

When to extubate the croup patient: the "leak" test

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The reliability of "leak" as a criterion for elective extubation of children with croup treated with nasotracheal intubation was studied during the three month "croup epidemic" in Ontario of September 1, 1983 to November 30, 1983. Twenty-eight patients experienced 36 extubations; 31 planned and five accidental. Three of 23 (13 per cent) planned extubations with "leak" required reintubation whereas three of eight (38 per cent) children electively extubated after seven days of intubation without "leak" required reintubation. "Leak" is a helpful but not absolute prognostic indicator of a successful extubation.

Croup, a relatively common manifestation of viral infection of the respiratory tract in children, ranges in severity from trivial to life-threatening. Children manifesting the most severe airway compromise require artificial airways, i.e., tracheostomy or nasotracheal intubation, for varying lengths of time. In most paediatric Intensive Care Units, tracheostomy has fallen into relative disfavor and intubation has become the preferred method of treatment.^{1,2} Criteria for extubation vary in different institutions and reintubation remains a significant possibility even after planned extubation.¹ We set out, retrospectively, to evaluate "leak" as a criterion for successful extubation.

Between September 1, 1983 and November 30, 1983, 28 patients with croup were managed with nasotracheal intubation in the Intensive Care Unit of the Hospital for Sick Children in Toronto. Seventeen of these children were admitted to the ICU from the Emergency Department or from the wards as primary care patients of the Hospital for Sick Children, while 11 patients were trans-

ferred to the hospital in its capacity as a tertiary referral centre.

Methods

A "leak" was defined as one of: vocalization around the tube, an air leak heard with the child coughing, or an air leak demonstrated with a positive pressure insufflation of 40 cm H₂O using a modified Jackson-Rees "T" piece set. During the period of investigation, all patients intubated in the Intensive Care Unit were intubated by one of the six Intensive Care Fellows or by an anaesthetist in the Operating Room. When intubation was indicated, an inhalational anaesthetic technique with halothane and oxygen was used. An orotracheal tube was initially passed to ensure the rapid establishment of an airway and to determine the correct size tube to be used. The tube size selected was in general the smallest size that would give an adequate airway and yet minimize trauma to the mucosa at the swollen subglottis (Table 1). Once the child was fully oxygenated and excess secretions removed, a nasotracheal tube was passed. If the oral tube had not passed easily, a half size smaller was selected for the nasotracheal tube (but not less than a 3.0 Portex). The tube was positioned below the level of T₂ but at least 2 cm above the carina, and the position was confirmed radiographically. If the child found it difficult to breathe through the small airway, continuous positive airway pressure of 5 cm H₂O was added (two patients).

If the tube size was felt to be too large in children transferred from other centres (two), they were reintubated with a smaller size tube under general anaesthetic. Both patients were successfully extubated with "leak."

The children's arms were placed in restraints and humidification provided, either with humidified air by hood or "T" piece, or by the use of a "Swedish nose" (condenser humidifier Portex 570015) during play and parenting periods. Tracheal secretions were sent for gram stain and culture. Antibiotics were only used in situations where a significant number of pus cells was seen and a pure culture of pathogenic bacteria obtained (staph aureus).

Children were extubated when they were afebrile, when the endotracheal secretions had decreased, and "leak" was present. Children at seven days of intubation

Key words

LARYNX: croup; INFECTIONS: croup; INTUBATION, TRACHEAL: leak test, extubation.

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who were afebrile and whose secretions were small were extubated regardless of the absence of an air leak.

Extubations were performed in the Intensive Care Unit by one of the six ICU Fellows. If the child developed upper airway obstruction shortly after extubation, nebulized racemic epinephrine inhalations were administered. (Steroids were not used.) If this failed, reintubation under general anaesthetic was performed. Only one patient required reintubation more than 24 hours following extubation.

Results

Twenty-eight patients between the ages of five months and 54 months were extubated during the study period, of whom eight required reintubation (and subsequent extubation) for a total of 36 extubation attempts.

Of 31 planned extubations, 3/23 (13 per cent) with "leak," and 3/8 (38 per cent) without "leak" at seven days, failed. Of five accidental extubations, 2/4 without "leak" failed.

Overall, of 36 extubation attempts, 21/24 (88 per cent) with "leak" and 7/12 (58 per cent) without "leak" were successful (Table II).

Discussion

Management of the croup patient with severe airway compromise is much more difficult than that of the patient with epiglottitis. For epiglottitis, extubation criteria and programs for when and how to extubate patients are constantly being revised,³⁻⁵ but it now appears safe to extubate the usual epiglottitis patient within 24-48 hours of intubation if he has defervesced, if secretions are small, and if vocalizing around the tube. If the patient

with epiglottitis accidentally extubates, he is much less likely to require urgent reintubation and in many cases, particularly if 10-12 hours have elapsed since intubation, and if antibiotics have been given, may not require reintubation.⁴ On the other hand, children with croup are more problematic. The syndrome is variable, usually viral in aetiology, most often due to parainfluenza types 1 and 2,^{6,7} and as a viral disease may last anywhere from 3-14 days. The pathological process diffusely involves the subglottic region and passage of an endotracheal tube may be difficult if not impossible, should too large a tube size be chosen. The size of the tube chosen is critical. It must be large enough for adequate spontaneous ventilation and removal of secretions and yet small enough to minimize compression of the subglottic region.

Croup patients often have copious tenacious secretions associated with the inflammatory changes in the airway, and therefore are very prone to tube occlusions.¹ We were fortunate in our series that no tube occlusions occurred.

There are few studies advocating when to extubate the croup patient; however, our reintubation rate of 19 per cent of planned extubations in 1983 compares favourably with that of Zullinger *et al.*¹ Although our numbers are small, with 28 patients (36 extubations) in a three-month period, the reintubation rate of 12.5 per cent (3 of 24 patients) extubated after demonstrable "leak" would seem to support "leak" as a helpful, but certainly not absolute, prognostic factor for successful extubation ($p = 0.05$). Of the three cases reintubated without "leak" at the initial extubation, one child was extubated six days after the first attempt, this time with "leak"; the second child was extubated successfully a further seven days later without "leak" and the third child was extubated successfully with "leak" after bronchoscopy, excision of granulomata of vocal cords, and innominate artery suspension.

The three children who failed planned extubation with "leak" were extubated again with "leak" two days, six days and four days following their initial extubation.

Although in this series only five children accidentally extubated themselves, 40 per cent (two of five) required reintubation, a significant figure.

A number of factors influence the presence of "leak" around an endotracheal tube. These include the amount of positive pressure applied to the tube, the presence of airway narrowing below the tube, the presence of neuromuscular blockade, and head position.⁸

Standardization of the "leak" test by applying a set pressure with the child's head in the neutral position and fully paralyzed with neuromuscular blocking drugs may improve the specificity of the test and reduce the likelihood of reintubation,⁸ but the use of muscle relaxants in this situation is not justifiable.

TABLE I Nasotracheal tube sizes based on age

Age	Internal diameter (mm)	
	Usual	Croup
0-6 months	3.0-3.5	3.0
6 months-2 years	4.0	3.5
2-5 years	5.0	4.0
>5 years	5.5	4.5

TABLE II Extubations during the "epidemic" period, September 1, 1983-November 30, 1983. (Total ICU intubated croup patients (primary and transfers). Number of patients - 28)

	Successful	Failed	Total
With "leak"	21* (88%)	3	24
Without "leak"	7* (58%)	5	12
Total number of extubations			36

* $p = 0.05$.

Intubated children with croup can usually be successfully extubated when endotracheal secretions have decreased, and when an audible air "leak" can be heard with coughing or demonstrated with a positive pressure insufflation of less than 40 cm H₂O.

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Résumé

La fiabilité du test d'apparition d'une fuite d'air comme critère d'extubation des enfants intubés par voie nasotrachéale pour croup (laryngotrachéite) a été étudiée du 1er septembre 1983 au 30 novembre 1983 lors d'une épidémie de croup en Ontario. Vingt-huit patients ont eu un total de 36 extubations; 31 planifiées et cinq accidentelles. Trois des 23 (13 pour cent) extubations planifiées avec (fuite) ont nécessité une réintubation tandis que trois des huit (38 pour cent) enfants extubés électivement après sept jours d'intubation sans (fuite) ont dû être réintubés. Une fuite est un indice de pronostic utile mais non absolu du succès d'une extubation.