TREATMENT IN GENERAL PRACTICE

This article is one of a series on the management of some of the major medical disorders met with in general practice

TREATMENT OF DIPHTHERIA

BY

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Apart from the special requirements of laryngeal diphtheria, the treatment of diphtheria may be summarized under the headings of general management, specific treatment, and the treatment of sequels and complications.

General Management

The keynote of this is the maintenance of the recumbent position and the complete avoidance of all effort. At first the patient should be given only one pillow, all movement and sitting up in bed being strictly forbidden. Daily soap-and-water enemata should be administered, and careful note made of the amount of urine passed and of albuminuria. Spoon-feeding should be carried out. Owing to the condition of the throat the patient at the outset will be on a milk diet, but this should be supplemented daily with glucose 3 to 5 ounces dissolved in water flavoured with lemon or orange juice. As soon as the throat permits, and in all except the very severe cases this will not be more than a few days, the diet should be increased by milk puddings, egg beaten in milk, custards, jellies, mashed potatoes, pounded fish, minced chicken, and indeed anything within reason so long as digestion is satisfactory. Local treatment of the throat has now largely been abandoned, except where there is necrotic membrane or superadded septic infection, when flushing of the throat with sodium bicarbonate solution (6 grains to 1 ounce) three or four times daily will help to clear it up.

In mild or moderate cases a second pillow may be given at the end of two or three weeks, and in the course of another week a third pillow. The patient is next permitted to sit up in bed for a short period, and the process is gradually extended until, about the fifth or sixth week, he may leave his bed to rest on a reclining chair or sofa. Then a few steps about the room are allowed, and finally, at the end of two months, he should be taking short walks. In the mildest cases the above programme can obviously be speeded up, but, on the other hand, in severe cases, or when cardiac irregularities have occurred, it is wise to keep the patient flat for seven or eight weeks, and in bed for about twelve. In every instance, with each simple advance away from the recumbent posture, the most careful watch should be kept for variations in pulse rate and rhythm, faintness, or nausea, and at the slightest sign of these the patient may require to be put back one or two stages. Careful nursing is essential, the various nursing operations, such as daily bed bathing and toilet of the mouth, being performed with the maximum of gentleness, and a careful watch must be kept for early signs of pulse irregularities and the disturbance of function characteristic of the various palsies. Reading, for those so inclined, need not be prohibited, but in view of the possibility of ocular paresis this should be in moderation.

Specific Treatment

The most important step to be taken in treatment is to give the patient an adequate dose of antitoxin at once. In estimating dosage the factors to be taken into account

are the extent and severity of the local lesion, cervical adenitis, and the amount of toxæmia as estimated by prostration, pallor, and albuminuria, while the duration of the disease before the administration of antitoxin must also be considered. Age and body weight are generally disregarded in this country. Since it is believed that better results are obtained from a single dose of antitoxin administered at the outset than by the injection of successive fractions whose total is the same, an effort should be made to estimate the requirements of the case at the beginning; but this is not always easy, even by the most experienced, and the practitioner should not hesitate to repeat his injection if he is uneasy about the adequacy of the amount already given. Mild cases with slight patching on one or both tonsils, with adenitis limited to a very slight enlargement of the tonsillar glands, and with no clinical evidence of toxæmia will need 2,000 to 8,000 units. Cases of moderate severity, in which both tonsils are well covered with membrane, with a tendency to spread to the faucial pillars, the palate, or the uvula, and in which a slight degree of toxæmia and moderate enlargement of the cervical glands are present, should receive 10,000 to 24,000 units. Severe cases, with extensive membrane in the fauces and nasopharynx, marked faucial oedema, profuse nasal discharge, great swelling of the cervical glands, and profound toxæmia, shown by drowsiness, prostration, waxy pallor, and albuminuria, should be given 30,000 to 60,000 units. It may not be out of place to mention here that extent of membrane may be an unreliable guide to the severity of the process, as some of the gravest cases may show relatively small amounts of membrane, limited to the inner surfaces of the tonsils. Faucial oedema, prostration, and cervical adenitis will, however, give the clue to the severity of these lesions.

Patients with laryngeal diphtheria will seldom require more than 16,000 to 24,000 units, but if severe faucial or nasopharyngeal lesions are present in addition maximum doses as outlined above should be administered. When the diphtheria is limited to the nose and there is no evidence of toxæmia 2,000 to 8,000 units will be sufficient. Wound diphtheria, occasionally met with in children, and conjunctival diphtheria are comparatively rare, but should be treated as moderate or severe cases.

The minimum dosage as outlined above for each grade of severity would be applicable to cases coming early under treatment on the first or second day, the larger doses being indicated for those coming under treatment on the third, fourth, or fifth day. Furthermore, the patient should be re-examined after eight or twelve hours, since a spread of membrane or a worsening of the toxæmia would necessitate a reclassification of the case and additional serum. While numerous clinical observations bear out that little benefit is likely to follow the administration of serum after the fifth day of disease, it should be clearly understood that antitoxin should never be withheld, however late the stage and however hopeless the case may appear.

ROUTE OF INJECTION

In mild cases the serum should be given intramuscularly into the vastus externus. In moderate cases a quarter or half of the serum should be given intravenously and the remainder intramuscularly. In severe cases no effort should be spared to inject intravenously the whole, or

at least the greater part, of the serum, but should this be impossible—and this will occasionally be the case in small children with collapsed veins and marked toxæmia—intraperitoneal injection should be performed to secure more rapid absorption than is possible by the intramuscular method. This is carried out with the ordinary syringe and needle, the latter being pushed through the anterior abdominal wall in the midline, about two inches below the umbilicus. The various commercial serums now on sale are invariably concentrated, each cubic centimetre containing about 2,000 units of antitoxin. With a 20 or 30 c.cm. Record syringe, therefore, the injection of very large doses without refilling is possible, but, if necessary, refilling can be done by leaving the needle in the vein after carefully detaching the syringe. As all diphtheria antitoxin on sale in this country must conform to the standards of potency and sterility laid down in the regulations made under the Therapeutic Substances Act of 1925, the practitioner may rest assured as to the quality of any antitoxin that he may be supplied with.

While I am satisfied that the system of dosage laid down above will give all the results that can be expected from the administration of diphtheria antitoxin, it must be stated that agreement on the subject of dosage is not complete. Some experienced clinicians consider that for the severe case a total dosage of 100,000, or even 200,000, units, the great bulk of which should be given intravenously in one injection, is necessary. Whatever the experimental, clinical, and statistical considerations underlying these varying points of view, it should be made quite clear that it is never wrong to inject too much antitoxin, and a practitioner in doubt as to whether he should give a larger or a smaller dose should invariably decide on the former.

Sequels and Complications

In severe toxæmia some benefit may be brought about by the administration of glucose. Following the work of Schwentker and Noel, Benn and his co-workers in Birmingham advocated giving insulin as well, but the recent work by Begg and Harries has indicated that there is no advantage to be derived from insulin. Glucose administration should be initiated at the onset of treatment by following up the intravenous serum with the injection of 20 grams of glucose in 50 per cent. solution without withdrawing the needle. Thereafter 100 to 200 grams of glucose should be taken daily by the mouth in lemonade; or if this becomes impracticable by reason of nausea, 40 to 100 grams in 50 per cent. solution are injected intravenously each day until the obvious signs of toxæmia have abated. The administration of glucose will require, therefore, to be continued for from one to three or four weeks.

HEART FAILURE

At the first sign of this the foot of the bed should be elevated. Vomiting and pain require the application of frequent hot fomentations to the heart region, and all feeding by the mouth should be withheld, thirst being alleviated by moistening the lips and tongue with iced water. Rectal and intravenous salines should also be tried, if the latter can be given without much disturbance of the patient. Every drug with any reputation as a cardiac stimulant has been employed, but with little success. In common use are alcohol, ether, strychnine, camphor, caffeine, atropine, ephedrine, adrenaline, and pituitrin, while more recently coramine has been tried. If restlessness is marked small doses of morphine (for example, grain 1/16 in a child aged from 5 to 10 years) may be cautiously employed.

Friedemann has recommended hot baths as helpful in the vasomotor collapse in diphtheria, the patient being carefully conveyed to a bath at 105° to 110° F. in a sheet

and immersed for ten to thirty minutes. The traditional treatment of diphtheria in this country would probably render clinicians cautious in applying the method, but I have had the opportunity of trying this line of treatment in a modified form—namely, the application of the hot-air bath. This can readily be improvised from the ordinary bed cradle by fitting it up with two or three electric light bulbs and covering with blankets until the required temperature is attained. It is not claimed that the benefit is more than temporary, but in several cases I have seen a striking improvement in the colour and comfort of the patient, and it is conceivable that some patients may be tided over a critical period. In patients who recover from this complication the remote prognosis is generally considered very good, but it would be well to forbid strenuous exercises for a year after recovery.

PARALYSES

The post-diphtheritic palsies proceed to spontaneous recovery, and need no treatment beyond tonics such as Easton's syrup. In palatal paresis, owing to the patient's tendency to regurgitate fluids through the nose, semi-solids should be given. In pharyngeal paralysis feeding by the nasal tube should be resorted to, care being taken to prevent the aspiration of even a few drops of the feed into the larynx, otherwise a septic bronchopneumonia may be set up. Respiratory paralysis is a hopeless condition unless early admission to a hospital equipped with a Drinker or Bragg-Paul apparatus can be obtained. In severe cases of generalized paresis, in which various groups of skeletal muscles are involved, massage, passive movements, and electrical treatment are necessary. Tonsillitis, adenitis, and otitis media, occurring in the course of convalescence, are treated on ordinary lines.

ISOLATION

Diphtheria patients are usually kept in isolation until two or three consecutive negative swabs from nose and throat have been obtained at weekly intervals.

[For details regarding the precautions to be observed during isolation, intravenous serum administration, and the treatment of serum sickness, attention is invited to the corresponding section of the article on scarlet fever.]

Laryngeal Diphtheria

Whilst important developments have taken place in recent years in the diagnosis and treatment of laryngeal diphtheria as a result of the application of endoscopic methods by which the larynx may be inspected, membrane removed by aspiration from the cords and subglottic space, and direct intubation performed through the laryngoscope, these remain entirely in the realm of hospital practice. Short of these methods operative intervention consists in indirect intubation and tracheotomy. In indirect intubation a cannula is introduced through the mouth into the larynx by means of the special introducer devised by O'Dwyer, but this is also very much a hospital procedure, requiring specialized medical and nursing care. For the practitioner, therefore, the main essentials are specific treatment, expectant treatment in cases in which signs of laryngeal obstruction are not urgent, and the operation of tracheotomy for the relief of urgent symptoms. Specific treatment has already been dealt with.

Expectant Treatment

As soon as a diagnosis has been made diphtheria antitoxin should be given. The question of operation will occur to the practitioner, but if signs and symptoms indicate the initial stage of laryngeal obstruction—that is, are limited to hoarseness, quickened respirations, a characteristic croupy cough, but no dyspnoea—expectant treatment should be adopted. The patient should be

placed in a half tent, improvised by placing an ordinary draught screen round the head of the bed and roofing it over with a sheet for about one-third of its height from the top. Into this tent is led steam from a bronchitis kettle, over the spout of which are tied a few thicknesses of gauze soaked in tinct. benzoin. co. Frequent hot fomentations are applied to the neck, and I employ the following mixture for its antispasmodic effect in full doses (1 drachm to 1½ drachms) four-hourly, according to age:

℞ Tinct. belladonna m iv
Tinct. camph. co. m vij
Aq. ad 3 j

The onset of a sudden emergency, such as the occlusion of the airway by detachment of a piece of membrane, is always a possibility, and the practitioner should visit as frequently as possible to see how the patient is responding to treatment, and should arrange to be within easy call.

Tracheotomy

If when first seen the child is obviously in the spasmodic stage, or in spite of expectant treatment this stage has been arrived at, as shown by stridor, aphonia, restlessness, cyanosis, spasms of coughing, dyspnoea, and well-marked recession of the soft parts in the lower intercostal spaces, the pit of the stomach, and at the root of the neck, then operation should be decided on at once. In hospital it is permissible to hold on to expectant treatment further, but for the general practitioner the situation is well summed up by Ker, who suggests that in the above circumstances there are three alternatives: "The first is to send the child into hospital at once, the second is to live in the house and not leave the child for a moment, and the third, which is sometimes the only one possible for him to adopt, is to perform tracheotomy on the spot."

When the operation is performed in private practice a general anaesthetic, such as chloroform, may be given, but if time permits a local anaesthetic is to be preferred. Frequently the urgency is so great that the operation will have to be done without anaesthesia. The patient is wrapped tightly in a blanket to control the arms and legs, and placed on a table with a rolled-up sheet under the shoulders. The head must be held by an assistant so that the median plane is exactly at right angles to the floor, and this position must be maintained till the trachea is incised. Before commencing operation it is a wise precaution on the part of the operator, if he does not usually wear spectacles, to provide himself with a cheap pair of plain glasses to protect his eyes.

The skin having been prepared the practitioner should make sure of the cricoid cartilage, placing his second finger and thumb on each side of the larynx and the index finger on the middle of the lower border of the cricoid. Throughout the operation the left hand should not be moved from this position. The incision is then made downwards from the lower border of the cricoid for about an inch, commencing at the tip of the left index finger and taking care that the incision does not tail off to one side or the other. Dissection should then be made through the various tissues until the rings of the trachea are recognized, cutting through the isthmus of the thyroid gland if necessary. At this stage much venous oozing will probably occur, but this should be met by swabbing rather than by the application of forceps. When the trachea is reached the upper two rings should be severed and laryngeal dilators inserted into the wound. There will be immediate expulsion of blood-stained frothy mucus, and the patient should be allowed to cough the upper air passages clear before the tracheotomy tube is put into place. To prevent the aspiration of blood at this stage, it is good practice to elevate the trunk above the level of the head and neck. A suitably sized Parker's tube, with a fenestra in the shoulder, is then inserted (one fitting fairly closely to the trachea is to be preferred) and tied in position with a layer of boric lint between the shield and the skin: the patient is returned to the steam tent for twenty-four hours after operation.

After-treatment

While the immediate results of the operation are frequently spectacular, the remote results, which ultimately depend on the successful removal of the tube, must be considered. The after-care consists in the careful supervision of the patient and attention to the inner tube, which must be removed every few hours and thoroughly cleaned out in the following solution:

℞ Acid. boric. 3 ss
Sod. bicarb. 3 ss
Aq. ad O j

The outer tube should not be removed except in an emergency, but if a sudden obstructive attack occurs it must be withdrawn and laryngeal forceps inserted in an attempt to remove the obstructing membrane. If mucus tends to become inspissated cautious spraying of the trachea with sod. bicarb., 15 grains to the ounce, may help to loosen it. An expectorant mixture containing ammonium carbonate may also be prescribed. During fits of coughing, also, the tube may be displaced from the trachea, the signs being the return of dyspnoea, stridor, and recession.

When the airway is well established and the respiration comfortable, the patient should be kept as quiet as possible for three or four days. During this time he is spoon-fed. On the third or fourth day the plugging of the outlet of the tube with the finger should be attempted for a few minutes to see if respiration can occur by way of the fenestra and the natural passage. If the patient is comfortable while this is being done the tube should be quietly removed, and if there is no return of dyspnoea for an hour or two after removal it is unlikely that reinsertion will be required. Should signs of respiratory obstruction follow the withdrawal of the tube it should be replaced, but daily attempts must be made to get it out. In some children the main obstacle to this is psychological, but organic obstruction due to granulation above or below the wound may be the cause. In the latter case the introduction of a larger tube may remove the difficulty, but when the granulations are above the wound delay in seeking the expert aid of the laryngologist should not be incurred lest complete laryngeal stenosis result.

This unfortunate sequel, in my experience, has usually been the result of damage caused to the larynx by an inexperienced, agitated operator, but it may also follow the most perfectly executed operation, and it would be wise to call for direct laryngoscopy if at the end of two or three weeks it is impossible to get the tube out. Bronchopneumonia may also follow tracheotomy within a day or two of operation, and should be treated on general lines by stimulants, poulticing, oxygen, and abundant nourishment, but the outlook in this complication is very grave.

Treatment of Carriers

An individual should not be designated a carrier until the diphtheria bacillus obtained on culture has been shown to be virulent. The carrier state may be related to the throat, nose, both throat and nose, and, infrequently, the ear, and is perpetuated by some pathological or anatomical abnormality in the region affected. Efforts must be directed to the eradication of this, and the carrier's general condition should be toned up with nourishing food and exercise in the fresh air. Insufflations of dimol directed into the nose and throat by means of an atomizer are helpful, and if the patient will co-operate, douching with a solution of equal parts of sodium bicarbonate, sodium baborate, and sodium chloride, 2 drachms to the pint, should be carried out three times

daily, using half a pint at each douching, as recommended by F. H. Thomson, E. J. Mann, and H. Marriner.

Should these measures fail after three or four weeks' conscientious trial, the nasopharynx should be thoroughly examined by a throat specialist with a view to operative treatment. In throat carriers tonsillectomy can be relied on to terminate the carrier state in practically every case. Nasal carriers should be examined with a view to clearing out such defects as hypertrophied adenoids, enlarged turbinates, or deflected septa. Ear cases, in which the diphtheria bacillus is usually associated with a chronic otitis media, may require a mastoid operation. Proof of the termination of the carrier state should only be accepted when the patient has given three consecutive negative cultures at weekly intervals.

TESTS FOR RESPIRATORY EFFICIENCY

A CRITICAL REVIEW

BY

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Ever since the researches of Hutchinson on vital capacity in the middle of the last century many workers have considered methods which might be of help in assessing respiratory efficiency. Dr. Alan Moncrieff, in a recent valuable monograph,¹ gives an admirable survey of the tests which have been recommended in the past. After careful consideration of them all he selects four of these as giving the most useful and reliable information, and describes the results of applying these tests in a group of eighty-six patients suffering from various pulmonary affections. The tests employed were the measurement of the vital capacity, the determination of the ventilation equivalent for oxygen, the measurement of the dead space, two tests with the mercury tube (the maximum height to which the mercury column can be raised by an expiratory effort and the time for which the mercury can be maintained at a level of 40 mm.), and the ratio of expiratory to inspiratory time as shown by graphic records. A careful and detailed account is given of the way in which the tests are best carried out, and it is explained how they can be completed in less than ten minutes. Dr. Moncrieff has classified his cases according to the clinical estimate of their respiratory state into "good," "fairly good," "fair," "poor," and "bad," and has attempted to correlate the clinical assessment with the results obtained from the use of the tests that have been enumerated.

VITAL CAPACITY

The vital capacity, as is well known, depends on the age, sex, height, weight, and the physical fitness and occupation of the subject. Normal standards have been worked out with which the figures obtained in patients can be compared. It may be reduced by 20 to 30 per cent. by physical weakness uncomplicated by organic disease. Moncrieff's studies show that on an average there is a fairly satisfactory relation between the clinical estimate of respiratory inefficiency and the degree of reduction of the vital capacity. The averages for the cases labelled "bad," "poor," and "fair" were 36, 54, and 69 respectively (with 100 taken as the normal standard), against 76 and 97 for the groups described as "fairly good" and "good." In the "poor" group all the cases had a vital capacity below 74, but in the "fairly good" nineteen out of thirty-one, and in the "fair" seven out of twenty-nine, had a capacity of 75 or over. It seems, then, that significance can only be attached to a low figure for the vital capacity. In none of the cases described as "good" did the vital capacity fall below 70. A case is, however, quoted

which serves as a warning of the limited value of an isolated test—that of a man whose clinical state was "fair" and who suffered from a pneumothorax. His vital capacity was well above the normal.

VENTILATION EQUIVALENTS

The term "ventilation equivalent for oxygen" was introduced by Anthony in 1930, and is defined as the volume of air inspired (in litres) per 100 c.cm. of oxygen consumed; in the normal subject its value is on an average 2.5 litres. By expressing the pulmonary ventilation in this fashion variations due to differences in metabolic rate and consequently in oxygen consumption are excluded. The ventilation equivalent and the respiratory exchanges can be readily determined by means of a modified Knipping apparatus, and convincing evidence is provided that this method is reliable; it has the advantage over the usual Benedict-Roth type of apparatus that the carbon dioxide output as well as the oxygen consumption can be measured.

The ventilation equivalents in Moncrieff's series were quite irregular in their distribution both in respect of the average in the different groups and the range within each group. This is not altogether surprising when one bears in mind that the ventilation equivalent is, as explained, simply a measure of the amount of respiratory effort involved in obtaining a standard volume of oxygen. It must be remembered that breathing serves other purposes than the provision of oxygen. It is affected, for example, by alterations in blood reaction; thus in states of acidæmia (such as occur in diabetes or nephritis) the pulmonary ventilation is increased not to provide oxygen but to eliminate excessive amounts of CO₂ in order to preserve the normal alkalinity of the blood. Though the ventilation equivalent would be high in such conditions it does not indicate respiratory insufficiency, but merely means that breathing is being used for a purpose other than the provision of oxygen. The hyperpnoea produced by emotional causes would result in a similar raising of the ventilation equivalent, but would throw no light, of course, on the state of the respiratory apparatus. It is likely that such emotional hyperpnoea occurs very commonly in patients who are being examined with novel apparatus. On the other hand, in states of central respiratory depression such as that produced by morphine poisoning the ventilation equivalent would be low. That merely means that breathing is becoming inadequate for its purpose rather than indicating a high level of respiratory efficiency.

SIZE OF DEAD SPACE

The size of the dead space is calculated from a knowledge of the composition of the expired and the alveolar air and the measurement of the tidal air, the formula employed being:

$$\text{Dead space} = \frac{\text{Tidal air (CO}_2\% \text{ in alveolar air} - \text{CO}_2\% \text{ in expired air)}}{\text{CO}_2\% \text{ in alveolar air.}}$$

It must be acknowledged that alveolar air determinations are difficult to carry out accurately in untrained subjects. In all probability the anatomical dead space—or in other words the actual capacity of the respiratory passages—alters comparatively little in different conditions, and is only affected by constriction or dilatation of the bronchioles. Calculated in the manner described above, the dead space usually amounts to about 150 c.cm. and constitutes 25 to 30 per cent. of the tidal air. In some conditions the apparent or calculated dead space rises to 500 or 600 c.cm., and may constitute 60 or 70 per cent. of the tidal air. These figures cannot represent a true anatomical change, but indicate that a larger proportion of the tidal air is functioning as dead space in the sense that it is not helping to remove carbon dioxide from the alveoli of the lungs. Moncrieff very properly suggests that the dead space should be expressed not as a volume but as a percentage of the tidal air, and put in this way it indicates what proportion of each respiratory effort is being turned to good use in eliminating CO₂. Dead space determinations carried out in this way are influenced very readily by emotional hyperpnoea, and this probably reduces the value of the test in untrained subjects. On the whole, Moncrieff's results show that there is little correlation between the size of the dead space and the clinical state of the patient. In all probability this is because the factors which have been

¹ *Tests for Respiratory Efficiency*. By A. A. Moncrieff. Medical Research Council Special Report Series, No. 198. H.M. Stationery Office. (1s.)