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Best Practice in Airway Management of the Neonatal Population

Brittaney Montcalm

Introduction of the Problem

The neonatal population has the highest incidence of airway injury, resulting in the need for improved endotracheal intubation criteria (Litman & Maxwell, 2013). Neonates are at an increased risk for intubation-related injuries due to differences in airway anatomy and physiology (Harless et al., 2014). Whether to use a cuffed or uncuffed endotracheal tube (ETT) in the neonatal population remains controversial. While uncuffed ETTs have traditionally been the preferred method for intubation in neonates, current research has shown the increasing use of cuffed ETTs. This practice change can be attributed to the development of newer generations of cuffed ETTs and a better understanding of neonatal airway anatomy (Dariya et al., 2022).

Due to the lack of standardized recommendations for ETT selection in neonates, the host facility requested an integrative review of the current literature to determine if cuffed ETTs, compared to uncuffed ETTs, have the best evidence-based outcomes for the neonatal population. There was a high necessity for best practice management recommendations developed from current literature on ETT selection in neonatal patients to ensure the best outcomes and prevent complications.

Literature Review

Selecting the appropriate size ETT is essential to prevent injuries from repeated intubation attempts. Undersized ETTs can cause leakage of inhalational agents, and excessive movement of the tube with the ventilator can cause mucosal damage (James, 2001). The disadvantages of uncuffed tubes impact the patient and other healthcare factors. The patient has an increased risk of airway fire, tube exchange rate, risk of aspiration, and accidental extubation with uncuffed ETTs (Litman & Maxwell, 2013; Mukhopadhyay et al., 2016; Weiss et al., 2006). In addition, the anesthesia provider could have increased waste and cost of inhaled anesthetics,

environmental contamination, difficulty ventilating patients with lung disease, and difficulty measuring end-tidal CO_2 concentration (Litman & Maxwell, 2013; Mukhopadhyay et al., 2016; Weiss et al., 2006).

Current studies showing the pediatric airway as an elliptical shape challenge the safety and efficacy of uncuffed tubes. The elliptical shape of the airway may lead to significant pressure on the posterolateral walls of the tracheal mucosa, with an air leak still present (Tobias, 2015). Thus, current research shows that most lesions associated with uncuffed tubes are found posteriorly at the laryngeal inlet and tracheal wall. In addition, testing for an air leak may not be a reliable indicator of correct sizing for an uncuffed ETT. An airway pressure of 20 cmH2O may lift the tracheal mucosa from the tube anteriorly while causing dangerously high pressure at the posterior subglottic structures (James, 2001). A cuffed tube would allow for a smaller tube and reduce the danger of injuring the laryngeal inlet and cricoid ring from dangerously high pressures (James, 2001; Tobias, 2015).

Cuffed tubes have gained significant popularity in the pediatric population due to several advantages over uncuffed ETTs. These include lower reintubation rates, lower risk of aspiration, use of lower fresh gas flows, less leakage of inhalational agent, more effective capnography tracing, optimal ventilation management, and avoidance of multiple laryngoscopies/intubations (Bhardwaj, 2013; Klabusayova et al., 2022). In 2016, a survey revealed that 85% of pediatric anesthesiologists preferred cuffed tubes for children over two, and 60% preferred cuffed tubes for full-term neonates (Sathyamoorthy et al., 2016). The cuffed ETT is beneficial in conditions such as a full stomach, laparoscopic surgery, repair of a traumatic rupture of the left mainstem bronchus, occluded tracheoesophageal fistula, the performance of sophisticated lung function measurements, and in children with severe pulmonary disease (Bhardwaj, 2013). No study has

demonstrated that a cuffed ETT with an appropriate size and cuff pressure causes an increased risk of airway complications (compared to an uncuffed ETT) (Bhardwaj, 2013). Postoperative stridor is associated with oversized outer tube diameters, poorly designed cuffs, incorrect tube placement, and overinflation of the cuff, increasing the risk of airway damage. However, the proper size ETT, appropriate cuff inflation pressure, and careful length adjustments can prevent post-operative airway injury (Banerjee et al., 2018).

The microcuff ETT manufacturer recommends the 3.0 mm tube for patients weighing 3 kg or more (Thomas et al., 2018). William et al. (2022) studied 1,162 patients weighing less than 5 kg and 189 weighing between 2-3 kg, comparing the use of the 3.0 microcuff tube and an uncuffed tube. Cuff pressures were continuously monitored perioperatively. The study concluded the safety and efficacy of cuffed ETTs in neonates and infants weighing 2-5 kg. There was a decreased need for tube exchange and repeat laryngoscopy without increased postoperative airway complications (Williams et al., 2022). There is a lack of research in neonatal patients weighing less than 3 kg. Studies have determined that microcuff ETTs may be safe, but more research is needed to address this patient population (Thomas et al., 2018; William et al., 2022).

Project Methods

This project involved a comprehensive literature review of best-practice recommendations for neonatal airway management, focusing on the use of uncuffed versus cuffed ETTs. The findings were presented in the form of a PowerPoint presentation and a printed copy to the certified registered nurse anesthetists (CRNAs) and anesthesiologists via a small nonexperimental group meeting at a Level I trauma center in Central Illinois. The development of a quick reference guide to help guide the best practices for neonatal airway management was created and available for the participants. Also, laminated copies of the resource were provided

and accessible to staff unable to attend the presentation. After the educational presentation, a post-implementation questionnaire was administered to determine the effectiveness of the presentation and its perceived application in clinical practice. Questions and open discussion occurred after the completion of the presentation.

The project was submitted to the Institutional Review Board (IRB) at Southern Illinois University Edwardsville before implementation. As a non-experimental design without human subjects, it was deemed a Quality Improvement Project and therefore exempt from IRB approval. The project presented minimal to no risk to human subjects. Participation in the presentation and post-implementation questionnaire was voluntary and without consequence.

Evaluation

Participants present for the educational presentation were asked to complete a 12-question post-implementation survey to determine knowledge enhancement and utilization of the handout tool. The survey consisted of demographic questions, knowledge-based questions, and Likert-style questions evaluating the hand-out tool itself. The final question was left for additional comments that the participants might have. Completed surveys were collected and analyzed to determine the effectiveness and acceptance of the information presented and the handout tool created.

Eight staff members completed the posttest and were present for the presentation. Most of the participants (75%) were CRNAs with over 10 years of experience. Results of the questionnaire implied that knowledge was increased regarding pediatric airway injury and cuffed ETTs in the neonatal population (62.5%). All participants answered “yes” when asked if they used cuffed ETTs in the neonatal population (100%). However, only 50% report using the cuffed ETTs 100% of the time. All participants (100%) responded with an 8 or higher on the Likert

scale questions, indicating that the presentation increased their knowledge of the pediatric airway, cuffed versus uncuffed ETTs in the neonatal population, and improved their preparation and ability to determine the best choice of ETTs for the neonatal population. One participant did not respond to the back page. Participants that did complete the back page felt the handout was appropriate for the operating room and rated it as very user-friendly (100%). All participants that completed the back page responded with an 8 or above on the Likert scale, indicating they are very likely to incorporate the handout tool in their own practice.

Limitations to this project included sampling bias, small sample size, and limited participation from the anesthesia staff. The results of this posttest may not be generalizable to a larger population due to these limiting factors. Future projects could build upon this project by implementing the pediatric airway handout at other SIUE clinical sites. Patient outcomes could also be tracked, since no significant clinical results can be inferred from this project alone.

Impact on Practice

The primary goals of this doctoral project implementation were met. Overall results were positive and indicated buy-in from the anesthesia staff. The immediate impact of this project is increased knowledge regarding pediatric ETT selection among the anesthesia staff at the host site. This project can improve patient care among pediatric anesthesia providers and lays the foundation for future projects regarding this important topic.

Conclusions

The historical idea that uncuffed ETTs are the best method for pediatric airway management is being challenged in today's current anesthetic practice. Cuffed ETTs carry numerous advantages over uncuffed tubes. Current research has shown that cuffed ETTs are safe and effective in neonates and children weighing 3 kg or more. Additional research in patients

weighing less than 3 kg is necessary to provide further recommendations. Studies must include both full-term and low-birth weight neonates and evaluate both short and long-term use of cuffed ETTs. As the debate between cuffed and uncuffed ETTs continues, great progress has been made in recent years to determine best practices. Though the change to cuffed tubes is slow in neonatal intensive care units, the most significant incidence of airway damage occurs in neonates, supporting the need for optimizing endotracheal tube standards in this population (Litman & Maxwell, 2013).

Author Contact Information

Brittaney Montcalm BSN, RN, SRNA

Brcastl@siue.edu