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Lidocaine for preventing postoperative sore throat (Review)

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[Intervention Review]

Lidocaine for preventing postoperative sore throat

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ABSTRACT

Background

Sore throat is a common side-effect of general anaesthesia and is reported by between 30% and 70% of patients after tracheal intubation. The likelihood of a sore throat varies with the type, diameter, and cuff pressure of the endotracheal tube used. If intubation is essential, it may be helpful to give drugs prophylactically to alleviate postoperative sore throat. Local anaesthetics and steroids have been used for this purpose. This review was originally published in 2009 and was updated in 2015.

Objectives

The objective of this review was to evaluate the efficacy and any harm caused by topical and systemic lidocaine used prophylactically to prevent postoperative sore throat in adults undergoing general anaesthesia with endotracheal intubation.

Search methods

We searched CENTRAL (*The Cochrane Library* 2013, Issue 9), MEDLINE (January 1966 to October 2013), and EMBASE (1980 to October 2013). We also contacted manufacturers and researchers in the field. The original search was undertaken in June 2007. We reran the search in February 2015 and found four studies of interest. We will deal with those studies when we next update the review.

Selection criteria

We included randomized controlled trials (RCTs) of topical and systemic prophylactic lidocaine therapy versus control (using air or saline) that reported on the risk and severity of postoperative sore throat as an outcome.

Data collection and analysis

Two authors independently assessed trial quality and extracted data. We contacted study authors for additional information, such as the risk of any adverse effects.

Main results

We included 19 studies involving 1940 participants in this updated review. Of those 1940 participants, 952 received topical or systemic lidocaine therapy and 795 were allocated to the control groups. Topical and systemic lidocaine therapy appeared to reduce the risk of postoperative sore throat (16 studies, 1774 participants, risk ratio (RR) was 0.64 (95% confidence interval (CI) 0.48 to 0.85), the quality of the evidence was low), although when only high-quality trials were included (eight studies, 814 participants) the effect was no longer significant (RR 0.71, 95% CI 0.47 to 1.09). Lidocaine given systemically in two studies (320 participants) did not reveal evidence of an effect (RR 0.44, 95% CI 0.19 to 1.05). The severity of sore throat as measured on a visual-analogue scale (VAS) was reduced by lidocaine therapy

(six trials, 611 participants, (mean difference (MD) -10.80, 95% CI -14.63 to -6.98). The adverse effects of lidocaine were not reported in these studies, though toxicity is generally rare.

Authors' conclusions

In our revised systematic review, although the results of included studies show generally positive results, they should be interpreted carefully. The effect size of lidocaine appeared to be affected by study quality; drug concentration; route of administration; management of cuff pressure during anaesthesia; the included population; and the type of outcome measured.

PLAIN LANGUAGE SUMMARY

Lidocaine for prevention of a sore throat following an operation under general anaesthetic

Review question

We reviewed the evidence of the effect of lidocaine for preventing a sore throat in people following an operation under general anaesthetic. (General anaesthetics are medicines used to send people asleep. They can be given via an intravenous line (IV) into the person's veins, via a mask, or via an endotracheal tube placed through the mouth past the larynx (voicebox) into the trachea. In this review the anaesthetic was given via an endotracheal tube.)

Background

Sore throat is a common side-effect of having a general anaesthetic. It is usually caused by the endotracheal tube that is inserted through a person's mouth, placed in the airway, to keep their airway open and make sure that person is breathing properly. People sometimes buck and cough when the tube is inserted in their airway and even if they do not, the presence of the tube during the operation can give them a sore throat. It may be possible to use drugs, such as the local anaesthetic lidocaine, to prevent postoperative sore throat. (A local anaesthetic prevents a person feeling pain. It is given to one specific area rather than the whole body.)

Study characteristics

The evidence is current to October 2013. We included 19 randomized controlled trials (1940 participants) in this updated review. (We reran the search in February 2015 and found four studies of interest. We will deal with those studies when we next update the review.) Lidocaine was either put into the cuff (the cuff makes sure that the tube stays in place), sprayed onto the person's vocal cords, or used as a gel smeared on the end of the tube.

Key results

The summarized results of the included studies showed positive results. However, the interpretation of the results should be judged carefully. Though the possible adverse effects of using lidocaine were not reported in the included studies, there are a few case reports about lidocaine toxicity, although this is very rare.

Quality of evidence

For lidocaine therapy versus control, the quality of the evidence for risk of sore throat was low (according to Grading of Recommendations Assessment, Development and Evaluation (GRADE)). This is because most of the trials did not describe how allocation was concealed and the results of the risk of sore throat were inconsistent, the quality of the evidence of the severity of sore throat, measured by the visual-analogue scale, was moderate (according to GRADE).

SUMMARY OF FINDINGS

Summary of findings for the main comparison. lidocaine versus control (air/saline) for preventing postoperative sore throat

lidocaine versus control (air/saline) for preventing postoperative sore throat

Patient or population: patients presenting with postoperative sore throat

Settings:

Intervention: lidocaine versus control (air/saline)

Outcomes	Illustrative comparative risks* (95% CI)		Relative ef- fect (95% CI)	No of Partici- pants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Lidocaine versus control (air/saline)				
Risk of sore throat 12 hours to 30 hours after the operation	Study population		RR 0.64 (0.48 to 0.85)	1744 (16 studies)	⊕⊕⊕⊖ low ¹	
	306 per 1000	196 per 1000 (147 to 260)				
	Moderate					
	300 per 1000	192 per 1000 (144 to 255)				
Severity of sore throat 12 hours to 30 hours after the operation		The mean visual-analogue scale of severity of sore throat in the intervention groups was 10.8 lower (14.63 to 6.98 lower)		611 (6 studies)	⊕⊕⊕⊖ moderate ²	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

We downgraded the quality of evidence for the reasons below.

1. Allocation concealment was not described in most studies and there was inconsistency of results of risk of sore throat.

-
2. Allocation concealment was not described in most studies.

BACKGROUND

Description of the condition

Sore throat is a frequent side-effect of general anaesthesia and is reported by between 30% and 70% of patients after tracheal intubation (Combes 2001; Herlevsen 1992; Navarro 1997; Xu 2012). This means more than 0.51 million to 1.2 million patients might experience postoperative sore throat per year in Japan (Ministry of Health, Labor and Welfare 2012). The aetiology of sore throat is thought to involve mucosal erosion caused by the cuff of the endotracheal tube (Combes 2001; Xu 2012), trauma from intubation, and mucosal dehydration (Navarro 1997; Stout 1987). Mucosal erosion may be caused by the patient bucking or coughing, or friction between the tracheal mucosa and the endotracheal tube during general anaesthesia. Whilst medical staff may concentrate on avoiding problems during surgery, patients will only be aware of postoperative complications. These complications can affect their satisfaction with treatment (Estebe 2002; Macario 1999). The prevalence of postoperative sore throat varies with the diameter and the type of endotracheal tube used (Mandoe 1992), which patients do not know about. The cuff pressure may also influence the prevalence and severity of postoperative sore throat. Use of a laryngeal mask airway is known to reduce the risk of sore throat and can be a good alternative for some types of surgery where tracheal intubation is not essential (Brimacombe 1995; Joshi 1997). If tracheal intubation is required then prophylactic use of drugs may help to alleviate postoperative sore throat. Local anaesthetics and steroids have been used for this purpose (Ayoub 1998; Goddard 1967; Herlevsen 1992; Navarro 1997). These studies showed the effectiveness of such interventions. To reduce heterogeneity, we selected only lidocaine therapy in this review. Steroids and non-steroidal anti-inflammatory drugs may be considered in future systematic reviews. This review was originally published in 2009 (Tanaka 2009); and updated in 2015.

Description of the intervention

The interventions used in the studies were lidocaine in the cuff of the endotracheal tube, aerolized lidocaine, intravenous lidocaine, and lidocaine gel on the endotracheal tube. The doses of lidocaine used were: 2% lidocaine in the cuff of the endotracheal tube; 4% spray (aerolized lidocaine); 4% lidocaine gel.

How the intervention might work

Patients bucking and coughing at intubation are the main causes of injury to the tracheal mucosa. Lidocaine in the cuff of the endotracheal tube has a pharmacological action during the operation. By preventing these complications lidocaine is effective in reducing sore throat even after its pharmacological action has worn off; the local anaesthetic effect of lidocaine on the upper airway lasts from 20 minutes to 30 minutes. The strong stimulation of laryngoscopy or moving the tube may excite sensory C fibres and produce secondary neuroplasticity, associated with postoperative sore throat and cough. Lidocaine prevents this excitement of sensory C fibres (Chang 1999). Therefore, another possible mechanism for preventing postoperative sore throat is to use lidocaine to suppress excitation of airway sensory C fibres and the release of sensory neuropeptides such as tachykinins that produce bronchoconstriction (Sloway 1991). Lidocaine is also thought to be useful in reducing injury to the tracheal mucosa during extubation.

Why it is important to do this review

This is an update of a Cochrane review first published in 2009 (Tanaka 2009). The risk of postoperative sore throat is high (30% to 70%) following surgery under general anaesthesia. There are preventive methods for this common and sometimes severe condition; in such cases lidocaine is commonly used. Technological advances in surgery have meant safer anaesthesia with the use of airway management tools including video laryngoscopes and supraglottic airway devices, perioperative assessment by transoesophageal echocardiography (during non-cardiac and cardiac surgery), and new anaesthetic agents and muscle relaxants such as remifentanyl and rocuronium bromide. Nowadays, the emphasis is on the quality of a patient's postoperative recovery (Murphy 2011); and sore throat is known to affect a patient's perception of the anaesthesia (Estebe 2002). Many randomized controlled studies have been undertaken examining lidocaine for preventing postoperative sore throat; however, there are controversies about the effects of this lidocaine therapy and, therefore, conducting a systematic review and meta-analysis is important.

OBJECTIVES

The objective of this review was to assess the efficacy and any detrimental effects of topical and systemic lidocaine used prophylactically to prevent postoperative sore throat in adults undergoing endotracheal intubation during general anaesthesia.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomized controlled trials (RCTs) of topical and systemic prophylactic lidocaine therapy to prevent postoperative sore throat. All methods of randomization were acceptable and the differences in the study quality were taken into account in the analysis. Factors such as the type of endotracheal tube; number of intubation attempts; method of anaesthesia; type of surgery; cuff pressure during anaesthesia; and the time of evaluation of sore throat after the operation would have strongly affected the rates of sore throat and would be clearly described in the relevant studies.

We included all the results of the RCTs that were of interest and excluded observational studies.

Types of participants

We included trials that investigated topical and systemic lidocaine therapy to prevent postoperative sore throat in adults.

We excluded children because different anaesthetic techniques may be used from adults, and children cannot always report postoperative sore throat in the same way.

Types of interventions

We included the use of various concentrations of lidocaine in the cuff of the endotracheal tube, aerolized lidocaine, intravenous lidocaine, and lidocaine gel on the endotracheal tube. The doses were 2% lidocaine in the cuff of the endotracheal tube; 4% aerolized lidocaine spray; and 4% lidocaine gel.

Types of outcome measures

We monitored the risk and severity of sore throat at 12 hours to 30 hours after the operation. On occasions patients are unable to correctly assess sore throat because of a residual effect of the general anaesthesia.

Primary outcomes

1. Risk of sore throat 12 hours to 30 hours after the operation.

Secondary outcomes

1. Severity of postoperative sore throat at 12 hours to 30 hours after the operation, assessed on a visual-analogue scale (VAS) (0 to 100 mm).
2. Risk of adverse effect due to lidocaine; occurrence of lidocaine toxicosis such as allergic reaction, unconsciousness, convulsion, coma, respiratory arrest, and cardiovascular system depression.

Search methods for identification of studies

We searched for studies and presented the results according to the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011); and PRISMA statement (Moher 2009).

Electronic searches

In this updated review, we searched the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2013, Issue 9); MEDLINE (1966 to October 2013); and EMBASE (1980 to October 2013). We identified RCTs using the search strategies found in [Appendix 1](#) (MEDLINE Silver Platter); [Appendix 2](#) (EMBASE Silver Platter); [Appendix 3](#) (CENTRAL). The original search was undertaken in June 2007 (Tanaka 2009). We combined the search strategy with the Cochrane highly sensitive search strategy detailed in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

We reran the search in February 2015. We will deal with any studies of interest when we next update the review.

Searching other resources

We identified additional articles from the searches named above. Furthermore, we contacted relevant pharmaceutical companies and asked them to provide information on both published and unpublished trials.

Data collection and analysis

Selection of studies

We were not blinded to study authors, institutions, published journals, or study results. Two authors (in a combination from YT or MN or YS or YTs) independently evaluated the titles and abstracts of trials identified in the literature search. We resolved disagreements through discussion. If this method was not successful, a third author (TN) evaluated the disputed study and decided on its eligibility.

Data extraction and management

We recorded the information on participants, methods, interventions, outcomes, and adverse events using a modified Cochrane Anaesthesia Review Group (CARG) data extraction sheet. We recorded dichotomous outcomes as the number of participants

with the outcome event and the number of participants in the treatment group. If the dichotomous outcome was expressed as a proportion, we converted the data into the original fraction. For continuous data (such as measures on a visual-analogue scale (VAS)), we extracted the mean value and standard deviation (SD) for each group. Two authors (YT, MN, YS or YTs) independently extracted data from the included studies. We resolved disagreements by consulting with a third author (TN).

Assessment of risk of bias in included studies

We used the criteria described in the *Cochrane Handbook for Systematic Reviews of Interventions* to describe the quality of trials researched (Higgins 2011). Two review authors independently assessed risk of bias of the selected studies (YT and YT for the original review and for the update). We resolved any differences of opinion by discussion and consensus and finally by discussion with a third author (TN). To assess any risk of bias we focused on the following dimensions as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

1. Adequate sequence generation (such as computer-generated random numbers and random number tables; inadequate approaches included the use of alternation, case record numbers, birth dates or days of the week or no description of methods of randomization).
2. Adequate measures to conceal allocation. Concealment was deemed adequate where randomization was centralized or pharmacy-controlled, or where the following were used: serially numbered containers, on-site computer-based systems where assignment is unreadable until after allocation, other methods with robust methods to prevent foreknowledge of the allocation sequence to clinicians and participants.
3. Blinding was deemed adequate if blinding was applied (whether the participant, care provider or outcome assessors).
4. Incomplete outcome data addressed; high risk: the number of missing data was large enough to produce significant bias. Low risk: the number of missing data was small and did not have a clinically relevant impact on the intervention effect estimate. Unclear: the information could not be obtained for detecting missing data.
5. Freedom from selective reporting: this was deemed to be adequate if all stated outcomes were reported on and presented. We highlighted any selective outcome reporting.
6. Other bias: the study-specific issues that may raise concerns about the possibility of bias should be considered and judgement should be formulated about them under this domain of the tool.

The risk of bias graph for each trial was made available to assess quality.

Measures of treatment effect

We used risk ratio (RR) as the measure of effect for each dichotomous outcome. The absolute risk reduction (ARR) was used to estimate the number needed to treat for an additional beneficial outcome (NNTB) to prevent one sore throat. We also used the visual analogue scale for continuous data about intensity of postoperative sore throat.

Unit of analysis issues

We managed unit of analysis issues according to the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). The unit of analysis was a problem of participants who were individually randomized to the treatment group (intervention or control). Some RCTs selected for this review had multiple interventions. We also described studies with multi-arm interventions. The SD, sample size, and mean of the combined group was calculated according to the formula described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

Dealing with missing data

If too much data was missing (i.e. follow-up rate was less than 80%), we excluded the study.

Assessment of heterogeneity

We used the I^2 statistic to interpret the heterogeneity between included studies (Higgins 2002).

Assessment of reporting biases

A funnel plot using the data for the primary outcome of risk of postoperative sore throat was used to test for publication bias. Asymmetry in the funnel plot indicates the presence of publication bias (Egger 1997). Recently the validity and reliability of these plots has been questioned (Tang 2000; Terrin 2005). We used Harbord's modified test to detect any large publication bias (Harbord 2006).

Data synthesis

For I^2 less than 30% we used a fixed-effect model; if I^2 was greater than 30% we used a random-effects model. The fixed-effect model used the Mantel-Haenszel method and the random-effects model the Der Simonian and Laird method. For continuous data, the methods for summarizing results were based on variance.

Subgroup analysis and investigation of heterogeneity

The subgroup analysis involved the different kinds of intervention such as topical, systemic (or both), the description of controlled cuff pressure of endotracheal tube and the alkalinization of lidocaine.

Sensitivity analysis

The sensitivity analysis was done for the quality of the study.

Assessment of quality of evidence using GRADE and selection of outcomes for Summary of findings tables

We assessed the quality of the evidence according to the GRADE system. We included the following patient-centred outcomes into the 'Summary of findings' table: we exported data from Review Manager to GRADE profiler (GRADEpro version 3.6) in order to create a 'Summary of findings' table.

We included the following outcomes into the 'Summary of findings' table:

1. Risk of sore throat 12 hours to 30 hours after the operation
2. Visual-analogue scale of severity of sore throat

RESULTS

Description of studies

Results of the search

We updated our search in October 2013. We reran the search in February 2015. We identified 1322 citations through electronic searching. Of those initial 1322 articles, 39 articles were of interest to us and we obtained full paper copies for review. From those initial 39 full reviewed articles, we included four new trials in this updated review and another four new studies are awaiting classification (Figure 1).

Figure 1. Flow diagram.

Included studies

In total, we included 19 studies (see '[Characteristics of included studies](#)') in this updated review; 18 of the 19 studies reported obtaining informed consent from the participants and had prior ethics committee approval. We recorded the data on the interventions, outcomes, and study characteristics such as participant age and gender, the method of anaesthesia, the kind of endotracheal tube, and the type of surgery for included studies, using a modified version of the Cochrane Anaesthesia Review Group's (CARG) data extraction form.

Types of participants

The eligible participants were 1940 surgical patients who received general anaesthesia and endotracheal intubation. One study did not describe the gender of the participants ([Basaranoglu 2004](#)). One study included only female participants ([Porter 1999](#)); and the remaining 17 included studies gave the numbers of female and male participants.

Surgical procedure

[Altintas 2000](#) included orthopaedic surgery. This study excluded neck surgery and cases involving massive blood loss.

[Bajaj 2004](#) included surgery of less than three-hours duration.

[Basaranoglu 2004](#) gave no description regarding the type of surgery.

[Estebe 2002](#) and [Estebe 2004](#) involved lumbar spinal surgery.

[Estebe 2005](#) involved only thyroidectomy surgery.

[Hashimoto 1981](#) included general surgery without thoracic surgery.

[Hara 2005](#) included supine position surgery without neck or oral surgery.

[Herlevsen 1992](#) and [Takekawa 2006](#) included abdominal, gynaecological, urological, and orthopaedic surgery.

[Klemola 1988](#) targeted otolaryngical surgery that did not involve the mouth, pharynx, and larynx.

[Navarro 1997](#) excluded neck and head surgery.

[Porter 1999](#) included gynaecological surgery, but excluded eye, nose, and ear surgery.

[Soltani 2002](#) included only cataract surgery.

[Krishnan 2008](#) included orthopaedic urological general surgery, ear, nose and throat (ENT) or neurosurgical procedures.

[Jaicobandram 2009](#) included any ophthalmic surgery.

[Xu 2012](#) included only participants undergoing thyroid surgery without laryngeal surgery and tracheotomy.

Intervention

Lidocaine was administered via various routes including: in the cuff of the endotracheal tube, as a lubricant on the endotracheal tube, and sprayed on the vocal cords. Ten studies used lidocaine solution in the cuff of the endotracheal tube ([Altintas 2000](#); [Bajaj 2004](#); [Estebe 2002](#); [Estebe 2004](#); [Estebe 2005](#); [Jaicobandram 2009](#); [Krishnan 2008](#); [Navarro 1997](#); [Navarro 2012](#); [Porter 1999](#)).

In [Basaranoglu 2004](#) lidocaine jelly and pomade were used as a lubricant on the distal end of the endotracheal tube.

Three studies used lidocaine spray on the pharynx ([Hara 2005](#); [Hashimoto 1981](#); [Herlevsen 1992](#)).

In one study both jelly on the end of the endotracheal tube and spray on the larynx were used as the intervention ([Klemola 1988](#)).

Two studies used lidocaine administered intravenously ([Takekawa 2006](#); [Xu 2012](#)).

[Soltani 2002](#) had multiple interventions such as lidocaine sprayed on the distal end of endotracheal tube (ETT) for group 1; lidocaine sprayed on laryngopharyngeal structures near the inlet of the larynx for group 2; lidocaine jelly lubricated on the distal end and the cuff of the ETT for group 3; lidocaine administered intravenously at the conclusion of surgery for group 4; and lidocaine in the cuff of the ETT for group 5

Contents of cuff

The cuff of the ETT contained either air or saline.

In three studies the cuff was filled with saline in the control group ([Altintas 2000](#); [Krishnan 2008](#); [Navarro 2012](#)). In one study, the cuff of the ETT was filled with air ([Navarro 2012](#)). Three studies used both saline and air in the control intervention ([Bajaj 2004](#); [Jaicobandram 2009](#); [Porter 1999](#)). In six studies the contents of the cuff were not described ([Basaranoglu 2004](#); [Hara 2005](#); [Hashimoto 1981](#); [Herlevsen 1992](#); [Soltani 2002](#); [Takekawa 2006](#)); however, it is likely that air was used. In six studies the cuff was filled with air in the control group ([Estebe 2002](#); [Estebe 2004](#); [Estebe 2005](#); [Klemola 1988](#); [Navarro 1997](#); [Navarro 2007](#)).

Sample size calculation

Eight studies used sample size calculations in experimental planning to control type one and type two errors ([Estebe 2002](#); [Estebe 2004](#); [Estebe 2005](#); [Hara 2005](#); [Herlevsen 1992](#); [Navarro 2007](#); [Takekawa 2006](#); [Krishnan 2008](#)). In the other included studies the sample sizes were 50 to 240 participants.

Excluded studies

Of the initial 1322 articles, 39 were of interest to us and we obtained full paper copies for review. We excluded 16 papers for the following reasons: four studies assessed sore throat immediately after general anaesthesia, which was too early for inclusion in our chosen outcome analysis ([Durmus 2001](#); [Huang 1998](#); [Shroff 2009](#); [Yörükoğlu 2006](#)); four studies did not use random allocation of participants ([Cox 1996](#); [Fuller 1992](#); [Kori 2009](#); [Maruyama 2004](#)); in five studies the control group was not relevant ([el Hakim 1993](#); [Honarmand 2008](#); [Hung 2010](#); [Lee 2011](#); [Sumathi 2007](#)); in [Loeser 1980](#) an endotracheal tube was not used during anaesthesia; in [Cramer 2008](#) the intervention was a larger size intubation tube and the control used smaller sized endotracheal tubes; and we were unable to extract the data from [D'Aragon 2013](#); (see [Characteristics of excluded studies](#)).

Awaiting classification

There are four studies awaiting classification ([Bousselmi 2014](#); [D'Aragon 2013](#); [Ishida 2014](#); [Zeng 2014](#)). Please see [Characteristics of studies awaiting classification](#) table for more information.

Ongoing studies

There are no ongoing studies.

Risk of bias in included studies

Three authors (YT, YT, TN) independently assessed the methodological quality of the included trials. We resolved any discrepancies by discussion. We based the quality assessment on: method of randomization, concealment of treatment allocation, use of blinding or masking, completeness of trial data. If necessary, we sought additional information from trial authors. This information was presented in the 'Risk of bias' tables within the '[Characteristics of included studies](#)'. The funnel plot was presented in [Figure 2](#). The existence of major publication bias was not evident by Harbord's modified test for small-study effects (the bias; P value = 0.52) ([Habord 2006](#)).

Figure 2. Funnel plot of comparison: 1 lidocaine versus control (air/saline), outcome: 1.1 Risk of sore throat 12 hours to 30 hours after the operation.

Allocation

All included studies were described as having random allocation. However, only three included studies described true random allocation i.e. using a random allocation table, or computer-generated random sequence (Estebe 2005; Hara 2005; Porter 1999). In the remaining 16 studies random allocation was not clearly described (Altintas 2000; Bajaj 2004; Basaranoglu 2004; Estebe 2002; Estebe 2004; Hashimoto 1981; Herlevsen 1992; Jaicobandram 2009; Klemola 1988; Krishnan 2008; Navarro 1997; Navarro 2007; Navarro 2012; Soltani 2002; Takekawa 2006; Xu 2012).

Concealment of random allocation was adequate in two included studies using opaque envelopes (Hara 2005; Herlevsen 1992). In 17 included studies there was no explicit description about concealment of random allocations (Altintas 2000; Bajaj 2004; Basaranoglu 2004; Estebe 2002; Estebe 2004; Estebe 2005; Hashimoto 1981; Jaicobandram 2009; Klemola 1988; Krishnan 2008; Navarro 1997; Navarro 2007; Navarro 2012; Porter 1999; Soltani 2002; Takekawa 2006; Xu 2012).

Blinding

Basaranoglu 2004 had no description of blinding; however, as the participants were anaesthetized, they could be considered to have been blinded. The authors of one study stated that it was

double blinded (Porter 1999). In 12 studies there were explicit descriptions of double blinding (Bajaj 2004; Estebe 2002; Estebe 2004; Estebe 2005; Hara 2005; Hashimoto 1981; Herlevsen 1992; Klemola 1988; Krishnan 2008; Navarro 1997; Navarro 2012; Porter 1999). In Xu 2012, the blinding was described as single blinding; however, the participants and assessor were also blinded. In five studies participants and independent outcome assessors were blinded to the intervention received (Altintas 2000; Estebe 2004; Jaicobandram 2009; Navarro 2007; Soltani 2002).

Incomplete outcome data

In seven studies follow up was 100% (Altintas 2000; Bajaj 2004; Basaranoglu 2004; Estebe 2005; Hashimoto 1981; Porter 1999; Takekawa 2006). Analysis included all participants with outcome data.

In eight studies follow-up was unclear as there was no description or information on drop-outs (Estebe 2002; Estebe 2004; Jaicobandram 2009; Krishnan 2008; Navarro 1997; Navarro 2007; Navarro 2012; Soltani 2002).

In Herlevsen 1992, 96% of participants were followed up. The reason for dropping out was a mistake in the procedure.

In [Hara 2005](#), 93% of participants were followed up. The reasons for dropping out were failure of the intubation procedure and low Ramsey sedation score.

In [Klemola 1988](#) the follow up ratio was 87%. The reasons for dropping out were not described.

Selective reporting

Outcome measures were clearly defined in all included studies. The risk and intensity of postoperative sore throat were the outcomes for this review and were the main outcome of interest for included studies. Three studies reported only intensity of postoperative sore throat ([Estebe 2002](#); [Estebe 2004](#); [Estebe 2005](#)). Three studies described both outcomes of risk and intensity of postoperative sore throat ([Altintas 2000](#); [Navarro 1997](#); [Xu 2012](#)). Thirteen studies reported only risk of postoperative sore throat ([Bajaj 2004](#); [Basaranoglu 2004](#); [Hara 2005](#); [Hashimoto 1981](#); [Herlevsen 1992](#); [Jaicobandram 2009](#); [Klemola 1988](#); [Krishnan 2008](#); [Navarro 2007](#); [Navarro 2012](#); [Porter 1999](#); [Soltani 2002](#); [Takekawa 2006](#)). There were no explicit descriptions about selective reporting or the making of protocols before conducting the studies.

Other potential sources of bias

In two studies, all included participants had hyperreactive airways because of their smoking history ([Jaicobandram 2009](#); [Navarro 2012](#)). In two studies, only thyroidectomy participants were included ([Estebe 2005](#); [Xu 2012](#)).

Effects of interventions

See: **Summary of findings for the main comparison** lidocaine versus control (air/saline) for preventing postoperative sore throat

Risk of sore throat 12 hours to 30 hours after the operation

See [Table 1](#).

Sixteen of the 19 included studies reported risk of postoperative sore throat ([Altintas 2000](#); [Bajaj 2004](#); [Basaranoglu 2004](#); [Hara 2005](#); [Hashimoto 1981](#); [Herlevsen 1992](#); [Jaicobandram 2009](#); [Klemola](#)

[1988](#); [Krishnan 2008](#); [Navarro 1997](#); [Navarro 2007](#); [Navarro 2012](#); [Porter 1999](#); [Takekawa 2006](#); [Xu 2012](#); [Soltani 2002](#)). A total of 1744 participants were analysed: 952 were allocated to lidocaine therapy and 795 to the control group. The summary preventive effect of lidocaine, expressed as a risk ratio (RR), was 0.64 (95% confidence interval (CI) 0.48 to 0.85) ([Analysis 1.1](#)). The number needed to treat for an additional beneficial outcome (NNTB) was 8 (95% CI, 6 to 13). The quality of the evidence for the risk of sore throat 12 hours to 30 hours post-operatively was low (according to GRADE), since in most included trials allocation concealment was not described and there was inconsistency of results of the risk of sore throat.

Severity of postoperative sore throat (assessed on a 0 to 100 mm visual analogue scale)

See [Table 2](#).

Six trials reported the intensity of postoperative sore throat measured on a visual analogue scale ([Altintas 2000](#); [Xu 2012](#); [Navarro 1997](#); [Estebe 2002](#); [Estebe 2004](#); [Estebe 2005](#)). In total, 611 participants were included. Of those 611, 339 participants were allocated to lidocaine therapy and 272 participants to the control group. The summary preventive effect of lidocaine for intensity of postoperative sore throat was a mean difference (MD) of -10.80 (95% CI, -14.63 to -6.98 ([Analysis 1.5](#))). The quality of the evidence of intensity of sore throat (VAS) was moderate (according to GRADE)

Sensitivity analysis

The sensitivity analysis was about the quality of studies. The evaluation of the quality of studies was based on the 'Risk of bias' table ([Figure 3](#); [Figure 4](#)). There were eight high-quality studies ([Bajaj 2004](#); [Basaranoglu 2004](#); [Hashimoto 1981](#); [Herlevsen 1992](#); [Hara 2005](#); [Navarro 1997](#); [Porter 1999](#); [Takekawa 2006](#)). The summary effect of high-quality studies, without low-quality studies, favoured lidocaine therapy (RR 0.71, 95% CI (0.47 to 1.09). However, it was not significant. The summary effect of eight low quality studies favoured lidocaine therapy (RR 0.57, 95% CI 0.37 to 0.86) ([Altintas 2000](#); [Jaicobandram 2009](#); [Klemola 1988](#); [Krishnan 2008](#); [Navarro 2007](#); [Navarro 2012](#); [Soltani 2002](#); [Xu 2012](#)).

Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding (performance bias and detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Altintas 2000	?	?	+	?	?	?
Bajaj 2004	?	?	+	+	?	?
Basaranoglu 2004	?	?	+	+	?	?
Estebe 2002	?	?	+	?	?	?
Estebe 2004	?	?	+	?	?	?
Estebe 2005	+	?	+	+	?	-
Hara 2005	+	+	+	-	?	?
Hashimoto 1981	?	?	+	+	?	?
Herlevsen 1992	?	+	+	+	?	?
Jaicobandram 2009	?	?	+	+	?	-
Klemola 1988	?	?	+	?	?	?
Krishnan 2008	?	?	+	?	?	?
Navarro 1997	+	?	+	?	?	?
Navarro 2007	?	?	+	?	?	?
Navarro 2012	?	?	+	?	?	-
Porter 1999	+	?	+	+	?	?
Soltani 2002	?	?	+	?	?	?
Takekawa 2006	?	?	+	+	?	?
Xu 2012	+	?	+	+	?	-

Figure 4. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

Subgroup analyses

The first subgroup analysis considered the method of lidocaine administration. The summary effects of studies of topical lidocaine favoured lidocaine therapy (RR 0.68, 95% CI 0.48 to 0.98) (Altintas 2000; Bajaj 2004; Basaranoglu 2004; Hara 2005; Hashimoto 1981; Herlevsen 1992; Jaicobandram 2009; Klemola 1988; Krishnan 2008; Navarro 1997; Navarro 2007). The summary effect of systemic use of lidocaine favoured lidocaine (RR 0.44, 95% CI 0.19 to 1.05) but was not statistically significant (Takekawa 2006; Xu 2012). Both topical and systemic use of lidocaine favoured lidocaine (RR 0.57, 95% CI 0.28 to 1.18) but was not statistically significant (Soltani 2002).

The second subgroup analysis looked at cuff pressure. Eight studies did not describe controlled cuff pressure (Bajaj 2004; Basaranoglu 2004; Hara 2005; Hashimoto 1981; Jaicobandram 2009; Krishnan 2008; Soltani 2002; Takekawa 2006). The results favoured lidocaine therapy and were statistically significant (RR 0.58, 95% CI 0.41 to 0.83). Eight studies described controlled cuff pressure (Altintas 2000; Herlevsen 1992; Klemola 1988; Navarro 1997; Navarro 2007; Navarro 2012; Porter 1999; Xu 2012). The results showed a trend toward favouring lidocaine therapy but statistically were not significant (RR 0.74, CI 0.50 to 1.09).

The third subgroup analysis reported about alkalinization of lidocaine. In 14 studies alkalinized lidocaine was not used and the summary effect of these studies favoured lidocaine (RR 0.66, 95% CI 0.50 to 0.89) (Altintas 2000; Bajaj 2004; Hara 2005; Hashimoto 1981; Herlevsen 1992; Klemola 1988; Krishnan 2008; Navarro 1997; Navarro 2007; Porter 1999; Soltani 2002; Takekawa 2006; Xu 2012). In two studies alkalinized lidocaine was used and the summary effects were statistically significant (RR 0.34, 95% CI 0.12 to 0.99) (Jaicobandram 2009; Navarro 2012).

DISCUSSION

Summary of main results

The conclusion of this updated systematic review remains the same as the original systematic review (Tanaka 2009): lidocaine

given topically and systemically reduces the risk and severity of postoperative sore throat. The risk of postoperative sore throat was reduced significantly (RR 0.64, 95% CI 0.48 to 0.85) after adding four new included studies (Jaicobandram 2009; Krishnan 2008; Navarro 2012; Xu 2012); and correcting the data of one study (Hara 2005). The severity of sore throat on a visual analogue scale (VAS) was also reduced significantly (mean difference (MD) -10.80, 95% CI -14.63 to -6.98). We updated our search strategy from 2007 to 2013 and we found 12 new trials from the updated search strategy. Of those 12 studies we included four new studies which met our inclusion criteria (Jaicobandram 2009; Krishnan 2008; Navarro 2012; Xu 2012). We excluded the remaining eight trials (Crerar 2008; D'Aragon 2013; Honarmand 2008; Hung 2010; Kori 2009; Lee 2011; Sumathi 2007; Shroff 2009). We corrected data input from one study into RevMan 5.3 (Hara 2005). In Tanaka 2009, the previous published version of our review, Hara 2005 favoured lidocaine for reducing the risk of postoperative sore throat (RR 0.56, 95% CI 0.20 to 1.59). We responded to feedback (Feedback 1) and corrected the data, which now favoured the control intervention (RR 1.77, 95% CI 0.63 to 5.00). There were reports about the risk of postoperative sore throat in each of the studies; however we could not find out from the data how many participants were affected by this condition. There were multiple doses of lidocaine so the interpretation of the results may be difficult. Though the possible adverse effects of using lidocaine were not reported in these studies, there were a few case reports about lidocaine toxicoses. They reported it as a very rare incident (Lee M 2011; Menif 2011).

Overall completeness and applicability of evidence

We conducted comprehensive search strategies for finding relevant studies. We included 19 studies and analysed 1940 participants. Therefore, the studies identified might be sufficient to address all of the objectives of our reviews. We identified the relevant participants who underwent surgery under general anaesthesia with endotracheal intubations, testing interventions of topical and systemic lidocaine therapy for preventing postoperative sore throats and outcomes such as risk and intensity of postoperative sore throat. The results of this review are applicable to adults

who undergo an operation under general anaesthesia with endotracheal intubations. We excluded children because different anaesthetic techniques may be used from adults, and children cannot always report postoperative sore throat in the same way. The interventions of topical and systemic use of lidocaine investigated all seemed relevant. The outcome 'postoperative sore throat' is a relevant issue for participants in clinical practices.

Quality of the evidence

We included 19 studies involving 1940 participants in the updated review. In all included studies, summary of risk of postoperative sore throat and the intensity of postoperative sore throat showed a statistically positive effect for lidocaine as an intervention ([Analysis 1.1](#); [Analysis 1.5](#)). The majority of the trials included were small and many had methodological weaknesses ([Figure 3](#)). There was substantial heterogeneity ([Analysis 1.1](#)); this might be explained by variations in the control, type of intervention, the surgical procedures and risk of bias. The first subgroup analysis of quality study showed that the combined effect size of a high-quality score was not statistically significant ([Analysis 1.2](#)). That may show that there was an effect of risk of bias. The second subgroup analysis, investigating the route of lidocaine administration, showed that systemic lidocaine, or systemic and topical lidocaine, were not effective statistically for preventing postoperative sore throat ([Analysis 1.1](#)). This seems to show that effectiveness of lidocaine varies according to the route of administration. The third subgroup analysis was about the control of cuff pressure. The summary effect of studies with the descriptions of controlled cuff pressure were not statistically significant ([Analysis 1.3](#)). That may mean that the controlled cuff pressure changed the effectiveness of lidocaine for preventing postoperative sore throat. According to the GRADE evaluation, the quality of evidence of lidocaine for preventing the risk of postoperative sore throat was low ([Summary of findings for the main comparison](#)).

Potential biases in the review process

We attempted to reduce bias by identifying all relevant studies through a comprehensive systematic search of the literature and using electronic search engines such as EMBASE, MEDLINE and CENTRAL. There was also contact with the authors and pharmaceutical companies for both published and unpublished studies. However in this updated review, unlike the previous review ([Tanaka 2009](#)), we did not use Google or Google scholar. We accept that we have possibly overlooked relevant studies and that some publication bias is inevitable and this is indicated by the rather asymmetrical funnel plot ([Figure 2](#)); though it was not statistically significant according to Harbord's methods ([Harbord 2006](#)). This is likely to lead to an overestimate of effect size of lidocaine, because positive trials are more likely to be published than negative trials. The criteria for sore throat is not standardized. Therefore, the variation of measurement of sore throat may produce biases.

Agreements and disagreements with other studies or reviews

To our knowledge there is no other systematic review of our research question; therefore, we cannot state that our systematic review agrees or disagrees with other reviews. The conclusion of this review agrees with 11 of the 16 included studies about decreasing the risk of postoperative sore throat. The five studies that disagree may have had their own specific conditions ([Hara](#)

[2005](#); [Herlevsen 1992](#); [Klemola 1988](#); [Krishnan 2008](#); [Porter 1999](#)). [Klemola 1988](#) pointed out that lidocaine jelly contains impurities which seemed to affect the results. In [Porter 1999](#), all of the included participants were women; an earlier study has shown that late complications are more common in women than in men ([Jensen 1982](#)); therefore, the population studied may affect the results. In [Herlevsen 1992](#), larger intubation tubes, size 9.5 inner diameter, were used for men rather than the size 8.5 inner diameter used for women. Thirty-two participants among the 197 participants were intubated with smaller endotracheal tubes than outlined in the protocol of this study. The prevalence and severity of sore throat after endotracheal intubation were both reduced by using a smaller endotracheal tube in one study ([Stout 1987](#)). In one study, the intervention was lidocaine spray on larynx and trachea ([Hara 2005](#)). The control was saline spray. The authors stated that the reason for the worsening of postoperative sore throat might be because of the additive in the lidocaine spray. Moreover, in this study 15 participants dropped out during the study period. This might break the condition of 'intention to treat' and create bias. In one study, the intervention was 4% lidocaine in the cuff of the endotracheal tube and the control was saline in the cuff ([Krishnan 2008](#)). This study did not show a statistically significant effect of lidocaine. The authors stated that water in the cuff may reduce the risk of sore throat compared with air in the cuff. In a previous positive study, there was air in the cuff of the endotracheal tube ([Navarro 1997](#)).

AUTHORS' CONCLUSIONS

Implications for practice

It is common clinical practice to use lidocaine for the prevention of postoperative sore throat. This practice appears to be generally beneficial, though the evidence is weaker when only high-quality trials are considered. The effectiveness of lidocaine would appear to be influenced by the type of participant, the concentration used, the route of administration and the outcomes measured.

Implications for research

Additional high-quality randomized controlled studies of the topical and systemic use of lidocaine for reducing sore throat will still be useful. Other kinds of drug therapies, such as steroids and non-steroidal anti-inflammatory drugs, could be investigated more actively. One study reported that participants with postoperative sore throat had a negative impression of anaesthesia practice ([Estebe 2002](#)). Correlation of studies of satisfaction with anaesthesia with postoperative sore throat may be meaningful. Therefore, studies on preventing postoperative sore throat by any method are warranted.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Altintas 2000

Methods	Prospective double-blinded randomized controlled trial
Participants	70 patients aged 17 to 60 years, American Society of Anesthesiologists (ASA) class1 and class 2, who were to undergo plastic surgery
Interventions	10% lidocaine to inflate the endotracheal tube (ETT) cuff Saline to inflate the ETT cuff
Outcomes	Sore throat Severity of sore throat (visual analogue scale of intensity of sore throat: 0 to 100 mm) Bucking on extubation Plasma lidocaine concentrations
Notes	Topical lidocaine therapy Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	The information on sequence generation is not described. Insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Allocation concealment (selection bias)	Unclear risk	The information on allocation is not described. Insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "Patients were asked about the presence of sore throat by the same anaesthesiologist". The "anaesthesiologist" means "anaesthesiologist who was unaware of the nature of the fluid in the cuff". The patient was anaesthetized and therefore blinded to the intervention. There is no description about double-blinding.

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Altintas 2000 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	The information on incomplete outcome reporting is not described. Insufficient information about the incomplete outcome data.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Bajaj 2004

Methods	Prospective double-blinded randomized controlled study
Participants	80 patients (33 males and 47 females) ASA 1~2
Interventions	Group 1: inflated with air in cuff Group 2: inflated with nitrous oxide (60%) and oxygen (40%) Group 3: inflated with normal saline Group 4: inflated with 4% lidocaine
Outcomes	Barky cough Difficulty in swallowing Sore throat
Notes	Topical lidocaine therapy Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	The information on sequence generation is not described. Insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Allocation concealment (selection bias)	Unclear risk	The information on allocation concealment is not described. Insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "Complications were observed by blinded persons". The patient was anaesthetized, therefore the patients were blinded to intervention.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No patients dropped out during this study.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Basaranoglu 2004

Methods	Prospective randomized controlled study
Participants	75 patients scheduled for abdominal hysterectomy
Interventions	Group K: 2% lidocaine jelly lubricant on the distal end of tracheal tube Group A: 5% lidocaine lubricant on the distal end
Outcomes	Sore throat: 1 hour or 24 hours after the operation. Cough: 24 hours after the operation. Hoarseness: 24 hours after the operation
Notes	Topical lidocaine therapy Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	The information on sequence generation is not described. Insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Allocation concealment (selection bias)	Unclear risk	The information on allocation concealment is not described. Insufficient information about the allocation concealment process to permit judgement of 'Yes' or 'No'.
Blinding (performance bias and detection bias) All outcomes	Low risk	Patients were anaesthetized. Therefore, this study was blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	The number of patients analysed is consistent with number of participants.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Estebe 2002

Methods	Prospective double-blinded randomized controlled study
Participants	75 adult patients (ASA physical status 1, 2, 3) scheduled to spine lumbar surgery were consecutively enrolled
Interventions	Group 1: lidocaine hydrochloride Group 2: alkalized lidocaine hydrochloride Group 3: air control (standard air); Each group had 25 participants
Outcomes	Visual analogue scale (VAS) measure of sore throat (0 to 100 mm)

Lidocaine for preventing postoperative sore throat (Review)

Estebe 2002 (Continued)

Global satisfaction scale

Notes
Topical lidocaine therapy
Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	The information on sequence generation is not described. Insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Allocation concealment (selection bias)	Unclear risk	The information on allocation concealment is not described. Insufficient information about the allocation concealment process to permit judgement of 'Yes' or 'No'.
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "The sore throat was measured in the recovery room by a blinded nurse with a visual analogue scale". The patients were anaesthetized and blind to interventions. Therefore, this study is thought to be double-blinded.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	There is no information about drop-outs. The information on the incomplete outcome data is insufficient to permit judgement of 'Yes' or 'No'.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Estebe 2004

Methods	Prospective double-blinded randomized controlled study
Participants	60 adult patients (ASA physical status 1, 2, 3) scheduled for lumbar spinal surgery, consecutively enrolled
Interventions	Group 1: ETT cuff lubricated with sterile water and filled with air Group 2: ETT cuff lubricated with sterile water and filled with alkalinized lidocaine Group 3: ETT cuff lubricated with water-soluble gel and filled with alkalinized lidocaine
Outcomes	Visual analogue scale measure of intensity of sore throat (0 to 100 mm) Time to spontaneous ventilation time, time to extubation, cough effort, restlessness, PONV, dysphagia, hoarseness; systolic blood pressure, diastolic blood pressure, heart rate (beats/min)
Notes	VAS can be read from Table 2 Topical lidocaine therapy Muscle relaxants used

Estebe 2004 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	The information on sequence generation is not described. There is insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Allocation concealment (selection bias)	Unclear risk	The information on allocation concealment is not described. There is insufficient information about the allocation concealment process to permit judgement of 'Yes' or 'No'.
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "A nurse blinded to the study groups measured the degree of sore throat".
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	There is no description about drop-outs. The information on incomplete outcome data is insufficient to permit judgement of 'Yes' or 'No'.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Estebe 2005

Methods	Prospective double-blinded randomized controlled study
Participants	60 patients consecutively-enrolled (ASA physical status 1, 2) who underwent total thyroidectomy
Interventions	Air in cuff of ETT; 8.4% NaHCO ₃ + 2% lidocaine in cuff of ETT; 1.4% NaHCO ₃ + 2% lidocaine in cuff of ETT
Outcomes	Visual analogue scale of severity of sore throat (0 to 100 mm) Time to spontaneous ventilation time, time to extubation, cough effort, restlessness, PONV, dysphagia, hoarseness; systolic blood pressure, diastolic blood pressure, heart rate (beat/min)
Notes	Topical lidocaine therapy Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Patient randomization was performed using a computerized list".
Allocation concealment (selection bias)	Unclear risk	The information on allocation concealment is not described. Insufficient information about the allocation concealment process to permit judgement of 'Yes' or 'No'.
Blinding (performance bias and detection bias)	Low risk	Quote: "The anaesthetic team were unaware of the experimental protocol. A nurse blinded to the study groups measured the degree of sore throat".

Lidocaine for preventing postoperative sore throat (Review)

Estebe 2005 (Continued)

All outcomes

Incomplete outcome data (attrition bias) All outcomes	Low risk	The number of patients analysed is consistent with participants. The information on the incomplete outcome data is insufficient to permit judgement of 'Yes' or 'No'.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	High risk	All patients enrolled underwent total thyroidectomy.

Hara 2005

Methods	Prospective randomized controlled study
Participants	122 patients, aged 15 to 87 years (ASA physical status 1~3) scheduled to undergo elective surgery in spinal position
Interventions	Lidocaine spray (5 sprays), lidocaine (1 spray) Control: normal saline
Outcomes	Sore throat, hoarseness, dysphagia Sore throat graded as: 0 absent; 1 minimal; 2 moderate; 3 severe
Notes	Topical lidocaine therapy Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Treatment assignments were written on sheets of paper, which were folded up and shuffled in a large envelope".
Allocation concealment (selection bias)	Low risk	Quote: "The patient's name was written on the sheet to record the group assignment. Thereafter, the sheet was sealed in another envelope, which was not opened again until the evaluation was finished".
Blinding (performance bias and detection bias) All outcomes	Low risk	Neither the patients nor the interviewer were notified of the results of allocation.
Incomplete outcome data (attrition bias) All outcomes	High risk	15 patients dropped out.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no evident description about other bias.

Hashimoto 1981

Methods	Prospective randomized controlled study
Participants	100 patients (49 male and 51 female)
Interventions	Group1: lidocaine group, sprayed 2.4 ml of 4% lidocaine into the larynx and trachea Control group: sprayed 2.4 ml of 0.9% NaCl into the larynx and trachea
Outcomes	Sore throat Hoarseness Stridor
Notes	Topical lidocaine therapy Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	The information on sequence generation is not described. There is insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Allocation concealment (selection bias)	Unclear risk	The information on allocation concealment is not described. There is insufficient information about the allocation concealment process to permit judgement of 'Yes' or 'No'.
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessor blinded. Used red-coated plastic syringes for spraying drugs into the larynx trachea, preventing the contents from being recognised.
Incomplete outcome data (attrition bias) All outcomes	Low risk	The number of patients analysed is consistent with number of participants.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Herlevsen 1992

Methods	Prospective double-blinded randomized controlled study
Participants	200 patients (ASA group1, 2) who were scheduled for elective gynaecological, urological, orthopaedic, or abdominal surgery
Interventions	Group 1: lidocaine spray (100 mg) 2 min before intubation Group 2: no spray
Outcomes	Day of surgery (before leaving recovery): One or more of the following symptoms: sore throat, hoarseness, and cough Next day:

Lidocaine for preventing postoperative sore throat (Review)

Herlevsen 1992 (Continued)

One or more of the following symptoms: sore throat, cough

Notes	Topical lidocaine therapy
	Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	The information on sequence generation is not described. There is insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Allocation concealment (selection bias)	Low risk	Quote: "Each patient was assigned a numbered envelope containing the result of randomization".
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "Neither the patients nor the interviewer was notified of the results of randomization".
Incomplete outcome data (attrition bias) All outcomes	Low risk	Quote: "Seven patients were excluded because of procedural mistakes".
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Jaicobandram 2009

Methods	Randomized double blinded study
Participants	75 ASA grade I or II patients, aged 19 to 70 years undergoing any ophthalmic surgery. Included patients either with a history of chronic smoking (> 10 cigarettes/day) for two years or more or those with recently treated (< 2 weeks interval) URTI, to study the effect on hyperactive airways.
Interventions	Air in cuff of endotracheal tube, saline in cuff of endotracheal tube, alkalized lidocaine in the cuff of endotracheal tube
Outcomes	Sore throat, hoarseness, heart rate in extubation
Notes	Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Subsequently randomized.
Allocation concealment (selection bias)	Unclear risk	No description of allocation concealment.

Jaicobandram 2009 (Continued)

Blinding (performance bias and detection bias) All outcomes	Low risk	Patients were anaesthetized (blinded); and independent evaluators.
Incomplete outcome data (attrition bias) All outcomes	Low risk	The number of allocations is consistent with the outcome.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	High risk	The included patients had hyperreactive airways because of a history of smoking.

Klemola 1988

Methods	Prospective double-blinded randomized controlled study	
Participants	114 patients undergoing otolaryngological surgery	
Interventions	Randomly allocated into four groups: Group 1: no lubricants and no spray Group 2: jelly group, lubricated with lidocaine 2% gel Group 3: spray group, larynx sprayed with 10% lignocaine aerosol Group 4: jelly + spray group	
Outcomes	Prevalence of sore throat (in recovery room and 1 day after operation) Hoarseness Tendency to cough Cough	
Notes	Topical lidocaine therapy Muscle relaxants used	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	The information on sequence generation is not described. There is insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Allocation concealment (selection bias)	Unclear risk	The information on allocation concealment is not described. There is insufficient information about the allocation concealment process to permit judgement of 'Yes' or 'No'.
Blinding (performance bias and detection bias) All outcomes	Low risk	The patients were anaesthetized. Therefore, single-blinding was achieved. The grading was made in the recovery room by a nurse and on the first postoperative day by one of the authors.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	There is no description of drop-outs. The information on incomplete outcome data is insufficient to permit judgement of 'Yes' or 'No'.

Klemola 1988 (Continued)

Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Krishnan 2008

Methods	Randomized double-blind clinical trial
Participants	150 ASAPS grade adult (> 18 yrs) patients undergoing general anaesthesia for elective surgeries of expected duration of more than 2 h were included in this randomized double-blinded clinical trial. Orthopaedic, urological, general surgery, ENT or neurosurgical procedures.
Interventions	Group L1: 4% Lidocaine In cuff of endotracheal tube Group C: distilled water in cuff of endotracheal tube
Outcomes	Sore throat, cough vital at extubation
Notes	Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Patients were randomized by block randomization into 1 of 2 groups.
Allocation concealment (selection bias)	Unclear risk	No description of allocation concealment.
Blinding (performance bias and detection bias) All outcomes	Low risk	The patients were blinded, however it is not clear if staff or outcome assessors were blinded.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	There is no description about completeness.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Navarro 1997

Methods	Prospective double-blinded randomized controlled study
Participants	106 patients (ASA 1~2) undergoing elective surgery The following patients were excluded: ASA physical status 3 or greater, patients with estimated surgical time less than 30 minutes, patients whose tracheas were difficult to intubate, bloody secretion present with oral suctioning, multiple intubation attempts, having a nasogastric tube, being treated with intravenous lidocaine

Lidocaine for preventing postoperative sore throat (Review)

Navarro 1997 (Continued)

Interventions	4% lidocaine in cuff of endotracheal tube versus air in cuff of endotracheal tube
Outcomes	Prevalence of sore throat Severity of postoperative sore throat (visual analogue scale 0 to 100 mm)
Notes	Topical lidocaine therapy Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Patients were randomized via random number table".
Allocation concealment (selection bias)	Unclear risk	No information about allocation concealment was provided.
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "Postoperative sore throat was evaluated by a blinded investigator at one hour and 24 hours following extubation".
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	There is no description of drop-outs. The information on incomplete outcome data is insufficient to permit judgement of 'Yes' or 'No'.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Navarro 2007

Methods	Prospective double-blinded randomized controlled study
Participants	50 female adult patients aged 18 to 65 years (ASA 1 or 2 with Mallampati classification equal to 1). These patients underwent general anaesthesia for gynaecological surgery (abdominal hysterectomy) or plastic surgery (abdominoplasty, reductive mastoplasty, or implantation of silicone prostheses)
Interventions	Control group: air in cuff of ETT Intervention group: lidocaine in cuff of ETT
Outcomes	Prevalence of sore throat
Notes	The cuff pressure was monitored Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
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Navarro 2007 (Continued)

Random sequence generation (selection bias)	Unclear risk	The information on sequence generation is not described. There is insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
Allocation concealment (selection bias)	Unclear risk	No information about allocation concealment was provided.
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "An independent observer, who did not know which group each patient belonged to evaluated...". Moreover the patients were anaesthetized; therefore, this study was performed in double-blinded manner.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	There is no description of drop-outs. The information on incomplete outcome data is insufficient to permit judgement of 'Yes' or 'No'.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Navarro 2012

Methods	Prospective, randomized double-blind study
Participants	All patients were over 18 years of age, of either gender, with ASA physical status I or II, and their Mallampati classification was equal to 1. All patients had smoked for longer than five years, consuming at least five cigarettes a day, and did not stop before the surgical procedure.
Interventions	Intervention group: ETT intracuff alkalinized 2% lidocaine (L group). Control group: ETT intracuff 0.9% saline (S group).
Outcomes	Coughing, sore throat, and hoarseness were evaluated. Risk of sore throat and hoarseness were evaluated at the time of release from the postanaesthesia care unit (PACU) and 24 hours after extubation.
Notes	All the patients are smokers. Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	There is no description about methods of allocation.
Allocation concealment (selection bias)	Unclear risk	There is no description about methods of concealment.
Blinding (performance bias and detection bias) All outcomes	Low risk	The trial was double-blinded.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	All patients might be analysed; there was no description of drop-outs.

Lidocaine for preventing postoperative sore throat (Review)

Navarro 2012 (Continued)

Selective reporting (reporting bias)	Unclear risk	There is no description about a priori protocols.
Other bias	High risk	The included patients were all smokers with hyperreactivity of upper respiratory tract.

Porter 1999

Methods	Prospective randomized controlled double-blinded study
Participants	75 adult women scheduled to receive general anaesthesia for gynaecological surgery. Excluded: eye, nose or throat procedure, history of liver disease, cardiac dysrhythmias or heart block, sensitivity or allergy to lidocaine; prior lidocaine, anticholinergic or steroid therapy; known difficult airway, difficult intubation, intubation less than 30 minutes; nasogastric tube placement; upper respiratory tract infection or preoperative sore throat; pregnancy; weight less than 35 kg
Interventions	Randomly allocated into three groups: Group 1: lidocaine to inflate the ETT cuff Group 2: saline to inflate the ETT cuff Group 3: air to inflate the ETT cuff
Outcomes	Sore throat: 1 to 3 hours after surgery Sore throat: 22 to 25 hours after surgery Hoarseness Cough
Notes	Topical lidocaine therapy. Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was performed by using a random number table; participants were not informed of their group assignments".
Allocation concealment (selection bias)	Unclear risk	The information on allocation concealment was not described. There is insufficient information about the allocation concealment process to permit judgement of 'Yes' or 'No'.
Blinding (performance bias and detection bias) All outcomes	Low risk	The patients were anaesthetized. Therefore, this study was single-blinded, though the authors stated it was double-blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	The number of patients analysed is consistent with number of participants.
Selective reporting (reporting bias)	Unclear risk	There is no information about selective reporting.
Other bias	Unclear risk	There is no apparent description of other bias.

Soltani 2002

Methods	Prospective double-blinded randomized controlled study
Participants	204 patients (ASA physical status 1 or 2) scheduled for cataract surgery under general anaesthesia
Interventions	<p>Group 1: 10% lidocaine sprayed (3 puffs) on the distal end of ETT</p> <p>Group 2: 10% lidocaine sprayed on laryngopharyngeal structures near inlet of the larynx - through a nozzle connected to the spray device during laryngoscopy</p> <p>Group 3: distal ends of the ETTs and their cuffs lubricated with 2.5 g of 2% lidocaine jelly</p> <p>Group 4: 1.5 mg/kg of lidocaine IV administered at the conclusion of surgery</p> <p>Group 5: 7 to 8 ml of 2% lidocaine for 90 minutes before intubation, evacuated before intubation</p> <p>Group 6: the distal ends of ETTs and their cuffs lubricated with normal saline</p>
Outcomes	Number of coughs per patient, absolute frequency of sore throat (after 1 hour), frequency of sore throat (after 24 hours), absolute frequency of stridor, haemodynamic variables
Notes	<p>Both topical and systemic lidocaine therapy</p> <p>Muscle relaxants used</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Sequence generation was not described. There is insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'. Quote: "Patients were randomized via the convenience sampling method".
Allocation concealment (selection bias)	Unclear risk	Allocation concealment was not described.
Blinding (performance bias and detection bias) All outcomes	Low risk	<p>Quote: "All patients were observed by an investigator who was blinded to the study".</p> <p>The patients were anaesthetized, therefore this study is double-blinded.</p>
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	There is no description of drop-outs. The information on incomplete outcome data is insufficient to permit judgement of 'Yes' or 'No'.
Selective reporting (reporting bias)	Unclear risk	There is no description about selective bias.
Other bias	Unclear risk	There is no apparent description of other bias.

Takekawa 2006

Methods	Prospective triple-blinded randomized controlled trial
Participants	Total of 80 adult patients (ASA physical status 1~2) without airway symptoms
Interventions	Group 1: lidocaine (1 mg/kg) intravenously

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Takekawa 2006 (Continued)

Group 2: lidocaine (1.5 mg/kg) intravenously

Control: normal saline

Outcomes	24 hours after surgery, graded scale scores of sore throat
Notes	Systemic lidocaine therapy Muscle relaxants used

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Sequence generation was not described.
Allocation concealment (selection bias)	Unclear risk	Allocation concealment was not described.
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "All intubations and interviews were performed by the teaching staff using the triple-blind method".
Incomplete outcome data (attrition bias) All outcomes	Low risk	The number of patients analysed is consistent with number of participants.
Selective reporting (reporting bias)	Unclear risk	There is no description about selective bias.
Other bias	Unclear risk	There is no apparent description of other bias.

Xu 2012

Methods	Prospective randomized, single-blinded trial
Participants	248 American Society of Anesthesiologists physical status I or II patients aged 20 to 70 years and undergoing thyroid surgery.
Interventions	Group A: ETT size 7.0 with saline; Group B: ETT size 6.0 with saline; Group C: ETT size 7.0 with lidocaine; Group D: ETT size 6.0 with lidocaine; Patients in Groups C and D received 10 ml of 1.5 mg/kg lidocaine IV from a syringe filled 5 minutes before induction of anaesthesia; patients in Groups A and B received an equal volume of saline.
Outcomes	At 1, 6 and 24 hours after tracheal extubation, the incidence of POST (postoperative sore throat) was determined using a direct question. The measurement of sore throat severity was accomplished with a 0 to 10 cm VAS, where a score of 0 meant no pain and a score of 10 represented the worst pain imaginable.
Notes	All patients underwent thyroidectomy

Lidocaine for preventing postoperative sore throat (Review)

Xu 2012 (Continued)

Muscle relaxants used

Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	The use of computer-generated codes was described.
Allocation concealment (selection bias)	Unclear risk	There is no description of allocation concealment.
Blinding (performance bias and detection bias) All outcomes	Low risk	Blinding is described as single blinding. However, the assessor of outcomes was also blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs clearly described.
Selective reporting (reporting bias)	Unclear risk	An a priori protocol was not described.
Other bias	High risk	All patients underwent thyroidectomy.

ASA: American Society of Anesthesiologists

ASAPS: American Society of Anesthesiologist Physical Status

ENT: ear, nose and throat

ETT: endotracheal tube

PACU: post-anaesthesia care unit

PONV: postoperative nausea and vomiting

POST: postoperative sore throat

URTI: upper respiratory tract injury

VAS: visual analogue scale

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Cox 1996	This study was not randomized.
Crerar 2008	This study had the wrong sort of participants for this review.
D'Aragon 2013	We could not extract outcome data from this study.
Durmus 2001	The outcome of sore throat was assessed too soon after the operation and general anaesthesia.
el Hakim 1993	The control group received steroid.
Fuller 1992	This study was not randomized.
Honarmand 2008	The control intervention was not appropriate for this review.
Huang 1998	The outcome of sore throat was assessed too soon after the operation and general anaesthesia.
Hung 2010	The control intervention was not appropriate for this review.

Lidocaine for preventing postoperative sore throat (Review)

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Study	Reason for exclusion
Kori 2009	The study is not randomized.
Lee 2011	The control intervention was not appropriate for this review.
Loeser 1980	This study included patients who were not intubated with an endotracheal tube.
Maruyama 2004	This study was not randomized.
Shroff 2009	The control intervention was not appropriate for this review.
Sumathi 2007	The control intervention was not appropriate for this review.
Yörükoğlu 2006	The outcome of sore throat was assessed within six hours of anaesthesia.

Characteristics of studies awaiting assessment *[ordered by study ID]*

[Bousselmi 2014](#)

Methods	A double blind, placebo-controlled, randomized trial
Participants	Eighty patients scheduled to elective surgery of less than 120 minutes under general anaesthesia
Interventions	<p>Instillation of 2% lidocaine or saline onto the glottis before intubation, and endotracheal tube cuff filled with 2% lidocaine or saline</p> <p>Participants were allocated into following four group: S-S (Saline instillation and saline in the cuff); S-Lido (saline instillation and lidocaine in the cuff); Lido-S (lidocaine instillation and saline in the cuff); Lido-Lido (lidocaine instillation and lidocaine in the cuff).</p>
Outcomes	Coughing before extubation, sore throat scores. Incidence of dysphagia, dysphonia and laryngeal dyspnoea
Notes	

[D'AragonF 2013](#)

Methods	Randomized double-blind prospective study.
Participants	One hundred and twenty women scheduled for gynaecological surgery < 120 min in duration
Interventions	<p>Prior to tracheal intubation, 4% lidocaine or 0.9% saline was sprayed onto the patients' supra- and subglottic areas.</p> <p>After tracheal intubation, the tracheal tube cuff was filled with either an alkalinized 2% lidocaine solution or 0.9% saline.</p> <p>Participants were allocated into following four groups: spray-cuff, spray-saline, saline-cuff, and saline-saline.</p>
Outcomes	Cough, severity of sore throat
Notes	

Ishida 2014

Methods	Randomized controlled study
Participants	62 patients (ASA physical status I or II)
Interventions	Participants were allocated into two groups: 4 ml of 2% alkalized lidocaine (Group AL) or 4 ml normal saline (Group S) in cuff of endo-tracheal tube.
Outcomes	The number of coughs at extubation, of sore throat and mean blood pressure (MBP) and heart rate (HR)
Notes	

Zeng 2014

Methods	Randomized controlled study
Participants	60 selective patients (ASA I or II) for lung lobectomy
Interventions	Lidocaine aerosol and saline were given to spray. After routine induction, the glottis was exposed and 3 presses of lidocaine aerosol or saline aerosol were given
Outcomes	HR, SBP, DBP, sore throat and hoarseness
Notes	Chinese

ASA: American Society of Anesthesiologists

DBP: diastolic blood pressure

HR: heart rate

MBP: mean blood pressure

SBP: systolic blood pressure

DATA AND ANALYSES

Comparison 1. lidocaine versus control (air/saline)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Risk of sore throat 12 hours to 30 hours after the operation	16	1744	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.48, 0.85]
1.1 Topical lidocaine	13	1220	Risk Ratio (M-H, Random, 95% CI)	0.68 [0.48, 0.98]
1.2 Systemic lidocaine	2	320	Risk Ratio (M-H, Random, 95% CI)	0.44 [0.19, 1.05]
1.3 Both topical and systemic lidocaine	1	204	Risk Ratio (M-H, Random, 95% CI)	0.58 [0.28, 1.18]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Sensitivity analysis	16	1744	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.48, 0.85]
2.1 High quality study	8	814	Risk Ratio (M-H, Random, 95% CI)	0.71 [0.47, 1.09]
2.2 Low quality data	8	930	Risk Ratio (M-H, Random, 95% CI)	0.57 [0.37, 0.86]
3 Sub group analysis 1	16	1744	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.48, 0.85]
3.1 Studies without describing controlled cuff pressure of ETT	9	918	Risk Ratio (M-H, Random, 95% CI)	0.61 [0.40, 0.93]
3.2 Studies with describing controlled cuff pressure of ETT	7	826	Risk Ratio (M-H, Random, 95% CI)	0.66 [0.44, 1.01]
4 Sub group Analysis 2	16	1744	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.48, 0.85]
4.1 Studies without using alkalization of lidocaine New Subgroup	14	1622	Risk Ratio (M-H, Random, 95% CI)	0.66 [0.50, 0.89]
4.2 Studies with using alkalization of lidocaine	2	122	Risk Ratio (M-H, Random, 95% CI)	0.34 [0.12, 0.99]
5 Visual-analogue scale of severity of sore throat	6	611	Mean Difference (IV, Random, 95% CI)	-10.80 [-14.63, -6.98]
5.1 Studies without using alkalization of intracuff lidocaine	3	416	Mean Difference (IV, Random, 95% CI)	-8.21 [-10.75, -5.67]
5.2 Studies with using alkalization of lidocaine	3	195	Mean Difference (IV, Random, 95% CI)	-13.50 [-21.12, -5.87]

Analysis 1.1. Comparison 1 lidocaine versus control (air/saline), Outcome 1 Risk of sore throat 12 hours to 30 hours after the operation.

Analysis 1.2. Comparison 1 lidocaine versus control (air/saline), Outcome 2 Sensitivity analysis.

Analysis 1.3. Comparison 1 lidocaine versus control (air/saline), Outcome 3 Sub group analysis 1 .

Analysis 1.4. Comparison 1 lidocaine versus control (air/saline), Outcome 4 Sub group Analysis 2.

Analysis 1.5. Comparison 1 lidocaine versus control (air/saline), Outcome 5 Visual-analogue scale of severity of sore throat.

ADDITIONAL TABLES

Table 1. The risk of sore throat

Studies	Intervention	Control	Relative risk (95% CI)	ARR (95% CI)
Altintas 2000	10% lidocaine to inflate the endotracheal tube (ETT) cuff	Saline to inflate the ETT cuff	0.20 (0.06 to 0.64)	0.33 (0.14 to 0.52)
Bajaj 2004	Cuff of ETT inflated with 4% lidocaine	Cuff of ETT inflated with air and saline	0.39 (0.05 to 2.89)	0.078 (-0.04 to 0.20)
Navarro 1997	4% lidocaine in cuff of ETTs	air in cuff of ETTs	0.55 (0.35 to 0.86)	0.26 (0.08 to 0.45)
Navarro 2007	Air group: air in cuff of ETT	Lido group: lidocaine in cuff of ETT	0.20 (0.06, 0.64)	0.36 (0.14 to 0.58)
Porter 1999	4% lidocaine in cuff of ETTs	Saline to inflate the ETT cuff Air to inflate the ETT cuff	1.15 (0.64 to 2.06)	0.06 (-0.2 to 0.18)
Soltani 2002	Group 1: 10% lidocaine was sprayed (3 puffs) on the distal end of ETT Group 2: the 10% lidocaine was sprayed on laryngopharyngeal structures near the inlet of the larynx through	Group 6: the distal end of ETTs and their cuffs were lubricated with normal saline	0.57 (0.28 to 1.18)	0.1 (-0.05 to 0.25)

Table 1. The risk of sore throat (Continued)

a nozzle connected to the spray device during laryngoscopy

Group 3: the distal end of the ETTs and their cuffs were lubricated with 2.5 g of 2% lidocaine jelly

Group 4: 1.5 mg/kg of lidocaine IV was administered at the conclusion of surgery

Group 5: 7 to 8 ml of 2% lidocaine for 90 minutes before intubation, evacuated before intubation

Takekawa 2006	Group 1: lidocaine (1 mg/kg)	Control: normal saline	0.25 (0.09 to 0.68)	0.3 (0.12 to 0.48)
	Group 2: lidocaine (1.5 mg/kg)			
Krishnan 2008	Group L1: 4% Lidocaine In cuff of endotracheal tube	Group C: Distilled water in cuff of endotracheal tube	1.05 (0.61, 1.81)	0.013(-0.15 to 0.13)
Jaicobandram 2009	Group L: alkalinized lidocaine in the cuff of endotracheal tube	Air in cuff of tracheal tube, Saline in cuff of endotracheal tube	0.40 (0.13, 1.25)	0.18(-0.03 to 0.34)
Navarro 2012	ETT intra cuff alkalinized 2% lidocaine (L group)	ETT intra cuff 0.9% saline (S group)	0.14 (0.01, 2.63)	0.1(-0.063 to 0.281)
Xu 2012	ETT size 7.0 with lidocaine, ETT size 6.0 with lidocaine.	ETTsize 7.0 with saline; ETT size 6.0 with saline	0.61 (0.44, 0.86)	0.183(0.06 to 0.30)

ARR = absolute risk reduction

ETT = endotracheal tube

Table 2. The severity of sore throat

Studies	Intervention	Control	MD (Random) (95% CI)
Altintas 2000	10% lidocaine to inflate the ETT cuff	Saline to inflate the ETT cuff	-10.20 (-12.97 to -7.43)
Estebe 2002	Group L: (2% lidocaine in the cuff of the ETT)	Group C (air in cuff of the ETT)	-7.5 (-12.06 to -2.94)
	Group LB: (alkalinized 2% lidocaine in the cuff of the ETT)		
Estebe 2004	Group W: ETT cuff lubricated with sterile water and filled with alkalinized lidocaine	ETT cuff lubricated with sterile water and filled with air	-19.5 (-24.09 to 14.91)
	Group G: ETT cuff lubricated with water-soluble gel and filled with alkalinized lidocaine		
Estebe 2005	8.4% NaHCO ₃ + 2% lidocaine in cuff of ETT, 1.4% NaHCO ₃ + 2% lidocaine in cuff of ETT	Air in cuff of ETT	-13.5 (-19.98 to -7.02)
Navarro 1997	4% lidocaine in the cuff of the ETT	Air in the cuff of the ETT	-6.90 (-17.3 to 3.48)
Xu 2012	ETT size 7.0 with lidocaine, ETT size 6.0 with lidocaine	ETT size 7.0 with saline; ETT size 6.0 with saline	-7.00 (-8.44, -5.56)

ETT = endotracheal tube

MD = mean difference

APPENDICES

Appendix 1. Search strategy for SilverPlatter MEDLINE

#1 explode Pharyngitis/ all subheadings#2 explode INTUBATION-INTRATRACHEAL/ all subheadings

#3 (SORE* or INFLAMM* or INFECT*) near THROAT

#4 Pharyngit*

#5 (ENDOTRACHEAL or INTRATRACHEAL) near INTUB*

#6 #1 or #2 or #3 or #4 or #5

#7 explode LIDOCAINE/ all subheadings

#8 LIDOCAIN*

#9 #7 or #8

#10 #6 and #9

#11 CLINICAL-TRIAL in PT

#12 randomized in AB

#13 placebo in AB

#14 (clinical trials) in MESH

#15 randomly in AB

#16 trial in TI

#17 #11 or #12 or #13 or #14 or #15 or #16

#18 TG=animals

#19 TG=humans

#20 #18 not (#18 and #19)

#21 #17 not #20

Appendix 2. Search strategy for SilverPlatter EMBASE

#1 explode Pharyngitis/ all subheadings

#2 explode "endotracheal-intubation" / all SUBHEADINGS in DEM, DER, DRM, DRR

#3 (SORE* or INFLAMM* or INFECT*) near THROAT

#4 PHARYNGIT*

#5 (ENDO?TRACHEAL or INTRA?TRACHEAL) near INTUB*

#6 #1 or #2 or #3 or #4 or #5

#7 LIDOCAIN*

#8 explode LIDOCAINE/ all subheadings

#9 #7 or #8

#10 #6 and #9

#11 "RANDOMIZED-CONTROLLED-TRIAL"/ all subheadings

#12 "RANDOMIZATION"/ all subheadings

#13 "CONTROLLED-STUDY"/ all subheadings

#14 "MULTICENTER-STUDY"/ all subheadings

#15 "PHASE-3-CLINICAL-TRIAL"/ all subheadings

#16 "PHASE-4-CLINICAL-TRIAL"/ all subheadings

#17 "DOUBLE-BLIND-PROCEDURE"/ all subheadings

#18 "SINGLE-BLIND-PROCEDURE"/ all subheadings

#19 #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18

#20 (RANDOM* or CROSS?OVER* or FACTORIAL* or PLACEBO* or VOLUNTEER*) in TI,AB

#21 (SINGL* or DOUBL* or TREBL* or TRIPL*) near ((BLIND* or MASK*) in TI,AB)

#22 #19 or #20 or #21

#23 HUMAN in DER

#24 (ANIMAL or NONHUMAN) in DER

#25 #23 and #24

#26 #24 not #25

#27 #22 not #26

#28 #10 and #27

Appendix 3. Search strategy for CENTRAL, The Cochrane Library

#1 MeSH descriptor Pharyngitis explode all trees

#2 MeSH descriptor Intubation, Intratracheal explode all trees

#3 PHARYNGIT*

#4 (ENDOTRACHEAL or INTRATRACHEAL) near INTUB*

#5 (SORE* or INFLAMM* or INFECT*) near THROAT

#6 (#1 OR #2 OR #3 OR #4 OR #5)

#7 LIDOCAIN*

#8 MeSH descriptor Lidocaine explode all trees

#9 (#7 OR #8)

#10 (#6 AND #9)

FEEDBACK

Error noted in data, 4 March 2013

Summary

With interest we read the review of Tanaka et al. about the prevention of postoperative sore throat with lidocaine. The authors calculated that topical or systemic lidocaine might effectively prevent sore throat after endotracheal intubations. One of their included studies with high quality was Hara and Maruyama ([Hara 2005](#)). These authors examined the effect of lidocaine and lidocaine spray on postoperative sore throat at the first day after surgery. They found that lidocaine spray applied on the cuff leads to higher incidence of sore throat (10 of 35 patients) versus lidocaine solution (4 of 36 patients) or saline (4 of 36 patients). A significant difference in the incidence of sore throat following application of lidocaine alone (without the additives used in a spray) or saline was not found on the day after surgery. Tanaka et al. used these data for analysis I.1, analysis I.2, analysis I.3 and analysis I.4 of the meta-analysis. However, we think, that some of the data presented are not identical to those in the original publication. The graphs of analysis I.1 to I.4 show at Hara 2005 an incidence of 4 of 36 patients in the lidocaine group and 14 of 71 patients in the saline group. In the original publication [[Hara 2005](#)] 14 of 71 patients in

the lidocaine group and 4 of 36 patients in the saline group had sore throat. The apparent transposition in the calculation of Tanaka et al., may therefore significantly alter the results of the meta-analysis.

Reply

Dr Tanaka wishes to thank Dr Marc Wrobel and Prof Thomas Volk for posting the criticism and acknowledges the error. The review is in the process of being updated and the error will be corrected.

Contributors

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2 Prof Thomas Volk, MD, Director of the Department of Anaesthesiology, Intensive Care Medicine and Pain Therapy, 66421 Homburg, Germany

WHAT'S NEW

Date	Event	Description
6 July 2015	New citation required but conclusions have not changed	<p>New authors have joined the review team.</p> <p>In general, our updated review reaches the same conclusion as the original published review (Tanaka 2009). However, we have included four new trials and thus have more precise estimates on the effectiveness of both topical and systemic lidocaine for preventing the risk and reducing the severity of postoperative sore throat. Furthermore we applied several sensitivity and sub-group analyses which generally supported the overall results. The summary reflects the high quality of studies and any variations in the results were not statistically significant.</p>
6 July 2015	New search has been performed	<p>This review is an update of the original Cochrane systematic review (Tanaka 2009). We reran the searches to October 2013. We included four new studies (Jaicobandram 2009; Krishnan 2008; Navarro 2012 Xu 2012)</p> <p>We responded to Feedback and corrected the data input of one study (Hara 2005)</p> <p>We have included a 'Summary of findings' table.</p>

HISTORY

Protocol first published: Issue 1, 2003
Review first published: Issue 3, 2009

Date	Event	Description
23 February 2008	Amended	Converted to new review format.
5 January 2008	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

Yuu Tanaka (YT) Takeo Nakayama (TN), Mina Nishimori (MN), Yuki Sato (YS), Yuka Tsujimura (YTs), Masahiko Kawaguchi (MK)

Conceiving the review: YT

Lidocaine for preventing postoperative sore throat (Review)

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Co-ordinating the review: TN, YT, MN, YS, YTs, MK

Undertaking manual searches: YT

Organizing retrieval of papers: YT

Screening retrieved papers against inclusion criteria: YT, MN, YS, YTs

Appraising quality of papers: YT, MN, YS

Abstracting data from papers: YT, MN, YS

Providing additional data about papers: YT

Obtaining and screening data on unpublished studies: YT

Data management for the review: YT

Entering data into Review Manager ([RevMan 5.3](#)): YT

RevMan statistical data: YT

Other statistical analysis not using RevMan: YT

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Interpretation of data: YT, MN, TN, MK

Statistical inferences: YT, MN, TN, MK

Writing the review: YT, MN

Securing funding for the review: TN, MK

Performing previous work that was the foundation of the present study: YT, TN, MN, YS

Guarantor for the review (one author): YT

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DECLARATIONS OF INTEREST

Yuu Tanaka: none known

Takeo Nakayama: none known

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Internal sources

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Salary

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Salary

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Salary

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Salary

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- No sources of support supplied

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INDEX TERMS

Medical Subject Headings (MeSH)

Anesthesia, General [adverse effects]; Anesthetics, Local [adverse effects] [*therapeutic use]; Intubation, Intratracheal [adverse effects]; Lidocaine [adverse effects] [*therapeutic use]; Pharyngitis [etiology] [*prevention & control]; Postoperative Complications [*prevention & control]; Randomized Controlled Trials as Topic

MeSH check words

Humans