Med & Health Jan 2026; 21(1): 299-307 https://doi.org/10.17576/MH.2026.2101.19

ORIGINAL ARTICLE

Effects of Endotracheal Tube Prewarming versus Precooling on Postoperative Sore Throat

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Received: 19 January 2025 / Accepted: 21 May 2025

ABSTRAK

Sakit tekak selepas pembedahan (POST) ialah komplikasi biasa anestesia am yang memerlukan intubasi endotrakeal. Kajian rabun dua-rawak ini membandingkan kesan pra-pemanasan dengan pra-penyejukan tiub endotrakeal (ETT) kepada POST. Seramai 122 pesakit dengan status fizikal American Society of Anaesthesiologists I atau II yang menjalani pembedahan di bawah bius am yang memerlukan ETT telah direkrut. Selepas perawakan, pesakit dalam Kumpulan A dan Kumpulan B telah diintubasi dengan ETT yang telah masing-masing direndam dalam salina 40°C dan 5-10°C. Insiden dan keterukan POST, suara serak dan batuk dinilai pada 1-jam dan 24-jam selepas pembedahan. Tiada perbezaan ketara diperhatikan dari segi sakit tekak, serak dan batuk pada jam pertama, mahupun dalam keterukan sakit tekak dan serak. Kumpulan B mempunyai insiden suara serak yang lebih rendah pada 24-jam selepas pembedahan (p = 0.013). Tiada perbezaan ketara dari segi sakit tekak diperhatikan antara kedua-dua kumpulan pada 24 jam selepas pembedahan (p = 0.521). Dalam analisis lanjut, pada 1-jam selepas pembedahan, majoriti pesakit yang mengalami suara serak sederhana adalah lelaki (p = 0.011), dan mereka yang diintubasi dengan ETT bersaiz lebih besar melaporkan serak dan batuk yang sederhana (p = 0.027 dan p = 0.024, masing-masing). Batuk dilaporkan hanya pada 1-jam selepas pembedahan, iaitu 18 (30.5%) dan 11 (18.6%) pesakit dalam ETT yang telah dipanaskan dan disejukkan (p = 0.134). Walaupun tidak terdapat perbezaan yang ketara antara ETT prapanas dan prasejuk berkaitan dengan POST, kami mendapati insiden suara serak yang jauh lebih rendah pada 24 jam selepas pembedahan dalam kumpulan kedua, yang akan mengurangkan komplikasi yang kerap selepas pembedahan.

Kata kunci: *Bius am; intubasi; sakit tekak selepas pembedahan; suara serak; tiub endotrakeal*

ABSTRACT

Postoperative sore throat (POST) is a common complication of general anaesthesia requiring endotracheal intubation. This randomised double-blind study compared the effects of endotracheal tube (ETT) prewarming versus precooling on POST. A total of 122 patients with American Society of Anaesthesiologists physical status I or II undergoing surgery under general anaesthesia requiring ETT were recruited. Following randomisation, patients in Group A and Group B were intubated with ETT

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immersed in 40°C and 5-10°C saline, respectively. The incidence and severity of POST, hoarseness of voice and cough were assessed at 1-hour and 24-hours postoperatively. No significant differences were observed in terms of sore throat, hoarseness and cough at the first hour, nor in the severity of sore throat and hoarseness. Group B had a significantly lower incidence of hoarseness at 24-hours postoperatively ($p = 0.013$). No significant difference in terms of sore throat were observed between the two groups at 24-hours postoperatively ($p = 0.521$). On further analysis, at 1-hour postoperatively, the majority of patients who developed moderate hoarseness were male ($p = 0.011$), and those intubated with larger-sized ETT reported moderate hoarseness and cough ($p = 0.027$ and $p = 0.024$, respectively). Cough was reported only at 1-hour postoperatively, which were 18 (30.5%) and 11 (18.6%) of patients in the prewarmed and precooled ETT, respectively ($p = 0.134$). Although there were no significant differences between prewarmed and precooled ETT in relation to POST, we found a significantly lower incidence of hoarseness at 24-hours postoperatively in the latter group, which would reduce a common postoperative complication.

Keywords: Endotracheal tube; general anaesthesia; hoarseness; intubation; postoperative sore throat

INTRODUCTION

Postoperative sore throat (POST) is a one of the commonest complications in patients who received endotracheal intubation, with an incidence ranging from 14.4% to 50.0% (McHardy & Chung 2002). The underlying mechanism is believed to be related to injury and erosion following the insertion of the endotracheal tube (ETT), as well as mucosal dehydration (Ganason et al. 2019). Despite being one of the most frequent complaints by patients after general anaesthesia, POST is self-limiting and often considered of minor importance by clinicians (El-Boghdadly et al. 2016; Macario et al. 1999). From the patients' perspective, the unpleasant and stressful experience of POST may lead to nausea, vomiting and poor oral intake leading to low patient satisfaction together with delayed patient recovery (Ali et al. 2021; Postier et al. 2020).

Numerous POST preventive measures have been investigated, of which pharmacological interventions included lignocaine, dexamethasone, non-steroidal anti-inflammatory drugs, glycyrrhiza (liquorice), ketamine and magnesium, all to varying levels of efficacy (El-Boghdadly et al. 2016; Wang et al. 2021). Non-pharmacological measures were primarily aimed at reducing the risk of airway trauma, such as a smaller ETT size selection, videolaryngoscopy usage and intracuff pressure monitoring (El-Boghdadly et al. 2016; Ganason et al. 2019).

Nasotracheal tube softening by immersion in warm saline of 40°C is commonly practised for nasal intubation as softened nasotracheal tubes are less likely to cause traumatic nasal injury and epistaxis (Yu et al. 2021). When thermal softening was applied to the ETT, studies had found a reduction in POST (Mohseni et al. 2022; Yu et al. 2021). On the other hand, a small study had found cold saline (5-10°C) tonsillar fossa wash reduced POST in post-tonsillectomy paediatric patients, attributing the anti-oedema and anti-inflammatory effects of cryotherapy by vasoconstriction and slowing down pain transmission (Jaiswal et al. 2020; Poonuraparampil et al. 2021). Building on the above assumption, we embarked to study the effects of prewarmed versus precooled ETT against the incidence and severity of POST, cough and hoarseness of voice.

MATERIALS AND METHODS

This single-centre, prospective, double-blind, randomised controlled study was approved by the department research committee and our institutional ethics research committee. Informed consent was obtained from eligible patients, who were aged between 18 and 65 years old, with the American Society of Anesthesiologist (ASA)

physical status of I or II, planned for general anaesthesia requiring single lumen endotracheal intubation, in either elective or emergency surgeries expected to be less than 6 hours. Exclusion criteria were pregnancy, preexisting sore throat, hoarseness of voice, upper respiratory tract infection, history of tracheostomy, history of difficult intubation, features of difficult airway during preoperative airway assessment, high risk of postoperative nausea and vomiting (PONV) based on the Apfel score, or if the planned surgery involved the airway or oral cavity (Apfel et al. 2012).

Recruited patients were randomised to either Group A or Group B using computer-generated randomised numbers. During consent taking, the investigator noted the patients' quality of voice for any changes postoperatively. Patients' demographic data and the operating team's surgical discipline were recorded.

Prior to intubation, a single-lumen ETT sized appropriately for each patient was immersed for 10 minutes in either warm saline (40°C) or cold saline (5-10°C) for Group A and Group B, respectively. For all ETT, at least 75% of the length was submerged. Prior and during immersion, the saline temperature was checked and maintained at the desired temperatures using an immersion thermometer. A single investigator, not involved with the intubation process, was responsible for preparing the saline and ETT based on the randomisation.

Preoperative fasting and intra-operative minimal monitoring were conducted according to the recommended ASA standard guidelines. Following pre-oxygenation with 100% oxygen for 3 minutes, general anaesthesia was induced using IV fentanyl 2 µg/kg and IV propofol 2-2.5 mg/kg titrated until loss of consciousness. Subsequently, neuromuscular blocking agent, IV rocuronium 0.6-1.0 mg/kg, was administered. Clinical assessment for example, jaw relaxation and ease of ventilation, together with adequate time for the muscle relaxant to take effect as per the usual duration for rocuronium were observed before endotracheal intubation was conducted. Intubation was performed using a C-MAC (Storz, Germany) videolaryngoscope by medical officers with a minimum of 3 years of anaesthesia experience who were blinded to the group randomisation. The ETT was inserted until the depth marker line was at the level of the vocal cords. Each intubation attempt was taken as the process of ETT insertion into the oral cavity until it was removed. If there was failure to intubate, alternative rescue airway management was implemented.

After inflating the ETT pilot cuff, the tube's placement was confirmed through the 5-point auscultation along with the presence of a normal capnography trace. The intracuff pressure was checked and adjusted to be between 20-25 cmH_2O. The size of the ETT, number of intubation attempts, Cormack-Lehane grade view, and the ETT cuff pressure were also recorded (Cormack & Lehane 1984). In order to reduce confounding factors, adjuncts such as IV lignocaine and IV dexamethasone were not administered (Apfel et al. 2012).

General anaesthesia was maintained with a mixture of oxygen, air, and sevoflurane titrated to a minimum alveolar concentration of 1.0. Throughout the surgery, positive pressure ventilation was applied with intermittent boluses of IV rocuronium 0.2 mg/kg administered to maintain adequate neuromuscular blockade. Adequate analgesia was administered depending on the type of surgery. Prior to completion of surgery, IV granisetron 1 mg was administered for the prevention of PONV. The time of surgical commencement and completion were also recorded.

Prior to extubation, gentle suction of the oral cavity was performed, and sevoflurane was discontinued. All patients were then given 100% oxygen, and the residual neuromuscular blockade was reversed with IV neostigmine 0.05 mg/kg and IV atropine 0.02 mg/kg. Once patients were deemed safe to be extubated, the ETT cuff was deflated before extubation was performed. Patients were then transferred to the post-anaesthesia recovery bay for monitoring before being discharged to the general ward.

Patients were excluded from data collection if

they required more than 2 attempts at intubation or inadvertently remained intubated for more than 6 hours; either due to prolonged surgery or unplanned postoperative admission to the critical care unit. The remaining patients were then followed up in the ward and assessed for intubation-related complications such as sore throat, hoarseness and cough at 1-hour and 24-hours postoperatively. A standardised form was used to aid data collection. Patients were asked about the absence or presence of sore throat. Sore throat was characterised as a sensation of dryness, scratchiness or irritation of the throat. The severity of those with POST was assessed using a visual analogue scale (VAS) of 1-10, which was categorised into mild (1-3), moderate (4-6) and severe (7-10). Hoarseness was defined as abnormal postoperative changes in the voice compared to before surgery, either mild (only noticed by patient), moderate (noticed by assessor) or severe (aphonia). Finally, the patients were assessed on the absence or presence of cough, which was defined as a persistent and dry cough that did not resolve upon extubation.

The sample size required for this study was calculated using Power and Sample Size Calculation software version 3.0 (WD Dupont & WD Plummer, Tennesse, USA). With the power set at 80% to achieve significance level of 0.05, and using the data of a prior study, the calculated sample size was 102 patients (Mohseni et al. 2022). Taking into account a 20% dropout rate, 122 patients were recruited into the study. The data were analysed using the Statistical Package for the Social Sciences (SPSS) software version 26.0. The differences in various outcomes between the two groups were compared using Independent t-test, Mann Whitney U-test, Pearson Chi-squared test and Fisher Exact test. All the tests were two-sided, and statistical significance was denoted by $p < 0.05$.

RESULTS

A total of 122 patients were recruited into the study. However, 4 were excluded from data analysis due to unanticipated difficult intubation, surgery duration more than 6 hours and loss to follow-up (Figure 1). The demographic data of the remaining 118 patients were shown in Table 1, which showed no significant differences between the two groups.

Table 2 showed the clinical data which included the surgical discipline, duration of surgery and details of intubation, which were the ETT size used, Cormack-Lehane grade, number of intubation attempts and the ETT cuff pressure. There were no significant differences observed between both groups. In terms of ETT size and gender, all males in Group A and 17 out of 21 in Group B were intubated with ETT size 7.5. Meanwhile, two female patients in Group A and 23 from Group B received ETT size 7.5.

Table 3 compared POST, hoarseness and cough at 1-hour and 24-hours post-operatively between prewarmed and precooled ETT. The number of reported POST, hoarseness and cough reduced at 24-hours postoperatively. No patients developed new symptoms 24-hours postoperatively. At 1-hour postoperatively, cough was reported in 18 (30.5%) and 11 (18.6%) of patients in the prewarmed and precooled ETT, respectively, which was not statistically significant ($p = 0.134$). No cough was reported during the 24-hours postoperative assessment.

On further analysis, there were no significant differences observed in the incidence and severity of POST and hoarseness between genders and age groups (18-30, 31-50 and 51-65 years old). However, moderate hoarseness was observed more amongst male patients compared to female patients at 1-hour postoperatively ($p = 0.011$). We also discovered that patients who were intubated with ETT 7.5 mm reported a higher proportion of moderate hoarseness ($p = 0.027$) and cough ($p = 0.024$) at 1-hour postoperatively.

DISCUSSION

Postoperative sore throat is a common airway complication following endotracheal intubation. The choice of airway management plays an important factor in the incidence of POST, as found in a study whereby patients intubated with

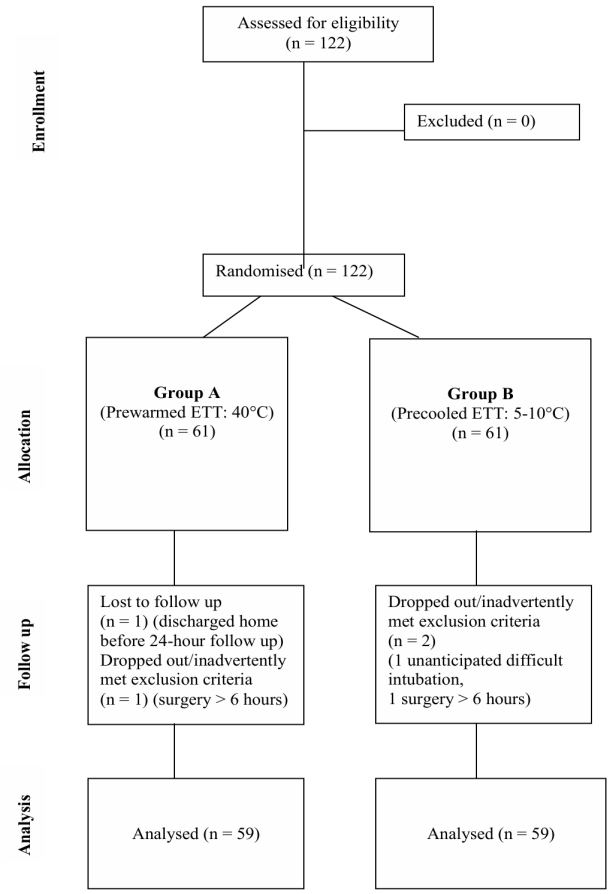

FIGURE 1: Consort flow diagram

TABLE 1: Demographic characteristics of the participants

	Group A (n = 59)	**Group B (n = 59)**	**p-value**
Age (years)	45.2 ± 13.1	46.6 ± 14.9	0.586[a]
Gender			
Female	32 (54.2)	38 (64.4)	0.261[b]
Male	27 (45.8)	21 (35.6)	
Ethnicity			
Malay	45 (76.3)	40 (67.8)	0.633[c]
Chinese	9 (15.2)	14 (23.7)	
Indian	2 (3.4)	1 (1.7)	
Others	3 (5.1)	4 (6.8)	
BMI (kg/m^2)	28.8 ± 4.1	27.8 ± 4.1	0.179[a]

[a]Independent sample t-test; [b]Pearson Chi-squared test; [c]Fisher Exact test; BMI: body mass index
Data expressed as mean ± standard deviation or frequency (percentage) as appropriate

TABLE 2: Clinical data of participants

	Group A (n = 59)	Group B (n = 59)	p-value
Specialty			
Gynaecology	3 (5.1)	7 (11.9)	0.186[b]
Ophthalmology	1 (1.7)	4 (6.8)	0.364[b]
Orthopaedic	11(18.6)	12 (20.3)	0.816[b]
Plastic	7 (11.9)	1 (1.7)	0.061[b]
General surgery	32 (54.2)	35 (59.3)	0.577[b]
Urology	5 (8.5)	0 (0.0)	0.057[b]
Duration of surgery (hours)	3.1 ± 1.0	3.0 ± 0.8	0.327[a]
ETT size (mm)			
7.0	30 (50.8)	40 (67.8)	0.061[c]
7.5	29 (49.2)	19 (32.2)	
Cormack-Lehane grade			
1	48 (81.4)	42 (71.2)	0.194[c]
2	11 (18.6)	17 (28.8)	
Intubation attempts			
1	58 (98.3)	59 (100.0)	>0.950[d]
2	1 (1.7)	0 (0.0)	
ETT cuff pressure (cmH_2O)	22.6 ± 1.4	23.0 ± 1.3	0.057[a]

[a]Independent sample t-test; [b]Mann-Whitney U-test, [c]Pearson Chi-squared test; [d]Fisher's Exact test; ETT: Endotracheal tube
Data expressed as mean ± standard deviation or frequency (percentage) as appropriate

TABLE 3: Postoperative sore throat and hoarseness at 1-hour and 24-hours postoperatively

	Group A (n = 59)	Group B (n = 59)	p value	Group A (n = 59)	Group B (n = 59)	p-value
	Postoperative 1-Hour			Postoperative 24-Hours		
POST present						
No	36 (61.0)	38 (64.4)	0.570a	43 (72.9)	46 (78.0)	0.521[a]
Yes	23 (39.0)	21 (35.6)		16 (27.1)	13 (22.0)	
POST severity						
VAS score	2.5 ± 1.0	2.8 ± 0.7	0.187[b]	1.3 ± 0.7	1.6 ± 0.6	0.185[b]
Mild	20 (87.0)	18 (85.7)		16 (100.0)	13 (100.0)	
Moderate	3 (13.0)	3 (14.3)	>0.950[c]	0 (0.0)	0 (0.0)	*
Severe	0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	
Hoarseness						
No	51 (86.4)	53 (89.8)	0.569[a]	52 (88.1)	59 (100.0)	0.013[c]
Yes	8 (13.6)	6 (10.2)		7 (11.9)	0 (0.0)	
Hoarseness severity						
Mild	6 (75.0)	5 (83.3)	>0.950[c]	7 (100.0)	0 (0.0)	*
Moderate	2 (25.0)	1 (16.7)		0 (0.0)	0 (0.0)	
Severe	0 (0.0)	0 (0.0)		0(0.0)	0 (0.0)	

[a]Pearson Chi-squared test; [b]Independent sample t-test; [c]Fisher Exact test. POST: postoperative sore throat.
Data expressed as mean ± standard deviation or frequency (percentage) as appropriate
* Unable to obtain statistical value as there were no patients with moderate or severe hoarseness

an ETT have a higher incidence of POST (45.5%) compared to supraglottic airway device (17.5%) and face mask (3.3%) (Higgins et al. 2002). Our study focused on patients who had ETT sited with no control group. It is believed that the occurrence of sore throat is associated with physical trauma to the airway (Yu 2021). As intubation involves placing the ETT through the vocal cords, the vocal folds become the most vulnerable site that could be affected. The stimulation of the mucosa at the distal end of the tube has been identified as the predominant complicating factor following intubation. Inflammation stemming from these injuries, in conjunction with the stimulation induced by traumatic laryngoscopy and cuff contact, can precipitate POST (Poonuraparampil et al. 2021).

Numerous studies have been conducted in the past to investigate the effects of thermal warming of ETT on POST, in which results have been of varying significance. Amongst these, significant reduction in POST has been found in patients who were intubated with ETT that have been warmed in 40°C saline (Mohseni et al. 2022; Yu et al. 2020). After being warmed, the ETT is not only softened but also become more flexible, thus reducing the risk of airway trauma during intubation. In our study, there was 39.0% incidence of sore throat within 1 hour postoperatively in patients intubated with warmed ETT, comparable to studies by Yu et al. (2020)(35.1%) and Mohseni et al. (2022)(20.7%). The types of surgeries for Mohseni et al. (2022) and Yu et al. (2020) were more specific compared to ours, who had undergone procedure of various specialties. Mohseni et al.'s (2022) patients had surgeries around the head and chest area, whereas Yu et al. (2020) focused on nasal procedures. One would surmise less analgesia usage with these two groups which would have resulted in a higher POST. However, our patients ended up with a higher percentage of POST.

There have been studies investigating the effects of applying cold vapour and ice cubes applied during the postoperative period with no significant reduction in POST (Bulut et al. 2016; Şahbaz & Khorshid 2020). On the other hand, Poonuraparampil et al. (2021) cooled the surgical field with cold saline wash at the end of surgery, and had shown a significant reduction in the severity of POST in post-tonsillectomy patients. In theory, cold therapy provides pain relief by promoting vasoconstriction, thereby limiting blood flow and subsequently reducing oedema and inflammation (El-Boghdadly et al. 2016; Poonuraparampil et al. 2021). A decrease in local temperature also results in reduced tissue metabolism, leading to lower oxygen requirements and limiting tissue damage (Jaiswal et al. 2020). Apart from reduced inflammation akin to cryotherapy, painful nerve impulses are slower as nerve conduction speed decreases in low temperatures. In our study, POST was reported in 35.6% and 22.0% postoperatively at 1-hour and 24-hours, respectively. Our study also found that a lower percentage of patients intubated with precooled ETT exhibited hoarseness at the 24-hour mark, compared to those intubated with warmed ETT, possibly due to less inflammation and swelling in the vocal cords and the surrounding mucosa. This finding aligns with the effects of cold therapy in reducing tissue inflammation and swelling, hence leading to faster recovery. Thus, precooling ETTs may provide a greater benefit in terms of lower postoperative hoarseness. Compared to the study by Poonuraparampil et al (2021), our study utilised the VAS rather than the Faces Pain Scale-Revised to suit the patients' age group in each study. However, we also found that patients intubated with precooled ETT who developed POST reported low pain scores.

While the ETT is softened by warm saline, there were concerns that a precooled ETT might be too stiff, making intubations challenging, thus predisposing to airway injury and potentially leading to POST. This was not found to be an issue as all patients in group B were intubated in a single attempt. At present, we cannot find any related study investigating the difficulty of intubation and temperature manipulation of ETT. We could not comment further, as firstly, patients with difficult intubation features were excluded and secondly, we did not recruit patients who

required nasal intubation.

Several factors influence the incidence and severity of POST for example, female gender, younger patients, airway management and the usage of the following: low cuff volume, high cuff pressure, larger-sized ETT and suxamethonium usage (Ganason et al. 2019; Higgins et al. 2002; McHardy & Chung 2002). In our study, we found that patients using larger sized ETT reported moderate hoarseness and cough, as expected. However, we did not observe any significant difference in the incidence and severity of POST between genders and age groups. Interestingly, we found that male patients are more likely to develop moderate hoarseness postoperatively compared to female patients. In our study, 44 out of 48 male patients were intubated with ETT size 7.5.

The duration of pre-warming tracheal tubes varies for each previous study, with 3 minutes being the shortest and extending up to 45 minutes (Kim et al. 2019; Shanahan et al. 2016; Takasugi et al. 2018). As previous studies with cooling methods involve soaking the surgical site and cool vapours rather than tracheal tubes, we could not determine a suitable duration for pre-cooling the ETT (Bulut et al. 2016; Poonuraparampil et al. 2021; Şahbaz & Khorshid 2020). Compared to pre-warming, pre-cooling ETTs are also not a common current practice in anaesthesia. In our study, we decided that a 10-minute duration, with temperature monitoring, was adequate as the solution's temperature may drift towards room temperature if the solution was left standing for a long period of time. The drift of temperature due to the effect of the patients' body temperature and fresh gas flow, especially with the pre-cooled ETT was also not known.

Our study was limited by several factors. Mainly, compared to previous studies, our study lacked a control group, which may have had similar or different incidences of POST. Despite using a standardised videolaryngoscope, variable pressure may have been applied to the airway during the procedure. The intraoperative analgesia was not standardised, as the recruited patients underwent different types of surgeries and necessitated varying amounts of analgesia, which may impact both the incidence and severity of the reported POST. One potential bias which could have affected the results was the clinical monitoring of adequate muscle relaxation prior to intubation, instead of quantitative nerve monitoring. We also did not explore the possibility of patients consuming over-the-counter medications, such as medicated lozenges, postoperatively. If this study were to be repeated, inclusion of a control group is recommended with limitation to types procedures which would require similar amounts of analgesia.

CONCLUSION

This study found no significant differences between prewarmed and precooled ETT in relation to POST. However, there was a significantly lower incidence of hoarseness at 24-hours postoperatively in patients who received precooled ETT, possibly due to faster recovery.

Author contributions: Conceptualisation: NIN; Methodology: NIN, MM; Data collection: NIN; Analysis: NIN, MM; Manuscript-original draft: NIN, MM; Manuscript-review and editing: NIN, MM, AMY, CJH, MKAK, SNMM, WRWM; Supervision: MM. All authors have approved the final manuscript.

Conflict of interest: There was no conflict of interest throughout the process of this study.

Funding: This research received no external funding.

Acknowledgement: The authors would like to thank Qurratu Aini Musthafa, Science Officer in The Department of Anaesthesiology & Intensive Care, Faculty of Medicine, UKM for her advice and assistance in the statistical analysis.

Ethical statement: This study was approved by our insititution's Research and Ethics Ccommitee (JEP-2022-421). All participants gave written informed consent."

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