Risk Reduction in Endo-Tracheal Tube Fixation

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Key Words

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Evidence suggests that tracheal intubation has been undertaken for about 4,ooo years (Szmuk et al 2008). Airway management is vital for the unconscious, ventilated patient, yet although the Royal College of Anaesthetists provide guidance for an Initial Assessment of Competence for UK Anaesthetics (RCA 2022) (Box 1), no national standardised protocol for ETT insertion and management exists, forcing individual organisations develop their own practices.

The lack of national guidance is not without issues; a 2009 review of patient safety incidents pertaining to airway devices (2005-2007) found that of 1085 incidents, 893 (82.3%) were classed as post-procedure problems such as displacement from patient (66%, n=317), pressure ulceration and infection (19%, n=73). Causes of displacement included patient turning, physiotherapy and patient agitation. Consequently, the authors recommended that investment should be made in design solutions to improve the fixation of tubes (Thomas, 2009).

In addition to the lack of guidance, few studies on the securing of ETTs in the operating theatre have been undertaken (Davies et al 2014).

This article will outline how such complications may arise and present a potential clinical solution.

Infection

While the process of intubation can lead to tissue damage and subsequently, infection, (Levine 1991) there is a ubiquitous source of infection for the intubated patient, the fomite. A fomite is '… an object that becomes contaminated with infected organisms and which subsequently transmits those organisms to another person.' (NHS England. 2020.) has been identified as a source of cross-contamination and healthcare acquired infection (HAI). Fomites include stethoscopes (O'Flaherty 2015) and a tiny but potentially lethal source of cross-contamination and healthcare acquired infection (HAI), a roll of adhesive tape, regularly used to secure ETTs (McCluskey et al 2015). A survey by McClusky et al revealed:

- no existing policies or standards of care related to tape storage or use
- tape stored in open containers in infrequently cleaned rooms
- tape rolls being carried in pockets or on stethoscopes

(McClusky 2015)

However, the role of tape on cross-contamination has been understood for over 50 years (Redelmeier 1999, Garg 2009, Harris 2012, Rammaert 2012, Lalayanni

2012). Berkowitz et al examined 23 rolls of adhesive tape being used in a 16-bed intensive care unit and found mixed flora on 15 rolls and pure cultures of *Staphylococcus aureus, Pseudomonas aeruginosa*, and various species of *Enterobacteriaceae* on eight rolls. (Berkowitz 1974), and concluded that such tape may contaminate the hands of those who handle it and may directly contaminate patients when used to secure airways and drainage tubes as it is in close contact with the mucous membranes. Further studies have explored the potential infection risks of adhesive tape in the securing of a patient airway (Krug 2014, Bernatchez 2021). Krug et al reviewed literature pertaining to endotracheal tube (ET) taping practice and found that overall, it was not safe as tape rolls were not discarded at the end of a surgical case, rather returned to the supply bin for re-use on other patients. They concluded that a disposable, individually wrapped, single patient use tape roll was needed.

Device-related skin stripping

Numerous studies have shown that surgical tape removal can cause Medical Adhesive-Related Skin Injury (MARSI) such as skin-stripping, the removal of the superficial stratum corneum, skin blistering, skin tears, inflammatory skin reaction and pain (Cutting 2008, Fumarola 2020, Bloria, 2020).

Zeng et al's study (Zeng, 2016) compared the incidence of facial skin injury and patient satisfaction with different tapes in 60 adult patients undergoing anaesthesia. Standard tape caused denudation of the skin and skin injury in 13.3% (n=4) and 37% (n=11) respectively, compared to silicone (0%) and 3% (n=1) respectively

Facial pressure injuries and ETT displacement

Literature has demonstrated that facial pressure injuries, damage to the skin or damage to underlying tissue can be caused by medical devices which have been secured incorrectly. Zakaria et al found in the three weeks of the study, 90% (n=27/30) of control group subjects developed oral ETT pressure ulcers compared to the intervention group (avoiding tape where possible and placing padding under areas of cloth fixation) (Zakaria 2018).

Other studies have found that the use of cloth tape or commercial ETT fixers can also cause pressure ulceration. Hampson et a's retrospective observational study sought to determine the impact a fixing device (AnchorFast™) on the incidence of oral pressure injuries in mechanically ventilated patients compared to the previous fixation method. Results showed that incidence increased from 1.53/100 to 3.73/100 (IRR = 2.43, 95%CI = 1.35–4.38; p = 0.003). There was also a significant difference in location of pressure injuries sustained with ETTs secured using cloth tapes (53.6% in corner of the mouth) vs. AnchorFast™ (75% on the lips) (p = 0.008). (Hampson 2018). Similar results with commercial fasteners were seen by Sleiwah et al (Sleiwah 2020)

Nursing a patient on the prone position also increases the potential for ETT pressure injury. Shearer et al observed that 47.6% of proned COVID-19 patients developed facial pressure ulcers (Shearer 2021)

Landsperger et al (2019) undertook a study that randomised patients undergoing ETT fixation to adhesive tape or endotracheal tube fastener at the time of intubation in order to determine the presence of lip ulcer, endotracheal tube dislodgement or facial skin tears. Results showed that lip ulcers occurred in 2.6 % (n=4) versus 11 (7.3%) patients (incidence rate of 6.5 versus 19.5 per 1000 patient ventilator days ($p = 0.053$) in the fastener and tape groups respectively. The ETT was dislodged 3.9% (n=6) and 10.3% (n=15) (incidences of 11.9 and 28.1 per 1000 ventilator days,) respectively. Facial skin tears were similar between the groups. (Landsperger 2019)

ETT management Studies

Given that an endotracheal tube (ETT) plays a vital part in keeping a patient alive, it must remain patent and *in situ*. An unplanned extubation (UE), 'the unintentional and uncontrolled removal of the endotracheal tube either due to actions of the patient or during nursing care or movement of the patient (da Silva 2012), can lead to serious harm, including dyspnoea, airway trauma, laryngeal and tracheal oedema, difficult reintubation, hospital-acquired infections (Hai) and death (Aydogan 2017).

Mannequin studies

Fisher et al evaluated nine ETT holders in simulated clinical conditions. ETT security was tested by measuring distance displaced after a tug. Sensors were located on a mannequin which measured applied forces when the head was rotated vertically or horizontally. From the results the authors concluded that non-commercial airway holders exert less force on a patient's face than commercial devices (Fisher 2014)

A further study used a mannequin to examine the amount of force required to dislodge endotracheal tubes secured with four different varieties of commercially available tape and three different taping methods, and concluded that the amount of force required to dislodge endotracheal tubes is affected by tape type, taping method, and direction of force. The silk tape was superior at holding the endotracheal tube in place when compared to other tape varieties and taping methods (Davis 2014). The author's also concluded that securing to both the mandibular and maxillary borders (Y-shape), created a strong fixation.

Interestingly, Shimizu et al's mannequin study demonstrated that if tape strips were of sufficient length and width, a conventional tape method was superior to the tested commercial ETT holders in holding the ETT in place (Shimizu 2011)

Clinical Studies

A questionnaire to explore anaesthetists' experiences of ETT fixation and displacement was undertaken by Li et al (Li 2021). From the 541 responses:

- adhesive tape was the most commonly used material fixation (90.4%, n=489)
- 61% (n=329) applied in the shape of the letter X
- 65% (n=351) experienced ETT displacement
- 4.3% (n=23) of displacements caused serious harm

As noted above, the use of adhesive tape (AT) and ETT fasteners was explored by Landsperger et al in a pragmatic, single-centre, randomised trial (Landsperger 2019) They found that the ETT was dislodged 3.9% (n=6) and 10.3% (n=15) (incidences of 11.9 and 28.1 per 1000 ventilator days,) respectively and concluded that 'The use of the endotracheal tube fastener…reduces the rate of a composite

outcome that included lip ulcers, facial skin tears, or endotracheal tube dislodgement compared to adhesive tape.

Davies et al (2014) that, due to increased resistance to inadvertent extubation forces via a maximised adhesive surface area, the most secure method of fixing the airway was to tape to the mandible and the maxilla.

Resource consequences

The clinical issues arising from inappropriately secured ETTs carry a resource cost. While a roll of adhesive tape may be a low-cost method of ETT fixation, its potential as a source of infection must be considered. For example, in a study to ascertain the cost of treating ventilator-associated pneumonia post cardiac surgery in the National Health Service, Luckraz et al determined that the additional cost of treating patients with ventilator-associated pneumonia was £8829 (Luckraz 2018).

Solution

While alternatives to cloth and adhesive tapes have been developed, such as the AnchorFast, Comfort-Fix and the Thomas Select tube holder, the latter of which can secure both ETT and other supraglottic devices. However in terms of cost and ease of use, these fall short in terms of price and ease of use:

- Anchorfast relies on a click security clamp to secure. The Slim costs £13.20 per unit, the Standard costs £11 per unit and the straps are £1.10. This is ordered through ORACLE rather than NHS supplies
- Comfort Fix relies on Velcro, a potential fomite, to secure in place
- The Thomas Select holder, £4.80 relies on a screw mechanism to secure in place.

Developed by two Operating Department Practitioners, the single-use LEAFix (Laryngeal, Endo-tracheal Airway Fixator), unlike other tape alternatives, secures both generations of supraglottic airway. As suggested by Davies et al (2014), the innovative 'Y' section secures the airway device to both the maxillary and mandibular borders (Box 2).

Leafix is used in a similar way to adhesive tape and therefore offers a focal point for standardising the practice of securing airways and ensuring a safer clinical environment in airway securement (Figure 1).

Conclusion

The current random use of tape is dependent on the random actions of an individual, meaning there is a lack of consistency in application. Leafix can change this, providing a safer clinical environment for airway securement. It is clear from the evidence that ETT fixation requires national guidance to avoid extubation, infection and skin damage. Leafix offers a safe and simple way of achieving these requirements.

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Box 1: Initial Assessment of Competence for UK Anaesthetics (RCA 2022)

- **Intraoperative care**
- Performs airway management including the following techniques:

  Mask ventilation
- Supraglottic airway insertion
- Endotracheal intubation using direct and video laryngoscopy
- Performs a Rapid Sequence Induction
- Conducts anaesthesia with controlled and spontaneous ventilation
- Understands the physiological effects of general anaesthesia
- Manages the risks posed to patients when positioning them for surgery, in particular related to pressure areas, peripheral nerves and other delicate structures.

- Follows infection prevention and control procedures in the operating theatre.

  Manages tracheal extububation

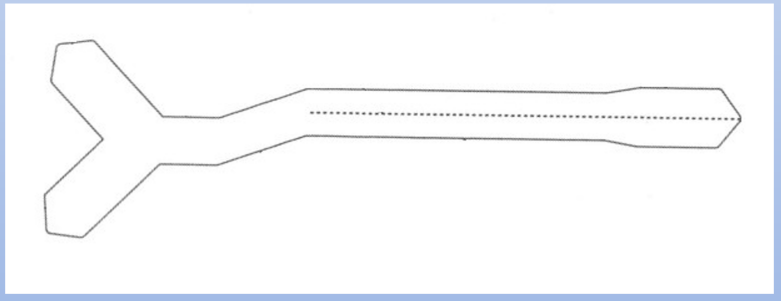
Box 2: LEAFix application

The self-adhesive foam backing-cover is removed before use.
The Y-shaped edge acts as a dual-anchor point that allows fixation to the face, and the downwards angled section allows the device to wrap around a variety of airway
device tube diameters whilst maximising surface contact. A light peel-force is used for removal. A perforated section along the longer end of the device can divide into two further anchor points to increase the securing options

Figure 1: LEAfix ETT fixation device

LEAFix

Single patient use endotracheal tube (ETT) fixation device



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