Effectiveness of a New Method for Endotracheal Tube Pilot Balloon Repair

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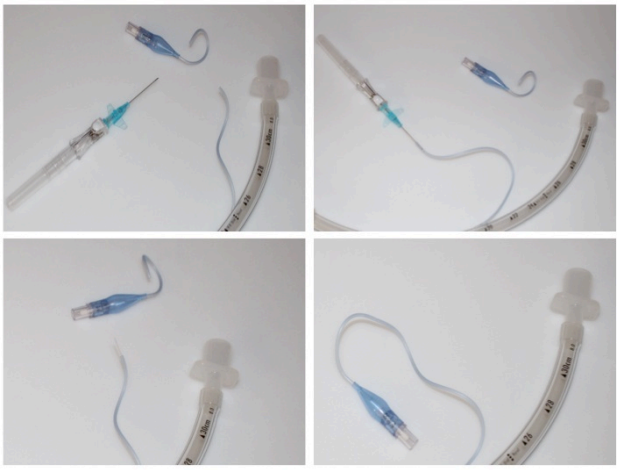
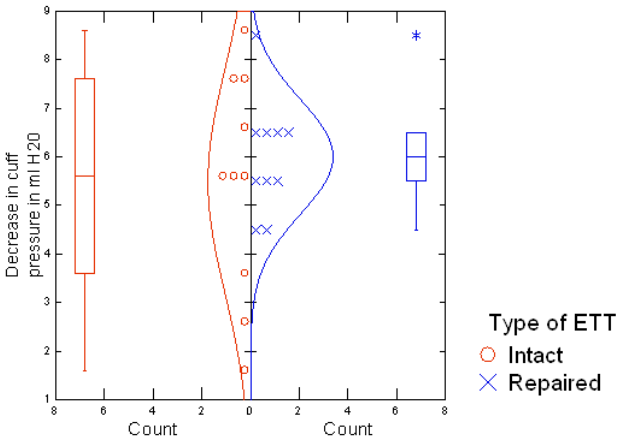
Introduction: An intact pilot balloon is crucial to proper function of a cuffed endotracheal tube (ETT). The one-way valve allows for maintenance and measurement of cuff pressure. Failure of the pilot balloon or disruption of the inflation tubing results in cuff deflation which may lead to inadequate ventilation and aspiration of oropharyngeal secretions. Replacement of the ETT in the presence of a failed pilot balloon can be done, but in the presence of airway edema or an anticipated difficult intubation, such an intervention may present a patient safety risk. We recently encountered a patient in whom the pilot balloon tubing was inadvertently transected during transfer to the ICU bed, resulting in a large leak. We describe the method that we employed using readily available components to repair the pilot balloon and inflation tubing, and report on the effectiveness of the repair method, as tested in vitro.

Methods: A 22 g IV catheter with the hub cut off was inserted into the severed end of the inflation tubing and cut just distal to the end of the catheter. A new pilot balloon assembly was cut off from an intact ETT and guided over the catheter, with the catheter serving as a stent. A ¼" Steri-Strip™ (3M™; MN, USA) was then wrapped around the repaired segment to mitigate against separation of the stented tubing. We tested the ability of the repaired ETTs to maintain cuff pressures of 20-30 cm H_20 measured with a Cufflator (Posey, CA, USA), over an 8-hour interval in an artificial trachea model (20 ml syringe) and the integrity of the repaired segment to high-pressure inflation (measured by placing the repaired segment under water and looking for air bubbles). In addition, we measured the static tensile strength of intact and repaired ETT inflation tubing. To assess generalizability of our repair method, we evaluated ETTs from Mallinckrodt as well as from Smiths Medical, Parker Medical and Sun Med.

Results: Data (mean ± standard deviation) from 10 unaltered ETTs were compared to 10 repaired ETTs.
Eight-hour interval measurement demonstrated a mean pressure drop of 5.5 cm H_20 (SD 2.28) in the unaltered ETTs in comparison to a mean pressure drop of 6.0 cm H_20 (SD 1.18) in the repaired ETTs representing a difference in means of 0.5 cm H_20 (p value = 0.54).
There was no visible air leak from the repaired inflation line segments at a pressure of 120 mm Hg. In addition, tensile strength testing revealed that the mean force needed to break brand new inflation tubing was 36.4 N (SD 2.69). Repaired inflation tubing was able to withstand a mean force of 14.5 N (SD 3.70) before disruption, representing a difference of means of 21.9 N (p value = $<10^{-6}$). Repairs using ETTs ranging in size from 3.0 to 8.0 and various manufacturer were successful in all cases; in some cases, a 24g IV catheter was required as the stent.



Two-sample t-test



Conclusion: Our method for ETT repair allows for quick, reliable repair of the pilot balloon using readily available supplies. A commercial product, BE 409 Pilot Tube Repair Kit (Instrumentation Industries Inc.; PA, USA) is available which uses a metal tapered needle as the stent, similar to our method. However, the assembly is not MRI compatible and may not be available. Our described method can be effectively used as a temporizing measure in a situation where ETT exchange would be difficult or risky. Due to the reduced tensile strength of the repaired segment, it is our recommendation to identify the repaired tubing with a marker, such as colored tape, in order to alert practitioners.