ORL anaesthesia update

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This session aims to give a brief update on some of the more topical developments in airway management.

PART ONE: Awake Intubation

The Difficult Airway Society (DAS) released a guideline for Awake Tracheal Intubation (ATI) in adults last year[1].

Useful updates from this guideline included:

- Oxygen therapy should always be administered during the procedure, which may not prevent desaturation but will reduce the severity.
  - Use of High Flow Nasal Oxygenation (HFNO) when attempting an oral awake intubation
  - Face tent or Hudson mask cut in half if attempting a nasal intubation
- Ergonomics for ATI, with two examples given; one with the proceduralist at the head of the bed and the other with the proceduralist beside the patient.
  - Essentially the aim is to optimize the position of the patient, proceduralist, assistant and equipment including monitors.
  - Monitors should be in the direct line of sight of the proceduralist
- Topicalization recommendations, with lignocaine maximum dose calculated at 9mg/kg lean body weight. They stress that this is a ceiling dose for lignocaine and not a target.
  - Reminder of lignocaine doses in commonly used preparations for topicalization:
    - Co-phenylcaine spray = lignocaine 5% + Phenylephrine 5mg/ml): 1 spray = 0.1ml=5mg lignocaine
    - Lignocaine 10% (100mg/ml)= 10mg/spray
    - Lignocaine 4% (40mg/ml)
- Recommendation of a two-point check for tracheal tube placement
  - Visualize tracheal lumen in trachea
  - Confirm capnography

We will also address common questions and troubleshooting points regarding ATI:

- Passage of endotracheal tube through the nose
  - Serial nasal dilatation will help with this, and can be done during topicalization of the oropharynx and set up in theatre.
- Difficulty visualizing the glottis
- Get patient to sniff, swallow, vocalize or breathe deeply.
- Hang up at the cords (usually the right arytenoid) - not uncommon as it is a blind procedure!
  - Use a reinforced tube
  - Continuous rotation as advancing
  - Get patient to breathe in

    - Using a videolaryngoscope in combination can help facilitate clearance of the tongue, elevate the epiglottis and advance the ET tube.
- Spray as you go technique
    - Get patient to breathe in as you spray above, at and below cords (by epidural catheter or via working channel).

PART TWO: THRIVE

High flow nasal oxygen (HFNO), which is also known as Trans-nasal Humidified Rapid Insufflation Ventilatory Exchange (THRIVE), is where oxygen that has been warmed to body temperature and 100% humidity is delivered at flows of up to 90 L/minute via nasal cannulae.

This allows for:

- Humidification
- Continuous Positive Airway Pressure (CPAP)
- Apnoeic oxygenation and a variable degree of apnoeic ventilation (some removal of CO_2 from respiratory dead space and replacement of oxygen that has been absorbed, thus assisting in the process of oxygen diffusion)[2]
- Reduction in the work of breathing and airway resistance[3]

In the operating room, THRIVE can be used in airway management in the following ways:

1) Preoxygenation and extension of safe apnoeic time during difficult airway management under anaesthesia
    - 30-40L/min usually well tolerated by the awake patient
    - Especially useful during Rapid Sequence Induction (RSI) and awake intubations as usually mask ventilation is not administered thus allowing for oxygen delivery and some ventilation. HFNO limits the amount of CO2 accumulation, especially in the first 20 minutes[4]
    - Caveats:
        - Airway must be open for THRIVE to work, so steps must be taken to ensure airway patency
        - Awareness is a risk, so intravenous anaesthesia should be used along with bispectral index (BIS) monitoring
        - Mask seal should not be attempted over the THRIVE cannulae (risk of barotrauma or gastric insufflation
            - Note: Fisher and Paykel are currently trialling new nasal cannulae ("Switch" cannulae) that allows for BMV in conjunction with HFNP oxygen delivery
        - High oxygen concentrations increase the risk and intensity of fire, because not only is there increased oxygen concentration, but also increased delivery of oxygen per unit time.
            - HFNP oxygen should be turned off after the airway is secured to avoid high oxygen concentrations around the patient which may pose an increased fire risk
2) Supplementary oxygenation during procedural sedation
    - Advantages: warmed, humidified high flow oxygen delivered.
    - Disadvantages: capnography not possible, and because it may extend the apnoeic period before oxygen desaturation occurs, this may mask patient apnoea and also unrecognised hypercarbia.

3) During elective/acute shared airway surgery using apnoeic gas exchange
    - e.g. during microlaryngeal surgery
    - If the procedure is longer than 20 minutes, then additional methods to ventilate and clear CO_2 are needed[2]
4) Management of an acutely compromised airways
    - e.g. a patient on the ward with an airway emergency
5) After extubation in PACU
    - e.g.in the obese patient who is extubated and breathing but may be a bit drowsy after GA

Contraindications to THRIVE:

ABSOLUTE:

- Use of diathermy within the larynx, pharynx, oral cavity or face
    - NB: Use on the neck for the superficial initial dissection of emergency tracheostomy is the exception
- Use of alcohol based skin prep during the use of HFNO
- Known or suspected base of skull fracture, CSF leak or other communication with the intra-cranial space
- Significant pneumothorax not treated with chest drain, as the CPAP may expand the pneumothorax[5]
- Complete nasal obstruction
- Active epistaxis or recent Functional Endoscopic Sinus Surgery (FESS)

RELATIVE CONTRAINDICATIONS:

- Partial nasal obstruction
- Disrupted airway e.g. laryngeal fracture, mucosal tear or tracheal rupture
- Use of laser or diathermy during the use of HFNO due to fire risk. This becomes an absolute contraindication once Fi02 > 30% required
- Patients with contagious pulmonary infections, especially Tuberculosis
- Patients in whom high concentration oxygen therapy is contraindicated (for example bleomycin chemotherapy)
- Patients unable to tolerate hypercarbia with prolonged apnoea, e.g.
    - Sickle cell anaemia
    - Pulmonary hypertension
    - Intracranial hypertension
    - Congenital heart disease
- Children under the age of 16 years. There have been some case reports of air-leak (e.g. pneumothorax and pneumomediastinum) in children[6]

When using THRIVE it is of utmost importance to remember the very real fire risk that exists. Patient and case selection are essential considerations, and should THRIVE be used in situations where a source of ignition is being used (for example laser or diathermy), an experienced team with knowledge on management of airway fires should be present.

Fire requires fuel, ignition source, and an oxidizer, all of which may be present in surgical cases using high flow nasal oxygenation. There have been several case reports where high flow oxygen channeled under surgical drapes to act as the oxidizer, where tissue or vaporized fat acted as the fuel, and diathermy or laser were the source of ignition to complete the fire triad[7-9]

PART THREE: Ultrasound for the airway

Point of care ultrasound (POCUS) is increasingly being used in airway management. The following are a few examples of how it is being utilised[10]

1) Airway Assessment
    a. Airway size
        i. Measure the subglottic airway diameter; especially important in paediatrics
    b. Prediction of difficult airway
        i. Small studies only at present, four studied methods reported to date:
            - Visualisztion of hyoid bone[11]
                a. Inability to visualize the hyoid bone on US using the sublingual approach predicts difficult intubation
                b. High sensitivity and specificity
            - Hyomental distance ratio[12]
                a. Hyomental distance ratio = the distance between hyoid bone and mandibular mentum in the neutral position to the hyperextended neck position
                b. Shorter hyomental distance ratio of 1-1.05 in morbidly obese patients predicts difficult laryngoscopy with high sensitivity
                c. Patients intubated easily were found to have a hyomental distance ratio ranging 1.12 - 1.16
            - Anterior neck thickness[13-15]
                a. Neck thickness at the level of the vocal cords, hyoid bone and thyrohyoid membrane have all been studied.
                b. At the level of the vocal cords, mean pre-tracheal tissue exceeding 28 +/- 2.7 mm was found to increase the risk of difficult laryngoscopy[13]. Unfortunately, not reproduced in other populations.
                c. However, at the level of the hyoid bone and thyrohyoid membrane, anterior neck thickness above 28mm was found to be a better predictor of difficult laryngoscopy compared to at the level of the vocal cords.
            - Tongue thickness and tongue thickness to thyromental distance ratio[16]
                a. Tongue thickness of more than 6.1cm measured using the submental approach may predict difficult tracheal intubation
                b. Higher tongue thickness to thyromental distance ratio of more than 0.87 are capable of predicting difficult tracheal intubation
2) Airway device placement and depth
    a. Endotracheal Tube (ETT) confirmation
        i. Cardiorespiratory arrest, low flow states, bronchoconstriction and technical malfunction may all result in no/poor capnography trace
        ii. Place transducer in a transverse plane, at suprasternal notch; this has been shown to have the best visualization and diagnostic accuracy[17]
        iii. ETT in oesophagus is seen as ‘double tract sign’ on static imaging[17]
        iv. ETT passing through trachea is seen as flutter of movement, “snowstorm sign” on dynamic imaging[17]

    v. No delay in confirmation using ultrasound, and at the level of the suprasternal notch, oesophageal intubation can be diagnosed with high sensitivity (98.9%) and specificity (94.1%)[18-19]
  b. ETT depth
    i. Clinical assessment by auscultation and observing chest rise and fall may fail to identify up to 55% of endobronchial intubations[20]
    ii. Using a longitudinal view, aim to visualize ETT cuff at the level of the sternal notch, with or without saline[17]
  c. LMA confirmation
    i. In children, ultrasound has been used to detect LMA malrotation with high sensitivity (93%) and specificity (82%) and accuracy of 87%[21]
      - LMA malrotation was recognized and graded based on sonographic arytenoid cartilage elevation in the transverse plane
    ii. LMA cuff can be visualized when inflated with saline and contrast agents

3) Procedures:
  a. Marking cricothyroid membrane
    i. Ultrasound provides accurate landmark identification allowing for improved procedural safety, especially when anatomy is not easily palpated
    ii. Locating the cricothyroid membrane is fast with a short learning curve[22] and real time ultrasound guided bougie assisted cricothyroidotomy has also been shown to have a high success rate in cadavers[23]
    iii. Transverse technique:
      - Place linear probe in midline of neck at level of cricoid cartilage
      - Slowly advance cephalad until thyroid cartilage is seen (hyperechoic, triangular structure)
      - Then move transducer caudally to visualize a hyperechoic white line with reverberation air artefact posteriorly; this is the cricothyroid membrane
      - To confirm, move probe caudally to visualize cricoid cartilage
      - Cricothyroid membrane can be marked in the midline above and below the probe
    iv. Longitudinal technique:
      - Place linear probe in midline of neck at level of cricoid cartilage
      - Rotate probe 90 degrees so that airway is in longitudinal axis
      - Tracheal rings will be a series of hypoechoic structures, anterior to a white hyperechoic line ("string of pearls")
      - Move transducer cephalad to visualize thyroid cartilage
      - Once cricothyroid membrane identified, slide a linear metallic object (e.g. blunt needle) under the probe to create a shadow over the membrane. Remove probe and mark the area
  b. Superior laryngeal nerve blocks for awake intubation[24]

4) Pathology:
  a. Epiglottis, e.g. can see thickness
  b. Vocal cord assessment, e.g. can see real time visualization of vocal cord movement for pathology such as a vocal cord palsy or vocal cord cyst
  c. Trachea location and surrounding structures
  d. Laryngeal injury

5) Predicting post-extubation stridor[25]
  a. By measuring the air column width difference at the level of the vocal cords before and after ETT cuff deflation

b. A smaller difference, means a narrower airway, meaning less air passing through the vocal cords and possible laryngeal oedema

During this session ultrasound images will be shown to demonstrate some of the above as well as key anatomy identifiable when scanning the airway.

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