Cuffed or uncuffed ETT in pediatric anesthesia?

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Overview

- History
- Survey
- Tradition
- Pro-Con Debate
- Conclusions
History of intubation

- **1878**: First tracheal intubation
- Rarely performed in children before the 1940s
- **1942**: Introduction of NMBA
- **1960s**: Development of PVC (polyvinylchloride) tubes
- **Late 1990s**: Development of newer PVC high-volume low-pressure (HVLP) cuffed ETT
- **2004**: Introduction of the ultrathin polyurethane Microcuff pediatric ETT
National Survey about the use of cuffed endotracheal tubes in pediatric anesthesia

METHODOLOGY
• Questions based on the literature
• Sent to +/- 2000 anesthesiologists
• 12 November – 6 December
• Anonymous

RESULTS
341 answers
Experience in pediatric anesthesia

62%
From what age do you consider using a cuffed ETT?

47%
What is your main reason for using a cuffed ETT?
Do you think there is a higher tube exchange rate when using an un cuff ed ETT? 59%
Do you use the same size for a cuffed or uncuffed ETT?

- 62.5% no, size -0.5
- 22.9% no, size depending on the case
- 14.7% yes
Do you regularly measure cuff pressure in pediatric patients?

- 39.6%: once, after intubation
- 43.2%: sometimes, in specific cases
- 17.2%: continuously
When using a cuffed ETT in pediatric patients, do you always inflate the cuff?

- 71.7%: No, only when there is a leakage
- 28.3%: Yes
What cuff pressure do you consider acceptable in pediatric patients?
The size of the ETT refers to:

- **the inner diameter**: 28.5%
- **the outer diameter**: 71.5%
Do you think a Murphy eye is an added value for pediatric ETT?

49%
Do you think a depth marking is an added value for pediatric ETT?

72%
Why do we use uncuffed ETTs in pediatric anesthesia?

**Traditional use:**
Cuffed ETT should not be used in children < 6 years

**Why?**
1. Fear of mucosal injury leading to subglottic stenosis
2. Uncuffed ETT: larger internal diameter → lower work of breathing / lower resistance
PRO-CON DEBATE
CON CUFFED ETT
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
3. Special characteristics – problems during placement
4. Efficiency of ventilation
5. Specific Indications
6. Complications of intubation
1. Economical aspects
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Anatomy of the larynx
1. Economical aspects
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Problems with the design of pediatric cuffed ETT

1. Variation in OD
2. Cuff diameter
3. Cuff position
4. Depth marking

1. Variation in OD

- Material (PVC)
- OD + deflated cuff

<table>
<thead>
<tr>
<th>ID (mm)</th>
<th>OD (mm)</th>
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<tbody>
<tr>
<td>3,0</td>
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<td>3,5</td>
<td>4,9</td>
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<tr>
<td>4,0</td>
<td>5,6</td>
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</table>
Problems with the design of pediatric cuffed ETT

1. Variation in OD
2. HVLP cuff & cuff diameter (20 cmH₂O)
3. Cuff position
4. Depth marking
Problems with the design of pediatric cuffed ETT

1. Variation in OD (~ material)
2. Cuff diameter (20 cmH₂O)
3. Cuff position
4. Depth marking
Fig 3 ID 3.0 mm cuffed tracheal tubes and age-related corresponding ID 3.5 mm uncuffed tracheal tubes are shown in 12 available tube brands. Missing CPTT are tracheal tubes not manufactured (Table 1). With the depth marking positioned at the glottic level (GL) or with the upper border of the cuff positioned 1 cm below the vocal cords some of the CPTT become with their tube tip critically low in the trachea (MT=mid-trachea; TC=tracheal carina).

Problems with the design of pediatric cuffed ETT

1. Variation in OD (~ material)
2. Cuff diameter (20 cmH₂O)
3. Cuff position
4. Depth marking
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
3. Special characteristics – problems during placement
4. Efficiency of ventilation
5. Specific Indications
6. Complications of intubation
Other size for a cuffed ETT?

- **no, size - 0.5** (62.5%)
- **no, size depending on the case** (22.9%)
- **yes** (14.7%)
- Increased work of breathing
- Higher ventilation pressures
- Faster tracheal tube obstruction
- Difficult tracheal suctioning
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
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6. Complications of intubation
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
3. Special characteristics – problems during placement
4. Efficiency of ventilation
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6. Complications of intubation
1. Capillary perfusion pressure in humans: 20 – 30 mmHg


2. CAVE need for additional monitoring
PRO CUFFED ETT
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
3. Special characteristics – problems during placement
4. Efficiency of ventilation
5. Specific Indications
6. Complications of intubation
Lower tube exchange rate

- Our survey
- Literature
  - Weiss *et al* (2009)
    2246 patients <5 years:
    2.1% (cuffed) vs 30.8% (uncuffed) reintubation rates
  - Dorsey *et al* (2010)
    228 patients <10 years:
    7.2% (cuffed) vs. 37.6% (uncuffed) reintubation rates
Decreased fresh and volatile gas use

• Decreased patient cost
• Decreased pollution of the atmosphere
  • Khine et al (1997)
    \( \text{N}_2\text{O} > 25 \text{ppm:} \)
    37% (no cuff) vs 0% (cuff)
  • Murat et al (2001)
    [Sevoflurane] 48.1 ppm → 0.3 ppm
    [\text{N}_2\text{O}] 92 ppm → 29.4 ppm
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
3. Special characteristics – problems during placement
4. Efficiency of ventilation
5. Specific Indications
6. Complications of intubation
Smaller ETT size

- Smaller ETT through delicate cricoid
- Level of sealing in trachea differs
  - Cuffed ETT: U-shaped cartilages
  - Uncuffed ETT: rigid cricoid ring
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
3. Special characteristics – problems during placement
4. Efficiency of ventilation
5. Specific Indications
6. Complications of intubation
Cuff pressure

- PVC HVLP cuffed ETT
- 2004: Microcuff ETT
  - Lower sealing pressures
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
3. Special characteristics – problems during placement
4. Efficiency of ventilation
5. Specific Indications
6. Complications of intubation
Adjustment of the cuff…

- Adequate sealing of the airway
- Lower clinically significant air leak
  - Dorsey *et al* (2010)
    - 228 intubation events:
      - air leak 1.8% (cuff) vs 23.1% (no cuff)
- Exact estimation of exerted pressure on tracheal mucosa
What is your main reason for using a cuffed ETT?

Minimizing ETT leak:
- Efficiency of ventilation
- Maintenance of PEEP
- Maintenance of constant minute ventilation
- Stabilising gas parameters
- More reliable respiratory monitoring
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
3. Special characteristics – problems during placement
4. Efficiency of ventilation
5. Specific Indications
6. Complications of intubation
Specific indications

• Rapid sequence induction
  • Full stomach
• Laparoscopy
• Oropharyngeal surgery
1. Economical aspects
2. Size – Anatomy of the pediatric larynx
3. Special characteristics – problems during placement
4. Efficiency of ventilation
5. Specific Indications
6. Complications of intubation
Decreased rates of aspiration

- Our survey

- Literature

  Tracheal aspirates positive for gastric pepsin:
  - PICU, 27 patients: 53% (cuff) vs 100% (no cuff)
  - Elective surgery, 10 patients: 10% (cuff)
Less airway damage

- Decreased reintubation rate to find correct sized ETT
- Smaller diameter tube through delicate cricoid
- Less movement of the ETT in the airway with inflated cuff
- Less accidental extubations
Should we use more cuffed ETTs?

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<thead>
<tr>
<th></th>
<th>PRO CUFF</th>
<th>CON CUFF</th>
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<tr>
<td><strong>Economical</strong></td>
<td>- Lower tube exchange rate</td>
<td>- High cost of cuffed ETT</td>
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<td>- Low flow anesthesia</td>
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<td>- Environmental pollution</td>
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<tr>
<td><strong>Size</strong></td>
<td>- Smaller ETT through delicate cricoid</td>
<td>- Need to use a smaller ID</td>
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<td><strong>Characteristics of ETT</strong></td>
<td>- Microcuff: lower cuff pressure</td>
<td>- Variation in OD</td>
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<td></td>
<td></td>
<td>- Cuff diameter &amp; cuff position</td>
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<td></td>
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<td>- Depth marking</td>
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<tr>
<td><strong>Efficiency of ventilation</strong></td>
<td>- Adequate sealing</td>
<td>- Increased work of breathing</td>
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<td>- Accuracy of capnography</td>
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<td>- Maintenance of PEEP</td>
<td>- Difficult tracheal suctioning</td>
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<td><strong>Specific indications</strong></td>
<td>- RSI</td>
<td>- Congenital cardiac surgery on CPB</td>
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<td></td>
<td>- Laparoscopy</td>
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<td>- Oropharyngeal surgery</td>
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<td><strong>Complications of intubation</strong></td>
<td>- Decreased rate of aspiration</td>
<td>- Potential morbidity of cuff pressure</td>
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<td></td>
<td>- Less airway damage</td>
<td>- Need for additional monitoring</td>
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State of the art

• Choose adequate size for ETT
• Always measure cuff pressure
• Specific indication?
• CAVE N₂O
• CAVE perfusion pressure
References

• Thomas R, Shripada R, Corrado M. Cuffed endotracheal tubes for neonates and young infants: a comprehensive review. Arch Dis Child Fetal Neonatal Ed. 2015; 0.
• Doherty J. et al. Pediatric laryngoscopes and intubation aids old and new. Pediatric Anesthesia 2009, 19: 30-37
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