

If the drug (which is now less effective) is administered in doses sufficient to produce degrees of complete relaxation and apnoea normally to be expected with suxamethonium, accumulative effects, overdosage, and slow recovery are to be expected, though likely to be antagonized by the administration of neostigmine. If the hypothesis is correct, that oxytocin modifies the action of suxamethonium by inducing some change in the end-plate reaction, it is likely that the clinical action of D-tubocurarine will be affected also. It would be expected that the increased resistance to depolarization would lead to a susceptibility to the non-depolarizing relaxant. However, we have not been able, as yet, to investigate this possibility in the normal course of our clinical practice.

Abnormal effects following suxamethonium are likely to be avoided by the administration of the relaxant in an infusion, by unhurried induction of the required level of relaxation, and by minimal titrated administration. It has been our practice, however, to advocate an initial dose of 50 mg. of suxamethonium intravenously in obstetric patients as there is a danger of regurgitation in such patients if endotracheal intubation is long delayed. These considerations have been discussed elsewhere (Hodges *et al.*, 1959).

Anaesthetists engaged in obstetric practice should bear in mind the atypical effects which may occur following the use of muscle relaxants, on those occasions when the oxytocic posterior pituitary extracts have been employed previously.

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The South-western Regional Cancer Records Bureau has now issued its annual report for 1957. The population of the region is nearly 3 million. According to the report, almost all cancer cases there are now notified to the Bureau. The number of new cases in 1957 was 9,552. Tables show the numbers of cases registered, treated, and alive from 1945 to 1952 classified under different types of malignant growth, while five-year survival rates for treated cases are appended to each table. Much the commonest form of malignant disease registered in 1945–52 was cancer of the breast, with 5,085 cases. Next was cancer of thoracic organs, 2,288 cases, and then cancer of stomach, 2,218. The lowest five-year survival rate was for cancer of oesophagus, 3.1% of cases, followed by cancer of thoracic organs, 5.5%, and of pancreas, 5.6%. Cancer of the eye showed the highest five-year survival rate, with 71.6%. The rate for cancer of the breast was 43.9%.

ACUTE LARYNGO-TRACHEO-BRONCHITIS

AN ACCOUNT OF 122 CASES STUDIED IN THE HOSPITAL FOR SICK CHILDREN, TORONTO*

BY

ANN M. PEACH, M.B., D.C.H.†

AND

ELISABETH ZAIMAN, M.A., B.M.‡

From the Research Institute, the Hospital for Sick Children, Toronto, Canada

During the first world war and the following five years, reports of "non-diphtheritic croup" began to appear. Physicians described cases of illness clinically resembling diphtheria, but without the typical membrane, that did not respond to diphtheria antitoxin. In addition the Klebs-Loeffler bacillus could not be isolated from the throat in such cases. Amongst the names given to this condition were "non-diphtheritic croup," "false croup," "pseudo-croup," and "acute stenotic laryngitis." Baum (1924) proposed the term "acute laryngo-tracheo-bronchitis," and this has been used with minor variations since that time.

The literature was reviewed extensively by Neffson in 1944, and his monograph (Neffson, 1949) summarized the current opinions on incidence, pathology, bacteriology, diagnosis, and management of the condition. Since then the newer antibiotics have been used and evaluated, otherwise the principles of treatment and the criteria for diagnosis have remained unaltered.

The present investigation was undertaken as part of a project to elucidate the aetiological factors in this condition. It has already been reported that some evidence was obtained from studies of tissue culture, using monkey kidney monolayer cultures, that a virus was present in the tracheal secretions of some of the cases (Morgan *et al.*, 1956). Further investigations in 1955–6 yielded more substantial evidence for such a virus aetiology, as a cytopathogenic virus, similar to that isolated by Chanock (1956), was recovered from 10 of the 15 cases studied (Beale *et al.*, 1958).

While the isolation of a virus from cases of acute laryngo-tracheo-bronchitis is of great interest, it has as yet no important practical applications. The present paper records some of the results of an extensive study of laryngo-tracheo-bronchitis in Toronto, where the condition is a common cause for admissions to hospital each winter.

Patients Studied

The majority of cases of acute laryngo-tracheo-bronchitis are admitted to the Hospital for Sick Children, Toronto, during the winter months, although some do occur at other times of the year. This study was carried out during the two winter periods from November to March, 1952–3 and 1953–4. Not all cases admitted to the tracheitis unit of the hospital during those periods were studied, but all severe and moderately severe cases, and approximately one-third of the mild cases, were selected. Severe cases were defined as those children who required tracheotomy to relieve the respiratory

*Aided by a grant from the Canadian Life Insurance Officers Association, Toronto.

†Now at St. George's Hospital, London.

‡Now at the Maudsley Hospital, London.

obstruction; moderately severe cases as those which at any time during the first 24 hours after admission might have required tracheotomy, but responded to medical treatment only; and the mild cases as those in which respiratory obstruction was not marked and the patient improved quickly with medical treatment.

General Description

During the two periods, 122 cases of acute laryngo-tracheo-bronchitis were studied. In the history of each patient particular note was made of the type of onset of the attack, antibiotic therapy prior to admission, and the type of central heating in the home.

Table I shows the number of cases classified as severe, moderate, and mild, and the numbers of males and females in each category. The ratio of males to females is 3.5 to 1, and this ratio holds for all categories of severity.

Table II shows the numbers and severity of cases in the various age groups. The largest number of cases occurred in those aged 12 to 23 months, 37% of all cases being in this age group. One-third of these children required tracheotomy. Only 9.8% of the total cases were under 12 months of age, but one-half of these required tracheotomy. This suggests that, although fewer children appear to develop acute laryngo-tracheo-bronchitis in the first year of life, as compared with the

TABLE I.—Number and Sex of Patients in Various Categories as Indicated

Category of Severity	Total No. of Patients	Male	Female
Severe	38	29	9
Moderate	37	33	4
Mild	47	33	14
Total	122	95	27

TABLE II.—Age in Relation to Number of Cases and Severity

	No. of Patients in Following Age Groups				
	< 1 Year	1 Year	2 Years	3-4 Years	5+ Years
Severely ill	6	14	3	7	8
Moderately and mildly ill	6	31	16	18	13
Total	12	45	19	25	21

second year of life, those that do develop it are more likely to become severely ill. In 17% the patients were over 5 years of age, and a little over one-third of these required tracheotomy.

Clinical Features

All the cases studied presented with a history of two or more of the following symptoms: coryza, hoarseness, croupy cough, stridor, and dyspnoea. All patients gave a history of stridor. In most of the severe cases croupy cough was not a prominent feature, the children being too tired to cough, or too obstructed to get enough air into the lungs to produce a loud cough.

The degree of pyrexia on admission seemed to bear no relationship to the severity of the condition. The admission temperature varied from 97.8 to 104.2° F. (36.6 to 40.1° C.), the average being 100° F. (37.8° C.).

Of the signs of respiratory obstruction, the constant one was that of inspiratory and expiratory stridor, accompanied by a variable amount of indrawing of the soft parts of the chest wall. A loud stridor did not necessarily indicate severe obstruction, as many of the

severe cases had a muffled, quiet stridor. Auscultation gave the best guide to the degree of obstruction, and it was found that where the air entry was poor, with the child at rest and not crying, obstruction was severe. Therefore a rising pulse rate and poor air entry into the lungs, despite adequate medical treatment, were taken as signs of the need for tracheotomy.

Only in the 38 severe cases was laryngoscopic and bronchoscopic examination carried out, and this was immediately prior to tracheotomy. Thirteen patients had supraglottic swelling only, 16 had subglottic swelling only, and nine had both supraglottic and subglottic swelling. The amount of secretions in the pharynx and trachea was variable, but in most patients it was minimal. Where there was a moderate amount the secretion was thick and sticky. In only a few patients were secretions seen to be coming from the bronchi.

TABLE III.—Type of Onset of Illness in Relation to Subsequent Severity

Type of Onset of Illness	Total	Severity of Illness		
		Severe	Moderate	Mild
Sudden	51 (42%)	12 (32%)	16 (43%)	23 (49%)
Gradual	71 (58%)	26 (68%)	21 (57%)	24 (51%)
Total	122	38	37	47

The mode of onset of the illness in acute laryngo-tracheo-bronchitis varied. A comparison was made between the severity of the illness and the type of onset, and Table III shows the numbers with different types of onset in the various categories of severity. "Sudden onset" is defined as the development over a period of hours of symptoms necessitating admission to hospital. Only one-third of severe cases were of sudden onset, while one-half of the mild cases had a sudden onset. This might suggest that the cases of more gradual onset, not responding to therapeutic measures at home, are those most likely to require tracheotomy eventually.

Complications in the present study were few and were restricted to the severe cases. There was only one death, that of a girl aged 4 years. Death occurred six days after tracheotomy, and was due to pneumonia and empyema caused by a pyogenic staphylococcus sensitive only to erythromycin. One child developed pyogenic staphylococcal bronchopneumonia 15 days after tracheotomy, but responded well to erythromycin. A third child developed surgical and mediastinal emphysema secondary to tracheotomy, but recovered well. Six cases had some degree of crusting of the secretions after tracheotomy, but this improved rapidly with adequate hydration. The average length of stay in hospital for all cases was six days.

Environment

It has been suggested that meteorological variations influence the incidence of the condition. In order to determine if the weather had any bearing on the present series of cases, graphs were made of the temperature and relative humidity in the city at intervals of six hours throughout each month. The information for these graphs was supplied by the Meteorological Division, Department of Transport, Toronto. The time of onset of respiratory difficulty in each patient was estimated from the history and was marked on the appropriate graph. Table IV shows the relationship between the onset of respiratory difficulty and the change in relative humidity and temperature of the atmosphere each

TABLE IV.—*Relationship of Onset of Respiratory Difficulty to Changes in Temperature and Relative Humidity*

Month 1952 and 1953	No. of Cases with Onset during Conditions of Temperature and Humidity as Indicated						Total
	Rising		Falling		Steady		
	Hum.	Temp.	Hum.	Temp.	Hum.	Temp.	
November ..	9	10	14	13	0	0	23
December ..	15	14	18	17	1	3	34
January ..	7	11	17	12	1	2	25
February ..	7	4	4	7	3	3	14
March ..	8	9	17	16	1	1	26
Total ..	46 (38%)	48 (39%)	70 (57%)	65 (54%)	6 (5%)	9 (8%)	122

month. It was found that more than half the cases had onset of symptoms during conditions of falling temperature and humidity.

When the type of heating in the home was considered, it was found that all patients came from homes that had some form of central heating. There was no clinical distinction between children coming from homes that were heated with hot-water radiators and those from homes heated by convection of hot air throughout all the rooms. A little more than one-half of the number came from homes in which the atmosphere was said to be dry with no attempt to add extra moisture. The almost universal presence of thermostatically controlled heating systems in Canadian homes suggests an explanation for the observation that more than one-half of the cases occurred while the outdoor temperature and humidity were falling. With the drop in outdoor temperature there is a coincidental rise in indoor temperature with a drying of indoor atmosphere; this dryness may precipitate symptoms of obstruction in a child with catarrhal inflammation in the nose and throat, through oedema and inspissation of secretions.

Principles of Treatment

1. *Provision of a Cool, Moist Atmosphere.*—Every child was treated in an atmosphere of 100% relative humidity. This was attained by placing the child in a "croupette." This consists of a lightweight aluminium frame, over which fits a plastic cover to form a tent. Humidity in this tent was maintained with a nebulizer in which compressed air or oxygen was used to vaporize the water. This meant that humidity and oxygen were both made available to the child at the same time. The high humidity prevented drying of secretions in the larynx and trachea, and these secretions could then be coughed up and not add to the obstruction already caused by oedema. The use of this cool, moist atmosphere is probably one of the most important factors in the treatment of laryngo-tracheo-bronchitis. Adequate hydration was also maintained. This was especially important after tracheotomy, for it helped to keep the secretions thin, and prevented crusting and obstruction below the level of the tube. When the children were not drinking well, especially infants under 12 months, fluids were given intravenously for 24 to 48 hours.

2. *Sedation.*—Mild sedation was of great help in allaying apprehension, and in reducing restlessness and need for oxygen. Quinalbarbitone, $\frac{1}{2}$ to $\frac{3}{4}$ gr. (32–48 g.) according to age, given rectally, was usually all that was required, and was repeated four hours later if necessary.

3. *Antibiotics.*—Penicillin alone, or in combination with streptomycin, was given intramuscularly. The broad-spectrum antibiotics were usually reserved for

those children with bronchopneumonia, or where bacteria resistant to penicillin and streptomycin had been isolated from the pharyngeal secretions.

4. *Tracheotomy.*—This operation was done in those cases that did not respond to adequate medical treatment. When a child was admitted with severe obstruction, cyanosis, and with peripheral collapse, tracheotomy was done without delay. Indications for operation were a rising pulse rate, diminishing air entry, and increasing restlessness. It was carried out before the child was *in extremis*, for when done at this time it could be carried out in an orderly manner, without the risk of severe haemorrhage or surgical emphysema, and before hypoxia endangered recovery.

5. *Close Observation.*—The same observer assessed at intervals the pulse rate and the degree of obstruction and was able to judge if restlessness was a sign of increasing anoxia or merely apprehension at the strange environment.

Conclusions

During the two winter periods from November to March, 1952–3 and 1953–4, 122 cases of acute laryngo-tracheo-bronchitis admitted to the Hospital for Sick Children, Toronto, were studied. Of these, 38 had respiratory obstruction severe enough to require tracheotomy. The remainder were relieved by medical treatment. There was only one death in the series, due to post-operative pneumonia and empyema caused by a pyogenic staphylococcus.

Special attention was given to meteorological conditions and to the method of heating the home. No typical weather pattern appeared to predispose to the onset of acute laryngo-tracheo-bronchitis, although in more than half of the patients symptoms of respiratory difficulty appeared during conditions of falling temperature and humidity. Because of the thermostatically controlled heating equipment in Canadian homes this fall may produce drying of the secretions associated with an upper respiratory infection and help to give rise to mechanical obstruction of the respiratory tract.

The clinical features of the condition did not reveal any change from those described previously, but the morbidity and mortality were greatly reduced as compared with the series reported by Morgan and Wishart (1947). In that series the overall mortality for the 10 years up to 1944 was 20%, with 9.2% in the single year of 1944. In the present series, which included all severe, moderately severe, and only one-third of the mild cases admitted during the winter months, the overall mortality for the two-year period was 0.8%. The age range of patients was 4 months to 10 years, and over one-third of the total studied were between the ages of 1 and 2 years. The ratio of males to females was 3.5 to 1.

In the four years that have elapsed since this study was carried out there has been little alteration in the principles of treatment. The effectiveness of observation, mild sedation, elective relief of obstruction, and, in particular, a cool, humid atmosphere in the treatment of acute laryngo-tracheo-bronchitis is shown by the low mortality amongst the children in the present study.

Summary

A clinical study of 122 cases of acute laryngo-tracheo-bronchitis admitted to the Hospital for Sick Children, Toronto, Canada, is presented.

The clinical findings and the age and sex distribution are given.

Climatic conditions and home environment are discussed in relation to the onset of symptoms.

Medical treatment is outlined and the indications for tracheotomy are given.

We thank Dr. E. A. Morgan and Dr. J. A. Turner for their advice in the assessment of the children; the paediatricians under whose care the children were admitted, for allowing us to study their patients; and Dr. A. J. Rhodes, Director of Research, for his constant help and encouragement.

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TRACHEOTOMY IN INFLUENZA

BY

JOHN H. DIGGLE, M.R.C.P.

Senior Registrar in Paediatrics, Sheffield

Obstructive tracheitis and laryngitis have not been noteworthy features in the many accounts of influenza epidemics. Stuart-Harris (1953) stated that influenza did not usually present in this way. He described surface lesions of the trachea which were necrotic and could have been due to the virus or to staphylococci. Roberts (1957) described the post-mortem findings in nine deaths from influenza in previously healthy persons. These patients had become rapidly dyspnoeic and cyanosed, and had severe retrosternal pain. They had coughed up frothy blood-stained fluid, and in all cases at necropsy the trachea contained blood-stained watery fluid and the epithelium showed necrotic ulceration. Roberts considered that suction through a tracheotomy tube would not have helped because exudates and haemorrhages were present in the pulmonary alveoli at the time of death. In subsequent correspondence this view was challenged by Rawlins (1957), who described the case of a dyspnoeic, cyanosed patient who recovered following repeated bronchoscopy and a tracheotomy. He suggested that deaths in the recent influenza epidemic might have been prevented by drainage of the main air passages.

Of the relatively few patients admitted with influenza to the Children's Hospital, Sheffield, in 1957, three required tracheotomy and a fourth had needed repeated laryngeal intubation and suction before admission. These four patients all made good recoveries. The following two cases with which I was concerned illustrate the severe obstruction encountered.

Case 1

In September, 1957, a 9-year-old boy was admitted to hospital with a history of fever and shivering followed by sore throat, cough, and vomiting for two days. Immediately before admission his face became puffy and his breathing noisy and difficult.

On examination he was afebrile but had pallid cyanosis, a loud inspiratory stridor, and considerable recession of the lower ribs, with very poor air entry to both lungs. A few crepitations were heard over the left lung only. The throat was slightly inflamed but there was no visible pus and no cervical lymphadenitis. His condition deteriorated rapidly. Within 30 minutes he was severely anoxic and an endotracheal tube was inserted through the larynx, with difficulty on account of subglottic oedema. This did not improve matters much and so tracheotomy was immediately performed under general anaesthesia administered through the intubation tube.

A large amount of blood-stained frothy fluid was forcibly coughed out of the intubation tube and the tracheotomy tube. Three members of the staff on to whom this fluid was coughed each developed an illness like influenza about 48 hours later. During the night an even greater quantity of thin blood-stained fluid, containing a few flecks of pus, was sucked repeatedly from the trachea through the tracheotomy tube, each time with obvious improvement in respiration. Culture yielded a mixed growth of *Haemophilus influenzae*, pneumococcus, and β haemolytic streptococcus (not Lancefield group A). The blood leucocyte count was 9,000 per c.mm., with 50% neutrophils.

Throughout the night he was nursed on his right side and very frequent aspirations of the trachea were needed. X-ray examination of the chest next day showed an appearance in the right lung which suggested aspiration of fluid into the alveoli. The left lung appeared normal. Some mediastinal emphysema and some surgical emphysema in the neck were also demonstrated. These were complications of the tracheotomy. During the second day his temperature reached 104° F. (40° C.). Obstructive symptoms were again relieved by suction of the trachea. He received intramuscular penicillin, oral sulphadimidine, and oxytetracycline, and his condition steadily improved after the second day in hospital.

A specimen of serum was sent to the Virus Research Laboratory in Sheffield on the day after admission and again two weeks later. Complement fixation against influenza A (soluble antigen) showed a rise in titre from 24 to more than 64. Haemagglutination inhibition against influenza A/Singapore/1957 showed a rise in titre from 40 to 160.

Case 2

A girl aged 11 years was admitted to hospital in September, 1957, late at night, with a history that a tight choking feeling in the throat came on before lunch. After this she felt feverish and developed a severe persistent cough.

On examination her temperature was 102° F. (38.9° C.) and she was pale and sweating. Her throat was merely reddened and there were no moist sounds in the chest. Breathing, however, was laboured and an inspiratory and expiratory whistle emanated from the larynx. Indirect laryngoscopy revealed reddened non-oedematous cords which moved with respiration. Beneath the cords there was a grey curtain of dry hard mucus stretching across the trachea. In the centre of this was a small hole through which respiration was taking place. The curtain descended with inspiration and rose with expiration. At this stage there were no signs of anoxia. She was given oral oxytetracycline and nursed in steam. During the next eight hours breathing became more difficult and there was a persistent difficult cough with restlessness and anxiety, intermittent cyanosis, and severe inspiratory recession of the lower ribs and suprasternal notch.

A general anaesthetic was given and then an intubation tube was forced with difficulty through the membrane of dry mucus beneath the larynx, but this did not produce the expected improvement. Tracheotomy was therefore performed, and this resulted in no improvement until some hard greenish brown material had been removed from the trachea through the tracheotomy tube. After this a large quantity of slightly blood-stained thick rubbery material was sucked off the tracheal wall and then the patient's respirations