Cuffed endotracheal tubes for children; use and abuse

Helen Smith
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In children...cuffed or uncuffed?

VOTE - two questions:

If you were handed a cuffed ETT would you use it:

1. In a child < 8 years?
2. In a child < 1 year?
History of Paediatric tubes

Sir Ivan Magill 1930

David Sheridan 1959
History of Paediatric tubes
History of Paediatric tubes
Factors leading to laryngeal mucosal damage

• Lateral wall pressure
• Movement
• Hypotension
• Local infection
• Use of steroids
• Duration of intubation
Eckenhoff J. E. Some anatomic considerations of the infant larynx influencing endotracheal anesthesia. Anesthesiology. 1951;12((4)):401-410

“cricoid ring is functionally the narrowest part of the airway”
However...


- Narrowest part of airway in child = vocal cords
- Doesn’t change with age (20 months - 8 years)
- Elliptical shape of larynx AP
But in children...

“Rigid cricoid ring is functionally the narrowest portion of the larynx”

“cricoid ring is unyielding, prone to the development of oedema and scarring in response to excessive mucosal pressure.”
Endotracheal cuff pressure and tracheal mucosal blood flow: endoscopic study of effects of four large volume cuffs

R D Seegobin, G L van Hasselt
Endotracheal cuff pressure and tracheal mucosal blood flow: endoscopic study of effects of four large volume cuffs

R D SEEGOBIN, G L van HASSELT

Adult study:
over 30 cm $H_2O$ impairment of mucosal blood flow
over 50 cm $H_2O$ total obstruction of blood flow

**Conclusion:** continuous monitoring of cuff pressure req’d
Sizing


Full term new born to 8yrs

Age/4 + 3

Table 1. Table of Tube Sizes

<table>
<thead>
<tr>
<th>Cuffed Size (mm ID)</th>
<th>Uncuffed Size (mm ID)</th>
<th>Patient’s Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>4.0*</td>
<td>Full term newborn to 1st birthday</td>
</tr>
<tr>
<td>3.5</td>
<td>4.5</td>
<td>1 y to 3rd birthday</td>
</tr>
<tr>
<td>4.0</td>
<td>5.0</td>
<td>3 y to 5th birthday</td>
</tr>
<tr>
<td>4.5</td>
<td>5.5</td>
<td>5 y to 7th birthday</td>
</tr>
<tr>
<td>5.0</td>
<td>6.0</td>
<td>7 y to 9th birthday</td>
</tr>
</tbody>
</table>

* Smaller at discretion of attending anesthesiologist: 3.0 in 4 patients; 3.5 in 11 patients, 4.0 in 34 patients.
Sizing


Full term new born to 8yrs

Age/4 + 3


Full term new born to 8yrs

≥ 3 kg - 1 yr: 3.0

1-2 yrs: 3.5

≥ 2 yrs: Age/4 + 3.5
Problems arising


Cuff diameters - variable OD for same ID
Cuff positions...
Problems arising
Problems arising

Ideally cuffed ETT:
HVLP cuff, short length
Adequate depth markings not to allow cuff to be inflated in subglottic region
Positioning

Cuff edges

Studies using cuffed ETT in children

Khine HH Anesthesiology 1997; 86: 627-631.

488 - new born to 8
  251 cuffed
  237 uncuffed

Same number of patients treated for croup like symptoms:
  1.2% cuffed
  1.3% uncuffed
Studies using cuffed ETT in children - Khine 1997

Benefits of cuffed ETT:
No rpted laryngoscopy
Low FGF
↓ Pollution
↓ aspiration
↑ Reliability of $CO_2$ monitoring
Studies using cuffed ETT in children - Khine 1997

**Against cuffed ETT:**
Requires smaller ETT - ↑airway resistance
↑work of breathing

Cuff not necessary - seal with uncuffed OK
“for the vast majority of children undergoing general anaesthesia and for many of those in intensive care, there is in truth little benefit to be gained using cuffed tubes.”

Studies using cuffed ETT in children


1997-2000 - 15000 pts all cuffed ETT no ↑ resp comp

2000 prospective - no resp comp due to ETT

• 5435 intubated
• 3834 < 8
• 904 < 1
Studies using cuffed ETT in children - Murat 2001

**Benefits of cuffed ETT:**

- ↓ ETT replacement
- ↓ Pollution
- ↓ Expense of volatiles
- ↑ Function of ventilators
Studies using cuffed ETT in children - Murat 2001

No subglottic stenosis in 10 yrs

Caution:
No inflation of cuff if no leak
Inflation cuff guided by difference in insp\(^y\) and exp\(^y\) volume
Weiss and Gerber (Zurich)

Involved in designing the Microcuff GmbH

• Short cuff
• Ultrathin polyurethane (10µm) – no folds/channels
• No Murphy’s eye
• Depth markings
“Large single centre experience and clinical studies have not confirmed a higher incidence of laryngeal trauma or post-intubation stridor caused by cuffed pediatric tracheal tubes in pediatric anesthesia or pediatric intensive care,...”
“... as long as correctly sized tracheal tubes and cuff pressure monitoring is used.”

2246 pts birth to <5 in 24 centres using... microcuff

Pressure monitored

≤20 cm H₂O

No increase in post extubation stridor

- 30 pts (1-17yr), >4hr, cuff at 20 cm H\textsubscript{2}O
- Intracuff pressure when compared to the baseline intracuff pressure ranged from -25.8 to +16.3 cmH\textsubscript{2}O
- In no patient, did the intracuff pressure remain the same as the baseline throughout the procedure.

20 PICU, 15 Anaes questionnaires (from 30)
5% PICU, 7% Anaes routinely used cuffed ETT <8
Reason against – minimal benefit
Reason for – low lung compliance
Cuff pressure, not monitored anaes (45% PICU)
Agreement that:
“endoscopically positioned, cuffed tube closely monitored control of cuff pressure and tube movement... 
...would be unlikely to cause difficulties.”

Plus:
“no study has demonstrated an increased risk of airway complications related to the use of CTT...
... provided a CTT of appropriate size is chosen and the cuff pressure is monitored and adapted.”
Ideal cuffed ETT:
• high-volume-low pressure cuff
• short cuff length,
• adequate depth markings and not allow the cuff to be inflated in the subglottic region
Risk of damage with cuffed ETT↑ if:

• Oversized outer tube diameters
• Poorly designed cuffs
• Wrongly positioned tubes
• Overinflating of the cuff
Cuffed ETT in children:

- ↓ need for multiple intubations,
- ↓ costs
- No ↑ adverse effects in children of all ages.
Personal experience...
For Cuffed ETT in children

• Less pollution/fewer leaks, reduced cost
• Easier ventilation, good seal, measuring CO2 more reliable (esp in neonates)
• Less changes of ETT/ less direct laryngoscopy attempts (reduced exchange rate) - first intubation may be the best!
• Too large ETT causes laryngeal damage, cuffed or uncuffed
• Less aspiration
Against Cuffed ETT in children

- Cuff causing damage to laryngeal mucosa - post extubation stridor (No evidence from lit...yet?)
- Overinflation of cuff
- Poor positioning (less forgiving)
- Diff succioning down small ETT as need to downsize by 0.5mm to allow for cuff
- More expensive (but save on gases)
- Difficulty placing small ETT in small children (no lit <3kg)
- Accidental extubation (clefts)