Pressure and Flow Dynamics of the Closed Suction System Using Simulated Mucus

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Abstract

Airway or alveolar pressure during the use of a closed suction system has been recently described in two bench studies[1,2]. Actual patient testing has been reported by three others[3-5]. Two of these studies did not mention the effect of mucus inside the lumen of the suction catheter itself, and measured airway pressures. The Frengley study[5] measured intra thoracic pressures at the tip ot the endotracheal tube. While the authors recognized that presence of mucus in the catheter could effect pressures they measured only when the secretions had been cleared. The aim of this bench study was to measure actual flow and pressures at the catheter tip while suctioning simulated mucus.

With the tip of a 14 Fr closed suction catheter (REF 2210, Ballard Medical Products, Draper Utah) inserted into a chamber connected to a flow and pressure transducer (Respical, Timeter St. Louis Mo.), we suctioned simulated mucus through the catheter (15% Methocel J12MS, Nelson Labs) using two different pressures; -120 mm/Hg (-15.9 kPa) and -170 mm/Hg (-22.9 kPa). We recorded flow and pressure simultaneously at the tip of the catheter. To prevent the simulated mucus from entering the transducer, it was slowly (8-10 sec.) injected into the catheter lumen approximately 2 inches above the tip with an 18 Ga. Needle. A new catheter was used for each of 10 recordings at both settings.

When mucus is present inside the lumen of the catheter, both flow and pressure are substantially reduced. At both –120 mmHg (-15.9 kPa) and -170mm/Hg (-22.9 kPa) settings, and no mucus within the catheter, flows averaged 20 liters per minute (LPM). When simulated mucus was present, the flow fell to 8 LPM and 10 LPM respectively. See figure 1. Negative pressures at the tip went from -30 mm/Hg (-3.97 kPa) to -10 mm/Hg on the 120 setting and from-40mm/Hg (5.8 kPa) to -10 mm/Hg on the 170 setting when the mucus was present. See figure 2.

Neither the pressure nor the flow returned to the pre-mucus suction levels. This indicates that without rinsing, some of the mucus remains inside the lumen of the catheter and reduces the ability of the catheter to suction efficiently. It reduces the flow and the pressure at the tip of the catheter. This emphasizes the importance of rinsing the closed suction catheter following use. Figure 3 shows a single suction episode recording at the 120 mm/Hg setting. During and after suction, pre suction levels are not reached.

During the actual suction event, while removing secretions both flow and pressures are reduced at the tip of the catheter. Large negative pressures were not seen in this bench test. Further investigation is warranted with actual clinical settings.

Introduction

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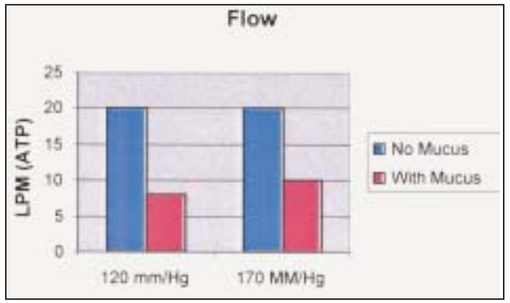

Figure 1 Average Flow

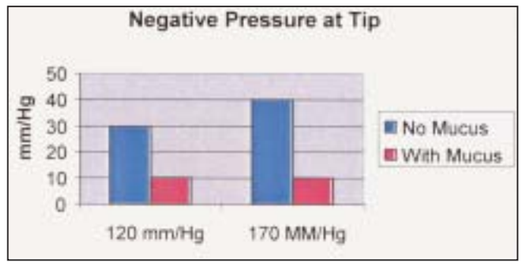

Figure 2 Average Pressure

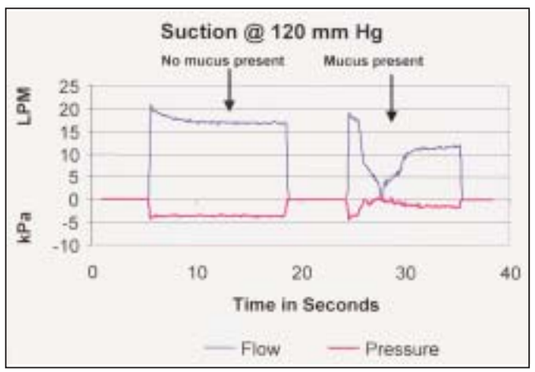

Figure 3 Single Suction Episode

Methods and Materials

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Results

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Conclusions

During the actual suction event, while removing secretions both flow and pressures are reduced at the tip of the catheter. Large negative pressures were not seen in this bench test. Further investigation is warranted with actual clinical settings.

References

1 Stenquist O, Lindgren S, Karason S, et al. Warning! Suctioning. A lung model evaluation of closed suctioning systems. Acta Anaesthesiologica Scandinavica 2001; 45:167-172

2 Wong S, Schettino G, Kacmareck R, et al. Evaluation of alveolar pressure changes during endotracheal suction (abstract). Respiratory Care 2002; 45:1070

3 Cereda M, Villa F, Colombo E, et al. Closed system endotracheal suctioning maintains lung volume during volume-controlled mechanical ventilation. Intensive Care Medicine 2001; 27:648-654

4 Maggiore S, Lellouche F, Pigeot J, et al. Comparison of 3 techniques of endotracheal suctioning (ES) in patients with acute respiratory distress syndrome (ARDS) (Poster). 2001

5 Frengley R, Closey D, Sleigh J, et al. The effect of closed system suctoning on airway pressures when using the Servo-300 ventilator. Critical Care and Resuscitation 2001; 3:148-152

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