

## Simulation and education

## Suctioning via the tube during endotracheal intubation in a model of severe upper airway haemorrhage: Is there an advantage vs. suctioning with a separate catheter?<sup>☆</sup>

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## ABSTRACT

**Introduction:** In a model of severe simulated upper airway haemorrhage, we compared two techniques of performing endotracheal intubation: (1) suctioning via the endotracheal tube during laryngoscopy with subsequently advancing the endotracheal tube, and (2) the standard intubation strategy with performing laryngoscopy, and performing suction with subsequently advancing the endotracheal tube.

**Methods:** Forty-one emergency medical technicians intubated the trachea of a manikin with severe simulated airway haemorrhage using each technique in random order.

**Results:** There was no significant difference in the number of oesophageal intubations between suctioning via the tube and the standard intubation strategy [8/41 (20%) vs. 6/41 (15%);  $P=0.688$ ], but suctioning via the endotracheal tube needed significantly more time [median (IQR, CI 95%): 42 (20, 39–60) vs. 33 (15, 35–48) s;  $P=0.015$ ].

**Conclusions:** Suctioning via the endotracheal tube showed no benefit regarding the number of oesophageal intubations and needed more time when compared to the standard intubation strategy.

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### 1. Introduction

For experienced rescuers with excellent skills in airway management, endotracheal intubation is the gold standard for securing the airway in critically ill or injured patients.<sup>1</sup> Compared to the well prepared intubation conditions in the operating theatre, the incidence of difficult intubation in the field is higher,<sup>2</sup> and is often associated with serious complications such as endobronchial or oesophageal intubation,<sup>3</sup> or even death.<sup>4</sup> For example, in case of massive upper airway haemorrhage or severe regurgitation, fluid blocks the view of the glottis during laryngoscopy, therefore complicating endotracheal intubation.

With the laryngoscope in the left hand, and alternating from suctioning to advancing the endotracheal tube with the right hand, the main problem is that ongoing flow of blood or vomitus may re-obstruct the view of the glottis for the rescuer during laryngoscopy, rendering intubation extremely difficult. We tried to solve this problem by using a suction catheter being inserted via the endotracheal tube and protruding the tube's tip by a few millimetres (Fig. 1). This preparation enables the rescuer to perform both laryngoscopy and suctioning simultaneously, thus preventing alternating from suctioning to advancing the tube with the right hand. While this strategy is theoretically sound, it is unknown whether it works in practice.

The purpose of this study was to evaluate possible benefits of: (1) suctioning via the endotracheal tube during laryngoscopy with subsequently advancing the endotracheal tube compared to (2) the standard intubation strategy by performing laryngoscopy, and performing suction with subsequently advancing the endotracheal tube in an established model<sup>5,6</sup> of severe airway haemorrhage. Our null-hypothesis was that there would be no differences between these two strategies on study endpoints number of oesophageal intubations, and duration to intubation.

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**Fig. 1.** A 20 French suction catheter is inserted via the endotracheal tube for suctioning via the tube.

## 2. Materials and methods

### 2.1. Subjects

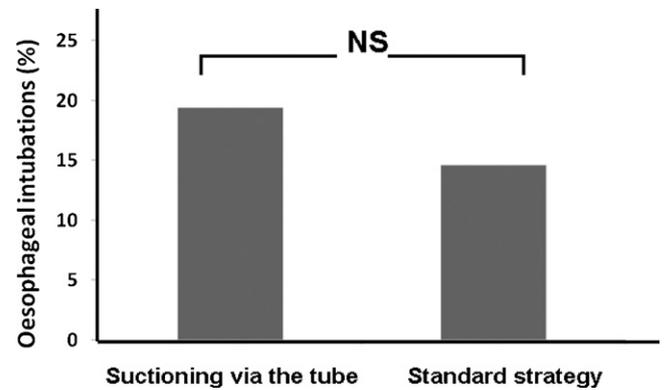
Ethical approval was sought, but formal submission was not required. Volunteers in this study were 41 volunteer emergency medical technicians responding with an emergency medical service to field emergencies in Augsburg county, Germany. If these volunteer emergency medical technicians arrive before a physician at the scene, they are trained to perform endotracheal intubation but employment of drugs to facilitate intubation is not allowed. Written informed consent was obtained from all volunteers before taking part in this study; there was no financial or commercial compensation for participation in this academic study.

### 2.2. Technical information

In a resuscitation manikin (Economy Adult Airway Management Trainer, Simulaids, Woodstock, NY), we simulated severe haemorrhage in the upper pharynx with black coffee running continuously into the nasopharynx via tubes fixed in the nostrils with a standardised flow of 500 ml/min. This model was established in prior experiments<sup>5</sup> and was found to produce extremely difficult intubation conditions, thus posing maximum stress upon the laryngoscopist. In this model of a simulated severe airway bleeding and massive regurgitation scenario, we compared two techniques of performing intubation: (1) suctioning via the endotracheal tube during laryngoscopy with subsequently advancing the endotracheal tube, and (2) the standard intubation strategy by performing laryngoscopy with the one hand, and performing suctioning with the other hand with subsequently alternating from suctioning to advancing the endotracheal tube. In both groups the same laryngoscopes (Macintosh, size 3) and same suction catheters (20 French, Seidel Medizin, Buchendorf, Germany), connected to the same 0.8 bar vacuum source were used. Since suctioning via the endotracheal tube leaves no place for a stylet with a suction catheter being inserted via the tube (Fig. 1), we abandoned its use in both groups.

### 2.3. Test procedure

Within a 60 min “difficult airway management” lecture, the two strategies of performing endotracheal intubation in this study were explained to the volunteers. Subsequently, they were asked to intubate the manikin’s trachea with an 8.5 mm internal diameter cuffed endotracheal tube by suctioning via the endotracheal tube,



**Fig. 2.** Oesophageal intubations (% of intubation attempts) with either suctioning via the endotracheal tube or using the standard strategy by performing laryngoscopy, and performing suction with subsequently advancing the endotracheal tube; NS indicates not significant.

or conventionally in random order. The time from touching the laryngoscope until placement of the tracheal tube and cuff inflation was measured with a stopwatch. Placement of the endotracheal tube was controlled by assessing lung ventilation via the tube with a bag-valve-device. The number of successful vs. unsuccessful intubation attempts was then recorded.

### 2.4. Statistical analysis

Based on a previous study,<sup>5</sup> we estimated a sample size of 31 participants to detect 30% difference in intubation success between devices with 80% statistical power and a two-sided alpha level of 5%. All data are given as median (IQR, CI 95%). Statistical analysis was performed using SPSS 15.0 statistical package (SPSS, Chicago, IL); Kolmogorov–Smirnov’s test was used to test for normal distribution of continuous parameters. As data deviated from normality, duration of intubation attempts was analysed using the Wilcoxon test, and intubation success was analysed using the McNemar test. Two-tailed *P*-values <0.05 were considered statistically significant.

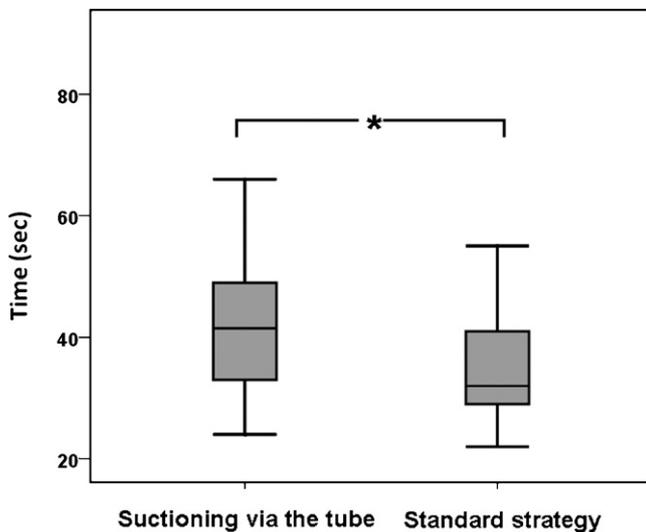
## 3. Results

There was no significant difference in the number of oesophageal intubations between suctioning via the endotracheal tube and the standard intubation strategy [8/41 (20%) vs. 6/41 (15%); *P*=0.688] (Fig. 2). Suctioning via the tube needed significantly more time compared to the standard intubation strategy [median (IQR, CI 95%): 42 (20, 39–60) vs. 33 (15, 35–48) s; *P*=0.015] (Fig. 3). The number of performed tracheal intubations [mean (SD)] performed during the last 12 months was 2.<sup>3</sup>

## 4. Discussion

In cases of severe airway haemorrhage and massive regurgitation, a three-handed rescuer who is able to perform laryngoscopy, suctioning and intubation simultaneously, would be required. Since endotracheal intubation is a complex manual skill, maneuvers that would be best to occur simultaneously are broken up in subsequently occurring components.

Endotracheal suctioning via an endotracheal tube is daily routine in intensive care units, but usually not during an intubation attempt. Our approach was to facilitate the manual skills part during endotracheal intubation by advancing a 20 French suction catheter via the endotracheal tube itself to reduce the number of manual skills components. Surprisingly, this strategy revealed no benefit, but actually consumed more time. Further, the num-



**Fig. 3.** Time (s) needed for intubation with either suctioning via the endotracheal tube or using the standard strategy by performing laryngoscopy, and performing suction with subsequently advancing the endotracheal tube; \* $P < 0.05$ . Note that Y-axis does not start at zero.

ber of oesophageal intubations could not be reduced. Although the suction catheter protrudes the tip of the endotracheal tube just slightly to ensure proper advancement through the vocal cords, most volunteers deemed this setting inconvenient and irritating. This discrepancy may be due to unfamiliarity with the novel strategy, and experience with the standard strategy. Another important reason for insecure endotracheal intubation attempts may have been lack of a stylet in both groups.

But what are alternatives in cases of upper airway haemorrhage? The laryngeal mask airway was shown to be helpful<sup>7,8</sup> and seems to give better protection from oropharyngeal secretions compared to the Combitube<sup>TM</sup>.<sup>9,10</sup> Endotracheal intubation, however, is superior regarding protection from aspiration of gastric contents. Interestingly, the use of a suction laryngoscope showed promising results in manikin-studies of severe airway haemorrhage.<sup>5,6</sup>

Some limitations need to be mentioned. The main study limitation is its manikin character and therefore, our results cannot be directly extrapolated to real patients. However, randomly evaluating new devices or methods in clinical airway bleeding scenarios is extremely difficult. Second, in the clinical emergency setting, most participants would have used a stylet, which was abandoned in this study to enable comparison between both methods. If suctioning via the tube had been superior to the conventional method, we would have designed a suction catheter which could be used as a stylet. Further, we do not know to which extent hygienic problems could occur as a consequence of pulling back the suction catheter through the tube after successful intubation, eventually contaminating the inside of the endotracheal tube. Moreover, we used black coffee instead of real blood or vomitus in order to avoid possible infections or clotting. Furthermore, the effect size was smaller than expected when designing the study and calculating the sample size. Therefore, we cannot completely exclude a type-II-error. Lastly, this study showed failure rates of 15–20%, which is very high. On the other hand, with a coffee flow of 500 mL/min running into the manikin's nasopharynx, we produced extremely difficult intubation conditions. Nevertheless, with approximately two endotracheal intubations per year, clinical experience of our participants, who intubate apneic patients in the field if no physi-

cian is present, was very low. Insufficient clinical practice<sup>11,12</sup> and high failure rates<sup>3,13,14</sup> are inconsistent to other reports in both physician- and non-physician-based emergency medical service systems, necessitating an improvement in airway management education and training.

## 5. Conclusions

In a model of severe airway haemorrhage, suctioning via the endotracheal tube showed no benefit regarding the number of oesophageal intubations and needed more time when compared to the standard intubation strategy.

## Conflict of interest statement

No author has any conflict of interest in regard of devices or methods described in this article.

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