Laryngotracheobronchitis: 2 years' experience with racemic epinephrine

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A relatively new form of treatment of laryngotracheobronchitis, administration of racemic epinephrine by intermittent positive-pressure breathing, was begun in 1973 in the pediatric unit of a large community hospital. A review of 2 years' experience with this treatment, compared with the experience of the 3 years prior to its introduction, has shown that it has reduced significantly the necessity for tracheostomy, to nearly zero, and the duration of hospital stay. A total of 119 children (33.15% of those admitted) received this treatment, the average number of treatments required being 1.8. There were no important complications of treatment and no deaths.

L'administration d'épinéphrine racémique par respiration sous pression positive intermittente est un traitement relativement nouveau de la laryngotrachéobronchite; son emploi dans l'unité de pédiatrie d'un important hôpital communautaire a débuté en 1973. La revue d'une expérience de 2 ans avec ce traitement, comparée à l'expérience enregistrée au cours des 3 années qui ont précédé son introduction, a montré que celui-ci avait diminué significativement la nécessité de recourir à la trachéostomie, l'abaissant presqu'à zero, ainsi que la durée d'hospitalisation. Dans 119 admissions (33.15% du total) ce traitement a été donné, le nombre moyen de traitements requis étant de 1.8. Aucune complication sérieuse attribuable au traitement n'a été observée et aucun décès n'est survenu.

Acute laryngotracheobronchitis (LTB) is one of the common emergencies in pediatric practice and a frequent cause of emergency room visits during the winter. None the less, this condition is poorly understood, nomenclature varies among authors, and treatment remains controversial.

LTB is an acute inflammatory condition of the subglottic portion of the trachea, with the tracheobronchial tree being affected to a variable extent. Inflammatory edema and viscid secretions may rapidly obstruct the upper respiratory airway, threatening asphyxia. Small children are particularly vulnerable because of their narrow airway and the looseness of the areolar tissue in the submucosa. Although LTB occurs in children from ages 3 months to 15 years, 80% of patients are less than 4 years old and males outnumber females about 2 to 1.[1] The etiologic agent is usually parainfluenza 1, 2 or 3 virus, respiratory syncytial virus, influenza A or B virus, or adenovirus.[2]

Clinical features

Two forms of LTB can be distinguished: "acute spasmodic croup", with sudden, usually nocturnal onset, barking cough, hoarseness, stridor and respiratory distress; and LTB of gradual onset, heralded by catarrhal symptoms, fever and slowly increasing obstruction of the upper respiratory tract. The latter form may be accompanied by leukocytosis.

Diagnosis is usually not difficult, but LTB has to be distinguished from acute epiglottitis, an inflammatory obstruction of the supraglottic structures caused by *Hemophilus influenzae* type b. The distinguishing features were well summarized by Fearon and Bell.[3] Acute epiglottitis affects older children and the onset is more rapid, progressing to painful dysphagia, drooling and a characteristic grunting stridor, but not the typical barking cough of LTB. Epiglottitis is usually accompanied by fever and leukocytosis. Visible swelling of the epiglottis is not a *sine qua non* of acute epiglottitis; the aryepiglottic folds and ventricular bands may be the only structures affected. Radiographs of the upper respiratory tract help to distinguish LTB from acute epiglottitis (Fig. 1). Rarer conditions to be distinguished include edema of the glottis, retrotonsillar or retropharyngeal abscess, neoplasms and vascular compression.

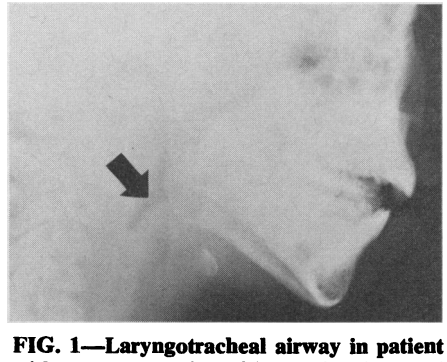

FIG. 1—Laryngotracheal airway in patient with acute epiglottitis: widening of epiglottis.

Treatment

Placing the child in a croup tent ("croupette"), with a nebulizer providing maximum humidity and varying concentrations of oxygen, is universally accepted treatment. Adequate hydration is essential and mild sedation is useful. Antibiotics, though rarely indicated, are commonly used. Syrup of ipecac in subemetic doses, an old standby, is of doubtful value.

The question of corticosteroids is by no means settled. Even the most recent papers on this topic lead to divergent conclusions. In 1966 Skowron, Turner and McNaughton[4] reported no appreciable improvement with dexamethasone, given parenterally, and Eden, Kaufman and Yu[5] reported similar results in 1967 with a smaller dose of dexamethasone. James,[6] also using double-blind methods, reported in 1969 faster improvement with a larger, single dose of dexamethasone. In 1973 Massicotte and Tétreault[1] used methylprednisolone in a carefully controlled double-blind study; they reported significant acceleration of improvement but only in cases of LTB with gradual onset, not in "acute spasmodic croup". (Are we dealing with two separate clinical entities?)

If, in spite of the above measures, the patient's condition continues to deteriorate, tracheostomy or nasotracheal intubation has always been resorted to in the past. In the best hands this has produced excellent results and a mortality of only 0.09%.[7] Reluctance to switch to other treatment modalities is, therefore, understandable.

A new form of therapy was introduced in 1966 by Jordan and colleagues,[8,9] first in cases of postintubational laryngeal edema, then in cases of LTB. Briefly, their method consists of administering 2.25% racemic epinephrine, diluted 1:8 with water, by intermittent positive-pressure breathing (IPPB) with a Bird-type respirator and a tight-fitting face mask. The drug is thought to act by local vasoconstriction. Ten years' experience with this treat-

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ment was reviewed by Adair and colleagues[10] in 1971. Their results were striking: following the introduction of this treatment in 1963 no tracheostomies were required and mortality was zero. These findings were subsequently challenged by Gardner and associates[11] from results of retrospective and prospective review and a small double-blind study. They found no significant difference between the effect of racemic epinephrine and that of placebo (normal saline). However, they had included cases of epiglottitis. In the course of an animated exchange in the correspondence column of *Pediatrics* Gardner and associates[12] claimed that removal of the cases of epiglottitis from their series resulted in no significant change in the results. Nevertheless, two points merit consideration: (a) Gardner and associates admitted that their double-blind study was "too small to allow statistical evaluation";[11] and (b) other studies[13,14] have shown excellent results with this treatment, similar to those of Jordan and Adair.

Our own experience with racemic epinephrine at Scarborough Centenary Hospital confirms the usefulness of this treatment. We introduced it in January 1973 and since then have used it exclusively in the treatment of more severe cases of LTB. Our data, presented below, parallel those of Rüll and Hargitai,[13] who also reported on a large series from a community hospital.

Analysis of our experience with racemic epinephrine therapy

Methods

The records of all 868 admissions of patients aged 15 years or less to Scarborough Centenary Hospital with a diagnosis of LTB during the years 1970-74, 589 (67.86%) of which were of boys, were analysed. Treatment with racemic epinephrine by IPPB was started on Jan. 1, 1973. We compared two groups of children — those admitted before initiation of this treatment and those admitted subsequently — for the proportion requiring tracheostomy and the duration of hospital stay.

The method of Jordan and Adair for treatment with racemic epinephrine was followed closely: we used a Mark VII Bird Respirator, set for the "assist mode", with the oxygen–air mix control adjusted for pure oxygen or an oxygen–air mixture, as required. Racemic epinephrine, 2.25% (Vaponefrin, Arlington Laboratories: racemic epinephrine hydrochloride, 2.25%, with 0.5% chlorobutanol as a preservative), diluted 1:8 with sterile water, is introduced into the nebulizing chamber. The pressure is set at 15 cm of H_2O. The flow rate is set at rapid initially and then decreased as the child adjusts to the treatment. The sensitivity control is set at 5 or less for ease of triggering by the fatigued child but not so low as to make the machine trigger itself. A close-fitting mask is applied firmly to the child's face. Treatment is continued for 15 minutes, with one or more brief pauses if necessary. Struggling by the child should not tempt one to abandon treatment. Improvement usually starts within 5 to 15 minutes and struggling ceases. Proper functioning of the equipment and tight apposition of the face mask are essential.

Results

Our experience with LTB in children during the years 1970-74 is summarized in Table I. One death occurred in 1972, in a child with epiglottitis who was moribund on admission; none occurred in 1973-74. In 1971 another patient suffered anoxic brain damage due to dislodgement of the tracheostomy tube.

Of the 359 admissions the patients required racemic epinephrine in 119 (33.15%) instances. Our indications for this treatment were stridor at rest, anxiety, pericostal or sternal retraction, or both, respiratory rate of more than 30/min and heart rate of more than 120 beats/min, all indicating severe LTB. However, we soon came to realize the advantage of treating milder LTB: rapid and unpredictable deterioration could be prevented by early treatment. No complications of the treatment were encountered, such as cardiac stimulation, arrhythmias or vasoconstriction with appreciable increase in blood pressure. In fact, the heart rate usually decreased to normal as soon as the patient responded to treatment. Furthermore, no "rebound effect" was observed and most patients required only 1 treatment (average number of treatments per patient, 1.8). In most cases striking improvement occurred within 10 to 15 minutes of

Table I—Numbers of hospital admissions for laryngotracheobronchitis (LTB) or acute epiglottitis (AE) in 1970-74 and proportions in which tracheostomy was required

Year	Diagnosis		Tracheostomy required	
	LTB	AE	Total	With LTB (% of LTB admissions)
1970	150	3	5	2 (1.33)
1971	201	3	8	5 (2.49)
1972	158	4	10	6 (3.79)
Total, 1970-72	509	10	23	13 (2.55)*
Racemic epinephrine therapy started Jan. 1, 1973				
1973	198	2	3	1 (0.51)
1974	161	3	1	0
Total, 1973-74	359	5	4	1 (0.28)*

*Difference between proportions significant at $P < 0.01$; $\chi^2 = 6.8$ (with 1 degree of freedom).

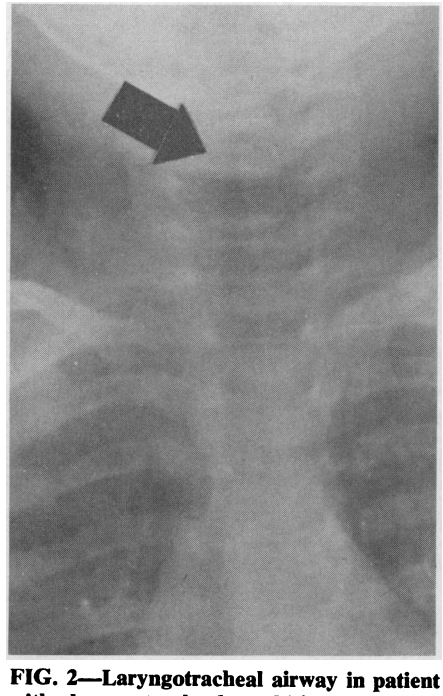

FIG. 2—Laryngotracheal airway in patient with laryngotracheobronchitis: hourglass-shaped narrowing of upper trachea due to subglottic swelling.

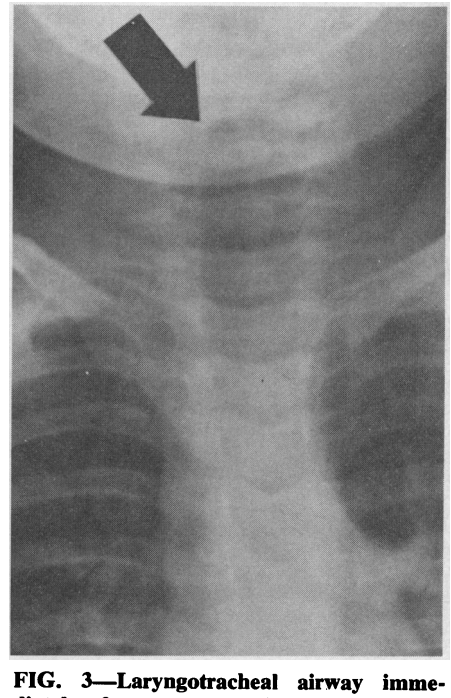

FIG. 3—Laryngotracheal airway immediately after treatment with racemic epinephrine: reappearance of "square shoulders" of normal subglottic space.

Table II—Duration of hospital stay for laryngotracheobronchitis

Year	Duration of hospital stay (days) and nos. of admissions											
	1	2	3	4	5	6	7	8	9	10	≥11	Total
1970	14	21	33	26	16	12	7	3	4	5	9	150
1971	19	32	53	43	20	7	8	4	2	5	8	201
1972	18	24	41	24	15	17	7	4	—	1	7	158
Total, 1970-72	51	77	127	93	51	36	22	11	6	11	24	509
Mean duration, 4.23 days* (SD, 2.9 days)												
1973	15	58	41	29	24	14	3	6	2	4	2	198
1974	32	40	32	29	12	5	3	4	2	—	2	161
Total, 1973-74	47	98	73	58	36	19	6	10	4	4	4	359
Mean duration, 3.45 days* (SD, 2.2 days).												

*Difference between means significant at $P < 0.001$ ($t = 4.28$).

initiation of treatment: stridor and chest wall retraction at rest were reduced or disappeared, heart rate and tachypnea diminished, and restlessness and distress disappeared. In the few who required repeated treatment the improvement was gradual, but only one patient failed to respond. The clinical improvement can be visualized radiologically (Figs. 2 and 3).

Of the 509 hospitalizations in the first 3 years tracheostomy was required in 13 (2.55%), whereas of the 359 hospitalizations in 1973-74 tracheostomy was required in only 1 (0.27%), that of a 6-month-old boy who was admitted in extremis with LTB complicated by bilateral bronchopneumonia. By chi-square analysis (with 1 degree of freedom) the difference between the two groups in the proportion requiring tracheostomy was significant ($P < 0.01$; $\chi^2 = 6.8$).

The effect of treatment on the duration of hospital stay is indicated in Table II. In 1970-72 the mean duration was 4.23 days (standard deviation [SD], 2.9 days), whereas in 1973-74 it was 3.45 days (SD, 2.2 days). The difference between the means was significant ($P < 0.001$; $t = 4.28$). When only patients without a secondary diagnosis such as pneumonia, sinusitis or otitis media were considered, the difference between the mean durations in the two groups was equally significant: for the 304 such admissions in 1970-72 the mean duration was 3.59 days (SD, 2.3 days), whereas for the 236 such admissions in 1973-74 the mean duration was 2.92 days (SD, 1.15 days), the difference being significant at $P < 0.001$ ($t = 3.85$).

Conclusion

Our experience with racemic epinephrine therapy by IPPB in the treatment of LTB confirms previous reports about its efficacy. It represents an important advance in the treatment of a potentially fatal disease. In the absence of any significant side effects or complications we did not find it necessary to substitute other α-adrenergic agents such as phenylephrine. Not only is response to this treatment rapid, but also tracheostomy can almost always be avoided. A small child is thus saved the psychological trauma of speechlessness and the discomfort of an indwelling tracheostomy tube. Lastly, there is a significant reduction in the duration of hospital stay, which has both psychological and economic implications.

We thank our colleagues Drs. R.Y.K. Ing, A. Shams and D.T.C. Givelas for permission to study the records of their patients, Professor A. Csima of the University of Toronto for statistical analysis, the nursing staff and the medical record librarians of Scarborough Centenary Hospital, and all those without whose help this study would have been impossible.

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