Factors Affecting the Incidence of Sore Throat Following General Anesthesia with Endotracheal Tube Versus Laryngeal Mask Airway

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Abstract

Purpose
Postoperative sore throat (POST) is a common, albeit minor, complication following general anesthesia. The aim of this literature synthesis is to evaluate how the use of an endotracheal tube (ETT) compared to a laryngeal mask airway (LMA) affects the incidence of sore throat in patients following general anesthesia, and to identify the factors related to POST.

Methods
Peer reviewed articles from several databases were compiled and analyzed to reveal significant contributors to the development of POST.

Results
The type of airway device, ETT size, cuff pressure, use of lubricants, duration of surgery, use of nasogastric tubes, aggressive airway suctioning, and medications used during anesthesia have all shown to affect the likelihood of POST.

Conclusions
Identification of the factors proven to contribute to and attenuate POST, and education of anesthesia providers will allow anesthetists to reduce risk factors, decrease the incidence of POST, and improve patient care.
PART ONE

Introduction

The incidence of postoperative sore throat (POST) varies from 0-50% in most research studies, but some report the incidence is as high as 51-100% following general anesthesia. The high variability is due to a large number of factors implicated in POST such as type of airway device, technique of insertion, use/type of lubricant, airway design, cuff pressure, length of procedure, anesthesia administered, evaluation techniques, and a multitude of patient features. POST is generally considered a minor consequence and is most often relieved within 24 hours. Regardless of the incidence or duration, POST is rated as a patient’s 8th most undesirable outcome in the postoperative period, and is certainly an opportunity to improve patient outcomes.

Due to the multitude of factors related to POST and the overwhelming volume of research available to healthcare providers, the purpose of this paper is to clearly define the most common factors associated with POST according to current literature. The main findings will be developed into an educational presentation that will be designed for presentation to the anesthesia staff at Plaza Medical Center in Fort Worth, Texas. Providers, armed with this new information, can institute changes to reflect evidenced-based practice and provide patients with an improved anesthesia experience. This literature review and results from the educational presentation will be submitted for publication.

Overview

This paper presents current literature findings in a narrative review that describes the factors most strongly associated with POST and methods for reducing its incidence. An
intervention is described for the development of a presentation to update anesthesia staff on these findings and provide evidenced-based recommendations for care. The implementation and evaluation of this educational intervention will be reviewed.

**Methodology**

A literature search was conducted to determine if the incidence of POST is higher with the use of an endotracheal tube (ETT) or laryngeal mask airway (LMA), to identify the factors most strongly associated with POST, and to determine evidence-based ways to decrease the incidence of POST. The databases Medline, CINAHL, Cochrane Library, and Google Scholar were searched in September-October 2009, July-August 2010, and again in October 2010 for articles containing key words in the title or abstract related to POST, LMA, and/or ETT. Additional references were obtained from the bibliographies of appropriate articles.

Only articles from peer review journals were included in this review. Any papers published before 1995 were excluded. Studies evaluating pediatric patients were excluded, as the target population for this review is adults undergoing general anesthesia. Research not published in the English language was also excluded. The final collection is 36 pieces of research, represented as a meta-analysis, reviews, a cross sectional descriptive study, a comparative study, single and double-blinded controlled studies, and primarily randomized prospective studies.
PART TWO

Literature

Background

Postoperative sore throat (POST) is a relatively minor complaint, but a frequent postoperative complication that is significant to patients. Study results are often highly variable due to the large number of factors related to an increased incidence of POST. As one might expect, current practice also varies widely. A thorough review of current evidence will present readers with the most important factors associated with POST. This information will allow anesthesia practitioners to avoid combinations of these factors and reduce the incidence of POST in their patient population.

Review of Literature

William Macewen is credited with the first orotracheal intubation for the purpose of airway protection during anesthesia in 1880. The endotracheal tube (ETT) has since evolved, but remains a critical tool in the practice of anesthesia. It was over a century later when Dr. Archie Brain developed the laryngeal mask airway (LMA) in 1981. His aim was to maintain an airway better than a facemask in a way that was less hemodynamically stressful than an ETT insertion. Dr. Brain has since made improvements on his original design in an effort to create a better seal, prevent gastric insufflation, allow for passage of a nasogastric tube, and provide a channel for any regurgitated fluid. Each method of securing the airway has its own strengths and weaknesses. An anesthesia provider’s selection of an ETT versus an LMA is multi-factorial decision based upon the patient and the procedure. It is unlikely that the choice of either device will be strongly influenced by the likelihood of POST. Reduction of the associated risk factors will decrease its incidence.
The etiology of POST has been attributed to intubation trauma, mucosal dehydration or edema, tracheal ischemia secondary to the pressure of ETT cuffs, aggressive oropharyngeal suctioning, and mucosal erosion from friction between delicate tissues and the ETT.

**Comparison of Postoperative Sore Throat Following ETT versus LMA.** A meta-analysis by Brimacombe evaluated 52 prospective randomized trials, and determined the advantages of LMA over ETT and found that the LMA has an increased speed and ease of placement by both experienced providers and inexperienced personnel. The LMA provided improved hemodynamic stability at induction and emergence, reduced anesthetic requirements for airway tolerance, a minimal increase in intraocular pressure following insertion, and a lower frequency of coughing and improved oxygen saturation during emergence. The disadvantages of the LMA were the lower seal pressures and a higher frequency of gastric insufflation. Brimacombe also reported that the LMA resulted in a lower incidence of POST when compared to an ETT.

Biro, Seifert, and Pasch also describe the advantages of tracheal intubation, which include the prevention of aspiration, reduction of dead space, accessibility of the airway for suctioning, and ability for controlled ventilation. They acknowledge that POST is among the most frequent subjective complaints of patients following intubation with an ETT, occurring in 40% of the overall population. Results showed that the factors most strongly associated with an increased risk of POST were female sex, smoking history or lung disease, duration of anesthesia, postoperative nausea/vomiting, bloodstain on the ETT, and natural teeth. Biro *et al* acknowledge that cuff pressure was a less significant factor in this study because high-volume/low-pressure type cuffs were used and the diffusion of nitrous oxide was not a factor because it was not used.
A review by McHardy and Chung describes that POST is most common following tracheal intubation with an ETT, and when ETT is directly compared with LMA, more patients report vocal changes after the use of an ETT. The use of smaller ETTs (7 mm for men and 6.5 mm for women) results in significant decreases in the incidence of POST without any ventilatory difficulties. They also evaluated the use of high-pressure, low-volume cuffs compared with high-volume, low-pressure cuffs and found that the high volume cuffs resulted in a higher rate of POST due to a larger area of tracheal-cuff contact though the damage was found to be more superficial when compared with the use of a low volume cuff. What seems to be more significant is that either design is capable of high pressure if overinflated, and that limiting the pressure to < 25 mm Hg will reduce POST. Careful monitoring of cuff pressure and intermittent adjustments (especially with the use of nitrous oxide, which diffuses into the cuff and increases pressure) are significant methods of reducing POST. Using saline to inflate the cuff of an ETT has been shown to be safe and eliminates any diffusion of nitrous oxide and the resulting increase in cuff pressure. McHardy and Chung also reviewed studies that evaluated the use of local anesthetic lubricants and conclude that no study clearly demonstrates that anesthetic lubricants are useful and may actually increase the incidence of POST.¹

McHardy and Chung also evaluated the LMA’s relationship to POST. While continuous throat pain is more common after an ETT, painful swallowing is reported more commonly after LMA insertion. Many studies compared alternative methods of LMA insertion compared to the manufacturer’s recommendations. Partial or full inflation of the cuff or the use of an insertion device was shown to reduce pharyngeal trauma and POST. Reducing the cuff pressure of an LMA produces varying results in the attempt to reduce the
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incidence of POST. Research that compared cuff pressure of 30 mm Hg and 180 mm Hg did not show significant differences in the incidence of POST. Other cited studies show that reduction of cuff pressure reduced POST to 0%. Reducing cuff pressure without compromising spontaneous tidal ventilation can be accomplished, but it may be necessary to maintain pressure high enough to protect the larynx from secretions. Similarly to findings related to the ETT, research found that the use of anesthetic lubricants did not decrease the incidence of POST and increased other postoperative complications like nausea/vomiting, hoarseness, and tongue paraesthesia.¹

A prospective, double-blind, randomized clinical trial by Radu et al also compared POST effects of ETT versus LMA. Fifty-three female patients undergoing elective breast surgery were assigned to either an ETT group or an LMA group. Patients in the ETT group were intubated with a 6.5-7.5 mm ETT, and patients in the LMA group had their airway secured with a size 3 or 4 LMA. Anesthesia induction was the same for all patients with propofol and sufentanil, and was maintained with sufentanil boluses, sevoflurane, and nitrous oxide. Patients in the ETT group also received atracurium. Patients were assessed for the presence of POST and dysphonia at 6 and 24 hours after surgery. Researchers state that the incidence of POST was significantly higher in patients after ETT at 6 and 24 hours after surgery when compared to LMA (6 hrs: 74% vs. 27%; 24 hrs: 27% vs. 0%). Hoarseness is more common at the 6 hour mark following ETT, but the 24-hour mark showed little difference. These researchers monitored and maintained the ETT cuff pressure < 25 mm Hg, and inserted LMA with the cuff partially inflated, and monitored the LMA’s cuff pressure as well. They used neuromuscular-blocking drugs with the use of ETTs, but not LMAs. They cite other studies, which describe muscle relaxants are effective
in decreasing postoperative hoarseness and vocal changes after tracheal intubation. Muscle relaxants do not impact severity of POST and dysphagia (painful swallowing) following the use of an LMA. Radu et al found that dysphonia (vocal changes) was less common in the LMA group, and report that soft tissue swelling around the vocal cords after ETT placement contributes to dysphonia.¹³

Mizutamari et al also directly compared POST following ETT placement and two LMA insertion techniques. These researchers enrolled 86 patients undergoing orthopedic surgery and assigned them to one of three groups. They compared LMA insertion techniques, using the manufacturer’s recommendation of fully deflating the cuff and also insertion with the cuff fully inflated, with the use of an ETT. Their main findings were that POST was worse in the LMA population when compared to the ETT group. They reported that insertion failures in their study occurred only in the deflated cuff, and state that no differences in LMA positioning were found using fiberoptic evaluation. These researchers also state they found no difference in blood trace or severity of POST in either of the LMA insertion techniques. They used a size 4 LMA for men and size 3 for women, and cite studies that found the smaller LMA reduced POST. Cuff volumes of both ETT and LMA in this study were not measured nor adjusted. The LMA cuff was filled with the recommended volume and ETT cuff was inflated just to minimum volume without gas leakage at 20 cm H₂O, and this difference in cuff pressure may be significant. This study used a 2% lidocaine lubricant for the insertion of all ETTs and LMAs, and acknowledges that this practice has been shown to increase side effects in other studies. They speculate that lidocaine in contact with a larger surface area in the LMA may have contributed to the increased incidence of POST in this population.¹⁴
A large prospective observational study by Higgins et al reported that choice in airway management was the most significant factor in the development of POST. They studied 5,264 patients undergoing general anesthesia for various surgical procedures. Patients were managed with either an ETT, a LMA, or by facemask. The anesthetic management is not discussed, other than to say that patients in the ETT and LMA groups had anesthesia maintained with oxygen and nitrous oxide while facemask patients received only oxygen. Researchers documented 12% of patients reported POST, 45% of those were managed with ETT, 17% of those were treated with LMA, and 3% of patients reported POST following use of a facemask. These researchers noted that their figures were higher than some other studies, and speculate that this may be related to the lack of use of humidity moisture exchanger, as dry gases have been implicated as a factor in POST. Researchers also acknowledge that they did not monitor nor adjust airway cuff pressures in either ETT or LMA devices. Female patients reported more POST than male patients. Those patients who were placed in lithotomy position reported a higher rate of POST than those who were supine during surgery. The use of succinylcholine was associated with an increased incidence of POST. This study also suggests that a difficult intubation does not significantly increase the likelihood of POST.6

Ahmed et al also evaluated the factors most strongly associated with an increased incidence of POST. They agree with other researchers that the method of airway management is the single most significant influence on a patient’s development of pharyngeal complications. They evaluated 312 patients undergoing general or gynecological surgery in a prospective observational study. The induction procedure is not discussed, but anesthesia was maintained with isoflurane in oxygen and nitrous oxide.
They found that 26% of all patients reported POST. Twenty eight percent of patients complained of POST following ETT while only 3.5% of patients complained after an LMA was used. A water-based lubricant was used for all ETTs and LMAs. For female patients, a 7.5 mm ETT was used and a 8.5 mm ETT for males. The size of LMAs is not discussed. Other associated factors that showed an increased incidence were the female population, older patients, difficult intubation, duration of surgery, and patient position.\textsuperscript{15}

A prospective randomized study by Shoff et al compared the Proseal LMA with an ETT. The Proseal is a newer generation of LMA that was designed to create a better seal, allow for positive pressure ventilation, and allow for the passage of a nasogastric tube. One hundred twenty-one patients undergoing laparoscopic surgical procedures were evaluated, using 7.5 mm ETT for women, a 9.5 mm ETT for males, and size 3 LMA for women and size 4 LMA for men. POST was the most common complication. Ten percent of patients in the ETT group reported POST while 5% of patients in the LMA reported POST, but due to the size of this study, this difference was only three more patients in the ETT group than in the LMA group. Other findings showed a quicker insertion time of the LMA compared to the ETT (15 seconds vs. 26 seconds), though the hemodynamic responses are defined as stable and similar in both groups.\textsuperscript{16}

Another study, published by Hohlrieder et al, evaluated the ETT versus the Proseal LMA. This randomized, double-blind, prospective study examined 100 female patients undergoing laparoscopic, gynecological surgery. The anesthesia management of patients in both groups was identical in regards to medications administered and methods that included positive pressure ventilation and use of nasogastric tubes. Seven millimeter sized ETT and size 4 LMA were used for all patients. Water-based lubricant was used and
intracuff pressure was measured and maintained throughout the procedure. There were no differences in the frequency of POST, dysphonia, or dysphagia in either group.⁹

Oczenski et al also compared the ETT and LMA alongside the Combitube, an esophageal-tracheal device most commonly used in emergency settings, in a small prospective study. Most relevant to the discussion in this paper, high-volume, low-pressure cuffed ETT were used. A 7.5 mm ETT was used to intubate women, and 8.5 mm ETT for men. A size 3 LMA was used for women and size 4 LMA for men. The methods of induction were consistent for all patients. Sixteen percent of patients in the ETT group and 12% of patients in the LMA group reported POST. Twelve percent of patients in the ETT group and 8% of patients in the LMA group reported dysphagia. No patient in either group described POST or dysphagia as severe. Forty-four percent of patients in the ETT group and 12% of patients in the LMA group reported hoarseness, and researchers state this is related to an ETT direct contact with vocal cords.²

Uerpaiojkit et al conducted a randomized, double-blind, controlled trial to compare the Proseal LMA (allows for higher airway pressures and facilitates gastric tube placement) and the Profile Soft-Seal ETT (high compliance, N₂O barrier cuff shown to decrease POST) in 138 patients. Fifty-three percent of patients who were intubated with the ETT and 33% of patients in the LMA group reported POST. Researchers also correlate that POST may lead to an increased incidence of postoperative nausea and vomiting and theorize that this may be due to laryngeal stimulation of the cranial nerves. Their research found that patients in this study did not report being dissatisfied with their anesthetic care, and feel this reflects that patients might not be bothered by minor throat complaints.
Researchers conclude that the Proseal LMA resulted in less POST and dysphonia when compared to the Profile Soft-Seal cuffed ETT.\textsuperscript{17}

**Postoperative Sore Throat Following Tracheal Intubation.** Edomwonyi, *et al* reports that 63\% of patients in their study reported some throat-related complaint after tracheal intubation. They did not find a statistically significant difference in the incidence of POST between males and females, nor was there a notable difference in groups where the tube was lubricated compared to tubes without lubricant. It is not surprising that they did report that patients who had throat-related surgeries did report more POST than patients who underwent non-throat procedures, and postulate that this is due to patient positioning and ETT movement. Multiple attempts at intubation nor skill-level of the anesthetist increased the reports of POST, but duration of anesthesia greater than 60 minutes did correlate with an increased incidence of POST. This group of researchers used 7-8 mm tubes for women and 8.5-9 mm sized tubes for men, but acknowledge that the use of smaller tubes does reduce POST. The associated use of nasogastric tubes or throat packing resulted in increased complaints of POST.\textsuperscript{18}

Maruyama *et al* conducted a study to evaluate POST after the use of total intravenous anesthesia (TIVA) in an effort to avoid the increased intra-cuff pressures associated with the use of nitrous oxide. Patients were divided into groups and researchers evaluated the use of water-soluble lubricants or lidocaine lubricants with or without lidocaine spray. A variety of ETTs were used. The most significant factors shown to contribute to POST were female sex and the use of lidocaine spray. The study does reveal that the lidocaine spray used, contained the additives ethanol and l-menthol, which may have impacted the increased POST. The study also reports an increased incidence of
POST is associated with the female gender, but cites evidence that this may be related to a tighter fitting ETT. The overall incidence of POST following TIVA was higher (50-55%) than in many other studies that report the incidence ranges from 14-50%. Researchers theorize that this may be related to the careful titration of drugs required to achieve an adequate depth of anesthesia, and that inadequate relaxation and increased movement may have contributed to the increased numbers of patients reporting POST. 

A prospective, randomized, controlled trial, published in 2009, hypothesized that the use of Glidescope (video-assisted method of laryngoscopy that allows for much lower lifting force) or Trachlight (a malleable lighted stylet that does not require laryngoscopy) would attenuate a patient’s hemodynamic response to tracheal intubation when compared to direct laryngoscopy. Their evaluation of 60 subjects revealed no significant differences in blood pressure or heart rate between the 3 intubation groups. They also found that direct laryngoscopy resulted in significantly lower intubation times and a decreased incidence of POST when compared with the Trachlight group. They found no differences in POST in the Trachlight and Glidescope groups.

Another study evaluated the differences in patient outcomes when direct laryngoscopy was compared to a lighted stylet. Researchers speculated that a lighted stylet would be less traumatic, but found no significant differences in the incidence of POST. There were no statically significant differences in intubation time or hemodynamic response. They did report that hoarseness was more prevalent in the lighted stylet group.

Ratnaraj et al studied the effect of reducing ETT cuff pressures in 51 patients undergoing anterior cervical spine surgery. Patients were questioned at several
Factors Associated with Postoperative Sore Throat postoperative time intervals, and they found that 74% of patients in the control group where cuff pressure was not adjusted complained of POST while only 51% of patients whose cuff pressures were adjusted to 20 mm Hg reported POST. Research also reflected a disparity between the sexes as 65% of women and only 35% of men reported POST. This study concludes that reducing ETT cuff pressures to 20 mm Hg may be helpful in decreasing POST.21

**Postoperative Sore Throat Following Laryngeal Mask Airway.** A randomized, double-blinded study published in 2000 compared pharyngo-laryngeal symptoms following general anesthesia with a facemask compared to an LMA with varied cuff volumes. A size 4 LMA was used for women and a size 5 for men. Eight percent of patients reported POST after facemask, while 20% of patients in the low volume cuff LMA, and 42% of patients in the high volume cuff LMA complained. There were no differences in POST between the sexes. Ultimately, evidence showed that higher cuff volumes predicted an increased incidence of POST.22

Burgard et al studied 200 patients to determine the effect of LMA cuff pressure on POST in a prospective random observational study. Subjects were placed into one of two groups, the first of which had cuff pressures monitored and the second group, which monitored and adjusted cuff pressures to the lowest pressure that maintained air seal. They found that cuff pressures steadily increased with the use of nitrous oxide, as much as 43 cm H₂O in the first 60 minutes following induction. Eight patients reported POST in the first group where cuff pressure was only monitored and not adjusted, and no patients reported POST in the group where the pressure was decreased just to maintain an
adequate seal. The researchers deduced that limiting cuff pressure could reduce the incidence of POST while still maintaining an adequate airway seal.\textsuperscript{23}

A prospective, double-blinded, randomized trial of 200 patients also evaluated the effect of reducing LMA cuff pressures, published by Seet \textit{et al} in 2010. These researchers studied the use of manometry to measure and adjust intracuff pressures in a pressure-limited group and compared results to those of a routine care group. LMAs were inserted according to the manufacturer’s recommendations and cuffs were inflated to achieve an audible seal. After pressure adjustments to maintain cuff pressures less than 44 mm Hg, the pressure-limiting group had intracuff pressures averaging 40 mm Hg while the routine care group’s intracuff pressures averaged 114 mm Hg. POST was reported in only 3\% of patients in the pressure-limited group at 24 hours, while 14\% of patients in the routine care group complained. Dysphonia and dysphagia were also significantly lower in the pressure-limited group. These researchers concluded that reducing LMA cuff pressure to less than 44 mm Hg reduces pharyngolaryngeal complaints by 70\%, and recommend the standard use of manometry for the reduction of cuff pressure.\textsuperscript{24}

One hundred and twenty patients were evaluated in a randomized, controlled trial to evaluate the effectiveness of varied insertion techniques for the placement of ProSeal LMAs in a study by Jeon \textit{et al}. A size 4 LMA was used for female subjects and a size 5 LMA was used for men. They compared the traditional insertion method in which the index finger is used to facilitate placement per the manufacturer’s instructions and a 90\degree rotation technique in which the cuff rests along the right side of the tongue and is advanced into the hypopharynx where it returns to midline. Size 4 LMAs were inflated with 15 ml of air and size 5 LMAs were inflated with 20 ml of air, both 50\% of the manufacturers recommended
volumes. They found that the 90° insertion technique was more effective on the first attempt (100% vs. 83%), though this difference was not statically significant. The time required to achieve successful airway seal was less with the 90° rotation group than in the standard insertion group (11 sec vs. 19 sec), and airway seal was effective in both groups. There was a lesser incidence of blood-staining (8% vs. 40%) and POST (12% vs. 33%) in the 90° rotation group when compared to the standard insertion group, and this may correlate with less pharyngeal trauma. Researchers determined that the 90° insertion technique was easier and produced less trauma than conventional insertion techniques and should be considered as a first choice for LMA placement.25

Kuppusamy and Azhar also studied the success of the conventional insertion technique of the LMA, but compared this with a laryngoscope-aided, bougie-guided insertion technique. They contrasted these two insertion methods in a study of 60 patients, and found that while the bougie-guided insertion technique took longer to achieve adequate seal (37 sec vs. 22 sec), it was more effective on the first attempt (97% vs. 87%) when compared to the traditional digital insertion technique. The leak pressure was 31 mm Hg in the bougie-guided technique and 23 mm Hg in the traditional insertion technique. There was a similar incidence of blood-staining on the LMA in both groups, but POST was more common with the traditional insertion technique. They conclude that bougie-guided insertion of a ProSeal LMA is excellent alternative to the conventional insertion technique.26

**Pharmacologic interventions for attenuation of POST.** The Cochrane Library published a systematic review that summarized the findings of 15 research studies evaluating the effectiveness of using lidocaine to prevent POST. Laryngoscopy and moving
an airway device may excite sensory C fibers and produce secondary neuroplasticity that is associated with POST and cough. Lidocaine is thought to prevent or suppress the excitation of C fibers and the release of sensory neuropeptides that cause bronchoconstriction. This review assessed the use of various concentrations of lidocaine used to inflate the cuff of the ETT, aerolized lidocaine, intravenous lidocaine, and lidocaine gel used directly on the ETT. The review concludes that both topical and systemic lidocaine significantly reduces the incidence and decreases the severity of POST. Researchers acknowledge some weakness in the review including studies of varied quality, assorted lidocaine interventions, and the omission of any harmful effects of lidocaine.11

Navarro and Baughman evaluated the effects of using 4% lidocaine in the cuff of ETT and the effect on POST in 106 patients. They used a high volume, low pressure 7.5 mm ETT for men and a 7 mm for women, and the anesthetic protocol was the same for all patients enrolled in this study. The ETT cuff was inflated with either air or 4% lidocaine. The lidocaine was placed in the cuff 90 minutes prior to intubation to allow diffusion of the drug through the cuff per the results of prior studies. Because N₂O was used to maintain appropriate anesthetic depth, and because N₂O has been shown to diffuse into ETT cuffs and increase cuff pressures, the volume of lidocaine needed to occlude tracheal leak was doubled. At 30 minutes the lidocaine cuffs measured higher pressures than the air-filled cuffs. While results did not show a statistically significant difference in the numbers of patients reporting POST at 1 hour, 59% of patients complained of POST in the air-filled cuff at 24 hours while only 32% of patients reported POST in the lidocaine-filled cuff group. The severity of POST was significantly lower in the lidocaine group at both 1 and 24 hours. These researchers add that additional advantages of a lidocaine-filled ETT cuff is that less
volume is needed to create tracheal seal and cuff pressure is not increased in a fluid-filled cuff due to $N_2O$ diffusion. Ultimate conclusions are that using lidocaine to inflate the ETT decreases the severity of POST in the immediate postoperative phase, and decreases both the incidence and severity of POST 24 hours after surgery. Researchers add that the cost of 4% lidocaine was $2.18 per patient.$^{10}$

Research by Sumathi et al compares the effects of lidocaine and betamethasone applied to the ETT in a prospective, randomized, double-blinded, controlled study published in 2007. These researchers argue that while local anesthetics may limit irritation to tracheal mucosa, a steroid is effective in preventing and treating the inflammation resulting from placement of an ETT into an airway. Patients were intubated with an ETT treated with lidocaine, betametasone, or nothing. High volume, low pressure size 8 mm ETT was used in male patients, and size 7 mm was used in females. Anesthetic protocol was the same for all patients in the study, and nitrous oxide was used for the maintenance of anesthesia. Cuff pressure was not monitored. Patients were assessed at 1, 6, 12, and 24 hours after surgery. The incidence of POST was significantly less in the lidocaine group when compared with the control group, and betamethasone produced even less POST. The ultimate conclusions were a statistically significant decrease in POST, cough, and hoarseness in patients who were treated with betamethasone at 6, 12, and 24 hours.$^{27}$

Hung et al compared the effects of 10% lidocaine, 2% lidocaine, and a nonsteroidal anti-inflammatory drug called benzydamine on the cuff of an ETT in a prospective, randomized, double-blinded study published in 2010. They studied 372 patients who were divided into four research groups. One group received benzydamine on the ETT cuff, one
group received 10% lidocaine on the cuff, one group received 2% lidocaine, and the fourth group received normal saline on the ETT cuff. The application of medication was applied to the cuff 5 minutes prior to intubation. Patients were managed with the same anesthetic plan including high volume, low pressure ETT. Males were intubated with a 7.5 mm sized tube and females with a 7 mm ETT. Cuffs were inflated to achieve a seal at 20 cm H₂O of peak airway pressures. All patients were assessed at 1, 6, 12, and 24 hours postoperatively. There was a statistically significant decrease in the numbers of patients reporting POST and in the severity of POST in the benzydamine group at each observation time. The highest incidence of POST was at the 6 hour mark. The 10% lidocaine group reported increased severity of POST at several of the timed assessments, but this may be related to additives like ethanol, polyethylene glycol, and menthol. Researchers stated that benzydamine causes numbness or tingling in the oral cavity, dry mouth, thirst, or nausea when gargled but report that there were no significant side effects relevant to the medications used. They conclude that the use of benzydamine reduces POST by more than 50% when compared to 2% lidocaine or placebo. Benzydamine is not available in the United States.28

A 2006 prospective, randomized, single-blinded, controlled study examined the effects of benzydamine and aspirin on POST. Agarwal et al divided 60 female patients undergoing modified radical mastectomy into one of three groups. Group 1 received mineral water, group 2 received aspirin 325 mg, and group 3 received benzydamine hydrochloride 22.5 mg. All medications were diluted into a 30 ml elixir and patients were instructed to gargle for 30 seconds prior to induction of general anesthesia. All patients were induced with fentanyl and propofol, paralyzed with vecuronium, intubated with a 7
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mm ETT, and maintained with nitrous oxide and propofol infusion. ETTs were lubricated with a water-based lubricant and cuff pressures were monitored and maintained between 18-22 cm H₂O. POST was assessed upon arrival to the post-anesthesia care unit, and at 2, 4, and 24 hours post-operatively. Results showed that the incidence of POST was most frequent in the control group that gargled with mineral water. Patients in the aspirin group reported less POST immediately post-operative and at the 2 hour mark. Patients who gargled with benzydamine reported less POST at all time intervals 0-24 hours postoperatively. The severity of POST was higher in the mineral water group and was similar in the aspirin and benzydamine group. Two patients in the benzydamine group complained of numbness in the mouth and a distorted sense of taste. Researchers concluded that both aspirin and benzydamine gargles are a simple and effective way to significantly reduce the incidence and severity of POST.⁵

Research published in 2010 by Huang et al also evaluates the effectiveness of benzydamine for the prevention or treatment of POST. Three hundred and eighty patients undergoing general anesthesia for various elective procedures were enrolled in this prospective, randomized, double-blinded study, and were allocated into one of four groups. Subjects in group one were treated with aerosolized benzydamine 0.75 mg sprayed into the oropharynx and ETT was lubricated with distilled water. Group two received benzydamine sprayed in the oropharyngeal cavity and onto the ETT cuff. Group three had their ETT sprayed with benzydamine and the oropharynx sprayed with water. Group four had both their oropharyngeal cavity and the ETT sprayed with water. Anesthesia induction was the same for all patients using fentanyl, lidocaine, and propofol and neuromuscular blockade was obtained with rocuronium. Tracheal intubation was achieved with 6.5 mm and 7.0 mm
ETT, and the cuff pressure was measured and adjusted following intubation to 20-25 cm H$_2$O. Nitrous oxide was not used. Anesthesia was maintained using desflurane. Patients were assessed for POST upon arrival to the post-anesthesia care unit, and again at 2, 4, and 24 hours. The highest incidence and severity of POST was found in group four, followed by group one (40.4% and 23.2% respectively). POST complaints were highest at the 2 hour mark. There were considerably fewer reports of POST in groups two and three, but there was little difference between the groups (13.8% and 14.7% respectively). Subjects in group two reported significantly higher rates of stinging, numbness, and burning when compared with group four who were not treated with benzydamine. Researchers conclude that the application of benzydamine on the cuff of an ETT will reduce the incidence and severity of POST for up to 24 hours. There was no advantage to spraying benzydamine in the oropharyngeal cavity, and researchers feel this demonstrates that the most significant causative factor of POST is the tracheal mucosa irritation at the level of the ETT cuff. They also add that the application of benzydamine to the oropharynx increases the rate of side effects such as numbness and burning. This study concludes that spraying benzydamine hydrochloride on the ETT cuff effectively decreases the incidence and severity of POST without increasing adverse side effects associated with the application of benzydamine on the oropharynx.  

A prospective, randomized, double-blinded, controlled study published in 2008 by Park et al documents the effects of the steroid, dexamethasone, on POST after general anesthesia and tracheal intubation with a double lumen endobronchial tube. Because dexamethasone is widely used to treat POST due to its ability to modulate the effects of tissue edema and pain, and because prophylactic dexamethasone is effective in reducing
laryngeal edema following tracheal extubation, these researchers hypothesized that dexamethasone would reduce the pain and hoarseness associated with airway edema. One hundred and sixty-six patients undergoing thoracic surgery were assigned to one of three groups. Group one received dexamethasone 0.1 mg/kg, group two received dexamethasone received 0.2 mg/kg, and group three received normal saline. Induction protocol was the same for all patients with midazolam, propofol, alfentanil, and rocuronium. Anesthesia was maintained with sevoflurane. A size 35 French double lumen tube was used for females, and a size 37 French tube for males. Correct placement was confirmed with a fiberoptic bronchoscope after intubation and after position changes. Intracuff pressure was measured and maintained less than 20 cm H$_2$O. Postoperatively, patients were treated with either a fentanyl/ketolarac intravenous or ropivica/fentanyl epidural patient-controlled analgesia unit. Patients were assessed at one and 24 hours after extubation. Results showed that the incidence and severity of POST was significantly lower in the groups one and two who were treated with dexamethasone (incidence of POST in group one: 31%, group two: 11%, group three: 53%). The 0.2mg/kg dose was effective for the reduction of incidence and severity of POST and hoarseness at both 1 and 24 hours after extubation while the 0.1mg/kg dose only produced statistically significant reduction of symptoms at 1 hour. Researchers ultimately determined that the prophylactic use of intravenous dexamethasone significantly decreased that incidence and severity of POST and hoarseness at 1 and 24 hours after surgery and extubation.$^{30}$

Tazeh-kand et al published a study in 2010 that evaluated the use of an inhaled steroids effects on POST, cough, and hoarseness. One hundred and twenty women undergoing elective cesarean delivery were enrolled in this prospective, randomized,
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single-blinded study. Subjects were assigned to either a group in which fluticasone propionate 500 micrograms (μg) was administered using a spacer upon arrival to the operating room, or to a group in which patients were told they would receive an intravenous injection to reduce the incidence of POST, but no medication was administered. The induction protocol was the same for all patients who received thiopental, succinylcholine, and atracurium. Anesthesia was maintained with nitrous oxide and halothane. A 7 mm ETT was used and cuff was inflated until no leak was heard at airway pressures of 20 cm H₂O. Patients were assessed for the presence of POST, cough, and hoarseness at 1 and 24 hours after extubation. Researchers found that the incidence and severity of POST, cough, and hoarseness were significantly less when inhaled fluticasone was administered. At one and 24 hours after extubation, only 6% and 26% of patients who received fluticasone reported POST while 73% and 80% of patients who received no treatment reported POST. No side effects were reported from the single use of fluticasone, but researchers state that the inhalation route of fluticasone allows for a smaller dose and less chance of side effects like aggravation of a subtle infection. This study reaches a conclusion that inhaled fluticasone propionate attenuates the incidence and severity of POST, cough, and hoarseness.³¹

Ketamine, an NMDA receptor antagonist, is known to be involved in the pain pathway and anti-inflammatory cascade. Canbay et al published a prospective, randomized, controlled, single-blinded study in 2008 that examined the effects of a ketamine gargle on POST. Forty-six patients undergoing septorhinoplasty were divided into two groups, one that gargled ketamine 40 mg and one that gargled saline for thirty seconds prior to induction of general anesthesia. Patients were anesthetized using the
same protocol with propofol, fentanyl, and vecuronium. Maintenance of anesthesia was achieved with sevoflurane and remifentanil infusion. Female subjects were intubated with size 7-8 mm ETT and males were intubated with size 8-9 mm ETT. ETT cuffs were inflated until no air leak was heard with peak airway pressures of 20 cm H₂O, and cuff pressure was measured and maintained between 18-22 cm H₂O. Patients were assessed in the immediate postoperative period, and at 2, 4, and 24 hours. Researchers found that both the incidence and severity of POST was reduced in the ketamine gargle group. None of the ketamine patients reported severe POST symptoms at any interval (fifteen of the saline gargle patients reported severe symptoms), and only two patients reported moderate symptoms in the immediate postoperative period (thirteen patients in the saline group reported moderate symptoms). These researchers determined that a ketamine gargle significantly reduced the incidence and severity of POST.32

Park et al also examined the use of ketamine for reducing POST. In a 2010 prospective, randomized, double-blinded study, researchers assigned 70 patients undergoing laproscopic cholecystectomy to one of two groups. Patients in the ketamine group received ketamine 0.5mg/kg intravenously prior to induction and a ketamine infusion of 10 micrograms/kg/min throughout the procedure. Patients in the control group received the same regime of saline injection and infusion. All patients received glycopyrulate 0.2 mg prior to induction. The induction protocol was the same for all patients with fentanyl, propofol, and rocuronium. Anesthesia was maintained with desflurane. High-volume, low-pressure cuffed ETT were used, size 7 mm for women and 8 mm for men. ETT cuffs were inflated until no leak was heard at 20 cm H₂O, and was then measured and adjusted to 10-20 cm H₂O. Patients were assessed at 1, 6, and 24 hours after
extubation. Researchers report no statistically significant differences in POST, cough, or hoarseness between the two groups. They report that the dose used may have been insufficient to yield analgesic effects, and theorize that topical application of ketamine may influence POST by a reduction in local inflammation and mediation of the peripheral pain pathways. Ultimately, this study concluded that intravenous ketamine in the studied doses were not an effective means of decreasing the incidence of POST.33

A 2009 study by Agarwal et al evaluated the effects of a licorice gargle in an effort to attenuate POST. Licorice is derived from the Glycyrrhiza glabra root and has been used for centuries as a topical anti-irritant, anti-inflammatory, and for its antitussive effects. This prospective, randomized, single-blinded study examined 40 adult patients undergoing lumbar laminectomy who were divided into two groups. One group gargled 0.5 grams of licorice in 30 ml of water for 30 seconds prior to induction. The other group gargled 30 ml of water for the same duration just prior to induction. The induction procedure was standard for all patients in the study with fentanyl, propofol, and vecuronium. Anesthesia maintenance was achieved with propofol infusion and intermittent fentanyl. Patients were intubated with water-soluble lubricated ETTs, size 7.5 mm for females and 8.5 mm for males. Cuff pressures were measured and monitored continuously to maintain cuff pressures 18-22 cm H2O. Patients were assessed immediately after surgery, and again at 2, 4, and 24 hours for the presence of POST or any side effects. The incidence and severity of POST was reduced in the licorice group at all time points when compared with the control group. Eighty-nine percent of patients in the control group reported POST immediately after surgery while only 26% of patients in the licorice group reported POST at the same time point. Twenty-four hours after surgery, 50% of patients still reported POST in the
control group and 11% of patients in the licorice group reported POST. There were no statistically significant side effects noted at any time. Researchers determined that a licorice gargle 5 minutes prior to the induction of anesthesia is an effective way to attenuate the incidence and severity of POST.34

Charuluxananan et al studied the use of chamomile extract in a lubricant for ETT to evaluate for any attenuation in POST. This 2004 study divided 161 patients undergoing orthopedic, gynecological or urological surgery into two groups. Group one was treated with ETTs lubricated with a chamomile extract and the other who’s ETT had no lubrication. A standard induction protocol for general anesthesia was used for all patients. Subjects were assessed immediately upon arrival to the post-anesthesia care unit, and again 24 hours after extubation. Results showed no statistically significant relationship as 49% of patients whose ETT was lubricated with chamomile extract reported POST, and 44% of patients with an unlubricated ETT reported POST. The study concluded that chamomile extract used to lubricate the ETT could not prevent POST or hoarsness.35

A 2010 study by Ebneshahidi and Mohseni researched the effects of an over-the-counter honey and lemon lozenge called Strepsils on POST. Strepsils have been successfully used to treat oral pain and inflammation after oral surgery. The active ingredients are 2,4-dichlorobenzyl alcohol 1.2mg and amylmetacresol 0.6mg. One hundred fifty patients undergoing elective orthopedic or gynecological surgery were divided into two groups, one that received Strepsils preoperatively and the other who received a placebo lozenge. All patients had a standardized induction of anesthesia that included oxazepam, ranitidine, fentanyl, lidocaine, propofol, and atracurium prior to tracheal intubation with a high-volume, low-pressure cuffed ETT inflated until no leak was heard at
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a pressure of 20 cm H₂O. Women were intubated with 7-8 mm ETT and men were intubated with 7.5-8.5 mm ETT. POST and hoarseness were evaluated on a graded scale 20 minutes after extubation and again after 24 hours. The incidence of early POST in patients who received Strepsils was one-third compared to the placebo group (13% vs 34%). Hoarseness in the early postoperative phase, and both POST and hoarseness 24 hours postoperatively showed statistically significant decreases in the Strepsils group.

Researchers concluded that perioperative use of Strepsils reduces POST and hoarseness.  

**Study Level of Evidence and Main Findings Summary**

<table>
<thead>
<tr>
<th>Research Author(s)</th>
<th>Year of Publication</th>
<th>Level of Evidence (appendix A), Study as defined by researchers</th>
<th>Number of Study Subjects</th>
<th>Main Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brimacombe J. 12</td>
<td>1995</td>
<td>Level I. Meta-analysis</td>
<td>52 publications, representing 2440 subjects</td>
<td>LMA advantages: increased speed and ease of placement, improved hemodynamic stability, reduced anesthetic requirements for tolerance, minimal increase in intraocular pressure, less coughing, and improved oxygen saturation on emergence, less sore throat. LMA disadvantages: lower seal pressure, more gastric insufflation.</td>
</tr>
<tr>
<td>Biro P, Seifer B, &amp; Pasch T. 3</td>
<td>2005</td>
<td>Level IV. Non-randomized, prospective study</td>
<td>809 subjects</td>
<td>ETT advantages: prevention of aspiration, reduction of dead space, accessibility of airway for suctioning, ability for controlled ventilation. ETT use results in complaint of POST in 40% of patients. Factors associated with POST: female sex, smoking, lung disease, duration of anesthesia, postoperative nausea/vomiting, bloodstain on ETT, and natural teeth.</td>
</tr>
<tr>
<td>McHardy F, &amp; Chung F. 1</td>
<td>1999</td>
<td>Level V. Review Presents research from multiple studies, ranging from</td>
<td></td>
<td>ETT produces more POST than LMA. Limiting ETT cuff pressure &lt; 25 mmHg will reduce POST. Using saline to fill ETT cuff will eliminate the diffusion of nitrous oxide, and the resulting increase in cuff</td>
</tr>
</tbody>
</table>
Factors Associated with Postoperative Sore Throat

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Design</th>
<th>Patients</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radu AD, Milead F, Marret E, et al.</td>
<td>2007</td>
<td>Level IV. Prospective, double-blind, randomized clinical trial</td>
<td>53 subjects</td>
<td>Incidence of POST is higher after ETT. Dysphonia less common with LMA.</td>
</tr>
<tr>
<td>Mizutamari E, Yano T, Ushijima K, et al.</td>
<td>2004</td>
<td>Level IV. Randomized, single-blind trial</td>
<td>86 subjects</td>
<td>POST was worse after LMA placement, but this may be affected by the use of lidocaine lubricant. LMA insertion with cuff partially inflated yields improved success and better placement than cuff deflated.</td>
</tr>
<tr>
<td>Higgins P, Chung F, &amp; Mezie G.</td>
<td>2002</td>
<td>Level IV. Prospective, observational study</td>
<td>5264 subjects</td>
<td>Airway device is most significant factor in POST, and ETT produces more POST than LMA. Use of humidity moisture exchanger decreases POST. Female sex, patient in lithotomy position, and the use of succinylcholine are risk factors for POST. Difficult intubation does not increase risk of POST.</td>
</tr>
<tr>
<td>Ahmed A, Abbasi S, Ghafoor H, et al.</td>
<td>2007</td>
<td>Level IV. Prospective, observational study</td>
<td>312 subjects</td>
<td>Method of airway management is most significant factor in POST. ETT produces more POST than LMA. POST risk factors: female, elderly, patient position, difficult intubation, and duration of surgery.</td>
</tr>
<tr>
<td>Shroff P &amp; Surekha K</td>
<td>2006</td>
<td>Level IV. Prospective, randomized study</td>
<td>121 subjects</td>
<td>ETT produces more POST than LMA and was the most common complaint. LMA insertion is quicker, but hemodynamic response is similar.</td>
</tr>
<tr>
<td>Hohlrieder M, Brimacombe H, Eschertzhuber S, et al.</td>
<td>2007</td>
<td>Level IV. Randomized, double-blind prospective study</td>
<td>100 subjects</td>
<td>No differences in POST, dysphagia, or dysphonia in ETT vs. LMA group when water-based lubricant was used and intracuff pressure was maintained throughout the procedure.</td>
</tr>
<tr>
<td>Oczenski W</td>
<td>1999</td>
<td>Level IV.</td>
<td>75 subjects</td>
<td>ETT produces more POST than LMA.</td>
</tr>
<tr>
<td>First Name, Last Name, et al.</td>
<td>Study Design</td>
<td>Year</td>
<td>Study Type</td>
<td>Subjects</td>
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<tr>
<td>Krenn H, Dahaba A, et al. 2</td>
<td>Prospective, randomized trial</td>
<td>2009</td>
<td>Level II. Randomized, double-blind, controlled trial</td>
<td>138 subjects</td>
</tr>
<tr>
<td>Uerpaiojkit K, Charuluxananan S, Werawatganon T, et al. 17</td>
<td>2009</td>
<td>Level IV. Prospective study</td>
<td>138 subjects</td>
<td>63% of patients intubated with ETT reported POST. No differences in male vs. female, ETT with water-based lubricant vs. no lubricant. Multiple attempts at intubation does not increase POST. Throat related surgeries and procedural duration &gt;60 minutes correlate with increased POST.</td>
</tr>
<tr>
<td>Edomwonyi NP, Ekwere IT, Omo E, et al. 18</td>
<td>2006</td>
<td>Level IV. Prospective study</td>
<td>200 subjects</td>
<td>50% of patients intubated with ETT reported POST immediately after surgery, 25% reported POST the next day. POST and hoarseness were more common in females and when lidocaine spray was used. Less POST when cricoid pressure was used.</td>
</tr>
<tr>
<td>Maruyama K, Sakai H, Miyazawa H, et al. 4</td>
<td>2004</td>
<td>Level IV. Prospective study</td>
<td>418 subjects</td>
<td>50% of patients intubated with ETT reported POST immediately after surgery, 25% reported POST the next day. POST and hoarseness were more common in females and when lidocaine spray was used. Less POST when cricoid pressure was used.</td>
</tr>
<tr>
<td>Siddiqui N, Katznelson R, &amp; Friedman Z. 19</td>
<td>2009</td>
<td>Level II. Prospective, randomized, controlled trial</td>
<td>60 subjects</td>
<td>Direct laryngoscopy provided significantly quicker intubation times when compared to Glidescope or Trachlight. No significant differences in hemodynamic responses in any group. Higher POST in Trachlight group.</td>
</tr>
<tr>
<td>Salvalaggio MF, Rehme R, Fernandez R, et al. 20</td>
<td>2010</td>
<td>Level IV. Randomized comparative study</td>
<td>98 subjects</td>
<td>No differences in POST in ETT vs. lighted stylet groups, but hoarseness is more common in lighted stylet. No differences in intubation time or hemodynamic response.</td>
</tr>
<tr>
<td>Ratnaraj J, Todorov A, &amp; McHugh T. 21</td>
<td>2002</td>
<td>Level IV. Prospective, randomized, blinded study</td>
<td>51 subjects</td>
<td>Decreasing ETT cuff pressure to 20 mm Hg may decrease POST. Increased cuff pressure, neck retraction time, and female sex were associated with increased POST in patients undergoing anterior cervical spine surgery.</td>
</tr>
<tr>
<td>Brimacombe J, Holyoake L, Keller C, et al. 22</td>
<td>2000</td>
<td>Level IV. Randomized, double-blinded study</td>
<td>300 subjects</td>
<td>LMA causes more POST and dysphagia when compared to a face mask which results in more jaw pain. POST is more common when LMA cuff pressure is high. No differences in the sexes.</td>
</tr>
<tr>
<td>Burgard G, Mollhoff, T, &amp;</td>
<td>1996</td>
<td>Level IV. Prospective</td>
<td>200 subjects</td>
<td>POST can be reduced when LMA cuff pressure is monitored and kept</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Publication Year</td>
<td>Study Type</td>
<td>Dataset Size</td>
<td>Summary</td>
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<tr>
<td>Prien T.</td>
<td>2010</td>
<td>Randomized, observational study</td>
<td>200 subjects</td>
<td>Reducing LMA cuff pressure &lt; 44 mmHg lowers POST. LMA cuff pressures should be routinely monitored and maintained by manometry.</td>
</tr>
<tr>
<td>Seet E, Yousaf F, Gupta S, et al.</td>
<td>2010</td>
<td>Level IV. Double-blind, randomized trial</td>
<td>120 subjects</td>
<td>A 90 degree rotation technique of LMA insertion was shown to yield better placement on the first attempt and resulted in less POST when compared to a standard insertion technique.</td>
</tr>
<tr>
<td>Kuppusamy A &amp; Azhar N.</td>
<td>2010</td>
<td>Level IV. Randomized, prospective, comparative study</td>
<td>60 subjects</td>
<td>A bougie-guided LMA insertion technique was comparable to standard insertion in regards to successful placement, airway time, airway trauma, and hemodynamic response during insertion. POST was more common with standard insertion, but dysphagia was more common in bougie-guided insertion.</td>
</tr>
<tr>
<td>Navarro RM, &amp; Baughman VL.</td>
<td>1997</td>
<td>Level IV. Double-blind, randomized study</td>
<td>106 subjects</td>
<td>Multiple concentrations and methods of lidocaine therapy were evaluated. Both topical and systemic lidocaine significantly reduced POST.</td>
</tr>
<tr>
<td>Sumathi PA, Shenoy T, Ambareesha M, et al.</td>
<td>2008</td>
<td>Level II. Prospective, randomized, double-blinded, controlled study</td>
<td>150 subjects</td>
<td>Betamethasone gel applied to ETT cuff was more effective at significantly reducing POST, cough, and hoarseness when compared to lidocaine and a control group.</td>
</tr>
<tr>
<td>Hung NK, Wu CT, Chan SM, et al.</td>
<td>2010</td>
<td>Level IV. Prospective, randomized, double-blinded study</td>
<td>420 subjects</td>
<td>Benzydamine hydrochloride sprayed on the ETT cuff is effective at reducing the incidence and severity of POST. It is superior to saline, 2% lidocaine, and 10% lidocaine. 10% lidocaine significantly increased the incidence and severity of POST.</td>
</tr>
<tr>
<td>Agarwal A, Nath SS, Goswami D, et al.</td>
<td>2006</td>
<td>Level II. Prospective, randomized, placebo-</td>
<td>60 subjects</td>
<td>Aspirin gargles were effective at reducing POST for 4 hours. Benzydamine gargles were effective at reducing POST for 24 hours.</td>
</tr>
<tr>
<td>Study</td>
<td>Year</td>
<td>Design</td>
<td>Subjects</td>
<td>Findings</td>
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<tr>
<td>Huang YA, Hung NK, Lee MS,</td>
<td>2010</td>
<td>Controlled, blinded, single-blinded study</td>
<td>380</td>
<td>Spraying Benzydamine on the ETT cuff is effective at reducing the incidence and severity of POST without increased benzydamine side effects associated with application to the oropharyngeal cavity.</td>
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<tr>
<td>et al.</td>
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<tr>
<td>Park SH, Han SH, Do SH, et</td>
<td>2008</td>
<td>Level II. Prospective, randomized, double-blind, placebo-controlled study</td>
<td>166</td>
<td>Prophylactic dexamethasone 0.2 mg/kg intravenously significantly reduces the incidence and severity of POST after tracheal extubation of a double-lumen tube.</td>
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<td>al.</td>
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<tr>
<td>Tazeh-kand NF, Eslami B, &amp;</td>
<td>2010</td>
<td>Level IV. Prospective, randomized, single-blinded study</td>
<td>120</td>
<td>Inhaled fluticasone 500 µg decreases the incidence and severity of POST, cough, and hoarseness.</td>
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<tr>
<td>Mohammadian K.</td>
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<tr>
<td>Canbay O, Celebi N, Sahin A</td>
<td>2008</td>
<td>Level II. Prospective, randomized, placebo-controlled, single-blinded study</td>
<td>46</td>
<td>Ketamine gargle significantly reduces the incidence and severity of POST.</td>
</tr>
<tr>
<td>et al.</td>
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<tr>
<td>Park SY, Kim SH, Noh JI, et</td>
<td>2010</td>
<td>Level IV. Prospective, randomized, double-blinded clinical trial</td>
<td>70</td>
<td>Ketamine intravenously was not effective at reducing POST in low-doses.</td>
</tr>
<tr>
<td>al.</td>
<td></td>
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<td></td>
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<tr>
<td>Agwarwal A, Gupta D, Yadav</td>
<td>2009</td>
<td>Level II. Prospective, randomized, single-blinded, placebo-controlled study</td>
<td>40</td>
<td>Licorice gargle 5 minutes prior to induction of anesthesia is effective in attenuating the incidence and severity of POST.</td>
</tr>
<tr>
<td>G, et al.</td>
<td></td>
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<tr>
<td>Charuluxananan S, Sumethawattana P, Kosawiboonpol R, et al.</td>
<td>2004</td>
<td>Level II. Prospective, randomized, blinded, controlled study</td>
<td>161</td>
<td>Lubrication of ETT cuff with chamomile extract prior to intubation is ineffective at preventing POST and hoarseness.</td>
</tr>
<tr>
<td>Edneshadhihi A &amp; Mohseni M.</td>
<td>2010</td>
<td>Level II. Prospective, randomized, blinded, controlled study</td>
<td>150</td>
<td>Perioperative use of Strepsils lozenges reduce POST and hoarseness.</td>
</tr>
</tbody>
</table>
Synthesis of Literature

POST is a common adverse event following general anesthesia,\(^1,3,6\) and may represent the more specific symptoms of pharyngitis, laryngitis, dysphonia, dysphagia, hoarseness, and cough. While generally considered a minor side effect,\(^3\) POST is important to patients\(^5,6,15,17,18,27,29,30,31,32,33,34,36\) and decreasing its incidence is an opportunity to improve anesthetic outcomes. While POST is generally most common after intubation with an ETT,\(^2,6,15,16\) the selection of an airway device is a multi-factorial decision based upon the patient and procedure, and it is unlikely that POST will be a major consideration in the device selection. POST can affect any patient undergoing general anesthesia, regardless of the method used to secure the airway.\(^5\) Studies have shown that patients who were supported only with facemasks still report POST.\(^6,14\) The etiology of POST is thought involve trauma to mucosa due to airway instrumentation and intubation, mucosal ischemia following decreases in blood flow related to high pressures of the airway device's cuff, the erosion and dehydration of delicate mucosal tissues, and the resulting inflammation.\(^10,11\)

Some of the risk factors such as sex, duration of procedure, or surgical positioning are beyond the control of the anesthesia provider. Identification of the factors associated with an increased risk of POST will however, allow anesthesia providers to avoid combinations of controllable factors, decrease the incidence of POST, and improve patient anesthetic outcomes.

The use of a smaller ETT has consistently been shown to significantly reduce the incidence of POST\(^1,3,5,18\) without resulting in problems ventilating

<table>
<thead>
<tr>
<th>Risk Factors Associated with Increased Incidence of POST</th>
</tr>
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<tbody>
<tr>
<td>Large sized airway device(^1,3,5,6,10,11,13,14,15,16,18,19,27,30,32)</td>
</tr>
<tr>
<td>High cuff pressures(^1,2,4,5,10,11,13,14,18,19,21,22,23,24,27,28,32)</td>
</tr>
<tr>
<td>Use of anesthetic spray or lubricants(^1,4,14,18,28)</td>
</tr>
<tr>
<td>Female sex(^3,4,6,15,21,31)</td>
</tr>
<tr>
<td>Duration of anesthesia(^3,4,13,15,18)</td>
</tr>
<tr>
<td>Surgical positioning(^6,15)</td>
</tr>
<tr>
<td>Use of Succinylcholine(^1,3,6,10,31)</td>
</tr>
<tr>
<td>Concurrent use of nasogastric tube(^1,4,18)</td>
</tr>
<tr>
<td>Aggressive oropharyngeal suctioning(^5,6,10,27,32)</td>
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</table>
Factors Associated with Postoperative Sore Throat

patients. Studies have documented the use of 6.5 mm ETT for women and 7 mm ETT for men that resulted in lower rates of POST when compared to larger sized ETT. Many researchers have suggested that the higher incidence of females reporting POST is more directly related to a tighter fitting ETT than to a distinct difference between the sexes. One group of researchers admit that their choices in ETT sizes did not truly fit the anatomy of patients (they used 8 mm for males and 7.5 mm for females), and suggest that a 7 mm ETT may be a better alternative for females. In fact, several studies seem to advocate a 7 mm sized ETT for female patients and a 7.5 mm ETT for males.

Not surprisingly, there are some studies supporting the use of smaller LMAs to result in a decreased incidence of POST. There is little evidenced-based research to support this practice, and a concern that an appropriately sized LMA (size 4 for women, size 5 for men) is required to ensure a good supra-glottic seal and allow for positive pressure ventilation. Some investigators have found that larger LMAs (size 4 for women, size 5 for men) actually reduces POST. Until more definitive research provides proven recommendations for anesthesia providers, it is best for providers to refer to manufacturers recommendations for appropriate LMA sizing.

There is significant evidence to support that limiting ETT cuff pressures will reduce the incidence of POST. Even the high-volume, low-pressure cuffs that are most common today can be over-inflated to produce high pressures resulting in mucosal ischemia and POST. Many researchers advocate for the routine use of manometry to monitor and maintain intracuff pressures < 20 mm Hg, but manometers may not be readily available in all institutions. It is important to determine the cuff seal point initially after tracheal intubation, and to intermittently measure and adjust cuff pressure to the
minimum required for adequate seal.\textsuperscript{1} The use of nitrous oxide will diffuse into any air-filled cuff and cause steady increases in pressure.\textsuperscript{1,4,10,13,14} This diffusion can be safely prevented by using an anesthetic gas mixture, saline, or lidocaine to inflate the cuff,\textsuperscript{1,10} or with the use of specially designed cuffs that act as a barrier to nitrous oxide.\textsuperscript{17}

Not all researchers agree that limiting LMA cuff pressures results in a decreased incidence of POST,\textsuperscript{1,14} but many studies show that this is an effective way to decrease POST.\textsuperscript{1,9,14,22,23,24,26} Investigators have documented that a LMA cuff pressure of < 60 cm H\textsubscript{2}O or < 44 mm Hg will decrease the incidence of POST,\textsuperscript{9,17,24,26} and is sufficient to provide an adequate seal for positive pressure ventilation.\textsuperscript{17} The use of nitrous oxide will cause significant increases in intracuff pressure in the first 60 minutes after insertion,\textsuperscript{23} so intraoperative monitoring of cuff pressure in the presence of nitrous oxide should be considered. Some studies have recommended the use of routine manometry to measure and adjust LMA cuff pressures,\textsuperscript{24} but other studies admit this is an uncommon practice and have used volumes rather than in vivo pressure monitors.\textsuperscript{22} Research has demonstrated that maintenance of the minimum cuff volume/pressure to ensure an effective seal during positive pressure ventilation will result in a decreased incidence of POST.\textsuperscript{1,22,23} It is also important to know that the decreased perfusion and ischemia due to over inflation of LMA cuffs have been linked to more serious events such as injuries to the recurrent laryngeal nerve, hypoglossal nerve, and lingual nerve.\textsuperscript{24}

While many studies use the manufacturers’ recommended LMA insertion technique,\textsuperscript{1,26,9,17,24} there are many researchers who have evaluated alternative insertion methods in an attempt to decrease the incidence of POST. The standard technique involves complete deflation of the LMA cuff and insertion with index finger.\textsuperscript{1,26,9,14,17,24} but many
studies have demonstrated significant decreases in POST when the LMA cuff is inflated prior to insertion.\textsuperscript{1,13,14} The use of LMA introducer tools have also established a decreased incidence of POST.\textsuperscript{1,16} Other insertion methods deemed to decrease POST include a 90° rotation technique in which the LMA is inserted into the patient’s mouth in a midline approach, rotated 90° around the patient’s tongue, and advanced until resistance was met.\textsuperscript{25} The use of a lubricated gum elastic bougie placed in the drain tube of a Proseal LMA, and placed into the distal esophagus under direct laryngoscopy also resulted in a decreased incidence of POST in one study.\textsuperscript{26} Researchers report these methods yield successful LMA placement, decrease the incidence of POST, and believe that these methods decrease the pharyngeal trauma as is often evidenced by blood staining on the LMA cuff.\textsuperscript{1,14,25} Research is not conclusive, in part due to the myriad of factors associated with POST. Some research evaluating the LMA with inflated cuff insertion technique found that this method produced more POST than an ETT, but believe this may be related to the use of a lidocaine lubricant.\textsuperscript{14} Ultimately, no single LMA insertion method has been consistently proven to be superior to another in terms of reducing POST. It is important to know alternatives to the standard LMA insertion technique, and to be familiar with the LMA insertion tools available to the anesthesia provider.

The LMA manufacturers recommend the use of a water-soluble lubricant to facilitate LMA insertion,\textsuperscript{1} but studies show that lubricating ETTs with a water-soluble lubricant does not reduce POST.\textsuperscript{18} The use of lidocaine lubricants and sprays is commonly seen in clinical practice,\textsuperscript{27} despite research that shows this is an ineffective way to decrease POST and may actually increase the incidence and severity.\textsuperscript{1,14,18,27,28} Research consistently demonstrates that lidocaine sprays are associated with an increased incidence of POST.\textsuperscript{1,14,18,27,28}
Lidocaine is believed to be irritating to tracheal mucosa,\textsuperscript{1,14,28} and additives such as ethanol, menthol, and polyethylene glycol, which are common to the aerosolized anesthetic, are thought to worsen POST.\textsuperscript{4,28} The role of lidocaine jelly is less clear, but research does not consistently find that the use of lidocaine jelly reduces POST and often reports the use of lidocaine increases POST.\textsuperscript{1,14,27} The disadvantages of using lidocaine jelly for LMA placement may be even more compelling as it too has been shown ineffective to reduce POST, but the larger area of mucosal contact is believed to increase the incidence of hoarseness, tongue paresthesia, nausea and vomiting.\textsuperscript{14}

Researchers continue to examine ways to maximize the anesthetic benefits of lidocaine, while avoiding the negative side effects discussed above. Filling the ETT cuff with 2 or 4\% lidocaine, 90 minutes prior to tracheal intubation, will allow for the diffusion of lidocaine and provide continual application of the local anesthetic while theoretically avoiding the chemical irritation from any additives. This method has been shown to safely reduce the incidence and severity of POST.\textsuperscript{10,11,28} Even systemic doses of intravenous lidocaine (1-1.5 mg/kg), administered at the conclusion of surgery, have been shown to reduce the incidence and severity of POST.\textsuperscript{11}

There are, of course, many studies evaluating other medications in an effort to reduce the incidence of POST. Most of these studies involve the use of steroids and non-steroidal anti-inflammatory drugs, both aimed at reducing the irritation and inflammation believed to be a causative factor in the development of POST.\textsuperscript{27,28,29,30,31} One study confirms the results of previous research, finding that widespread application of a 0.05\% betamethasone gel (a corticosteroid) to the ETT prior to tracheal intubation significantly reduced the incidence of POST, cough, and hoarseness. Researchers admit that local
infection is possible with the topical steroid, but no adverse side effects were reported. Dexamethasone (a corticosteroid) 0.2 mg/kg intravenously has been shown to significantly decrease the incidence and severity of POST, and these findings are supported by several similar studies. There are a large range of potential side effects resulting from systemic steroids, such as hyperglycemia and increased susceptibility to infection, but none were reported in the narrow range of follow-up in this study. Fluticasone propionate (a corticosteroid) 500 μg inhaled via a spacer device just prior to the induction of anesthesia has been shown to reduce the incidence and severity of POST, cough, and hoarseness. Fluticasone is a relatively new inhaled steroid more commonly used for the treatment of asthma. No other studies are referenced, supporting the specific use of fluticasone for the prevention of POST, but the successful use of other corticosteroids is documented. Researchers do reference a study evaluating the safety of intranasal fluticasone and report no systemic adverse events. Newly emerging research is evaluating the effectiveness of benzydamine hydrochloride, a topical non-steroidal, anti-inflammatory agent not yet available in the United States. This drug has analgesic, antipyretic, and antimicrobial properties and has been commonly used to treat radiation-induced oral mucositis, arthritis, and acute sore throat. Research shows that benzydamine hydrochloride sprayed onto the ETT cuff significantly reduced the incidence and severity of POST. In fact, spraying benzydamine hydrochloride on the ETT cuff is more effective than spraying the oropharyngeal cavity and decreases side effects like numbness, stinging sensation, dry mouth, and thirst. The effects of benzydamine hydrochloride lasts nearly 24 hours. Aspirin, also a non-steroidal anti-
inflammatory agent, has been shown effective in reducing POST when a 325 mg tablet is dissolved into 30 ml elixir and gargled for 30 seconds prior to induction.\textsuperscript{5}

Other medications have been evaluated for their ability to reduce the incidence of POST, including ketamine and licorice gargles, and over-the-counter lozenges, Strepsils, have all been found effective ways to attenuate both the incidence and severity of POST.\textsuperscript{32,34,36}

While steroids and non-steroidal, anti-inflammatory agents have the most evidence based support for their use to decrease the incidence of POST, it is important for anesthesia providers to maintain current knowledge of emerging research.
PART THREE

Intervention

After a thorough review of the literature, research demonstrates that the endotracheal tube (ETT) results in postoperative sore throat (POST) more frequently than a laryngeal mask airway (LMA).\textsuperscript{2,6,15,16} The selection of an airway device for patients undergoing general anesthesia is a multi-factorial decision based on the patient and procedure. The potential for POST is unlikely to be a deciding factor in the selection of airway device. There are a multitude of factors associated with POST and no single best way to decrease its incidence. For this reason, the goal and purpose of this intervention is to educate anesthesia providers on the factors associated with an increased incidence of POST and methods to minimize the controllable risk factors.

An educational presentation was developed for the anesthesia providers at Plaza Medical Center discussing the most significant factors affecting POST based upon current literature. A PowerPoint slide show (appendix B) would accompany the lecture, and a one-page color handout (appendix C) that highlights key points would be provided to attendees. A five question pre and post-test (appendix D) would also be administered to anesthesia providers to document attitudes and perceived importance of the issue, and to assess their knowledge prior to and following the presentation. The literature review and findings from this educational intervention would be submitted for publication to \textit{The International Student Journal of Nurse Anesthesia}. Publication is an effective means for the dissemination of information to a wide audience interested in improving care according to evidenced-based practice. If found to be beyond the introductory publication level accepted by \textit{The International Student Journal of Nurse Anesthesia}, submission to the \textit{AANA Journal} will be
considered at that time. The Rosswurm-Larrabee “Model for Change to Evidence-Based Practice”\textsuperscript{37} was used to guide the data collection and implementation.
PART FOUR

Implementation Plan and Results

Guiding Framework: Rosswurm & Larrabee

In 1999, Mary Ann Rosswurm and June Larrabee published “A Model for Change to Evidence-Based Practice.” Their purpose was to provide healthcare professionals with a systematic approach to using the vast amount of clinical research to make changes in practice.\(^37\) The design and application of this model was an effort to close the gap between accessing knowledge and translating that knowledge into practice.

Step 1: Assess the Need for Change in Practice

The frequent reports of postoperative sore throat (POST) from patients recovering from general anesthesia\(^1,3,6\) are the stimulus for this need in change of practice. Rosswurm and Larrabee recommend the use of a group of “stakeholders” for the purpose of discussion, review of data, and identification of the problem.\(^37\) No such group has been formed for this project, but research consistently demonstrates that POST is a common complaint,\(^1,3,6\) and the importance of the subject was supported by Dr. Mark Welliver and Dr. Kay Sanders, a professor and the nurse anesthesia program director at Texas Christian University, who recommended and supported this topic for evaluation. The subject and intervention was reviewed and approved by Dr. Terri Jones of Texas Christian University's...
Nursing Institutional Review Board (appendix E). No internal-external comparison data has been gathered specific to Plaza Medical Center or other local facilities,\textsuperscript{37} which may be valuable as evidence does show variability in the incidence from study to study. The review of current literature reveals a number of factors associated with an increased incidence of POST. There is no single solution to decrease its incidence.

**Step 2: Link Problem with Interventions and Outcomes**

The focus in this step according to Rosswurm and Larrabee is to use appropriate terminology and classifications, identify potential interventions, and outcomes.\textsuperscript{37} All attempts are made to use appropriate terminology to provide consistency and increase understanding among readers. Because no single intervention was identified in the research to decrease the incidence of POST, an educational presentation that informs anesthesia providers on the most common factors associated with POST will allow for the minimization of risk factors and result in a decreased incidence of POST. The following publication of this literature review and the results of the educational presentation in *The International Student Journal of Nurse Anesthesia* would reach a sizeable audience of emerging anesthesia providers.

Anesthesia providers who attend the educational in-service would receive a pre-test (appendix D) to evaluate their perceptions on the significance of POST, current practice methods, and knowledge of factors associated with an increased incidence of POST. A brief educational luncheon would educate anesthesia professionals on current research related to POST. This would involve a verbal presentation accompanied by PowerPoint slides (appendix B), and a handout (appendix C) highlighting significant points. After the educational portion of the meeting, attendees would take a post-test (appendix D) to
reevaluate knowledge of the factors affecting POST and methods to reduce its incidence. The pre-test and post-test would allow for a measurable outcome following the educational presentation. Lunch would be provided to encourage attendance.

**Step 3: Synthesize Best Evidence**

Rosswurm and Larrabee's model recommends the search and synthesis of relevant literature. A literature search was completed by exploring Medline, CINAHL, Cochrane, and Google Scholar databases over the course of a year (September 2009–October 2010) for full text, peer-reviewed research articles containing key words in the title or abstract related to POST, laryngeal mask airway (LMA), and/or endotracheal tube (ETT). Research was limited to those studies published after 1995, evaluating adults, and published in the English language. Additional references were used from the bibliographies of appropriate articles. The research was studied and critiqued. The summary of these findings can be found above.

**Step 4: Design a Change in Practice**

Because no single intervention emerged as the solution to POST in the review of current research, the development of a formal protocol or change in procedure is premature. Educating providers on the most significant factors associated with POST, and summarizing evidenced-based recommendations would aid providers in instituting changes in their own practice to decrease the incidence of POST. Rosswurm and Larrabee state that consideration of the practice environment, resources needed, and the opinions of stakeholders are crucial to the success of a change in practice. For this reason, the educational materials will be reviewed by peers and educators, and approved by Dr. Kay Sanders, Nurse Anesthesia Program Director at Texas
Christian University, Thomas Flores, Clinical Coordinator at Plaza Medical Center, and Dr. Swaminathan Karthik, Anesthesia Medical Director at Plaza Medical Center. Consideration of the practice environment is why the meeting would be held in the Doctor's lounge at Plaza Medical Center. This is located conveniently near the surgical suites, at a time convenient to providers, and over the period of two consecutive days in an effort to allow the majority of practitioners the opportunity to attend. The primary resources are the anesthesia providers at Plaza Medical Center. Peers, educators, and hospital administration are also necessary resources. Catering will be a consideration for cost requirements, but this provision would provide an incentive for anesthesia providers to attend.

The desired outcome is for anesthesia providers to understand the importance patients place on POST, to identify factors associated with POST, and know methods of decreasing the incidence of POST. This would be evaluated with a pre and post-test, and would be measured by an increase in the number of providers who consider POST when developing their anesthetic plan and by an increase in the overall test scores.

**Step 5: Implement & Evaluate Change in Practice**

Following the series of educational presentations and collection of anesthesia provider testing and feedback, the results would be incorporated into this literature review. Rosswurm and Larrabee's model focuses on the importance of the coordinator’s close involvement in the process. At that time, the outcomes of the pre-test and post-test would be reviewed for improved scores, which may reflect an increase in knowledge. Rosswurm and Larrabee encourage the evaluation of not just the outcomes but also the process itself. This can be achieved by allowing participants the opportunity to evaluate
Factors Associated with Postoperative Sore Throat

and provide feedback on the lecture, visual aids, and overall experience of the educational luncheon. This feedback can influence the decision to adapt, adopt, or reject the educational intervention itself as recommended by Rosswurm and Larrabee. The feedback can be used to address any points deemed unclear by participants in the educational sessions prior to submission for journal publication.

**Step 6: Integrate and Maintain Change in Practice**

This final phase of the model recommends communication with staff, administration, and other stakeholders involved in the process. Any adjustments in the implementation or practice should be considered and discussed at this time. The continued monitoring of the process and outcomes is important, and when evidence firmly supports a change in practice this change should be integrated into the standards of practice.

The literature review and findings from the educational intervention would be submitted as an evidence-based practice analysis report for publication in *The International Student Journal of Nurse Anesthesia*. Dissemination in this manner would present findings of this literature review to a large audience who is perceived to be interested in improving outcomes through evidence-based practice. This information could then be translated into changes in individual practices, resulting in decreased incidence in POST, and an improved anesthesia experience for patients.
Factors Associated with Postoperative Sore Throat

**SWOT Analysis**

**Strength**

The most obvious internal strength is the potential to improve the anesthesia experience of every patient undergoing general anesthesia, as some research documents that the incidence of POST is as high as 100%. Because there are a variety of ways to reduce POST, anesthesia providers may select the most appropriate, patient-specific methods to decreased risk of POST. Options may include techniques such as using smaller ETTs or monitoring the cuff pressures of ETTs or LMAs, or by implementing pharmacological methods like the avoidance of lidocaine sprays and use of steroids or other anti-inflammatory agents.

**Weakness**

The nature of the research itself has inherent weaknesses, as the wide range of risk factors identified to increase the risk of POST precludes the feasibility of a large-scale, all-inclusive study. The multiple variables identified to increase the risk of POST exclude the...
possibility of a single solution to prevent or attenuate POST. While a variety of methods can give providers many opportunities to decrease a patient’s risk of POST, this could overwhelm providers and produce inaction.

**Opportunity**

Anesthesia is the only safety system in healthcare that begins to approach near perfect “six-sigma” level. This dedication to excellence is undoubtedly attributed to anesthesia providers firm commitment to provide patients with a superior anesthesia experience. A growing emphasis on evidenced-based practice could urge providers to abandon old habits, and embrace these new methods to decrease the incidence of POST.

**Threat**

While POST is a widespread problem, this is generally considered a minor side effect and patients report symptoms are most often relieved in 24 hours. Anesthesia providers could feel that because POST is of such little long-term consequence, it does not merit any consideration when developing an anesthetic plan. Experienced anesthesia providers may resist any information or practice recommendations presented by a student who has trained under their guidance.
Factors Associated with Postoperative Sore Throat

PART FIVE

Conclusion

The incidence of postoperative sore throat (POST) is as high as 100% in some studies, and is ranked as a patient’s 8th most undesirable postoperative event. The method of airway management has been shown to be the most significant predictor of POST, but the selection of an airway device is a multi-factorial decision based upon the patient and the procedure. Awareness of the variables associated with an increased incidence of POST can allow providers to minimize combinations of risk factors, reduce the incidence and severity of POST, and improve a patient’s anesthesia experience.

Recommendations for Anesthesia Providers

To reduce the incidence of POST:

- Use a smaller endotracheal tube (ETT) to decrease POST without causing problems ventilating patients. Many studies support the use of 7 mm ETT for women and 7.5 mm ETT for men. Smaller ETT (6.5 mm for women and 7 mm for men) have also been successfully used in adults.

- Follow manufacturer’s recommendations for sizing laryngeal mask airway (LMA).

- Limiting ETT cuff pressure will decrease the incidence of POST. Some studies recommend routine manometry to measure and maintain cuff pressure < 20 mm Hg. Determination and maintenance of the minimum pressure for an effective cuff seal during positive pressure ventilation is an effective way to decrease POST.

- Limiting LMA cuff pressure will decrease the incidence of POST without interfering with the ability to deliver positive pressure ventilation.
Manometry has been recommended to measure and maintain cuff pressure\textsuperscript{24} < 60 cm H\textsubscript{2}O or < 44 mm Hg.\textsuperscript{9,17,24,26} Because monitoring cuff pressure is not a common practice, some studies measure volumes used to inflate LMA cuffs, and many agree that assessing and maintaining the minimum cuff volume/pressure required for positive pressure ventilation is adequate to reduce POST.\textsuperscript{1,22,23}

- Nitrous oxide, if used, will diffuse into any air-filled space (i.e. air-filled cuffs) and cause significant increases in intracuff pressures,\textsuperscript{1,4,10,13,14} particularly in the first hour of anesthesia.\textsuperscript{23} Filling the cuff with an anesthetic gas mixture, saline, or lidocaine (ETT only) have been shown to be effective methods of eliminating this diffusion and resulting increase in pressure.\textsuperscript{1,10}

- The use of water-soluble lubricants on LMA per manufacturer’s recommendation facilitates insertion.\textsuperscript{1}

- Do not use water-soluble lubricants on ETT, as this does not decrease POST.\textsuperscript{18}

- Lidocaine is believed to be an irritant to mucosa.\textsuperscript{1,14,28} Many studies show lidocaine lubricants are ineffective to decrease POST, and may actually increase the incidence and severity of POST.\textsuperscript{1,4,14,18,27,28} Lidocaine sprays are consistently associated with an increase incidence of POST.\textsuperscript{1,4,18,27,28} Additives like ethanol, menthol, and polyethylene glycol are common additives to aerosolized lidocaine, and are thought to worsen POST.\textsuperscript{4,28}

- Filling ETT cuffs with 2 or 4\% lidocaine, 90 minutes prior to tracheal intubation, allows for the diffusion of lidocaine and continual application of the local anesthetic while theoretically avoiding the chemical irritation to tracheal mucosa. This has been shown to safely reduce POST.\textsuperscript{10,11,28}
• 1-1.5 mg/kg intravenous lidocaine at the conclusion of surgery has been shown to reduce the incidence and severity of POST.\textsuperscript{11}

• Many pharmaceutical methods have been evaluated to attenuate POST. It is important for providers to stay updated on current research. The most common drugs evaluated are steroids and non-steroidal anti-inflammatory agents, which have been studied extensively and are shown to decrease the incidence and severity of POST.

  o Specific steroid examples include betamethasone gel 0.05% applied to the ETT prior to intubation,\textsuperscript{27} dexamethasone 0.2 mg/kg intravenously,\textsuperscript{30} and fluticasone 500 μg inhaled with a spacer\textsuperscript{31} have all been shown to decrease the incidence and severity of POST.

  o Not yet available in the US, benzydamine hydrochloride is a topical, non-steroidal, anti-inflammatory agent with analgesic, antipyretic, and antimicrobial properties. The subject of many recent studies, when sprayed onto the ETT cuff it has significantly reduced the incidence and severity of POST for up to 24 hours.\textsuperscript{28,29} Aspirin elixir (325mg tablet dissolved in 30 ml water) gargled just prior to induction has also been shown to decrease POST.\textsuperscript{5}
References

Factors Associated with Postoperative Sore Throat


### Appendix A

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I</td>
<td>Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs), or evidence-based clinical practice guidelines based on systematic reviews of RCTs</td>
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<tr>
<td>Level II</td>
<td>Evidence obtained from at least one well-designed RCT</td>
</tr>
<tr>
<td>Level III</td>
<td>Evidence obtained from well-designed controlled trials without randomization</td>
</tr>
<tr>
<td>Level IV</td>
<td>Evidence from well-designed case-control and cohort studies</td>
</tr>
<tr>
<td>Level V</td>
<td>Evidence from systematic reviews of descriptive and qualitative studies</td>
</tr>
<tr>
<td>Level VI</td>
<td>Evidence from single descriptive or qualitative study</td>
</tr>
<tr>
<td>Level VII</td>
<td>Evidence from the opinion of authorities and/or reports of expert committees</td>
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Factors Associated with Postoperative Sore Throat

Appendix B

Postoperative Sore Throat
Is it really important?
- The incidence of postoperative sore throat (POST) varies from study to study. Most studies report the incidence from 40-60%, but some state it as high as 100%.
- POST is generally considered a minor consideration, and is most often relieved in 24 hours.
- Patients rate POST as their 8th most undesired postoperative event, and research consistently shows POST is important to patients.
- If POST is important to patients, it should be important to anesthesia providers.

Methodology
- Literature search was conducted over the course of a year (September 2009 – August 2010).
- Multiple databases were searched: Medline, CINAHL, Cochrane Library, and Google Scholar.
- Research published prior to 1995 and studies evaluating pediatric patients were excluded.
- Final collection is 37 pieces of research is represented primarily as randomized, controlled studies, a meta-analysis, and reviews.

Etiology of POST
- Trauma to mucosa
  - Related to instrumentation and intubation
- Mucosal ischemia
  - High intracuff pressures decrease blood flow
- Mucosal erosion
  - Coughing, bucking on airway device
- Mucosal dehydration
  - Drying anesthetic gas mixtures
- Inflammation
  - As a result of the above

Selection of Airway Device
- The method of airway management is the most significant predictor of POST.
- Endotracheal tubes (ETT) result in more complaints of POST when compared to laryngeal mask airways (LMA), but patients managed with only a facemask still report POST.
- The selection of airway device is a multi-factorial decision based on the specific patient and procedure. POST is unlikely to be a major consideration when choosing airway management plan.
- Awareness and minimizing of the risk factors associated with POST will decrease its incidence.

Post Risk Factors
- Large sized airway device
- High intracuff pressures
- Use of anesthetic sprays or lubricants
- Female sex
- Duration of anesthesia
- Surgical positioning
- Use of succinylcholine
- Concurrent use of nasogastric tube
- Aggressive oropharyngeal suctioning

The focus of this discussion will be on the controllable risk factors associated with POST.
Factors Associated with Postoperative Sore Throat

**ETT Size**
- Use of a smaller ETT has consistently been shown to reduce POST without resulting in problems ventilating patients
- Some researchers believe that the higher incidence of POST in females is more directly related to a tighter fitting ETT than a distinct difference between the sexes
- Many researchers seem to support use of 7.0 ID ETT for women and 7.5 ID ETT for men. Studies have also documented successful use of 6.5 ID ETT for women and 7.0 ID ETT for men

**LMA Size**
- Because smaller ETTs have been consistently shown to reduce POST, it is no surprise that some research supports that smaller LMAs can decrease the incidence of POST
- Research is inconsistent
- There is concern that an appropriately sized LMA is required for adequate supra-glottic seal and allow for positive pressure ventilation
- Until more definitive research provides proven recommendations for providers, use manufacturers recommendations when sizing LMAs

**Limiting Intracuff Pressures**
- Significant evidence supports that limiting ETT intracuff pressures will reduce POST
- Even high-volume, low-pressure cuffs are capable of over-inflation and may produce mucosal ischemia
- Some advocate the routine use of manometry to measure and maintain ETT cuff pressures < 20 mmHg, but manometers may not be available in all institutions
- Determining the minimum cuff volume/pressure required for adequate seal and positive pressure ventilation, and maintenance of that minimum pressure have been shown to attenuate POST

**Limiting Intracuff Pressure**
- Most research also agrees that limiting LMA intracuff pressures will reduce POST, and the risk of injury to the recurrent laryngeal, hypoglossal, and lingual nerves
- Investigators have documented that maintenance of LMA intracuff pressures < 10 cmH2O or < 14 mmHg will decrease the incidence of POST and is sufficient to provide an adequate seal for positive pressure ventilation
- Routine manometry has been suggested, but researchers admit that measuring LMA intracuff pressures is an uncommon practice, and advocate using volumes instead of in vivo pressure monitor
- Maintenance of the minimum LMA cuff volume/pressure to ensure adequate seal during positive pressure ventilation will decrease the incidence of POST

**Nitrous Oxide & Intracuff Pressure**
- Nitrous oxide will diffuse into any air-filled space, and this includes air-filled cuffs of ETTS and LMAs
- This results in significant increases in intracuff pressures in the first 60 minutes of use
- Intraoperative intracuff pressure monitoring should especially be considered when nitrous oxide is used
- Diffusion can be prevented by inflating ETT or LMA cuff with anesthetic gas mixture
- Diffusion can also be safely prevented by inflating ETT cuffs with saline or lidocaine

**LMA Insertion Techniques**
- Many alternatives to LMA manufacturer’s recommended insertion methods have been evaluated in an effort to decrease POST
- The most common alternatives involve partial inflation of the LMA cuff prior to insertion and use of an introducer tool
- These methods have been shown to yield successful placement and decrease the incidence of POST
Factors Associated with Postoperative Sore Throat

**Lubricants**
- LMA manufacturer recommends the use of water soluble lubricant to facilitate LMA insertion
- Lubricating ETT has no effect on POST
- The use of lidocaine lubricants is commonly seen in practice, but research shows this is an ineffective way to decrease POST, and may actually increase the incidence and severity of POST

**Lidocaine Pros**
- Filling ETT cuffs with 2 or 4% lidocaine, 90 minutes prior to intubation, will allow for the diffusion of lidocaine and provide continual application of local anesthetic and decreased incidence of POST, while theoretically avoiding the chemical irritation
- Systemic lidocaine (1 – 1.5 mg/kg) administered intravenously at the conclusion of surgery has been shown to reduce the incidence and severity of POST

**Pharmacological Interventions**
- Most of the pharmacological interventions aimed at reducing POST focus on steroid and non-steroidal anti-inflammatory agents (NSAIDs) in a effort to reduce the irritation and inflammation believed to be a causative factor in the development of POST
- Steroids
  - Betamethasone 0.65% gel applied to the ETT prior to intubation significantly reduced POST, cough, and hoarseness
  - Dexamethasone 0.2 mg/kg intravenously significantly reduced POST
  - Fluocinonide 0.5% ointment applied to the ETT prior to intubation reduced the incidence and severity of POST
- Possible side effects (SE) of steroids include local or systemic infection and hyperglycemia, but no SE were reported

**Reduction the Incidence of POST**
- POST is a common postoperative complaint and is an important concern to patients
- Minimizing combinations of risk factors and implementing appropriate prophylactic interventions will decrease the incidence of POST
- Decreasing the incidence of POST will improve patient’s anesthetic experience

References are available upon request
Factors Affecting the Incidence of Postoperative Sore Throat

Incidence varies from 40-100% in most studies, and can affect any patient undergoing general anesthesia - regardless of airway management.

Etiology includes mucosal trauma, ischemia, erosion, dehydration, and inflammation.

ETT size Using a smaller ETT has consistently shown to decrease POST without problems ventilating patients.
- 6.5-7.0 for women
- 7.0-7.5 for men

LMA size Research is inconsistent in determining if a smaller LMA will decrease POST. Appropriately sized LMA may be required for adequate supraglottic seal and positive pressure ventilation.
- Use manufacturer's recommendations for LMA sizing

Limiting intracuff pressure has consistently been shown to reduce POST. Any cuff is capable of over-inflation. Determining and maintaining the minimum cuff volume/pressure that is required for adequate seal allowing for positive pressure ventilation will decrease the incidence of POST. High LMA cuff pressures have also been associated with injury to the recurrent laryngeal, hypoglossal, and lingual nerves. Consider routine manometry if available.
- Maintain ETT cuff pressures < 20 mmHg
- Maintain LMA cuff pressures < 44 mmHg or < 60 cmH2O

Nitrous oxide will diffuse into any air-filled cuff and result in significant pressure increases in the first hour of use. Intracuff pressure monitoring should be considered when nitrous is used.
- Diffusion can be prevented by filling ETT or LMA cuff with anesthetic gas mixture or by filling ETT cuff with saline or lidocaine

Water-based lubricants are recommended by the manufacturer to facilitate LMA insertion. No lubricant is recommended for ETT placement.

Lidocaine is believed to be an irritant to mucosa. Research is inconsistent in efforts to prove that lidocaine decreases POST, and most research indicates that it actually increases the incidence and severity of POST. Lidocaine side effects are more severe when used with LMA due to larger area of contact, and may include hoarseness, tongue paresthesia, nausea, and vomiting. Caution use of products with additives ethanol, menthol, and polyethylene glycol, which worsen POST and are common to lidocaine.
- Filling ETT cuff with 2-4% lidocaine, 90 minutes prior to intubation, allows for the diffusion of lidocaine, constant application of the local anesthetic, and reduces POST while theoretically avoiding the chemical irritation. IV lidocaine (1 – 1.5 mg/kg) at the conclusion of surgery has also been shown to decrease POST

Prophylactic pharmaceutical interventions most commonly involve steroids and non-steroidal anti-inflammatory agents are proven to decrease POST. Proven to decrease both the incidence and severity of POST:
- Betamethasone 0.05% gel applied to ETT prior to intubation
- Dexamethasone 0.2 mg/kg intravenously intraoperatively
- Fluticasone 500 µg inhaled prior to intubation
- Benydamine hydrochloride applied to the ETT prior to intubation
- Aspirin gargle prior to intubation
- Ketamine gargle prior to intubation
- Licorice gargle prior to intubation
- Strepsils lozenges prior to intubation
Appendix D

Postoperative Sore Throat Pre-Test

1. When developing your anesthetic plan, do you consider and implement methods to decrease the incidence of postoperative sore throat?
   
   YES  
   NO

2. When selecting an ETT size, do you prefer a larger sized ETT (7.5+ for women, 8.0+ for men) to avoid problems ventilating patients?
   
   YES  
   NO

3. Do you use lidocaine jelly or lidocaine spray in an effort to reduce POST?
   
   YES  
   NO

4. Do you routinely assess, monitor, and maintain the minimum cuff pressure (ETT or LMA) required to maintain seal with positive pressure ventilation?
   
   YES  
   NO

5. When using nitrous oxide, do you fill ETT cuff with anesthetic gas mixture, saline, or lidocaine to prevent diffusion/increased pressure?
   
   YES  
   NO
**Postoperative Sore Throat Post-Test**

1. When developing your future anesthetic plans, will you consider and implement methods to decrease the incidence of postoperative sore throat?

   YES  NO

2. When selecting an ETT size, will you consider smaller ETT (6.5-7.0 for women, 7.5 for men)?

   YES  NO

3. Will you use lidocaine jelly or lidocaine spray in an effort to reduce POST?

   YES  NO

4. Will you routinely assess, monitor, and maintain the minimum cuff pressure (ETT or LMA) required to maintain seal with positive pressure ventilation?

   YES  NO

5. When using nitrous oxide, will you consider filling ETT cuff with anesthetic gas mixture, saline, or lidocaine to prevent diffusion/increased pressure?

   YES  NO
Ms. Andrea Baker

Dear Ms. Baker:

RE: Factors affecting the incidence of postoperative sore throat

The proposed study has been reviewed by the TCU Nursing Institutional Review Board (IRB) and was determined to meet the criteria for an exempt review. The purpose of this study to improve the knowledge base of anesthesia providers specific to the factors associated with postoperative sore throat.

The study is approved for one year from the above date. Another review by the TCU Nursing IRB is required if your study changes in any way and the TCU Nursing IRB must be notified immediately with regard to any adverse events.

If you have any question please do not hesitate in contacting the TCU Nursing IRB.

Sincerely,

Terri S. Jones, CRNA, DNP
TCU Nursing IRB- Chair