

## Endotracheal Tube Intracuff Pressure is Not Equal to Tracheal Wall Pressure on a Simulated Trachea

**Presenting Author:** B. Randall Brenn MD, Vanderbilt University Medical Center, Nashville TN;  
**Co-Authors:** Dinesh K. Choudhry MD, FRCA, Alfred I. duPont Hospital for Children, Wilmington DE; Nicholas A. Brenn BSEE, MSEE, Nespresso: Industrial Engineering, Lausanne CH

**Introduction:** It has been known for decades that pressure exerted by the inflated endotracheal tube cuff on the tracheal wall (TWP), if excessive, can cause tracheal mucosal ischemia leading to necrosis, scarring and tracheal stenosis.(1) It is generally accepted that if the TWP does not exceed 30 mm Hg that there will be little chance of mucosal damage in long term intubation. (2) Also, it is accepted that high-volume low-pressure cuffs if not stretched, the intra-cuff pressure, as measured by the attached pilot balloon, should closely correlate with TWP. (3) The objective of this study was to test the correlation between intra-cuff pressures and TWP using 3 different cuffed tubes in a simulated trachea.

**Methods:** A 4mm force sensitive resistor (SEN-09673, Sparkfun.com) was transposed between the outside of ETT cuff positioned inside an 8 mm ID ETT serving as an in-vitro trachea (faux trachea). Three different sizes of ETT (3.0, 3.5, and 4.0 mm ID) were placed in the faux trachea for the study purpose. A voltage divider circuit was created with the sensor and a current limiting resistor. The pressure applied to the sensor generates a variable voltage output which is read by the Analog-to-Digital Converter (ADC) on an Arduino (Arduino Uno-R3) microcontroller (Software version: Arduino 1.8.5). The ETTs pilot balloon was attached to a three-way stopcock attached to tubing to a manometer in an airtight closed system. Each ETTs pilot balloon was inflated in 0.5cc increments. The pressures inside the cuff were measured with the connected manometer and force exerted by the inflated pilot balloon on the inside of the faux trachea were measured by the transposed sensor. Recordings of the serial pressures were transferred to a spreadsheet for graphical interpretation.

**Results:** The intracuff pressures and the transmural forces exerted between the ETT cuff and the faux trachea are recorded with an interposed sensor for each ETT are shown in figure 1. As the volume and pressure in the pilot balloon is increased, there are clear differences in the resultant recorded tracheal force exerted by the cuffs of different sized ETT tubes.

**Conclusions:** This apparatus revealed that the same intracuff pressure exerts different tracheal wall pressures depending on the size of the endotracheal tubes. The concept that the pilot balloon measured cuff pressure is a good measure of tracheal wall pressure exerted by the ETT cuff is not true.

**References:** 1.Knowlson GT, Bassett HF. Br J Anaesth. 1970;42(10):834-7. 2. Seegobin RD, van Hasselt GL. Br Med J. 1984;288(6422):965-8. 3.Talekar CR, Udy AA, Boots RJ, Lipman J, Cook D. Anaes Int Care2014;42(6):761-70.

Figure 1.

Cuff Pressure vs Tracheal Wall Force

