THE ANAESTHETIST'S ROLE IN THE CARE OF RESPIRATORY POLIOMYELITIS*

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RESPIRATORY poliomyelitis is becoming an increasingly great problem, both medical and economic, with wide implications over North America. There is an increasing incidence of the disease, and at times one would suspect greater virulence of the virus. Certainly it is no longer merely a children's disease. Figures are not prepared as yet for our 1953 epidemic, but in our own city there were more cases of adult respiratory poliomyelitis than children's cases. It is the belief of a few people that medical education and clinical methods pertaining to this dramatic and disastrous disease have not kept pace with the general advances in medicine in other fields and particularly have not made use of experts in the special fields of biochemistry, pathology, internal medicine, endoscopy, physical medicine and anaesthesia. In addition, other non-medical but important professional groups have not been employed or consulted to the optimum extent, namely the social or welfare case worker; the occupational therapist; the special school teacher; the pyschologist and psychiatrist; and the speech therapist. It is our belief now that poliomyelitis, whether spinal or bulbar in type, of whatever combination, can best be treated in an organized polio centre where the services of any or all of the specialists mentioned above are available at any time.

As for the Polio Centre itself, we believe that every effort should be made to have all patients under one roof throughout their course, with the possible exceptions of a few milder orthopaedic cases after the acute stage is over. This centralization in the long run is more efficient economically and physically for the many medical and social problems involved. A full-time director with sufficient medical staff to provide complete twenty-four hour coverage is mandatory. A person in the early stages of polio and one who requires a respirator has been likened to a patient on an operating table, under the influence of an anaesthetic, who deserves practically minute-to-minute observation and skilful care. The medical profession should no longer be content to merely "hope for the best" and relegate the care of these unfortunate people to nurses and orthopaedic specialists.

Management of Respiratory Insufficiency due to Poliomyelitis

The respiratory difficulties in polio are the result of multiple disturbances: dyspnoea, derangement of respiratory rhythm, bronchial hypersecretion and local vasomotor anomalies with oedema. All these contribute to varying pictures of asphyxia. Poliomyelitis has been mistaken for asthma, bronchopneumonia, pulmonary oedema of cardiac, renal or infectious origin, and commonly hysteria.

It is well known, of course, that no specific medication to combat the

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paralysis or the causative virus is available. At present, only mechanical devices for symptomatic treatment are available. We can, however, do much to prevent death by constant care and accurate clinical assessment of each case. Prior to 1929–30, the mortality from respiratory paralysis was practically 100 per cent. In 1945 it was still over 50 per cent. Since 1950 it has been reduced to 20, 15 and even 10 per cent, in some centres.

It is useful to consider that there are three main types of respiratory failure, although often combinations of these may occur in one patient:

1. Type due to paralysis of primary muscles of respiration—intercostals and diaphragm.
2. Type due to pharyngeal paralysis and resultant obstruction of the airway.
3. Type due to central disturbances—respiratory, vasomotor and vagal centres.

Type One. In those with simple paralysis, the pathology is easy to understand, and treatment is the use of a respirator. However mechanical respiration is very crude and is not a substitute for the intricate mechanisms normally regulating respiration. Ordinary biochemical tests available are too clumsy and too slow to be of practical value in the regulation of the mechanical respirators available in most hospitals. Until recently, astute clinical observation by the experienced operator, using trial and error settings, was the mainstay of management. In assessing the need for a respirator, a rough estimate of vital capacity may be had by asking the patient to count aloud slowly as far as possible with one breath. It is preferable to use some form of respiration meter or spirometer, which causes no effort, inconvenience or delay. Rising blood pressure, pulse and respiration rates, along with flaring of alae nasae, use of neck muscles, increasing anxiety, inability to sleep and of course cyanosis, are all signs which may indicate respiratory failure. On our admission or observation wards we keep a chart by the bedside, believing that, as in the operating theatre, a graph of frequent readings more readily indicates trends of the patient's condition. Such charts are also maintained in plain view beside each respirator and not concealed in the nurse's station. We have also found it important to have a card pasted near the controls of each machine, so that the respiratory rate, positive and negative pressures, tidal volume, and alveolar CO_2 estimations, can be entered daily or oftener and seen at a glance by all attendants. Fluid balance charts are likewise maintained.

Type Two includes those cases of pharyngeal paralysis (bulbar polio) and this group is much more difficult to deal with. There is often more likelihood of acute emergencies such as severe laryngospasm, or asphyxia from sudden aspiration. Laryngeal paralysis is rare but spasm is common. The majority in this group should have an early tracheotomy. Endotracheal equipment and bronchoscopes, to say nothing of experts in their use, should be within a few seconds' reach of bulbar patients. Some mild cases get by with only postural drainage, oral suction and "Lady Luck." All must have plenty of rest and yet be constantly watched.

Type Three includes those cases of involvement of the higher centres, respiratory, vasomotor, and vagal. This may be hard to detect and equally hard to treat. Vagal paralysis will produce tachycardia, an ominous sign. Irregular, jerking or hiccoughing respirations indicate central involvement and primitive

control. These patients do poorly in tank respirators because of inco-ordination and a tendency to "buck" the machine. We have tried the electrophrenic stimulator briefly but were discouraged by the technical difficulties. In its place, we have used "Flaxedil" as recommended by the Minneapolis group. This relaxing agent is relatively stable and free of histaminic effects. With the patient in a respirator, a curarizing dose can be given by the nurse about every half-hour using the intravenous drip. Adaptation to the respirator and hence more adequate pulmonary exchange are then possible. During such treatment, one must beware of severe changes in cardiocirculatory dynamics, especially if the patient is postured on the side.

Respirators

The tank-type is still the most efficient ventilator, having a potential of about twice the tidal air required. Some models have positive-pressure devices at the head and, used for short periods, facilitate physiotherapy or other procedures. None of these devices should be allowed to delay or prevent suction of secretions. Another improvement is a cam-type drive which produces a longer inspiratory phase and shorter, more expulsive expiration followed by a pause. This type of cycle is of more physiological benefit and promotes expulsion of secretions and greater comfort. Several other new features are being developed.

Of the "portable" respirators, the older chest-type of cuirass was uncomfortable and did not make enough use of the diaphragm and abdomen. Newer models employ larger, more comfortable shells, with a vastly improved mechanism and physiological cycle.

The "AGA Pulmospirator" from Stockholm is a very interesting and inexpensive positive pressure respirator which is actuated by compressed air or oxygen, thus avoiding the need of electric power which may be a serious difficulty in the transportation of patients from a distance. The pressure and duration of inspiratory and expiratory phases are readily adjustable.

The rocking-bed is not as efficient as the tank for pulmonary ventilation, but is very useful during recovery, in assisting in weaning from the tank, enabling better muscle tone and circulation in the body generally.

Tracheotomies

There is still a controversy over the tracheotomy, and a wide range of opinion: some would avoid it, others would apply it to every respiratory case and every bulbar case. In general, prime indications include inability to cough; inability to swallow; laryngeal stridor or croupy voice; and pulmonary oedema. The operation entails a calculated risk but this is usually much less than the risk of going without it. Tracheotomy has four advantages; (1) it promotes a free airway at all times; (2) it permits suctioning of tracheo-bronchial tree and greatly facilitates bronchoscopy; (3) it enables positive pressure devices to be used; and (4) if the tube is cuffed it prevents aspiration of foreign material.

In the Edmonton Isolation Hospital we have found vinyl ether satisfactory for small children, relatively small amounts being required to accomplish intubation. Older children and adults for whom local anaesthesia was not suitable, were given minimal amounts of thio-barbiturate and succinylcholine for rapid intubation, then nitrous-oxide-oxygen for maintenance. Many patients required full

or partial respiratory assistance because of the disease rather than the anaesthesia. In some centres the operation is carried out with a bronchescope in place, but we favoured a portex tube, believing that suctioning can be as good, adaptation for anaesthesia or assisted respiration is simpler, and toleration of the tube somewhat easier. Most authorities prefer not to premedicate, thus avoiding further depression of vital functions, and omit atropine in order to keep the secretions as thin and watery as possible.

The Minneapolis group have emphasized the need for using a large tracheotomy tube. Even a No. 7, the largest size, has only half the end-area of the adult trachea. Short sections of portex tubing with thin walls may be used in place of the standard silver tubes. The bevelled end must be smooth and of course not too long. It is essential to firmly suture the tying-tape to the tube to avoid slippage. Such a tube is easy to make, easy to adapt to positive pressure apparatus, can be changed easily, and causes minimum irritation.

The Problem of Regulating Optimum Respiratory Exchange

Clinical judgement based upon experience is important, but should be assisted by more objective methods. Much is rightly said about anoxia, but too little is said of CO_2 imbalance. Providing the lungs are normal, there will usually be adequate oxygen uptake in the presence of a reasonable minute volume. If extra O_2 is supplied, very slight respiratory movement may be sufficient to raise alveolar tension high enough that arterial blood will be nearly or completely saturated; but retention of CO_2 is presumed to occur in spite of the degree of O_2 saturation, and in the absence of cyanosis.

The importance of CO_2 retention is often demonstrated in respiratory poliomyelitis. On admission, patients frequently exhibit the picture of acute asphyxiation, with dyspnoea, stridor, inability to swallow, rigidity of muscles of respiration, cyanosis, tachycardia, and hypertension. When tracheotomy is done, the tracheobronchial tree cleansed, and normal ventilation restored, a rapid "wash-out" of CO_2 and immediate fall in blood pressure ensues. This picture is similar to that occasionally seen after cessation of a long, difficult or badly managed anaesthetic. In some patients, ventricular fibrillation and cardiac arrest have occurred. To prevent this catastrophe, the level of CO_2 should be slowly reduced over a period of twelve to twenty-four hours. This may be done with a partial rebreathing system or administration of small quantities of CO_2. Pulse and blood pressure must be charted and followed carefully. Early in our epidemic several cases of tetany occurred in the first few moments after tracheotomy or on the instigation of mechanical respiration. Another point is that a low CO_2 tension may prevent O_2 from leaving the red cells, and the tissues may thus be anoxic in the presence of fully saturated red cells. A CO_2 combining-power estimation is meaningless here, because there may be a normal value in the presence of a low CO_2 content.

We know that free CO_2 and blood bicarbonate constitute an important buffer system for keeping blood pH constant. With defective ventilation and CO_2 retention, changes in the pH may be manifested by elevation in blood pressure and alveolar CO_2 up to 8 or 10 per cent. With further retention, in the range of an alveolar CO_2 from 10 to 12 per cent, a narcotic effect occurs, with peripheral vasomotor collapse, coma, delayed cardiac conduction and bradycardia. Usually

anoxia is present as well. Such a state can occur insidiously in respirator cases from a multitude of mechanical and physiological causes.

To provide a practical basis for management, one should have a daily knowledge of air exchange (tidal air) and CO_2 content. Our work is based on the assumption that end-tidal samples of expired air are practically equivalent to alveolar air, and that CO_2 determinations thereon give sufficient information. This procedure eliminates the need for elaborate estimations such as blood pH determination and the solution of the Henderson–Hesselbach equation. Rice has devised an ingenious end-tidal sampling device, and a simple method of measuring the CO_2 percentage, both of which can be used quickly in the ward beside the patient. Details of his method will be published shortly.

Summary

An effort has been made to show that the anaesthetist is particularly qualified to assist with the assessment and management of respiratory poliomyelitis, and can contribute materially towards the scientific treatment of this disease. Time has not permitted a detailed discussion of the many facets of this interesting subject, but some of the physiological problems have been outlined and some practical suggestions given. An active poliomyelitis ward is recommended as a first-class laboratory for the study of respiratory physiology and electrolyte balance.

Résumé

Les difficultés respiratoires dans les cas de poliomyélite proviennent de troubles multiples: dyspnée, dérangement du rythme respiratoire, hypersécrétion bronchiale et anomalies vasomotrices locales avec œdème. Tout ceci contribue à former des cas variés d'asphyxie. On a comparé le malade atteint de poliomyélite dans les premiers degrés et celui dont l'état exige un poumon d'acier, au patient sur la table d'opération sous l'influence d'un anesthésique et nécessitant une observation incessante et des soins adroits. L'anesthésiste est particulièrement indiqué pour fournir les soins spéciaux réclamés par les problèmes respiratoires de ces malades.

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