Telescoping Tracheal Tubes into Catheters Minimizes Epistaxis during Nasotracheal Intubation in Children


Background: Numerous strategies have been used to reduce epistaxis after nasotracheal intubation. The authors compared the severity of epistaxis after nasotracheal intubation in children with tubes at room temperature, warm tubes, and tubes telescoped into catheters.

Methods: Children who were scheduled for elective dental surgery were randomly assigned to undergo nasotracheal intubation using a tube at room temperature (control), warmed in saline, or whose distal end had been telescoped into a red rubber catheter. After an inhalational induction and intravenous propofol, a lubricated tube or red rubber catheter was inserted into the right nares. Tracheal intubation was achieved by direct laryngoscopy and tube placement using Magill forceps. The pharynx was swabbed for blood by an observer who was blind to the treatment. The severity of bleeding was rated using reference figures. Data were analyzed using Kruskal-Wallis and Fisher exact tests. P < 0.05 was accepted.

Results: The demographics of the three groups were similar. The estimated median area of the gauze in the catheter group that was covered with blood (0%) was significantly less than the areas in the control (40%) and warm (20%) groups. The incidence of clinically relevant bleeding (≥ 40% of the gauze area covered in blood) in the catheter group (5%) was significantly less than in the control (56%) and warm (39%) groups. The incidence of no detectable blood in the catheter group (59%) was significantly greater than in the control (21%) and warm (26%) groups.

Conclusions: Telescoping the endotracheal tube into a catheter significantly reduces epistaxis in children undergoing nasotracheal intubation.

Nasotracheal intubation is commonly used to maintain an airway and optimize the surgical field of children undergoing dental and oral/maxillofacial surgery. As the tube passes through the nasopharynx, the leading edge of the tube often traumatizes the mucosa, resulting in bleeding.1,2 Several maneuvers have been recommended to reduce the incidence and severity of the bleeding during nasotracheal intubation, including warming the distal end of the tube and telescoping the tube into a red rubber catheter.3–8

In a randomized trial of nasotracheal intubation in children, Elwood et al. demonstrated that by telescoping the tip of a nasotracheal tube into the wide funnel end of a red rubber catheter, bleeding was reduced compared with warming the distal tip of the tube.3 In that study, the incidence of “obvious bleeding” decreased by two thirds when the tube was telescoped into a catheter rather than warming the tube. However, all of the children in that study were pretreated with topical oxymetazoline to the nose before the tube was introduced. Many clinicians do not use topical nasal vasoconstrictors in children, in part out of a lack of belief in their efficacy and in part out of concern for rare complications, such as cardiac arrest.9 At our institution, we do not instill topical nasal vasoconstrictors before passing nasotracheal tubes. Furthermore, there is no consensus among our faculty regarding the risk of bleeding associated with warming the tip of the endotracheal tube versus the use of a red rubber catheter to guide the tube through the nose. To determine the optimal strategy for nasal intubation in children when topical nasal vasoconstrictors are not used, we compared the incidence and severity of bleeding after intubation, time to intubation, and hemodynamic responses when nasotracheal intubation was performed with tubes at room temperature, tubes whose tips were warmed in saline, and tubes whose tips were telescoped into red rubber catheters.

Materials and Methods

With approval from the Children and Youth Institutional Review Board at Women and Children’s Hospital of Buffalo, SUNY at Buffalo, New York, informed written consent was obtained from the parents or guardians of 120 children who were scheduled for elective dental surgery. Assent was obtained from those children who were older than 7 yr. The children were aged 2–10 yr, American Society of Anesthesiologists physical status I or II, fasted, and unpremedicated. Children with a documented history of latex allergy, recurrent epistaxis, nasal polyposis, risk of gastroesophageal reflux, or contraindications to nasotracheal intubation such as abnormal coagulation status, and those children who were allergic to any of the anesthetic agents, had a history of malignant hyperthermia, or who refused to undergo an inhalation induction were excluded.
The children were randomly assigned to one of three treatment groups. In the control group, tracheal intubation was achieved using a tube at room temperature (22°C). In the warm group, tracheal intubation was achieved using a tube whose tip (the distal 10 cm of the tube) had been immersed in a 1-l bottle of warmed saline (42°C) for approximately 5 min before intubation. In the red rubber catheter group, intubation was achieved with a tube whose tip had been telescoped into the funnel end of a red rubber catheter (Davol® All-purpose Urethral Catheter; BARD, Covington, GA). The distal tips of all tracheal tubes were lubricated with sterile surgical lubricant before insertion in the naris. All tracheal intubations were attempted first via the right naris.

The randomization assignments were determined using a random sequence number generator without duplication. The computer program used a pseudorandom number generator to assign the 120 participants to three groups by using atmospheric noise to generate the random numbers. Each assignment was then concealed in an opaque envelope until consent/assent was obtained. Randomization was prepared for 140 children to account for dropouts.

Upon arrival in the operating room, standard monitors (including electrocardiogram, pulse oximeter, and blood pressure cuff) were applied to the children. Anesthesia was induced with 70% nitrous oxide in oxygen, at a total fresh gas flow of 9 l/min, via a pediatric circle circuit. When the response to verbal command was lost, 8% inspired sevoflurane was administered. When the eyelash reflex was lost, intravenous access was established and propofol, 2 mg/kg, was administered as a rapid intravenous bolus. Ventilation continued with 8% inspired sevoflurane in 100% oxygen. Sixty seconds after administration of the propofol, vital signs were recorded and nasotracheal intubation was initiated. The internal diameter (in millimeters) of the uncuffed nasotracheal tube (nasal R.A.E.; Mallinkrodt, St. Louis, MN) was selected using the formula: (age of the patient in years divided by 4) + 4.0. For children in the red rubber catheter group, 10-French catheters were used with tubes 5.0 mm ID and smaller, and 12-French catheters were used with tubes 5.5 mm ID and larger.

For children assigned to the control and warm groups, the endotracheal tube was passed through the right naris and advanced into the posterior pharynx. For children assigned to the red rubber catheter group, the distal end of the catheter was advanced through the right naris until the catheter-tube unit passed through the nasopharynx. When the catheter was visualized in the posterior pharynx, it was extracted through the mouth using Magill forceps and disengaged from the tube with an abrupt tug. The trachea was then intubated using direct laryngoscopy and Magill forceps. Two of the authors, a senior resident and fellow in pediatric critical care, performed all tracheal intubations.

Thirty seconds after tracheal intubation, vital signs were recorded. A 4 × 4-in gauze was prepared in a standardized manner by one observer who was blind to the treatment assignment. The gauze was folded once along its length, applied to the posterior pharyngeal wall, and then unfolded to maximize the area of contact between the gauze and the posterior pharyngeal wall. The gauze was held in place for 60 s to absorb the blood. Upon removing the gauze, the area of the gauze that was stained with blood was compared with six computer-generated diagrams in which a colored circle filled 0, 20, 40, 60, 80, and 100% of the central area of 4 × 4-in squares. The severity of the bleeding was determined by the same observer based on the estimated area of the gauze that was covered with blood. Before commencing the study, clinically significant bleeding was defined as bleeding that covered 40% or more of the area of the 4 × 4-in gauze.

Demographic data, including age, weight, and sex of the child, together with snoring history and recent upper respiratory tract infection (within the past 4 weeks), were recorded. Time zero was defined as the start of laryngoscopy. The times to visualizing the nasotracheal tube in the pharynx, passing the tube through the vocal cords, and inserting the gauze into the pharynx were recorded. The number of attempts at intubation, the number of naris recruited during intubation, and the level of difficulty of the intubation were all recorded. Vital signs, including hemoglobin oxygen saturation, heart rate, and systolic and diastolic blood pressures, were recorded immediately before and after intubation.

The primary outcome of this study was the incidence of clinically significant bleeding after nasotracheal intubation. Secondary outcomes included the incidence of no detectable bleeding in the pharynx after intubation; the times to viewing the tube, intubating the trachea, and inserting the gauze into the pharynx; and the hemodynamic responses to laryngoscopy/intubation. Sample size was estimated a priori using published data for the incidence of bleeding during nasotracheal intubation with a red rubber catheter. Assuming an incidence of bleeding with the catheter technique of 10% and an incidence with an untreated nasotracheal tube of 29%, an α of 0.05, and a β of 0.2, the estimated sample size was 40 children per group. All dropouts or incomplete studies were replaced to ensure a sample size of 40 children in each group.

Post hoc analyses of the data were performed as follows:

1. The times to view the tube in the pharynx, intubate the trachea, and insert the gauze in the pharynx were analyzed using one-way analysis of variance and the

Table 1. Demographic and Outcome Data

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Warm Tube</th>
<th>Red Rubber Catheter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of children</td>
<td>43</td>
<td>38</td>
<td>39</td>
</tr>
<tr>
<td>Age, yr</td>
<td>3.9 ± 1.3</td>
<td>4.5 ± 1.9</td>
<td>4.0 ± 1.6</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>19 ± 5.4</td>
<td>19.4 ± 5.3</td>
<td>19 ± 4.2</td>
</tr>
<tr>
<td>Sex, M/F</td>
<td>21/22</td>
<td>23/15</td>
<td>24/15</td>
</tr>
<tr>
<td>Time to view tube, s*</td>
<td>17 (6–45)§</td>
<td>14 (3–33)§</td>
<td>31 (21–59)</td>
</tr>
<tr>
<td>Time to intubate the trachea, s*</td>
<td>34 (11.7–104)†‡</td>
<td>27 (9–68)§</td>
<td>46 (24–87)</td>
</tr>
<tr>
<td>Time to insert gauze, min*</td>
<td>2.6 (0.67–12.0)</td>
<td>2.4 (0.77–6.9)</td>
<td>2.4 (1.0–7.0)</td>
</tr>
<tr>
<td>Area of the gauze covered in blood, %*</td>
<td>40 (0–80)§</td>
<td>20 (0–80)‡</td>
<td>0 (0–60)</td>
</tr>
<tr>
<td>Incidence of clinically significant bleeding, %</td>
<td>56</td>
<td></td>
<td>39#</td>
</tr>
<tr>
<td>Incidence of no bleeding, %</td>
<td>21**</td>
<td>26††</td>
<td>59</td>
</tr>
</tbody>
</table>

Data are mean ± SD unless otherwise indicated.
* Data that were not normally distributed are summarized as median (minimum–maximum). † n = 41 for the time to intubate (see text for two children who developed laryngospasm). ‡ P < 0.01, § P < 0.001, † P < 0.0001, # P < 0.0003, ** P < 0.0006, †† P < 0.0056 compared with the red rubber catheter.

Newman-Keuls post hoc test. If the data did not satisfy the assumptions for analysis of variance (i.e., the data were not normally distributed based on the Kolmogorov and Smirnov test or the variances were not homogeneous [using the Bartlett statistic]), then the data were analyzed using the Kruskal-Wallis test with Dunn multiple comparison test.

2. The severity of bleeding (percentage of the gauze covered in blood) was compared using the Kruskal-Wallis test and Dunn multiple comparison test.

3. The incidence of clinically significant bleeding and the incidence of no blood in the pharynx were compared using the Fisher exact test.

4. Heart rate and systolic and diastolic pressures, preintubation and postintubation, were compared using two-way analysis of variance with repeated measures and the Newman-Keuls post hoc test.

5. To determine whether experience with the red rubber catheter affected the speed of intubation during the course of this study, the times to intubation for the first and last 10 children in the red rubber catheter group were compared post hoc using the Mann-Whitney U test.

Statistical significance was accepted as P < 0.05.

Results

One hundred twenty children were enrolled and randomly assigned to a treatment. No child was excluded from the study. All children completed the study. There were no serious adverse or traumatic events.

Age, weight, sex (table 1), snoring history, history of tonsillectomy and adenoidectomy, and history of recent upper respiratory tract infection of the children were similar among the three groups. The left naris was used for intubation in 7 of 43 children in the control group, 1 of 38 in the warm group, and 0 of 39 in the red rubber catheter group.

The times to view the endotracheal tube in the pharynx (overall P < 0.0001) and to intubate the trachea (overall P < 0.0004) were significantly different among the three treatment groups. The times for the red rubber catheter group were significantly greater than those for the control and warm groups (table 1 for paired comparisons). The time to tracheal intubation was prolonged in two children in the control group who developed mild laryngospasm. A second dose of propofol together with 100% oxygen and continuous positive pressure were required to relieve the laryngospasm. The time to intubation for these two children was not included in the descriptive or statistical analysis; however, the remainder of their data were included and analyzed based on the intention-to-treat principle. The time interval from completion of the intubation until the gauze was inserted into the pharynx was similar among the three groups (table 1). Suctioning was not required to clear blood from the pharynx of any child after intubation.

The area of the gauze that was covered with blood (overall P < 0.0001), the incidence of clinically significant bleeding (overall P < 0.0001), and the incidence of no blood in the pharynx (overall P < 0.0006) were significantly different among the three treatments. The three bleeding endpoints for the catheter group all differed significantly from their respective values for the other two groups (table 1 for paired comparisons).

Mean heart rate for all three groups postintubation was significantly greater than pretubation (P < 0.01; table 2), although there was no significant differences among the treatments or with the interaction, treatment × time.

Mean systolic blood pressure after intubation did not change significantly compared with pretubation. Mean diastolic blood pressures postintubation for all three treatments were less than pretubation (P < 0.013; table 2), although there were no significant differences among the treatments or with the interaction, treatment × time.

To determine whether experience might have affected the time to intubation with the red rubber catheter, the times to intubation with the red rubber catheter for the first and last 10 sequential children were compared. The times for the two groups of children did not differ (P < 0.28).
Elwood ically relevant bleeding when the tube was telescoped two techniques. Interestingly, the 5% incidence of clinically relevant bleeding using a red rubber catheter than it was after the other was detectable after intubation was 2- to 3-fold greater after warming the tube at room temperature or warmed in saline. Although the time to complete tracheal intubation with the red rubber catheter was significantly greater than the times to complete intubation with the tube at room temperature and warmed in saline, the intubation times with the red rubber catheter were clinically acceptable because hemoglobin oxygen desaturation did not occur. We speculated that epistaxis is reduced when the tube is telescoped into a catheter because the soft catheter shields the stiff leading edge of the tube from the mucosa as the tube passes through the nasopharynx. The use of a catheter in this study decreased the incidence of clinically relevant bleeding 8- to 10-fold compared with the tube at room temperature and warmed in saline, the intubation times with the red rubber catheter were clinically acceptable because hemoglobin oxygen desaturation did not occur.

Oxygen saturation was maintained greater than 95% in all children throughout the study.

### Discussion

In the current study, we found that the incidence and severity of epistaxis when the nasotracheal tube was telescoped into the funnel end of a red rubber catheter were significantly less than when the tube was at room temperature or warmed in saline. Although the time to complete tracheal intubation with the red rubber catheter was significantly greater than the times to complete intubation with the tube at room temperature and warmed in saline, the intubation times with the red rubber catheter were clinically acceptable because hemoglobin oxygen desaturation did not occur.

We speculated that epistaxis is reduced when the tube is telescoped into a catheter because the soft catheter shields the stiff leading edge of the tube from the mucosa as the tube passes through the nasopharynx. The use of a catheter in this study decreased the incidence of clinically relevant bleeding 8- to 10-fold compared with the tube at room temperature and warmed in saline. Furthermore, the number of children in whom no bleeding was detectable after intubation was 2- to 3-fold greater after using a red rubber catheter than it was after the other two techniques. Interestingly, the 5% incidence of clinically relevant bleeding when the tube was telescoped into the catheter in this study is one half that reported by Elwood et al.,³ even though nasal oxymetazoline was administered before intubation in the latter study. Although we did not perform a direct comparison of the incidence and severity of bleeding with and without nasal oxymetazoline when the catheter technique was used, on the basis of these data, there seems to be no substantive benefit to pretreat children with a topical nasal vasoconstrictor if the endotracheal tube is telescoped into a red rubber catheter before nasotracheal intubation.

We designed this study to minimize bias by randomizing and concealing the treatment assignments, by blinding the observer, by eliminating interrater variability by using a single observer to determine the severity of bleeding, by using a set of six computer-generated 4-in square pictures each covered with a symmetrical colored circle that filled between 0 and 100% of the area of the square in 20% increments to quantify the bleeding, and by limiting the tracheal intubations to two physicians. The observer in this study was aware of the hypothesis of the study but was neither aware of the treatment assignment of the children nor present in the operating room until after the trachea was intubated. The observer estimated the percent area of the 4 × 4-in gauze that was covered in blood by comparing the blood stained area to the six printed squares each containing a symmetric circle that covered between 0 and 100% of the area of the square. Because the difference in the area of the circles between each pair of printed squares was 20%, the variability in the area of the gauze that was covered in blood was, at best, ± 20%.

One source of bias that we did not control was the behavior of the two anesthesiologists who performed the nasotracheal intubations. First, the anesthesiologists may have proceeded cautiously during the intubation because they were aware of the technique they were using to secure the airway, that bleeding was a major outcome variable in this study, and that the times to reach specific endpoints were being recorded. Both anesthesiologists were aware of the hypothesis of this study, which in retrospect might have been concealed from them to reduce bias. Nonetheless, the two anesthesiologists held neither preconceived notions nor knowledge regarding which technique was superior with respect to the outcome variables in this study. Second, we were concerned that despite the past experience of the two anesthesiologists with nasotracheal intubations with a red rubber catheter, the time to intubation with the catheter in this study might have decreased as their experience increased. To address this notion, we compared the times to intubation with the red rubber catheter for the first and last 10 children assigned to the catheter group. The absence of a statistically significant difference in the times to intubation suggested that experience did not affect the time to intubation with this technique.

The time to intubation with the red rubber catheter was 12-19 s greater than the times with the tube at room temperature and warmed. Although the additional time

### Table 2. Hemodynamic Responses to Intubation

<table>
<thead>
<tr>
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<th>Control</th>
<th>Warm Tube</th>
<th>Red Rubber Catheter</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Before Intubition</td>
<td>After Intubution</td>
<td>Before Intubition</td>
</tr>
<tr>
<td>Heart rate, beats/min*</td>
<td>114.0 ± 22.0</td>
<td>119.5 ± 19.9</td>
<td>116.7 ± 21.5</td>
</tr>
<tr>
<td>Systolic blood pressure, mmHg</td>
<td>98.7 ± 14.1</td>
<td>97.3 ± 16.4</td>
<td>101.8 ± 15.6</td>
</tr>
<tr>
<td>Diastolic blood pressure, mmHg†</td>
<td>48.3 ± 14.9</td>
<td>42.9 ± 11.2</td>
<td>49.8 ± 15.1</td>
</tr>
</tbody>
</table>

Data are mean ± SD.
* P < 0.01. Mean overall heart rate increased after intubation compared with before intubation, although treatment exerted no significant effect. † P < 0.013. Mean overall diastolic blood pressure decreased after intubation compared with before, although treatment exerted no significant effect.
to intubation was small and was without sequelae in this study, this may not hold true for those who are less experienced with this technique and/or who are not facile with nasotracheal intubation in children. Caution should be exercised to avoid hemoglobin oxygen desaturation when the red rubber catheter technique is adopted by those who are not skilled with this technique or those who are not skilled in nasotracheal intubation in children.

We were interested to find that warming the distal tip of the endotracheal tube in saline before nasotracheal intubation did not significantly affect the severity of epistaxis compared with a tube at room temperature. In part, this can be attributed to a lack of power in the study design, because this was not a primary outcome of this study. The incidence of clinically relevant bleeding with the warmed tube in this study, 39%, is consistent with the incidence of epistaxis in children reported by Elwood et al.,3 29%. Although the results are consistent, neither the temperature of the warmed water nor the time for which the tube was immersed in the water was specified in the previous study.3 In the absence of these data, it is difficult to be certain that the methods used to soften the tube in the two studies were similar and therefore that the incidences of bleeding in the two studies are comparable. Two studies in adults suggested that warming the tube reduced the incidence of epistaxis.5,7 However, outcomes were not evaluated by blinded observers, and the scale to determine the severity of the epistaxis was poor. Because the incidence and severity of epistaxis in this study with a tube at room temperature and with one warmed were not different, we submit that the results of this study do not support the practice of warming the endotracheal tube to reduce bleeding after nasotracheal intubation in children.

Nasotracheal intubation may be associated with trauma to the mucosa of the nasopharyngeal airway. The trauma may cause epistaxis, with blood in the pharynx and stomach, as well as avulsion of part or all of the turbinates and adenoids, submucosal tunneling of the tube and pain.10 These effects could extend the times in the operating and recovery rooms and increase both patient and parent dissatisfaction. Although there are limited data in children, the incidence of epistaxis after nasotracheal intubation is variable but common, whereas the incidence of other side effects such as damage to turbinates or adenoidal tissue is rare. By investigating the incidence and severity of epistaxis in a controlled trial during nasotracheal intubation in children, we sought to improve the quality of care that we provide for children and reduce perioperative morbidity. Telescoping nasotracheal tubes into red rubber catheters achieves these goals.

The red rubber catheters used in this study contain latex. We hope that the manufacturer will replace the latex in this product given the concern about latex sensitivity. However, in the interim, it is important to avoid these catheters in children who are at risk for latex anaphylaxis and substitute a latex-free product.

In summary, we compared the severity of epistaxis and the time to intubate the trachea as well as hemodynamic responses to nasotracheal intubation in children undergoing dental surgery when tubes that were prepared at room temperature, warmed in saline, or telescoped into a red rubber catheter were used. We found that when the tube was telescoped into a catheter, clinically relevant epistaxis was significantly less than when the tube was at room temperature or warmed. The time to complete the intubation when the tube was telescoped into a catheter was significantly greater than the times for tubes at room temperature or warmed, although the time with the catheter was not excessive, nor did it result in hemoglobin oxygen desaturation. Hemodynamic responses remained stable throughout for all three groups.

The authors thank Michele Yarussi, R.N. (Research Nurse, Department of Anesthesia), and the operating room staff at Women and Children’s Hospital of Buffalo, Buffalo, New York, for their assistance in conducting this study.

References