

Prevention of Infection
**“The Endotracheal Tube Cuff:
 Shape & Material”**

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Disclosures

- Covidien
- Kimberley-Clark / Halyard

Armamentarium to prevent VAP

- Prevention of microaspiration
- Prevention of bacterial translocation
- Prevention of biofilm formation
- Modulation of colonization
- Reduction of exposure time
- Basic infection control

Armamentarium to prevent VAP

Prevention of microaspiration

Prevention of bacterial translocation

Prevention of biofilm formation

Modulation of colonization

Reduction of exposure time

Basic infection control

Source: Expert Rev Respir Med 2012; Expert Rev Respir Med

- Subglottic secretions drainage
- PEEP
- Automated Pcuif control
- Ultrathin ETT cuff wall
- Tapershaped cuff

Effective sealing extraluminal airway
Cuff material: PVC vs. poly-urethane

Problem HV-LP cuffs: inflation → folds → channels



	PVC cuff	PU cuff
Cuff wall thickness	50 – 80 micron	~10 micron
	Folds with channel formation	Folds without channel formation

Effective sealing extraluminal airway
Cuff material: PVC vs. poly-urethane

- Systematic review
 - Laboratory
 - Clinical
- Outcomes
 - Leakage/micro-aspiration
 - Intubation-related pneumonia

Effective sealing extraluminal airway Cuff material: PVC vs. poly-urethane

- In vitro studies**
 - Dullenkopf, Intensive Care Med 2003
 - Lucangelo, Crit Care Med 2008
 - Dave, Br J Anesth 2010
 - D... (change and elasticity of the trachea model)
 - K...
 - O...
 - Z...
 - Li... (ventilatory simulation)
 - ± PEEP (at various levels)
 - ± tracheal suctioning simulation (at various suction pressures)
 - Lau, Hong Kong Med J 2014
 - duration of leakage observation (20 min. → 1 hr. → 24 hrs.)
- In vivo study**
 - Li Bassi, Chest 2016

(!) Broad heterogeneity in experimental set up

(!) In all in vitro studies PU cuffs sealed substantially / significantly better compared with PVC cuffs

→ proof of concept!

Blot S, et al. Crit Care 2016

Effective sealing extraluminal airway Cuff material: PVC vs. poly-urethane

Clinical data: outcome = micro-aspiration

- Lucangelo (Crit Care Med 2008)
 - RCT
 - Bronchoscopic evaluation of presence of Evans blue in trachea at 1, 5 and 12 hrs. post-intubation
- Nseir (Intensive Care Med 2010)
 - Prospective observational trial
 - Pepsin in tracheal secretions as measure for micro-aspiration
 - Recorded at 24 hrs. post-intubation

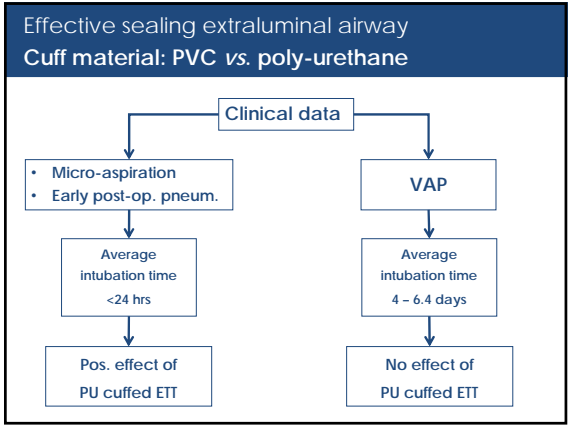
→ significantly less micro-aspiration in PU-cuffed ETTs

Blot S, et al. Crit Care 2016

Effective sealing extraluminal airway Cuff material: PVC vs. poly-urethane

Clinical data: outcome = pneumonia

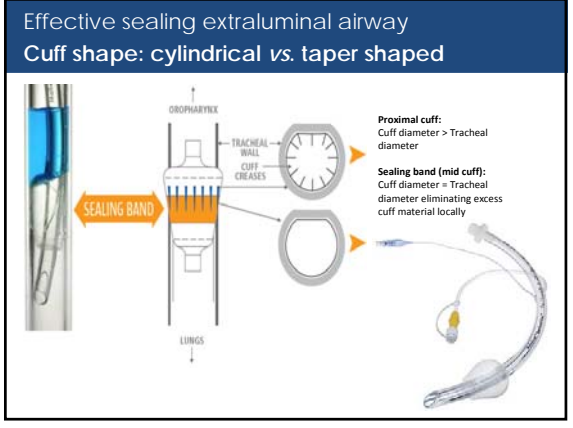
Author, year	Design, cohort	Outcome	Result	P
Poelaert, 2008	RCT, 1 CSICU	Early post-op. pneumonia	PU: 23% (15/67) PVC: 42% (28/67)	0.03
Miller, 2011	Before-after study; 5 ICUs	VAP	Baseline (PVC): 5.3/1000 MVD Intervent. (PU): 2.8/1000 MVD	0.014
Suhas, 2016	1-center RCT, SICU	VAP	PU: 15% (6/40) PVC: 33% (13/40)	0.07
Philippart, 2015	Multicenter RCT, 4 groups	VAP	PU-cylindrical: 17% PVC-cylindrical: 11% PU-tapered: 16% PVC-tapered: 13%	0.202 0.505



Effective sealing extraluminal airway Cuff material: PVC vs. poly-urethane

Conclusion

PU-cuffed ETT seems to postpone rather than to avoid micro-aspiration, and as such clinical benefits are more obvious in short-term intubated patients.



Effective sealing extraluminal airway Cuff shape: cylindrical vs. taper shaped

In vitro research: taper shaped cuffs...
- reduce fluid leakage by an average of 90%
- reduce air leakage

(!) → proof of concept!

Mecca R & Torpey H. white paper Covidien 2008
Madjidpour et al. Eur J Anaesthesiol 2009

Effective sealing extraluminal airway Cuff shape: cylindrical vs. taper shaped

Clinical data: outcome = micro-aspiration
Leakage of methylene blue dye besides the cuff in patients undergoing gastric bypass surgery:

Endoscopy confirmed leakage of methylene blue besides the cuff

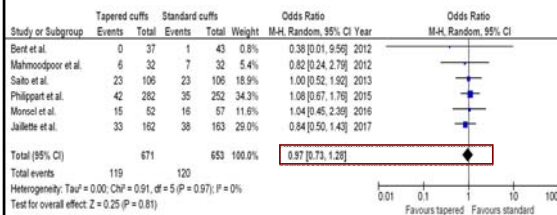
Taper-shaped PVC cuff	Barrel-shaped PVC cuff
0/33 (0%)	15/34 (44%)

Mulier J, et al. Congress of the ASA, San Diego, 2010

D'Haese J, et al. Acta Anaesth Scand 2013
Gaszynska E, et al. Polski Przegląd Chirurgiczny 2014

Effective sealing extraluminal airway Cuff shape: cylindrical vs. taper shaped

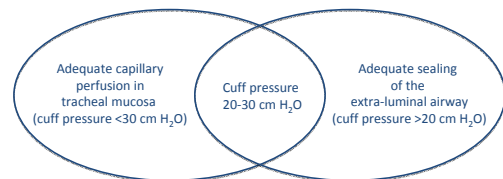
Clinical data: intubation-associated respir. tract infection



Maertens B, et al. Crit Care Med 2017; in press.

WARNING! Adequate cuff inflation

Target range: 20 – 30 cm H₂O



Rello J, et al. Am J Respir Crit Care Med 1996
Brimacombe J, et al. Br J Anaesth 1999

Effective sealing extraluminal airway Factors influencing Pcuff

Factor	Effect on cuff pressure (Pcuff)	References
Time	loss of cuff volume with time → Pcuff↓	Sole ML, et al. Crit Care Med 2003
Positive pressure ventilation	↑ pressure ventilation → Pcuff↑	Bernhard WN, et al. Chest 1985 Guyton D, et al. Chest 1991
Core temperature (T°)	as T° ↓ → Pcuff↓	Inada T, et al. Br J Anaesth 1995
N ₂ O ventilation	diffusion of N ₂ O in cuff → Pcuff↑	Nguyen T, et al. Anesth Analg 1999 Braz JR, et al. Sao Paulo Med J 1999
Sedation and neuromuscular block	↓ in muscle tone → Pcuff↓	Mehta, Myat. Ann Royal Coll Surg Engl 1984 Girling KJ, et al. Anesth Analg 1999
Bronchoconstriction, laryngeal spasms, edema formation	↑ in airway pressure or narrowing tracheal diameter → Pcuff↑	Sole ML, et al. Am J Crit Care 2002
Changes in patient positioning	migration of ETT in trachea → Pcuff↑	Kim JT, et al. Can J Anaesth 2009 Lizy C, et al. Am J Crit Care 2014
Helicopter transport	high altitude → Pcuff↑	Bassi M, et al. Ann Emerg Med 2010

WARNING! Adequate cuff inflation

(!) No use of automated Pcuff monitoring in the trials assessing value of PU- & taper-shape-cuffed ETTs.

(!) Clinical value of these cuffs can only be optimally assessed when Pcuff is completely controlled.

Conclusion: PU- & Tapershape-cuffed ETT

- Proof of concept
 - Reduce leakage (in vitro)
 - Reduce micro-aspiration
- No reduction of pneumonia in RCTs
 - Exception: PU-cuff → early post-op. pneumonia
- Both ETT-designs deserve re-assessment in circumstances with optimal Pcuff control

Thank you

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