPAP mask system delivering 100 % oxygen under 10 cm of water pressure can be used, (when the patient is able to cooperate and is not otherwise contraindicated to the use of a NIV system).

In situations of critically unwell hypoxic and **uncooperative** patients these additional methods of optimizing preoxygenation can be employed by the technique of **Delayed sequence induction.**

For a more detailed description of these techniques see separate document on Delayed Sequence Induction.

Administration of Induction Drugs and the Application of Cricoid Pressure:

The cricoid is the only complete ring of cartilage in the larynx and trachea. When firm backward pressure is applied to the cricoid, it will compress the oesophagus between the cricoid and a vertebral body and helps prevent any regurgitated gastric fluid from entering the pharynx.

Applied pressure is of the order of **3 - 4 kilograms**.

Note that if the cricoid pressure is incorrectly applied it may **hinder** intubation. If the larynx cannot be visualized the intubator must check that the cricoid pressure is not pushing the larynx to one side.

The intubator can move the assistant's hand to the correct position but the cricoid pressure must not be released.

- Give the induction agent (**light** cricoid pressure can be placed at this point).

Then

- Give the paralysing agent, (**firm** cricoid pressure can be placed at this point):

    - ♥ **Suxamethonium** has an ultra short duration of action (3 to 5 minutes).

      It is the most commonly preferred muscle relaxant used for a rapid sequence induction, unless the patient has a specific contraindication to it, then **rocuronium** is most commonly used alternative.

Cricoid pressure is not released until the intubator indicates that the ETT is in the correct place, the cuff is inflated and there is no air leak.

The cuff pressure should be checked with a dedicated **pressure gauge device.** Pressure should be adjusted to the minimum pressure required to abolish any air leak (this will usually be around **15- 25 mm Hg**).

Intubation:

Once the suxamethonium has been given, keep the facemask in place but do **not** attempt to ventilate the patient manually - unless the patient becomes hypoxic.

This is because some of the oxygen may be forced into the stomach, increasing intragastric pressure and increasing the risk of aspiration.

As soon as the suxamethonium is effective, intubate the patient, inflate the endotracheal tube cuff, check the position and check that there is no air leak.

Many brands of ETT now include a line marked proximal to the cuff which should be visible at the conclusion to laryngoscopy, in order to avoid placement of the ETT into the right main bronchus.

In general the ETT should be at

- **23 cm** at the incisors in adult males

- **21 cm** at the incisors in adult females.

Cricoid pressure can then be released.

Following intubation it is vital to then:

- **Confirm correct ETT placement**

.

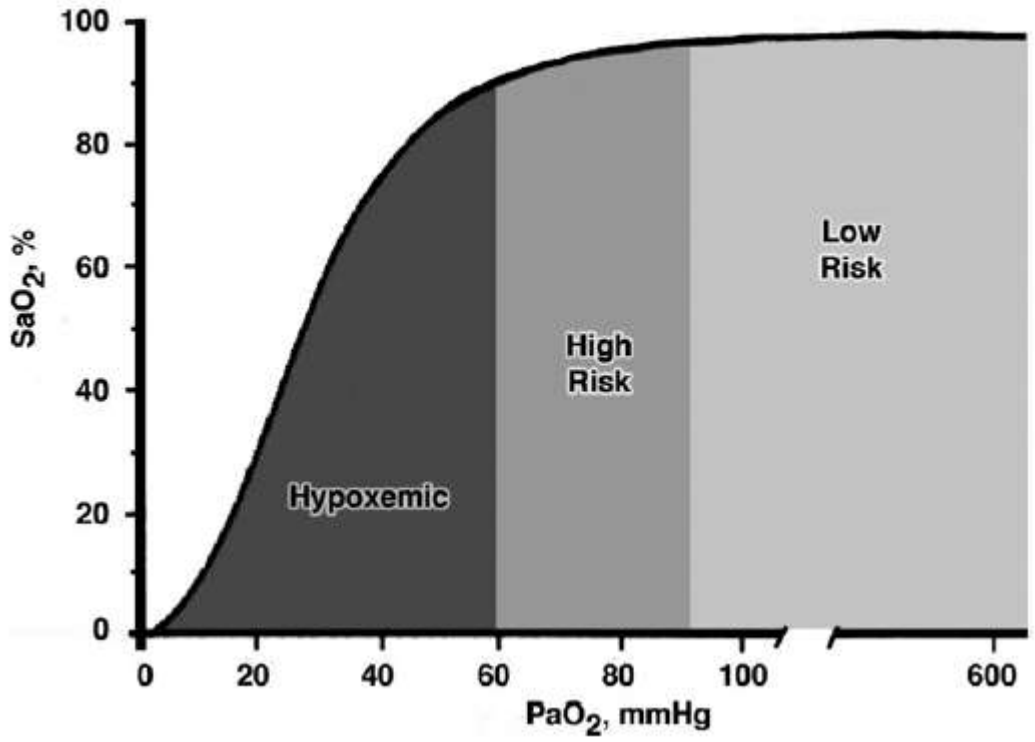
- **Secure the ETT in place.**

Appendix 1

The drawing up of predetermined doses, and the accurate labelling of drugs is an essential part of any rapid sequence induction intubation. (Photograph courtesy Dr Peter Jordan).

Appendix 2

The Oxyhemoglobin dissociation curve:



The oxyhemoglobin dissociation curve demonstrates the SaO_2 from various levels of PaO_2. Risk categories are overlaid on the curve. Patients near an SaO_2 of 90 % are at risk for precipitous desaturation, as demonstrated by the shape of the curve.[4]

Appendix 3

The Drake Equation:

Number of advanced civilizations = N^* x f_s x f_p x ne x f_i x f_c x L

N* = Stars in the Milky Way/ rate of new star formation

f_s = Fraction of sun-like stars

f_p = Fraction of stars that have planets

ne = Number of planets residing in the star's habitable zone

f_i = Fraction of potentially habitable planets, where life does actually arise.

f_c = Fraction of planets with life that evolves an intelligent species.

L= Percentage of the total life time of the planet that is inhabited by the intelligent species

A proposed updated version of the original Drake Equation by Peter Ward and Donald Brownleee (1999), which they term the "**Rare Earth Equation**":

N = N^* x f_p x f_{pm} x ne x ng x f_i x f_c x L x f_m x f_j x f_{me}

N* = Stars in the Milky Way

f_p = The Fraction of Stars with Planets.

f_{pm} = The fraction of metal rich planets

ne = The number of planets in the star's habitable zone.

ng = The number of stars in the galaxy's habitable zone.

f_i = The fraction of planets where life does arise.

f_c = The fraction of planets with life where complex metazoans evolve.

L = The percentage of the life time of a planet in which complex metazoans can exist.

f_m = The fraction of planets with a large moon.

f_j = The fracture of planets with Jupiter sized planets, at the right orbits.

f_{me} = The fraction of planets with low mass extinction events.

Note that as all terms are multiplied, if any *one* of the terms approaches zero then so does the entire equation!

References

1. Developing Anaesthesia Textbook v1.6 2007, Dr David Pescod.

2. S. Bernard; "Airway and Ventilation Management", in Textbook of Adult Emergency Medicine 4th ed Cameron et al. Churchill Livingston - Elsevier, 2015.

3. C. Nickson, "Rapid Sequence Intubation" and "Preoxygenation"; from Life in the Fast Lane Website, November 2014.

4. Weingart SD, Levitan RM. Preoxygenation and prevention of desaturation during emergency airway management. Ann Emerg Med. 2012 Mar; 59 (3): 165-75.e1. Epub 2011 Nov 3.

5. Ely E. Wesley et al. "Monitoring Sedation status over time in ICU patients: reliability and validity of the Richmond Agitation - Sedation Scale (RASS) JAMA 289 22 2003: 2983 - 2991.

Further reading:

"Rare Earth"; Peter D. Ward, Donald Brownlee, Copernicus, 2000.

Dr J. Hayes

Acknowledgements:
Dr Gerrard Marmor
Reviewed April 2015.