

## Endotracheal Tube Nursing Care: Current Evidence



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### 1. ABSTRACT

**Background:** Endotracheal intubation is a common clinical procedure applied for protecting critically ill patient's airway, and supporting their ventilation needs through the insertion of a large-bore, flexible, plastic tube in the trachea between the vocal cords called an endotracheal tube. Endotracheal tube care is an essential nursing practice for maintaining patient safety. The incompetent endotracheal tube care can increase patients' hospital stay, treatment costs, and morbidity and mortality. The literature highlighted that until now nurses' practices depend greatly on rituals and traditions. Critical care nurses are assigned to deliver safe nursing care directed by the best evidence. Most incompetent nursing care for intubated patients may be due to a lack of nurses' awareness and knowledge of the current evidence-based practice. To optimize nursing care quality; the nursing practice should be fed by scientific knowledge and standardized evidence-based practice. Hence, this review aims to highlight the recent evidence related to endotracheal tube nursing care.

**Keywords:** Endotracheal Tube, Endotracheal Tube Care, Nurses' Practice, Critically Ill Patient

### 2. Literature Searching Strategy

The authors searched electronic medical and health care databases, including Google Scholar, Ovid, Science Direct, PubMed, Cochrane Library, Pro-Quest, and Medline, to find appropriate relevant literature on this subject. As keywords, the following search phrases were used: "Endotracheal tube," "Nurses' practice," "ETT nurses' assessment", "ETT preparation", "ETT placement", "ETT securement", "ETT cuff pressure", "chest physiotherapy", "suction practices", "Oral care", "ETT post-care", and "Nurses' documentation".

### 3. Literature Review

The purpose of this review is to discuss the current evidence related to nurses' practices of endotracheal tube (ETT) care. The discussion covers three main sections as follows:

**Section I:** Overview of ETT

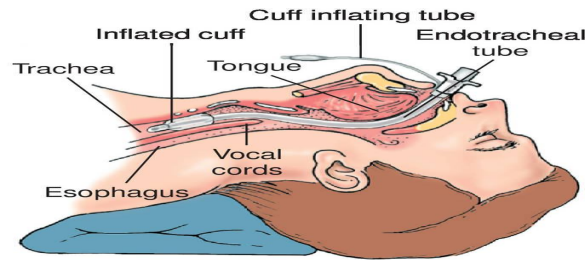
**Section II:** Factors affecting ETT nursing care

**Section III:** ETT nursing care and malpractice

#### Section I: Overview of ETT

The foundation of an actual airway via the ETT is to provide immediate life-sustaining therapy during resuscitation and maintain oxygenation and ventilation during anesthesia (Ahmed & Boyer, 2021). In the past, ETTs were made of several materials like reed, brass, and steel (Szmuk, Ezri, Evron, Roth, & Katz, 2008). Later, ETTs were designed from polyvinyl chloride that is the most commonly used today (Haas, Eakin & Konkle, 2014).

The ETT is a commonly used device that is essential for saving patients' life (Divatia, Khan, & Myatra, 2011). It is described as a large-bore flexible plastic tube introduced through the mouth traveling into the upper part of the trachea above the carina by the way to the voice-box in between the vocal cords (Arttime & Hagberg, 2018) as presented in figure 1. It is fixed to deliver oxygen under a certain controlled pressure to assure the patency of the upper airway and maintain adequate air passage. Additionally, it helps in providing oxygenation, preventing aspiration of gastric secretion, and allowing a way for emergency medications (Gurjar & Baronia, 2016).



**Figure 1.** The passage of ETT Adopted from “Procedure of artificial airways”. *Nursing-Skills.Blogspot.* (n.d). Retrieved from

<https://nursing-kills.blogspot.com/2014/01/procedure-of-artificial-airways.html>

### Indications for the ETT

Endotracheal intubation (ETI) is indicated during operations for general anesthesia and in non-operating settings for urgent situations. The airway problems such as external pressures on the airway, vocal cord paralysis, tumor, infection, and laryngospasm are also indications for ETI (Sahiner, 2018). Respiratory deficiencies and inadequate circulation such as cardiac arrest due to hypothermia and hypotension also need urgent intubation (Sahiner, 2018; Simpson, Ross, McKeown, & Ray, 2012). Furthermore, muscle and central nervous system problems, metabolic disorders, and interventional radiology under sedation as magnetic resonance imaging scan and endoscopic procedures are other indications for intubation (Cabrini et al., 2018).

Endotracheal intubation is also used in head surgeries, and thoracic, and abdominal interventions (Sahiner, 2018). These procedures may cause reflex bradycardia, vasospasm, and laryngospasm through vagal stimulation causing aspiration of the stomach contents, blood, mucus, or secretion (Artime & Hagberg, 2018). It is also needed for patients with hemodynamic instability, shock, or airway compromises such as stroke, drug overdose, or depressed level of consciousness (Sahiner, 2018; Simpson, et al., 2012). Other criteria for ETI include decreased level of

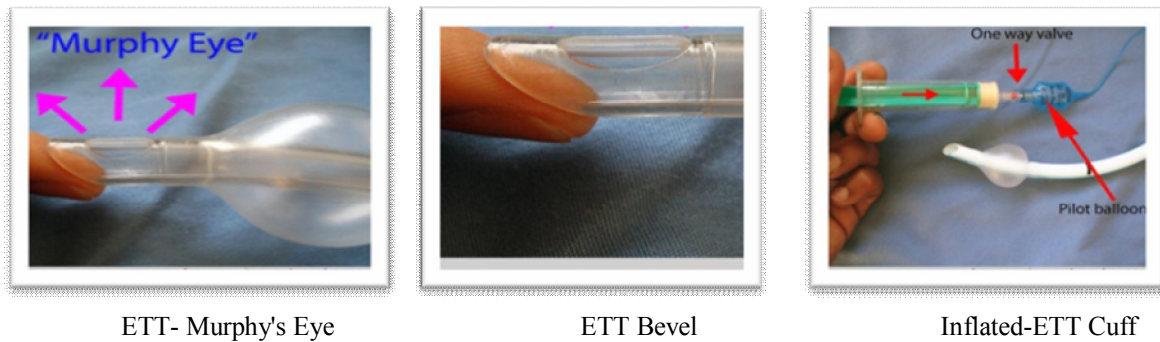
consciousness with a Glasgow coma scale (GCS) less than 8, a respiratory rate less than 8c/min or more than 30c/min, PaO<sub>2</sub> less than 55 mmHg, PaCO<sub>2</sub> more than 55 mmHg, and non-compensated acidosis-alkalosis (Sahiner, 2018).

### Components of the ETT

The ETT has a removable 15-mm adapter to connect the ETT to the oxygen devices and help the clinicians to re-size or shorten the tube and remove the accumulated secretion. At the end of ETT, there is a level that helps passage of the ETT and better vision of the tube tip (Figure 2). The 45-angle bevel is closed to a hole called the murphy's eye which allows airflow to the carina if the distal portion of the tube becomes blocked. The ETT distal part has an inflatable balloon called the cuff creating a seal, permitting the airflow via the trachea, and preventing air and fluid leakage around the tube. The cuff is inflated by a thin tube that ends by a one-way valve named the pilot balloon. ETT cuff inflation also acts as an antimicrobial agent that helps arrest the subglottic secretion from descending to the bronchus and the lungs (Gurjar & Baronia, 2016). However, the cuff pressure should be maintained at 20-30 cmH<sub>2</sub>O (Khalil, Salama, Mohammed & Sayed, 2018).



Adopted from “Endotracheal tube”. *Slideshare.* (2015). Retrieved from: <https://www.slideshare.net/HaseebManzoor/endotracheal-tube>



**Figure 2.** Components of ETT Adopted from “Tracheal tubes explained simply”. *How Equipment Work*. (n.d). Retrieved from: [https://www.howequipmentworks.com/tracheal\\_tubes/](https://www.howequipmentworks.com/tracheal_tubes/)

The tube is proved by an inner and outer diameter; the size of ETT refers to its inner diameter (ID). Suitable diameter tubes should be chosen depending on a standardized formula as the narrow diameter tube raises the resistance to gas flow and the largest diameter leads to laryngeal structure and tracheal mucosal damage (Urden, Stacy & Lough, 2020). The ETT length is measured from the distal part that goes into the trachea above the carina to the mouth angle (Gomez, Melo, Orozco, Chicangana, & Osorio, 2016). The approximate typical length for males is 23 cm and 21cm for females (Oh, Bang, Kwon, & Shim, 2016; Gomez et al., 2016). Some ETTs have a black marking proximal to the cuff as in figure 3 which helps measure the proper depth (Hass, Eakin, Konkle & Blank, 2014).

### Physiological effects of intubation

The ETT has a vital role in transporting the air to the lungs. However, its presence through the airway induces certain changes that relatively lead to unstable airflow (Sahiner, 2018). ETT placement through the trachea causes partial occlusion that minimizes the normal airway girth. The ETT as a foreign body triggers host and inflammatory effects that create a media for infection and can cause airway disturbances secondary to the pressure injury (Gurjar & Baronia, 2016).

The body reacts to the presence of ETT with different mechanics. Loss of humidity and heat is the most vital consequence of replacing the normal mucosa with a foreign set (Plotnikow, Accoce, Navarro, & Tiribelli, 2018). The gas flow is already dry and cool which reduces ciliary function impairing the removal of secretion and mucus plugging which activates the growth of an organism (Metete, & Akbudak, 2018; Plotnikow et al., 2018). These obstructed areas may induce

lobar collapse, a ventilation-perfusion mismatch, and inability to completely exhale leading to breathe stacking and auto-PEEP or possibly resultant barotrauma (Hagberg, Artime, & Aziz, 2017).

### Section II: Factors affecting ETT nursing care

Factors affecting ETT nursing care encompass two main aspects: organizational and human-related factors (Higges et al., 2018; Khalil et al., 2018). In Turkey, a study assessed the variables that affect nurses' practices and showed that the workers' acceptance is a significant base of any institution's success and production (Terzioglu, Temel, & Sahan, 2016). The researchers also found that a high percentage of nurses experienced mobbing that created a tense and gloomy work environment. They also explained factors related to nurses' work-stress including the institutional justice, culture, authorities, and workers' attitude that influence the environmental work health. Moreover, Bahadori et al., (2014) mentioned that the workload is one of the main reasons for nurses' burnout which can decrease the nurse-patient rapport, disturb the physician-nurse work confidence and reduce the quality of patient care.

Additionally, Haghghat and Yazdannik (2015) reported the necessity of applying hospital care policies, practical guidelines, and protocols that improve health care quality standards and nursing practices of tracheal suctioning. Another research revealed that lack of nurses' awareness of assigned responsibilities, and overloaded patients' admission were the main obstacles that affected nurses' performance, elevated medical errors, and increased nurses' stress (Bahadori et al., 2014). According to Booker, Murff, Kitko, and Jablonski, (2013), lack of supplies, insufficient staffing levels, patient acuity, and over-nurse-patient ratio are

barriers to the delivery of high-quality care. An Iranian study suggested that nurses' performance can be enhanced by the organizational continuous training and educational programs as well as applying the evidence-based nursing practice (Dehghani, Mosalanejad, & Nayrie, 2015).

Human factors involved patients' and nurses' related factors (Khalil et al., 2018). The reliable patients' risk factors are related to their health and illness (Booker, et al., 2013; Cosentino et al., 2017). Besides, some investigators documented that pain, discomfort, anxiety, agitation, delirium, low sedation level, lack of physical restraint, and lack of nurse-patient communication are serious elements affecting the quality of ETT nursing care practices (Kiekkas, Aretha, Panteli, Baltopoulos, & Filos, 2012; Selvan, Edriss, Sigler, & Tseng, 2014).

Moreover, Cosentino et al. (2017) clarified that patients' level of consciousness, physical restraint, inadequate sedation and ETT fixation tools are considerable factors that induce ETT slippage that may elevate the patient's risk for nosocomial infection. Accordingly, this may increase the patient's intensive care unit (ICU) stay, maximize the infection exposure rate, and elevate the cost of treatment.

A study conducted by Wang and Canggang, (2015) to investigate factors affecting nurses' performance in the ICU suggested that lack of patients' preparation can alter their cooperation, communication, and consequently, the quality of care they receive. The study also illustrated that nurses' decision-making, motivation, education, and job satisfaction can affect the quality of ETT care.

A study conducted by Yang, Yue, and Zhang (2017) to evaluate the ETT placement confirmation illustrated that patients' obesity, pneumothorax, and hemothorax were major factors affecting confirmation of ETT proper placement. They also concluded that these factors are considered barriers that may affect the patient's chest movement auscultation and observation. The level of nurses' practice is the main key factor for health care institutions' progress and success. Therefore, there is a need for addressing the gaps in nurses' knowledge and practice, and developing strategies for improving nurses' performance, encouraging distinguished performance, and maintaining an effective work environment (Tesfaye, Abera, Balcha, Namera, & Belina, 2015)

### **Section III: ETT nursing care and malpractice**

Nursing care of intubated patients is a high-risk, complex intervention that can lead to several complications (Lapinsky, 2015). Misconduct of practice and negligence to meet the required standards of care may cause patient harm, elevate treatment costs, and increase patients' ICU stay (Cheluvappa, & Selvendran, 2020). Some researchers suggested that nurses need to perceive the physiological effects of intubation and update their knowledge and skills based on the current recommendations. However, health organizations need to develop their own protocols of care to be implemented in ICUs (Al-Shameri, 2017).

Elbokhary, Osama, and Al-Khader (2015) reported that nurses' practices are depending on rituals and traditions. The authors analyzed the nurses' knowledge and practice regarding ETT suctioning of mechanically ventilated patients and revealed no significant relationship between the nurses' working experience and their practice and knowledge levels. Terzioglu et al's., (2016) study illustrated that poor nurses' performance could enhance the danger bell within any health organization as its success depends on the health care team practice and the quality of delivered care. Hence, the authors of the same study suggested continuous training programs for nurses.

Critically ill patients are subjected to invasive procedures, one of these procedures is the ETI which increases the risk of infections. Hence, critical care nurses (CCNs) should implement infection control practices to prevent cross-infection including proper hand hygiene (Mathur, 2011), personal protective equipment (PPE), and a clean environment that are essential elements preceeding any clinical procedure (Reddy, Valderrama, & Kuhar, 2019).

The health care manager should assure the availability of PPE to workers. These supplies are designed to minimize the exposure risk through contact to skin, mucous membrane, or respiratory secretions. Donning and doffing PPE is extremely important in the infection prevention process (Suen et al., 2018). Concerning nurses' compliance with the PPE before the ETT care practice, it may be poor due to the frequent patient care contact. Poor nurses' practices can be attributed to heavy workload, shortage of nursing staff, and insufficient supplies (Ali, 2013).

Immediately after ETI, nurses have to confirm the proper ETT placement at regular intervals as misplacement of the ETT can lead to

patients' mortality and morbidity (Sun et al., 2014). The traditional methods are less beneficial only for confirmation of ETT placement like chest auscultation for breath sounds and bilateral equal air entry, visualization of symmetrical chest expansion, and inflatable abdomen.

Chest radiography has been suggested as a rapid confirmative tool for ETT proper position (Schmolzer & Roehr, 2014). It was emphasized that the golden tools for ETI proper confirmation are through using manufactured devices as capnography for detection of end-tidal carbon dioxide (EtCO<sub>2</sub>) (Sun et al., 2014) and pulse oximeters that measure the hemoglobin saturation (Das, Choupoo, Haldar, & Lahkar 2015; Jordan, Ham, & Fataar, 2015). Other methods for ETT confirmation include direct palpation of the suprasternal notch, manual cuff palpation, bilateral auscultation of chest and palpation of symmetrical chest movements, and esophageal detector devices (Jordan et al., 2015).

An investigation reported that local trauma and face or neck poor skin integrity are complications due to the use of adhesive tape for external fixation (Mohamed & Hassan, 2015). Additionally, many complications can arise for intubated patients including nasal and oral inflammation and ulceration, sinusitis and otitis, laryngeal and tracheal injuries, and tube obstruction and displacement (Urden et al., 2020).

Confirmation of the correct ETT placement should be rapidly done for early detection of improper positions to prevent fatal consequences

(Arafa, Abouzkry, & Mohamady, 2018). The confirmation methods differ according to the hospital setting. For example; a Canadian study revealed that 77% of all participants (nurses and respiratory therapists) confirmed the children's ETT placement by auscultating their chest sounds. Besides, the researchers observed that 62% of them conducted a chest X-ray and only 19% of the participants measured EtCO<sub>2</sub> to confirm its position. In the same article, the investigators also reported that atelectasis (82%), pneumothorax (29%), and differential air expansion (68%) were complications for ETT malposition (Sakhuja, Finelli, Hawes, & Whyte, 2016).

Securement of the ETT (figure 3) is necessary for optimizing oral care, preventing lip ulcers, and maintaining airway patency (Gurjar & Baronia, 2016). Accidental tube migration may be induced during the daily nurses' care practice. Proper fixation of the ETT in position can help to prevent unplanned extubation (Cosentino et al., 2017). The most commonly used ETT fixation tools are adhesive tape, twill tape, and commercial devices. There is no evidence showing the best tool for fixation as each tool has its strengths and weaknesses (Fisher, Chenelle, Marchese, Kratochvil, & Kacmarek, 2014). Additionally, the authors clarified that non-commercial devices are force less than commercial holders on patients' faces. Commercial holders facilitate oral care and secure quick movement of ETT from the mouth side to another.



**Figure 3. Endotracheal Tube Securement Technique** Adopted from “Endotracheal tube securing tape, trach tape, cloth, adhesive, padloc foam”. Retrieved from: <https://www.tri-anim.com/endotracheal-tube-securing-tape-trachtape-cloth-adhesive-padloc-foam-product-24694-3791.aspx>

The patient's re-position or transfer out of the ICU can be a reason for the accidental tube slippage. Moreover, Cosentino et al., (2017) demonstrated that nurses' absence from the bedside and less experienced nurses may increase the risk

of ETT slippage. Additionally, they mentioned that nurse/patient ratio, lack of strong ETT fixation tool, and duty shift changing time were serious factors that induced unexpected extubation. Consequently, Alzahrani et al., (2015) suggested that the ETT cuff

pressure should be maintained between 20 and 30 cm H<sub>2</sub>O. Besides, proper cuff inflation technique and the use of cuff pressure manometer (Figure 4) should be routinely used for monitoring the ETT cuff pressure which is now standard practice in most ICUs (Abubaker et al., 2019).

Overinflated ETT cuff prevents proper perfusion of tracheal mucosa and can induce ischemia necrosis and tracheal rupture which are potential immediate over-inflation complications (Almarakbi, & Kaki, 2014). However, lower-

inflated ETT cuff results in bronchial aspiration of secretion raising the risk of ventilator-associated pneumonia (Asfour & Ayoub, 2016; Abubaker et al., 2019). Thus, to decrease mortality and morbidity, and improve the delivery of health care services; critical care providers should be trained and supervised during ETT cuff pressure monitoring using a manometer, and institution policies should be available to ensure safe, quality care (Abubaker et al., 2019).



**Figure 4.** Endotracheal cuff pressure manometer **Adopted from** “Endotracheal tube cuff pressure: An overlooked risk” by Almetualli, R., Fallatah, Alghamdi (2021). *Anaesth. Pain Intensive Care*; 25(1):88-97 DOI: 10.35975/apic.v25i1.1445.

A South African survey evaluated nurses' practice of cuff pressure management and revealed that 52% of the nurses monitored ETT cuff pressure every 6-12 hours. However, only 15% of the participant nurses assessed the cuff pressure only while air leaks, and 1% of them never monitored the cuff pressure. As the measurement is done through different techniques; 37% of participants utilized the cuff pressure manometer, 24% used the palpation method or listen to the air leak, 22% used minimal occlusive technique, and none of them used the minimal leak technique (Jordan, Rooyen, & Venter, 2012).

Similarly, Labeau et al. (2015) found that 36% of the nurses identified the median cuff pressure as 25 cmH<sub>2</sub>O while 32% of them reported it as 30 mmHg and 66% of them did not know the normal average. Additionally, they illustrated that 52% of nurses knew the correct pressure and 84% were aware that the manometer measurement was accurate.

A recent study illustrated that tracheal intubation can seriously impair mucociliary function causing risky respiratory complications (Newstead, Seaton, & Johnston, 2017). Hence, the investigators recommended chest physiotherapy to enhance the patient's alveolar ventilation, improve lung compliance, optimize oxygenation and reinforce clearance of respiratory secretions.

Moreover, chest percussion, vibration, postural drainage, and suctioning are helpful approaches in maintaining airway patency (Spapen, Regt, & Honore, 2017).

A study was carried out in Australia to investigate critical care nurses' attitudes toward the performance of chest physiotherapy and reported that 85% of the CCNs considered the traditional chest physiotherapy as a part of daily nursing care. This study also cited that 16% of the CCNs had excellent self-rated understanding of percussion to the chest wall and 12% of them had excellent understanding of chest vibration. However, 52% of the participant nurses poorly self-rated understanding of the percussion technique while 48% of them poorly understood the vibration technique (Newstead et al., 2017).

To promote patient's patent airway, improve alveolar gas exchange, and avoid airway obstruction and lung collapse, suction should be applied to extract pulmonary secretion (Gurjar & Baronia, 2016). Before tracheal suctioning, CCNs should comply with infection control precautions such as hand hygiene and donning PPE to prevent cross-infection (Haghighat & Yazdannikm 2015). They must perform a patient assessment before initiating the suction procedure to confirm his/her needs for suctioning through auscultating the breath sounds and noisy or visible secretion. During the

suction procedure, hyper-oxygenation is needed before and after suctioning for 30-60 seconds to reduce hypoxemia and related potential cardiac dysrhythmias (Pinto, D'silva, & Sanil, 2020). Also, normal saline instillation is not suggested as it creates risky media for pathogen entrance to the lung causing pneumonia (Elbokhary et al., 2015).

An Iraqi study described nurses' tracheal suctioning practices and illustrated that most nurses were interested in hyper-oxygenating the intubated patients before suctioning and a high proportion of them prepared oxygen supplies and the ambo-bag (Majeed, 2017). In the same study, the author also observed that more than half of the nurses did not aspirate secretions while inserting the suction catheter, and about one-third of them pulled out the catheter with a gentle rotation.

An Iranian observational study evaluated CCNs' practice of a closed endotracheal suction system. The investigators found that only 10% of the nurses auscultated the patients' chest and 27.5% of them prepared the patients and explained the procedure to them. Additionally, 70% of the nurses hyper-oxygenated patients' airways and 72.5% of them instilled normal saline before suctioning. During the procedure, the majority of the nurses (87.5%) used improper suction catheter size, and 20% of them performed suctioning more than the recommended episodes. Therefore, the authors highlighted the need for including ETT care standard guidelines in CCNs education (Haghighat & Yazdannik, 2015).

Oral hygiene after suctioning is an important nursing practice to maintain oral health and prevent oral diseases (Dagnew et al., 2020). A study conducted by Wami et al., (2018) to investigate the effect of CCNs' knowledge and practice on ventilator-associated pneumonia (VAP) prevention found that only 18.6% of nurses inadequately provided oral hygiene and brushed patients' teeth using a clean swab. In addition, Dagnew et al., (2020) study depicted that oral care was perceived among caregivers as unessential care practice that might be safely neglected, and they performed it inconsistently and based on ritual care.

Batiha, Bashaireh, AlBashtawy, and Shennaq (2013) assessed the Jordanian ICU nurses' performance of ETT care and illustrated that most nurses conducted ETT care incompetently. The investigators also reported that only one-third of the nurses swabbed the oral cavity using hydrogen peroxide solution (H<sub>2</sub>O<sub>2</sub>) or 2% chlorhexidine every 2-4 hours. The usage of chlorhexidine and implementation of ventilator care bundle has a significant reduction in the VAP rate.

Consequently, it minimizes the length of ICU admission from 9.7 to 6.5 days and reduces the mortality rates from 23.4% to 19.1% (El Azab et al., 2013).

Nursing documentation is considered the best guidance tool for healthcare professionals. It is important for practical and legal reasons. It also enhances the continuity of patient care. The proper nursing documentation helps in reducing medical errors and promoting the delivery of high-quality patient care (Khattak, Zaman, & Ghani, 2016). Therefore, CCNs must develop their documentation skills through education and training.

Research conducted in South Africa to study the challenges experienced by nurses concerning record-keeping reported that nurses face various recording challenges including the limited time to fulfill the patients' records, high patients' flow rate, and lack of recording material. They also concluded that nurses should be motivated about the significance of recording the implemented nursing interventions for each patient (Mutshatshi, Mothiba, Mamogobo, & Mbombi, 2018). In addition, an American study assessed the proper documentation of ETT confirmation position and its relationship with the in-hospital cardiac arrest patient outcome and illustrated that health care personnel might have a gap knowledge regarding the documentation of the proper techniques for confirming ETT placement (Phelan, Ornato, Peberdy & Hustey, 2013).

Endotracheal tube care is one of the main responsibilities of CCNs. Identification of nurses' background and the best evidence for ETT practice can promote patient safety and minimize undesirable complications that affect patient outcomes. Hence, CCNs should follow evidence-based practice related to caring for intubated patients. Additionally, they should attend continuous educational activities and training programs to enhance their clinical competence and ensure high-quality care in ICUs (Colombage and Goonewardena, 2020).

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