PREHOSPITAL CARE

Cuffed endotracheal tube use in paediatric prehospital intubation: challenging the doctrine?

R S Clements, A G Steel, A T Bates, R Mackenzie

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Questioning traditional doctrines is essential if patient care is to improve and progress. Historically accepted teaching is to use uncuffed tubes in all children up to puberty. This has been the practice in anaesthesia, intensive care and paediatric resuscitation both in and out of hospital. The use of cuffed endotracheal tubes (ETTs) in pre-pubertal children is evolving in general anaesthesia and intensive care in hospital practice. In contrast, uncuffed tubes are still widely recommended for use in the prehospital environment in this age group. There are a number of good reasons why a cuffed tube should be considered in preference to an uncuffed tube in children intubated out of hospital, regardless of their age or size. There are also some counterarguments which are worthy of consideration. This article presents the arguments for and against the use of cuffed tubes in children in prehospital care with a view to stimulating open discussion and debate.

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IN SUPPORT OF CUFFED TUBES

1. Historically, the principle reason for advocating the uncuffed tube was the concern that friction induced oedema at the cricoid ring causes temporary or permanent tracheal stenosis. The literature contains case reports of tracheal stenosis after prolonged intubation (with an uncuffed tube),⁸ but there have been no large studies documenting the risk of tracheal stenosis in children intubated with a cuffed tube. Indeed, a recent prospective controlled non-randomised study of 210 children on a paediatric intensive care unit has challenged this long-held belief. There was no difference in post-extubation oedema, rate of successful extubation or the need for tracheostomy in the 210 children under 5 years of age intubated with a cuffed tube compared with 287 children with intubated with uncuffed tubes.⁹
2. There is a theoretical reason to believe that a cuff might actually reduce the risk of tracheal stenosis by preventing the trauma created by the tip of the uncuffed tube as it rubs against the trachea. The cuff would hold the tip away from the inner surface of the trachea thereby preventing it from rubbing. Although the tube should always be firmly secured, some tube movement is likely with the number of transfers inevitable between the prehospital and intensive care environments.
3. The aim of a prehospital intubation is to achieve a secure airway with safety and speed. Although the modified Cole formula (age/4+4) gives a good estimation of the optimal internal diameter of the ETT based on the age of the patient, it is not always perfect. An ETT which is too small may leak to such an extent that adequate ventilation may not be achieved. A randomised clinical trial of electively anaesthetised children between 1 and 8 years old showed that the rate of tube change in the 251 children randomised to cuffed tubes was significantly lower ($p < 0.001$) than in the 237 children randomised to uncuffed tubes.¹⁰ To change an already secured airway exposes the patient to

Endotracheal intubation in the prehospital management of injured or ill children is controversial. There are data reporting adverse outcomes in an urban setting with conventional ambulance personnel.¹ These data cannot be extrapolated to the critically unwell children who are attended by a team skilled in airway management, anaesthesia and critical care. This discussion therefore rests with not whether these children should be intubated but what they should be intubated with.

Historically accepted teaching is to use uncuffed tubes in all children up to puberty. This has been the practice in anaesthesia, intensive care and paediatric resuscitation both in and out of hospital.² The most recent resuscitation guidelines released in November 2005 from the Resuscitation Council (UK)³ state that "cuffed tracheal tubes are as safe as uncuffed tubes for infants (except newborns) and children if rescuers use the correct tube size and cuff inflation pressure, and verify tube position". The guidelines state that this applies "only in the hospital setting".

The resuscitation guidelines are developed following rigorous reviews of the available literature.^{4 5} Whereas the evidence supporting the use of cuffed tubes in hospital is "acceptable and useful", the recommendation regarding its out of hospital use is of "indeterminate" value. There has been no out of hospital research involving cuffed tubes in children. Evidence from hospital studies is relevant to the prehospital environment; decisions related to intubation of critically ill or injured children are not dependent on location but the clinical need and the safety and efficacy with which it can be conducted.^{6 7}

See end of article for authors' affiliations

Correspondence to:
R S Clements, MAGPAS,
105 Needingworth Road
Stives, Cambridgeshire,
PE27 5WF, UK;
rachelclements@
doctors.org.uk

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Abbreviation: ETT, endotracheal tube

the risk of hypoxia and mucosal trauma from repeated laryngoscopy and tube insertion and may prolong scene time. Use of a cuffed tube from the outset may obviate the need for this risky procedure.

4. Owing to the nature or severity of their injuries (or illness) some children may require particularly high inflation pressures. This is more achievable with a cuffed tube than an uncuffed tube (which would allow the higher pressure to dissipate around the tube). In addition, a cuffed tube allows for the delivery of positive end expiratory pressure. Both of these features allow for the development of more sophisticated and flexible ventilation strategies.¹¹
5. Monitoring of end tidal carbon dioxide using capnography is an essential tool in the safe transfer of all ventilated patients. This is more accurate with a cuffed tube than an uncuffed tube. It also facilitates more complex ventilatory monitoring within the intensive care unit.¹²
6. Part of the reason that cuffed tubes are preferred in the adult population is to minimise aspiration risk. In the unstarved prehospital population aspiration is a risk in paediatric patients.¹³ An inflated cuff reduces this risk.¹⁴
7. If a cuffed tube is used, there is an option not to inflate the cuff unless certain circumstances such as poor lung compliance, high airway resistance or a large glottic leak exist at the time of intubation or develop during the clinical course. This strategy would need to be weighed against the loss of accurate monitoring and risk of aspiration and the theoretical risk that the ridges present in an uninflated cuff may cause friction.
8. Paediatric prehospital intubation is a rare event. In the prehospital environment the use and management of cuffed tubes, as in adults, will be much more familiar to most practitioners. Furthermore, the ability to assess and manage leaks around uncuffed tubes, although easily performed in quiet hospital settings, can be extremely challenging in the noisy out-of-hospital environment.

AGAINST CUFFED TUBES

1. Positioning of a cuffed tube could be problematic in the smallest children with a relatively short trachea. If the tip of the tube is in an optimum position in the mid trachea, an inflated cuff may extend upwards into the subglottic larynx or even through the vocal cords. In an attempt to avoid this, the tube may be inserted too far, thus risking an endobronchial intubation.^{14 15}
2. A cuffed tube with an internal diameter calculated by $(\text{age}/4)+3$ was appropriate for 99% of paediatric patients.¹⁰ This is a 1.0-mm smaller internal diameter than the uncuffed tube for the same age using the modified Cole formula. Under laminar conditions, the resistance to gas flow increases as the diameter of the tube decreases (according to the Hagen-Poiseuille equation, flow is proportional to the radius to the power of 4), such that an uncuffed tube with its larger internal diameter allows for less resistance to air flow. Modern intensive care unit ventilators are readily able to compensate for this potentially increased resistance to airflow. However, many of the prehospital and transport ventilators in current use may generate unnecessarily high peak inspiratory pressures. As care extends from the prehospital phase through into intensive care and onto the weaning phase, the increased resistance to air flow could pose a problem as the child attempts to self-ventilate through the ETT. Smaller internal diameters also present difficulties with endobronchial suctioning and may be more prone to obstruction with endobronchial secretions.

3. There will be legitimate concerns regarding the ability of prehospital teams to satisfy the three qualifiers which are attached to the use of cuffed tubes in hospital practice: correct tube size, safe cuff inflation pressures and verification of tube placement. If the age of the child is known, the formula described above can be employed to calculate tube size. If the age is unknown, use can be made of the Broselow tape (or similar) with modification.⁷ Cuff inflation pressures can be estimated manually or a manometer could be carried. Tube position in the airway can be confirmed with capnography, with clinical examination to diagnose endobronchial placement.

CONCLUSION

There are a number of compelling reasons to support the use of cuffed tubes in those children who might benefit from intubation in the prehospital environment. When performed by competent and properly equipped personnel, prehospital anaesthesia and endotracheal intubation provides a continuum of care with hospital intensive care. The concept that a cuffed tube should be reserved for in-hospital practice is illogical and may expose the patient to unnecessary risk as tubes are changed, as well as potentially delaying the optimum delivery of care. There is no doubt that targeted research addressing the use of cuffed tubes in prehospital care is needed. Until it is available, prehospital critical care practitioners should use the current evidence to question contemporary doctrine and should consider using cuffed endotracheal tubes in this highly selected group of critically injured and ill children.

Authors' affiliations

R S Clements, MAGPAS and Basildon and Thurrock University Hospitals NHS Foundation Trust, Basildon, UK

A G Steel, MAGPAS and Norfolk and Norwich University NHS Trust, Norwich, UK

AT Bates, MAGPAS and East of England NHS Ambulance Trust, Norwich, UK

R Mackenzie, New South Wales Neonatal and Paediatric Emergency Transport Service (NETS), Westmead, NSW 2145, Australia

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