The results show that tetracycline is as effective as chlortetracycline in the treatment of bacterial pneumonia. Deaths were few and were confined to elderly patients with serious complicating diseases.

The incidence of side-effects amounted to about 30% with each antibiotic, although most of these effects were mild. This does not confirm the reported lower toxicity of tetracycline.

The only serious complications followed tetracycline therapy, that is, one case each of staphylococcal enteritis, pulmonary moniliasis, and aspergillosis; in the last case the patient died.

Tetracycline suffers from the same disadvantages as other broad-spectrum antibiotics and should be used only with appropriate care and consideration.

The tetracycline ("achromycin") and the chlortetracycline used in this study were supplied by Dr. A. T. Mennie, of Lederle Laboratories. Our thanks are also due to Dr. K. J. G. Milne, under whose care a number of patients were treated, and to the house-physicians and members of the nursing and technical staff of the hospital for their help.

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MANAGEMENT OF ACUTE RESPIRATORY OBSTRUCTION WITH REPORT OF A CASE

BY

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Acute respiratory obstruction is one of the few remaining otolaryngological emergencies with a high risk of catastrophe, and when it occurs in a small child who has previously been well the failure of treatment is tragic. The case discussed here showed certain unusual features and problems of management.

Case History

A boy aged 3 years and 5 months was admitted to hospital on September 15, 1955. He had been well until five months previously, when, following a short illness manifest by pyrexia and dyspnoea, he had shown undue dyspnoea on exercise. Several (presumptive) upper respiratory infections had occurred in the interim, and whooping-cough had been diagnosed some seven weeks before admission. He had been immunized against diphtheria about 18 months previously.

On the day of admission he had appeared quite well on rising. About 10.30 a.m. he complained of difficulty in breathing, and during a short walk severe dyspnoea developed. At mid-day his parents noticed that his colour had a "blue tint" [*sic*] and this was followed by two bouts

of convulsions. About 3.45 p.m. he would not answer his name and appeared to be unrousable. All through this period his breathing had become increasingly rapid and more laboured. There was no history of hoarseness or of a foreign body being either inhaled or swallowed.

He arrived in hospital at 4.40 p.m. He was sitting hunched forward in bed, with eyes staring and pupils fixed, and the facies anxious. He did not react to his name being spoken. Expiratory and inspiratory stridor was pronounced; dusky cyanosis was present; and there was extreme activity of the accessory respiratory muscles, with inspiratory indrawing of the supraclavicular fossae, the intercostal spaces, and the upper abdomen. The respiratory rate was 60 a minute, temperature 99° F. (37.2° C.), and pulse 160. On auscultation no inspiratory or expiratory air movements could be heard in either lung.

A tentative diagnosis of tracheobronchitis was made, but the possibility of an unsuspected foreign body with super-added infection was considered. The obstruction was thought to be low in the trachea, so that, whatever its cause, laryngoscopy and bronchoscopy were indicated in preference to a primary tracheostomy, for the latter could be performed afterwards if necessary. The child being comatose, no anaesthetic was necessary.

Operation

The fauces were normal. The larynx and the immediate subglottic area were healthy and free from obstruction. The cords moved freely. A Negus child's size bronchoscope, 5 mm. diameter, was then passed through the glottis and the laryngoscope removed. The upper trachea was normal. The lower third was pinker than usual. At the level of the carina a whitish gelatinous mass was seen, completely obstructing the right main bronchus, "riding" the carina, and all but completely obstructing the left main bronchus.

During this procedure, which was carried out rapidly, oxygen was given through the suction attachment to the bronchoscope and, intermittently, by pressure through the bronchoscope itself. One of us kept a constant watch on the radial and carotid pulses.

Cupped biopsy forceps were passed in an attempt to grasp and remove the obstructing mass. This resulted only in the removal of a small piece of very tenacious material, with no relief of the obstruction. Repeated attempts gave the same result, even with a change of forceps. The size of the bronchoscope severely limited the type of forceps used. By now the pulse was irregular and just perceptible in the carotid artery.

As the use of forceps was a failure, the largest aspirating sucker was passed, and an attempt was made to suck the mass free. This succeeded in moving it a little from the left main bronchus, but the suction was just not sufficient to lift it into the trachea and bronchoscope. At this stage, approximately five minutes after the beginning of the operation, the carotid pulse could no longer be felt. The second surgeon therefore started cardiac massage through an upper abdominal incision. He found that cardiac arrest had occurred. While the massage continued, positive-pressure insufflation of oxygen was performed through the bronchoscope, which had been pushed into the left main bronchus past the obstruction. Regular spontaneous cardiac movements began again after one minute. Inflation was continued for a further minute and then another attempt at removing the obstruction by forceps and suction was made.

With oxygenation of the left lung the child's general condition improved, and it was at this stage that he himself did most to relieve the obstruction. While suction was being applied he gave a violent cough, the force of which shot the obstructing mass into the bronchoscope, completely blocking it. The bronchoscope, with the plug, was rapidly removed and oxygen under pressure was administered through a face-mask. There was an immediate further improvement in the child's general condition. After the lungs had been

inflated for a further four to five minutes the bronchoscope, from which the fleshy mass had been removed, was again passed. The mucous membrane of the main bronchi and the carina was covered with exudate and grossly inflamed, while on the right side tenacious pieces of fibrinous exudate were adherent to the walls as low as the secondary bronchi. The exudate was removed so far as was possible, and this did not cause bleeding. The changes on the left side were similar, but not so extensive.

By now spontaneous respiration had started and both sides of the chest were moving well. The pulse was regular and of good volume and force. With the bronchoscope still in place, a tracheostomy was done through the third tracheal ring, a No. 18 Jackson tracheostomy tube being inserted. The abdominal incision was closed.

Tracheostomy was considered advisable, (1) because the bronchi still contained much exudate which had to be liquefied and aspirated, and (2) because the prolonged instrumentation added the risk of subsequent glottic oedema.

Post-operative Progress

The child was conscious on return to the ward, and it was noted that the pupillary reaction to light had returned. He was nursed sitting upright in a steam-tent. The trachea and main bronchi were aspirated through the tracheostomy tube every 15 minutes for the first 24 hours, and thereafter every half-hour. "Alevaire" inhalations through the tracheostomy tube proved very effective in liquefying tenacious bronchial secretion. Streptomycin, $\frac{1}{2}$ gr. (32 mg.), twice daily, and crystalline penicillin, 500,000 units every six hours, were given by intramuscular injection. As soon as the child was able to swallow he was allowed $\frac{1}{2}$ oz. (14 ml.) of water by mouth every half-hour, and by the end of the third day he was given a semi-solid diet.

Although dyspnoea was relieved by the operative treatment, cyanosis and tachypnoea persisted, and radiography on the second day revealed a complete left pneumothorax. This was relieved by the insertion of a No. 9 Jaques catheter through the second intercostal space anteriorly. The cyanosis and tachypnoea subsided within 24 hours, complete re-expansion of the affected lung being obtained.

Post-operative progress thereafter was uneventful. Laryngoscopy on the eighth day showed no abnormality. The tracheostomy was retained, since difficulty in clearing the bronchial secretion persisted, but antibiotic therapy was stopped. The tracheostomy tube was removed on the twenty-second day without incident, and the stoma was allowed to close by granulation.

The child was able to return home on the thirtieth day after operation. When reviewed two months later the tracheal stoma had closed and there was no evidence of respiratory distress when he undertook physical activity with other children of his age.

Histology.—"The section showed much degenerate fibrinoid material in which there were bluish staining areas of bacteria. There was much infiltration by acute inflammatory granulation tissue, in which a few multinucleate cells were seen. No evidence of neoplasm was seen."

Discussion

The site of the lesion in this case coincides with that found by Briggs and Heseltine (1952). We cannot entirely agree with their view that "removal of this (tracheal) obstruction can readily be achieved by adequate and, if necessary, repeated suction." It was both frustrating and frightening to grasp the mass "firmly," only to find small pieces coming away, the larger part remaining adherent to the bronchial wall and the obstruction unrelieved. Suction did move it a little, but the progress was too slow and uncertain, and had the patient not coughed when he did the result may well have been fatal. In these severe cases of respiratory obstruction we feel it is of the utmost importance that the cough reflex should in no way be depressed

by general anaesthesia or sprays of local analgesic. The children are easy to hold, often comatose, and, while it may seem a cruel procedure at the time, it may well be life-saving. All who have passed a bronchoscope will be acquainted with the tussic force transmitted through the instrument in expelling pus, secretion, or blood clot. P. R. Allison (personal communication) has stated that, in the complete absence of a history of aspiration, a foreign body may remain in one place in the bronchial tree for months, and not give rise to cough. If, however, the foreign body is even slightly moved with a bronchoscope or forceps it will immediately give rise to a marked paroxysm of coughing.

In every instance of acute respiratory obstruction diphtheria must of necessity be excluded. Unfortunately in the above case no bacteriological examinations were made on the secretion of the "fleshy" exudate removed. Such a diagnosis is most unlikely in view of the length of history, the report of recent immunization, the clean fauces and larynx, and the absence of bleeding beneath the exudate. However, while it is true that epidemic diphtheria in this country has not been seen for some years, there is a suggestion that the immunization rate of the population is falling (See Table). Should the trend continue, the problem of a

Immunization in the City of Leeds (From Annual Report of M.O.H. for Leeds, 1954)

Year	Population	Births	No. of Persons Receiving Immunization Against Diphtheria	Relation of Number Receiving Immunization Against Number of Live Births, as a Percentage
1948	501,900	9,234	10,338	111.95
1949	504,900	8,447	8,665	102.56
1950	509,700	8,113	7,464	92.00
1951	503,030	8,044	8,154	101.24
1952	504,800	7,740	7,456	96.30
1953	505,500	7,932	6,510	82.09
1954	507,200	7,584	6,857	90.49

series of respiratory emergencies from diphtheria may occur again; in this connexion the observation of Murray (1935), that respiratory obstruction is the only complication to be feared in *Corynebacterium diphtheriae* mitis infections, is worthy of note.

In the case described an added difficulty in diagnosis was the duration of symptoms for five months. It would seem that the original illness, some five months before admission, was an acute respiratory infection, either viral or bacterial in nature. This resulted in a tracheobronchitis, with desquamation of the mucosal epithelium which, with the inspissated secretion, was never effectively expectorated. This caused segmental and even lobar collapse, as evidenced by the continued dyspnoea and intermittent pyrexia which, with a cough, led to the diagnosis of whooping-cough. A further reinfection of the bronchial tree prior to admission led to increased secretion, loss of ciliary action, and consequent swelling of the bronchial plug(s).

In the management of acute and severe respiratory obstruction the primary aim is restoration of the airway. Diagnosis of the cause of the obstruction is of secondary concern, but a knowledge of the aetiology and site of the obstruction, often only revealed by the endoscopy, is essential for further definitive treatment. If a foreign body is found it must be removed, the lung aspirated, and any associated infection treated. If bacterial or viral infection is the cause the measures mentioned above must be employed, antibiotics and any appropriate antisera given, and the patient isolated.

The use of endoscopy prior to tracheostomy in this case, regardless of the site of obstruction, emphasizes once again the long-enunciated view of Jackson, reiterated by Morgan and Wishart (1947). Laryngoscopy and bronchoscopy should be done first; the purpose of the succeeding tracheostomy is to facilitate the aspiration of secretions from the

bronchial tree when these cannot be effectively moved by ciliary action. The unhurried tracheostomy, with a clear airway maintained by the bronchoscope, contrasts sharply in ease of performance with the difficulty found in the congested neck of a semi-asphyxiated patient.

In any case of respiratory obstruction cardiac arrest may occur. When possible, we feel that such emergencies should be managed by "two-surgeon" teams as described above. One operator watches the carotid pulse and is prepared to undertake cardiac massage at any time, while the other concentrates on the bronchoscopic work and the continuous supply of oxygen through the bronchoscope. Oxygen under pressure should also be administered at regular intervals, using the bronchoscope as an endotracheal tube. This is of the utmost importance, and should not be forgotten by the operator who is engrossed in attempting to clear the airway.

It is stressed that time should not be wasted trying to ascertain the presence of the heart beat, either by palpation at the apex or by auscultation. The time available once arrest has occurred is very limited. Greenfield (1938), quotes Gildea and Cobb in their conclusion that cortical neurones may suffer irreparable damage from five minutes of circulatory arrest. When arrest occurs in the presence of anoxia, a much shorter period would suffice. Therefore, once the carotid pulse is no longer palpable, the chest or abdomen should be opened immediately and rhythmic cardiac massage started. In the above case a trans-abdominal approach was used, as this was the route most familiar to the surgeon concerned. It is only fair to state, however, that cardiac massage through an anterior incision in the fourth left intercostal space is no more difficult or time-consuming to perform. It is easily learnt and should be within the scope of all surgeons regardless of their specialty. The thoracic approach has the added advantage of more effective "massage," since the pericardium can be incised to get more effective compression. This also allows the surgeon to observe whether the ventricles are inert or fibrillating, for, if the latter is found, an electric defibrillator as described by McMillan *et al.* (1952) should be used.

Pneumothorax as a complication of tracheostomy and neck incisions has been well described by several authors (Macklin, 1937, 1939; Neffson, 1942; Morgan and Wishart, 1947; Reading, 1949; Michels, 1951). In the present case there were three possible causes: (1) rupture of an emphysematous bulla on the left lung when this lung was inflated during the cardiac arrest; (2) injury to the bronchial wall during removal of the secretions; and (3) mediastinal emphysema with rupture into the pleural cavity, or an extrapleural spread causing an extrapleural pneumothorax secondary to suction of air through the tracheostomy wound. This last cause is the most likely, for even with the bronchoscope in position there was a degree of obstruction still remaining in the smaller bronchi due to the exudate. At no time during the post-operative period had the tracheostomy tube slipped out of the tracheal opening—the usual cause of air being sucked into the mediastinum.

The use of alevaire almost continually for the first three post-operative days was of great help in liquefying the secretions and rendering them more easily aspirated.

Summary

A case of acute and severe respiratory obstruction and its management is described.

The cause was thought to be acute tracheobronchitis added to an already present partial obstruction, this obstruction being caused by a previous respiratory infection.

Immediate treatment by bronchoscopic aspiration and tracheostomy was given. Cardiac arrest, which occurred during this treatment, was dealt with satisfactorily by cardiac massage.

The possibility of cardiac arrest occurring in these cases is stressed and its treatment discussed. This part of the management is greatly facilitated by a second surgeon being available.

Pneumothorax as a post-operative complication is discussed.

The value of alevaire in the immediate post-operative period is mentioned.

We are indebted to Dr. E. C. Allibone, under whose care the patient was admitted, for permission to publish this report. We thank Professor P. R. Allison, Dr. G. A. W. Neill, and Mr. G. S. Seed for their encouragement and their many helpful criticisms.

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A COLORIMETRIC METHOD FOR THE DIAGNOSIS OF PHEOCHROMOCYTOMA

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It is well known that a patient suffering from pheochromocytoma excretes a large amount of noradrenaline in the urine. Such urine, or an extract made from it, produces a rise in blood pressure when injected into a cat (von Euler and Hellner, 1951; Burn, 1953): in our opinion this biological method is reliable for quantitative assay (Burn, 1954). However, it is expensive, and recently there has been a dearth of suitable cats. Accordingly we have developed a chemical method of estimating noradrenaline in urine with which we have been able to diagnose two cases of pheochromocytoma.

Method

At pH 6.5 noradrenaline can be adsorbed from urine on the cation-exchange resin "amberlite IRC-50" (Bergström and Hansson, 1951), and can be eluted with excess of hydrogen ions. This stage gives a relatively large volume of solution free from the urinary pigments. Concentration of the extract is effected by adsorption on aluminium hydroxide, followed by solution in a small volume of acid and precipitation of the aluminium.

The colour reaction employed is the condensation of noradrenaline with ethylene diamine (Natelson, Lugovoy, and Pincus, 1949); the reaction produces a yellow colour with an absorption maximum of 405 m μ and a millimolar extinction coefficient of 10.

Preparation of Urine.—Urine was collected for 24 hours into a Winchester bottle containing 5 ml. of conc. HCl. An aliquot of 100 ml. was adjusted to pH 6.5 with *N* NaOH, using a glass electrode.

Construction of Amberlite Column.—The amberlite column was set up as shown in the Diagram. The glass tube containing the amberlite was of 18-mm. bore and about