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## Brief Report

# COMPARING THE EFFECTIVENESS OF A NOVEL SUCTION SET-UP USING AN ADULT ENDOTRACHEAL TUBE CONNECTED TO A MECONIUM ASPIRATOR VS. A TRADITIONAL YANKAUER SUCTION INSTRUMENT

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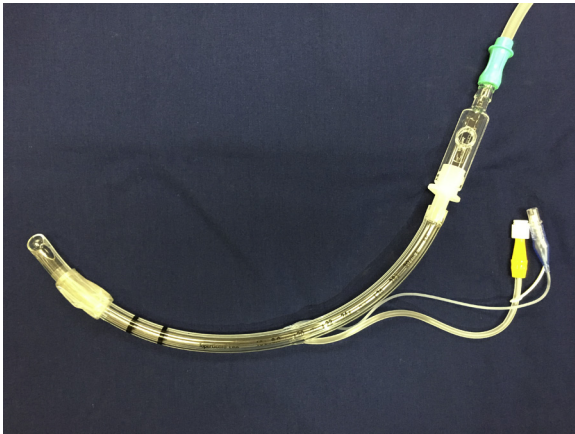
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**Abstract—Background:** It has been suggested that an adult 8.0 endotracheal tube (ETT) connected to a neonatal meconium aspirator would improve suctioning during emergent endotracheal intubation compared to the Yankauer suction instrument, the standard tool used by emergency physicians. **Objectives:** This study was designed to compare the effectiveness of a Yankauer vs. an ETT-meconium aspirator set-up in suctioning liquids of different viscosities. **Methods:** The Yankauer and ETT-meconium aspirator device underwent a head-to-head timed comparison, suctioning 250 mL of three different fluids, varying in viscosity. The first comparison test used tap water to represent simple oral secretions. The second comparison test used porcine whole blood as a proxy for human blood. The third comparison test used a coarsely blended mixture of a hamburger, French fries, and a soda to simulate emesis from a recently ingested meal. Five separate time trials were conducted for each liquid and for each suction device. **Results:** The ETT-meconium aspirator device compared to the Yankauer suctioned faster in both the water comparison test (mean = 2.6 s vs. 3.4 s;  $p < 0.001$ ) and the porcine whole blood comparison test (mean = 2.9 s vs. 4.3 s;  $p = 0.0015$ ). In the emesis trial, the Yankauer immediately clogged, whereas the ETT-meconium aspirator apparatus managed to suction an average of 90 mL prior to clogging. **Conclusion:** Compared to the Yankauer, an adult 8.0 ETT connected to a meconium aspirator was superior in suctioning liquids of varying viscosities and should be considered when encountering a difficult airway due to copious secretions, blood, or emesis. © 2016 Elsevier Inc. All rights reserved.

**Keywords—**airway; intubation; rapid sequence intubation; suction; gastrointestinal bleeding

## INTRODUCTION

Endotracheal intubation can be complicated by the presence of copious secretions, active bleeding, or vomitus, which have the potential to obscure visualization of the airway or lead to aspiration (1). One key component in the preparation for emergent endotracheal intubation is having suction readily available. The Yankauer suction instrument has become the standard tool used by emergency physicians when trying to control secretions, a hemorrhagic airway, or vomitus during intubation. Although effective in suctioning simple secretions and fresh blood, there is concern that more viscous fluids containing coarse matter like blood clots and vomitus may clog these suction devices, rendering them ineffective. As an alternative, Weingart and Bhagwam described a novel set-up using an adult 8.0 endotracheal tube (ETT) connected to a neonatal meconium aspirator (Neotech™ Products, Inc., Valencia, CA) for improved suctioning and simultaneous intubation (Figure 1) (2). In theory, a large-caliber ETT would be more effective in suctioning patients during endotracheal intubation, allowing for



**Figure 1.** An 8.0 endotracheal tube connected to a meconium aspirator.

more rapid suctioning of a larger volume of fluid (Figure 2).

This study was designed to compare the effectiveness of a Yankauer vs. an ETT-meconium aspirator set-up in suctioning liquids of different viscosities.

## MATERIALS AND METHODS

This study was an experimental design in which the Yankauer suction instrument (Argyle™ Flexible Yankauer; Covidien Medtronic Inc., Minneapolis, MN) and the ETT-meconium aspirator device underwent a head-to-head timed comparison, suctioning 250 mL of three different fluids, varying in viscosity. A total of 500 mL of the fluid being tested was placed in a 1-liter graduated pitcher. In each trial, 250 mL was suctioned out of the 500 mL total using a portable Laerdal® Suction Unit



**Figure 2.** Comparison of the different tip sizes of the 8.0 endotracheal tube (above) and the Yankauer suction instrument (below).

(Laerdal, Wappingers Falls, NY) set at a maximum pressure of 500 mm Hg. A designated timekeeper recorded the time to suction 250 mL of each liquid with a stopwatch. In each comparison test, five separate time trials were conducted for each of the two different suction devices. The suction devices and suction tubing were thoroughly cleaned in between each trial.

The first comparison test used tap water to represent simple oral secretions. Suction times were recorded for the Yankauer and the ETT-meconium aspirator device for all five trials.

The second comparison test used porcine whole blood as a proxy for human blood. Congealed porcine blood was placed in a Blendtec Total Blender Classic® (Blendtec, Orem, UT) and blended on the pulse setting for 5 s. The resultant mixture had the consistency of fresh blood with some dime-sized blood clots. Again, suction times were recorded for the two devices.

The third comparison test used a coarsely blended mixture of a hamburger, French fries, and a soda to simulate emesis. All of the ingredients were placed in a Blendtec Total Blender Classic and mixed on the pulse setting for a total of 3 s. The final mixture was primarily liquid in consistency with scattered solid food particles throughout.

For each comparison test, the five recorded times for each device were averaged and an unpaired *t*-test was used to compare the data between the devices.

## RESULTS

The ETT-meconium aspirator device suctioned 250 mL of water faster than the Yankauer in all five water trials and also outperformed the Yankauer in the porcine blood comparison test (Table 1 and Figure 3). As for the blended hamburger meal, the Yankauer immediately clogged in all five trials and no fluid reached the suction tubing. The ETT-meconium aspirator apparatus managed to suction an average of 90 mL of the emesis-like mixture for each of the five trials prior to clogging (Table 2). In addition, the blockages occurred at the level of the suction tubing connecting the meconium aspirator to the portable Laerdal Suction Unit. The ETT itself never clogged despite the presence of solid food particles in the emesis-like mixture.

## DISCUSSION

The Yankauer suction instrument is one of the most widely used suction devices for secretion control during endotracheal intubation. However, the small fenestrations at the tip can become problematic when blood clots or emesis are present and have the potential to clog the

**Table 1. Average Time in Seconds to Suction 250 mL of the Different Liquids by Type of Device (n = 5 for Each Category)**

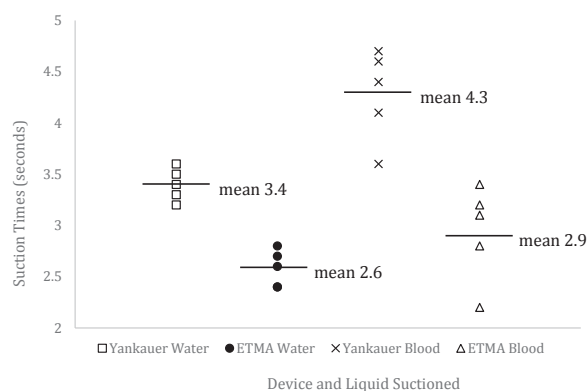
Liquid Suctioned (250 mL)	Yankauer	ETT-Meconium Aspirator Set-up	p Value	95% Confidence Interval
Water	3.4 s	2.6 s	$p < 0.001$	0.59–1.05
Blood	4.3 s	2.9 s	$p = 0.0015$	0.68–1.98

ETT = endotracheal tube.

suction instrument. Visualization of the airway is critical during intubation and the presence of copious secretions, blood, or vomitus can lead to a failed airway. The attachment of a meconium aspirator to an adult-sized ETT is a simple and cost-effective way to quickly convert an airway tube into a suction device. The main benefit is the large-bore internal diameter of the ETT that can accommodate larger amounts of fluid with particulate matter. An 8.0 ETT (8.0 mm internal diameter) is significantly larger compared to the Yankauer with its smaller caliber tip. The tiny suction holes at the Yankauer tip easily clog with large blood clots or food matter.

The ETT-meconium aspirator device outperformed the Yankauer in all three fluids comparison trials (water, blood, and emesis). In both the water and blood trials, the ETT-meconium aspirator device was able to suction 250 mL of each liquid more quickly. As expected, increasing the viscosity from water to blood prolonged the total suction time for both methods.

When it came to the emesis-like mixture, the ETT-meconium aspirator device suctioned a larger amount compared to the Yankauer instrument, which immediately clogged. Furthermore, the rate-limiting factor was the suction tubing that clogged, not the ETT itself. The ETT holds approximately 25 mL of total fluid volume

**Figure 3. Scatter plot of suction times by type of device, Yankauer or endotracheal tube with meconium aspirator (ETMA), and liquid suctioned.****Table 2. The Results of the Emesis Suction Test Between the Yankauer and ETT-Meconium Aspirator Set-up**

Suction Device	Average Amount of Emesis-like Mixture Suctioned (n = 5)	Clogging Location
Yankauer	0 mL	At the Yankauer suction instrument (no fluid reached the suction tubing)
ETT-meconium aspirator set-up	90 mL	At the suction tubing (no clogging in the ETT)

ETT = endotracheal tube.

and the meconium aspirator holds about 20 mL of fluid. All together, the ETT-meconium aspirator set-up holds about 45 mL of fluid. On average, the ETT-meconium aspirator apparatus suctioned 90 mL of the emesis-like mixture, further supporting the idea that none of the clogging occurred at the level of the ETT.

### Limitations

The first limitation to this study was the timekeeper who visually determined when a total of 250 mL was suctioned out of the graduated pitchers. Although the volume markers were clearly indicated on the pitchers, manually starting and stopping the stopwatch has the potential to introduce some timing inaccuracy. To minimize this impact, a single timekeeper was used for every trial and a total of five trials were done for each device in each liquid comparison. The average times of each trial were calculated to help account for any possible timing inaccuracies. The ETT-meconium aspirator device still outperformed the Yankauer with statistical significance.

Secondly, this study was an experimental design and was not conducted during actual intubations on patients in the emergency department. Although water, porcine blood, and a blended emesis-like mixture are not exactly the same as oral secretions, human blood, and actual vomitus, they are very close proxies and likely did not alter the outcome of the study. This study shows the advantages of using the ETT-meconium aspirator set-up for improved suctioning from a mechanical standpoint, despite not testing these devices in actual patients. Further studies may want to address the ease of use of this novel set-up in vivo.

Although this study focuses only on the suction aspects of the ETT-meconium aspirator set-up, it did not address the effectiveness of using this set-up for

intubation. Further studies are needed to address the intubation aspect of this device, with and without a stylet, and the potential complications of bagging through an endotracheal tube that is soiled with secretions, blood, or emesis.

### CONCLUSION

Compared to the Yankauer, an adult 8.0 ETT connected to a meconium aspirator was superior in suctioning liquids of varying viscosities. When encountering a difficult

airway due to copious secretions, blood, or emesis, the ETT-meconium aspirator set-up should be considered.

### REFERENCES

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### ARTICLE SUMMARY

#### **1. Why is this topic important?**

Endotracheal intubation can be complicated by the presence of copious secretions, blood, or emesis in the airway. Having a proper suction set-up is critical to a successful intubation.

#### **2. What does this study attempt to show?**

Although the Yankauer suction instrument has become the standard tool used by emergency physicians during intubation, a more effective suction alternative may be a novel set-up using an adult endotracheal tube connected to a meconium aspirator.

#### **3. What are the key findings?**

Compared to the Yankauer, an adult 8.0 endotracheal tube connected to a meconium aspirator was superior in suctioning liquids of varying viscosities. It not only suctioned water and blood faster than the Yankauer, but it avoided clogging to a much greater extent when confronted with an emesis-like mixture.

#### **4. How is patient care impacted?**

The simple attachment of a meconium aspirator to an adult endotracheal tube may provide effective suctioning of a patient's airway that is compromised with secretions, blood, or emesis and may help a practitioner avoid a failed airway.