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Objective Measurement of Endotracheal Tube Cuff Pressures Improves Patient Outcomes: Expert-Reviewed Practice Considerations

Abstract

Background: Incorrect endotracheal tube cuff pressure (ETCP) during mechanical ventilation is associated with patient complications, including tracheal injury and ventilator-associated pneumonia. Although manometry is the gold standard for ETCP monitoring, many anesthesia providers continue to rely on subjective "guesstimation" techniques, increasing the risk of patient harm.

Purpose: This project aimed to develop an evidence-based, expert-validated educational infographic promoting objective ETCP monitoring using a manometer and highlighting the risks associated with subjective methods.

Methods: A comprehensive literature review informed infographic development. A Modified-Delphi approach, using the validated Mini Checklist tool, was employed to establish expert consensus. A panel of 12 experts, including anesthesia providers and intensive care unit physicians, evaluated five infographic sections using a structured Qualtrics survey. These sections included: (1) myths and facts about ETCPs, (2) patient-related cuff pressure complications, (3) factors that influence cuff pressures, (4) ETCP measuring techniques, and (5) the gold standard for cuff pressure monitoring in practice. Each section was assessed for content, efficacy, usability, understandability, and completeness.

Results: All infographic sections met the predefined threshold for consensus (≥80%) after a single survey, with a high overall interrater reliability (Gwet's AC-2 = 0.97). Qualitative feedback was minimal but provided insights on the target audience and equipment considerations that may inform future iterations or dissemination strategies.

Conclusion: This project achieved expert consensus on an evidence-based infographic promoting objective ETCP monitoring with a manometer. The infographic is a practical, up-to-date educational tool that aligns with anesthesia providers' commitment to evidence-based practice and protecting patients from anesthesia-related harm. Its use may help improve airway safety and inform future clinical and educational initiatives. Further dissemination and evaluation of this tool in diverse clinical environments will help determine its impact on provider practices and patient outcomes.

Keywords: endotracheal tube cuff pressure, objective monitoring, manometer, anesthesia, patient safety

MYTHS & FACTS ABOUT ENDOTRACHEAL

CUFF PRESSURES

MYTHS

Accurate measures of cuff pressures include:
- Pilot balloon palpation
- Minimal occlusive volume technique
- Fixed air volume technique

Cuff pressure complications are rare and not a significant concern

Cuff pressure monitoring is only necessary for long-term intubation or in the ICU

Cuff pressure monitoring with a manometer is complex and time consuming

FACTS

These techniques are **HIGHLY** inaccurate and unreliable! [1,2,3]

Tracheal stenosis, fistulas, and aspiration-related pneumonia are some of the few COMMON risks [4,5,6]

Complications can occur within 15 MINUTES if cuff pressures are not safely monitored [4]

Using a manometer is quick, easy, and takes LESS THAN 1 MINUTE!

PRACTICE CONSIDERATIONS FOR OPTIMIZING ENDOTRACHEAL TUBE (ETT) CUFF PRESSURE MONITORING

For Healthcare Providers

PATIENT-RELATED CUFF PRESSURE COMPLICATIONS [1,2,6]

Microaspiration of Oral Secretions

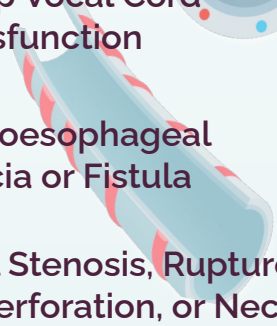
Microaspiration of Stomach Contents

Aspiration Pneumonia

Hypercapnia, Hypoxia, Respiratory Acidosis

Post Op Sore Throat

Post Op Vocal Cord Dysfunction



Tracheoesophageal Malacia or Fistula

Tracheal Stenosis, Rupture, Ulcertion, Perforation, or Necrosis

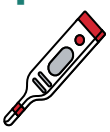
Did You Know These *ALSO* Affect ETT Cuff Pressures?

Nitrous Oxide (N_2O)

INCREASES ETT CUFF PRESSURE

N_2O diffuses more rapidly into the ETT cuff than nitrogen diffuses out of the cuff [7,8,9]

Temperature



INCREASES OR DECREASES ETT CUFF PRESSURE

Charles's Law: Increase in temperature → increase in volume if pressure remains constant [10,11]

Head & Neck Positioning

INCREASES OR DECREASES ETT CUFF PRESSURE

Position changes like head extension, neck rotation, tracheal compression, and increased intrathoracic pressure, can change airway pressure [12,13,14]

By: Janice Tso, SRNA at Northeastern University. IRB Approval #: 25-02-23

ETT Cuff Pressure Measuring Techniques
What Does The Research Say?*

Scan for References

METHOD	HOW IT'S DONE	EVIDENCE
MANOMETER	Attaches to the pilot balloon and directly measures cuff pressure	HIGH [1,2,5]
LOSS OF RESISTANCE SYRINGE (LOR)	Overinflate pilot balloon and allow syringe plunger to passively draw back until ceased	HIGH [3,15,16]
PRESSURE VOLUME LOOP (PV-L) CLOSURE	After intubation, inflate ETT cuff by 2mL of air followed by increments of 0.5mL until complete closure of PV-L	MODERATE [17,18,19]
MINIMAL OCCLUSIVE VOLUME	Volume of air injected until it eliminates an audible end-inspiratory leak	LOW [3,20,21]
MINIMAL LEAK	Volume of air injected until there's a "small" audible leak during end-inspiration	LOW [3,22,23]
FIXED AIR VOLUME	Random predetermined volume of air injected with a syringe	LOW [2,23,24]
PILOT BALLOON PALPATION	Inflate pilot balloon while palpating it until balloon feels "appropriate"	LOW [2,15,16]

*Arranged in descending order based on strength of available evidence regarding the technique in achieving optimal cuff pressures incorporated in this review

Gold Standard for Cuff Pressure Monitoring in Practice

MANOMETER

Recommended ETT Cuff Pressure Range:

20 - 30 cmH_2O

(14 - 22 mm Hg)

Perform **objective** measurements of ETT cuff pressures at least **every 8 to 12 hours** or as needed using a pressure manometer connected to the pilot balloon [1,4,25]

If a manometer is not readily available, the LOR and PV-L techniques are viable options.