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The USE of the RESPIRATOR in Poliomyelitis

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The USE of the RESPIRATOR in Poliomyelitis

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FOREWORD

The National Foundation for Infantile Paralysis presents this brochure on the use of the respirator in a sincere hope that this valuable aid in the treatment of infantile paralysis can be made to serve with the maximum efficiency.

Prolonged artificial respiration has a place in the treatment of the disease. Frequently the respirator has been called into play either too late or for the wrong type of case. In the minds of many, as the result of this misuse, the device has been discredited unjustly. Others have thought of it as a panacea with promises of cure impossible of fulfillment.

This publication, offered to the physician and his public, is an attempt to secure a balance between these extreme viewpoints, and thereby to promote the proper use of the "iron lung" and other machines designed to provide respiration by mechanical means over prolonged periods of time.

BASIL O'CONNOR, *President*
The National Foundation for
Infantile Paralysis.

THE USE OF THE RESPIRATOR IN POLIOMYELITIS

THE respirator, after some eighteen years of use, is now generally available and well-known to the medical profession and to the public. New machines for prolonged artificial respiration are being developed, and more and more of all types are being distributed. Their use is best established and recognized in poliomyelitis.

The respirator has been often wrongly used. It is frequently applied to types of respiratory failure where its action cannot be effective and where its use is futile and sometimes harmful. In the minds of many, both physicians and laymen, its use is associated with a last desperate effort to save life, and a patient is not put into a machine until his need is extreme and urgent. This attitude is unfortunate and has, to a considerable extent, prevented the use of the respirator where benefit would be greatest. The early signs of weakness of respiratory muscles are not generally looked for or recognized, and there exists a great deal of difficulty in the correct analysis of the confusing causes of respiratory distress in this disease and as to the exact indications for respirator treatment.

Indications for Use of the Respirator

Not all poliomyelitis patients with difficulty in breathing can be helped with a respirator. Sometimes the use of the respirator may be harmful.

Poliomyelitis can prevent efficient respiration in three ways:

1. By actual paralysis of the primary respiratory muscles, the intercostals and the diaphragm, due to damage to the anterior horn

cells of the cord. *Only in these cases is the respirator consistently helpful.*

2. By disturbance of the nerve centers in the medulla or bulb which presumably control the rate, rhythm, and depth of respiration. *The respirator occasionally is of aid here.*

3. By the collection of mucus or vomitus around the glottis in patients with paralysis of the pharynx, causing constantly interrupted inspiratory efforts resulting in shallow, irregular, and ineffective respiration, and leading to extreme fatigue and respiratory failure. *The respirator is rarely effective and sometimes harmful in these cases.*

In the first situation, that with actual paralysis of the intercostal muscles or of the diaphragm, the lesion exists in the dorsal and cervical cord. This type, therefore, should not be classed as bulbar, although respiratory failure occurs.

The lesions existing in the second and third situations, involvement of the respiratory centers or paralysis of the pharynx, are in the medulla, and, therefore, this type is properly called "bulbar."

The respiratory difficulty in any patient ill with poliomyelitis may be due to a single one of these three factors or to any combination. Paralysis of the respiratory muscles frequently occurs alone without bulbar complications. Paralysis of the pharynx, the palate, or the facial muscles is often associated with involvement of the "vital centers," most evidently the respiratory center. The marvelously complicated and congested mass of nerve paths and nerve centers of the medulla makes it remarkable that such association does not always occur. Disturbance of the respiratory "centers" alone without evidence of pharyngeal or palatal paralysis is rare. Respiratory muscle paralysis is intermediate in frequency, and is the only type commonly aided by the respirator.

It needs to be re-emphasized that the ***respirator will consistently give aid only when there is paralysis of the intercostal muscles or diaphragm,*** or in the rare instances where there is a hypofunction, not a dysfunction, of the respiratory centers. It will not help when pharyngeal paralysis obstructs respiration, when the respiratory centers are irregularly active and produce something like an "auricular fibrillation" of respiration, or when respiratory failure is secondary to circulatory collapse with tachycardia, as is so frequently the case in this disease. It will not help, therefore, in most cases of "bulbar" poliomyelitis, except where the paralysis of muscles innervated from the medulla is complicated by intercostal or diaphragmatic paralysis. Since bulbar cases outnumber the cases of severe paralysis of the essential respiratory muscles in most epidemics, it is not surprising that physicians who place in a respirator every patient with respiratory symptoms, regardless of their nature, have only an unhappy experience with a series of patients with "bulbar" poliomyelitis futilely treated.

The respirator is a device for providing physiologic rest for the muscles of respiration.

The respirator should be considered much *more* than a device for emergency life saving in this disease. As we believe we should make a great effort to enforce rest of the tender and partially paralyzed muscles of the arms and legs, we should equally desire to rest partially paralyzed respiratory muscles. The respirator cannot give complete rest such as that enforced by a cast or splint and can only substitute passive for forced active use of muscles. There is no question that the muscles of respiration are rested, and possibly fewer nerve impulses need to pass through the anterior horn cells to those muscles when a patient is given successful respirator treatment. Possibly much more can be accomplished by the respirator in pro-

tecting the muscles of the many mildly paralyzed, than in the saving of a few lives of the desperately paralyzed.

Indication for Initiating Respirator Treatment

The first principle to be followed in the use of the respirator is therefore to *use the respirator at the first evidence of any paralysis of the intercostal muscles or the diaphragm. Avoid any fatigue.*

When this is conscientiously carried out, it will sometimes be found that patients, particularly frightened children, will refuse to relax in the machine and will therefore obtain no benefit before they, themselves, feel the need of help. Nothing is lost by the effort however; the patient can be watched safely near a machine, and soon reassurance and gentleness will make it possible to give them rest. Generally, the evidence of relief and comfort given by the use of the respirator, as shown by relaxation and sleep, is alone an indication on general medical principles for the early use of the machine.

Patients with only a moderate degree of paralysis of the respiratory muscles, who are far from being cyanotic and show only slight dyspnea with perhaps only a little motion of the nostrils on inspiration, will often, on being first placed in a respirator, drop into such a profound sleep that it simulates coma, a sleep evidently the result of the relief from the necessity of prolonged conscious attention to respiration.

The phenomenon of mental confusion due to low grade and persistent anoxia must be recognized. One sees, particularly in older patients, mental disorientation and confusion due to low grade, but persistent, anoxia possibly aggravated by fatigue. This condition

may confuse the diagnosis, and seriously raise the question of some form of encephalitis, but often without showing much direct evidence of respiratory muscle weakness, and patients may respond remarkably after a few hours of respirator treatment and demonstrate a much clearer sensorium.

It is impossible to foretell the degree of recovery which will take place in a patient seen during the acute stage of the disease.

Many badly paralyzed patients do not recover enough muscle power to breathe alone for many months. These patients may become such hopeless cripples that survival is regretted. Frequently, however, recovery rate is remarkable.

Therefore, one cannot, even if he would, choose patients with a good prognosis to help and let nature take its course with those with a bad prognosis. Patients with respiratory weakness first seen after the acute febrile stage is over sometimes show apparent dangerous progression of their weakness. This is often only an evidence of cumulative fatigue and will respond dramatically to respirator treatment.

Indication for Removal from the Respirator

Avoid Fatigue. The same indications for allowing partially paralyzed muscles of an extremity to be first subjected to active motion should be followed with the respirator. *Do not remove patient from a respirator at the first moment he can adequately ventilate his lungs by his own efforts.* Many patients after one or two days in the machine may seem to be able to breathe by themselves comfortably in bed. If such patients even though evidently much relieved from their original condition are taken out of the machine, they may be discovered in a serious state of collapse a few

hours or a few days later with apparently an increase in the extent of the respiratory paralysis.

This phenomenon is occasionally referred to as a secondary advance of the paralysis. It is not necessarily so. It is frequently only the result of cumulative fatigue in a patient who may be able to breathe for himself for a few hours without much evidence of strain but, who, after a longer period becomes seriously exhausted.

An important principle in respirator treatment is to ***allow independent unaided breathing only after fever and muscle tenderness have passed.***

The patient should stay in a respirator until the temperature is normal and muscle tenderness has disappeared. At that time, depending on the degree of paralysis, independent breathing for increasing periods can be allowed. Always stop independent breathing short of fatigue.

The intermittent use of the respirator should be continued probably for months, using the machine primarily for graduated rest but also to prevent as far as possible deformities of the thorax. It is well to increase the hours spent in the machine by patients with limited vital capacity when they acquire respiratory infections.

A third principle in respirator treatment is to ***encourage "weaning" from the respirator as soon as the fever subsides and muscle tenderness, if there is any, becomes less acute.*** The danger of excessive fatigue is not greater than the danger of too great dependence upon the respirator.

It should be recognized that there is a great tendency for both children and adults, but particularly adults, to become psychologically dependent upon the respirator. They may, in fact, develop such strong conditioned reflexes

that they become dyspneic when the machine is not being run in spite of the fact that one can determine that their respiratory exchange is not greatly impaired.

As soon as possible, therefore, the patient should be encouraged to take a few independent breaths, or to breathe for some time with the machine's pressure reduced to a minimum. Often one can detect how far to go in this matter by surreptitiously reducing the pressure in the machine while the patient is asleep, and observing the point at which the nostrils begin to dilate or the patient wakes.

Only a general outline can be offered for "weaning" from the respirator. It is important not to frighten the patient and it is certainly important not to allow over-fatigue, but one should avoid the situation where a patient becomes so acutely conscious of the exact pressure at which the machine is run that he becomes apprehensive of any slight reduction of pressure or becomes frightened at more than a moment's independence of its action. There are few patients so completely paralyzed that they cannot be gradually weaned from the respirator so that they can carry on independently for at least minutes at a time after two or three weeks of their illness.

Diagnosis of Paralysis of Muscles of Respiration

The early diagnosis of weakness of the muscles of respiration is obviously of great importance.

Wakefulness, restlessness, anxiety and mental confusion are usually apparent first, though obviously these symptoms may be brought about by many other causes than respiratory muscle failure. ***An increase in the rate of breathing, dilation of nostrils, a slight respiratory grunt, and disinclination to talk***

Use of the Respirator in Poliomyelitis

are suggestive of respiratory muscle paralysis.

Occasionally slow, irregular, shallow respiration in a patient not obviously in a serious state may surprisingly conceal a respiratory weakness. A very helpful early sign particularly in a child is a curious *frequently interrupted speech* which progresses to a point where it is monosyllabic. Reduction in vital capacity or "shortness of breath" is often strikingly brought out by asking the patient to count as rapidly as possible. None of these signs is specifically indicative of paralysis of the muscles of respiration, but demand very careful examination. In a child who will not co-operate by "taking a deep breath" it may be helpful in the demonstration of a partial paralysis of the muscles of respiration to inhibit the action, first of the intercostals and then of the diaphragm, by splinting the chest or the abdomen with the hands and thus forcing the alternate respiratory muscles to greater action.

Paralysis of both shoulders is usually associated with paralysis of the intercostal muscles, so that when this is detected the respiratory muscles should be carefully watched.

Likewise, paralysis of the neck muscles is often associated with a paralysis of the diaphragm, though the value of this sign is greatly diminished by the difficulty in distinguishing true neck muscle paralysis from failure to use these muscles because of pain.

Cyanosis from respiratory muscle weakness is a late sign, it should not be allowed to occur. When it occurs, the situation is very urgent and death is near, and except in unusually rapidly advancing cases, its presence implies neglect and lack of careful observation. The strained use of the accessory muscles of respiration, the jutting forward of the chin and attempts to swallow air are too well recognized as late signs to need discussion.

In the patient with bulbar poliomyelitis

without paralysis of the intercostal muscles or of the diaphragm, it is often difficult to untangle the causes of the respiratory difficulty. In some cases the respiratory disturbance seems purely "central" in origin and may make itself manifest by shallow, irregular respirations or by jerky spasmodic inspiratory efforts, sometimes almost amounting to a succession of hiccoughs. If the disturbance is purely central in origin and if the patient's own respiratory efforts are unsuccessful in properly ventilating the lungs, the respirator may justifiably be given a therapeutic trial. For the most part, however, such patients are little helped by the apparatus. Their own irregular, inefficient respiratory efforts do not synchronize with the rhythm of the machine, but, rather, prevent its effective action.

Care of Patient in Respirator

Detailed directions for the operation of the mechanics of the respirator will not be given here. The machines available vary in construction details, but are not complicated and the method of operation is easily learned. When dealing with an emergency where speed is essential, one individual who thoroughly understands the situation and is wholly in command will expedite the procedure.

The medical and nursing care of the patient apart from the treatment of his respiratory paralysis warrants some comment. The question frequently arises as to what harm the machine can do. Will it produce emphysema? Will it rupture a lung? Will it produce alkalosis and tetany? These possibilities, which will be discussed later, are of minor importance compared with the ill effects which appear from neglect of the nursing care of the patient because of the difficulties brought about by enclosing him in this machine.

Many patients whose respiratory paralysis has been adequately treated in the respirator have died from conditions resulting from poor nursing and medical care.

It is of great importance for the patient's position to be changed frequently. This cannot be emphasized too greatly. The danger of pneumonia is considerable. If a patient cannot swallow, posture drainage becomes necessary. Care of the skin to prevent bed sores is of great importance. Care of the bowels, administration of enemas, subcutaneous injection of salt solution, intravenous administration of glucose solution, all frequently need to be carried out without interrupting the action of the respirator. In dealing with situations necessitating prolonged artificial respiration associated with pharyngeal paralyses, types of machines which can be tipped on the transverse axis so that the head is low, should be used. It is possible to construct respirators so that almost any procedure necessary for the care of a severely ill patient can be carried out without stopping the machine. These factors must be considered to be equally as important in the treatment of patients with paralysis of the respiratory muscles as is the maintenance of adequate artificial respiration.

Conditions Influencing Effective Action

Experience has shown that it can be said with confidence that the respirator will accomplish what can reasonably be expected of it, *i.e.*, it will bring about the passage of air into and out of a patient's lungs for indefinite periods without harm to the patient, provided there is no obstruction to the airway, either by foreign materials or by the patient's own muscular efforts. These provisos cover a great many possibilities, a thorough discussion of which would necessitate a review of all the mechanisms of respiratory failure.

Control of Speed and Amount of Vacuum

No definite schedule can be offered by which the optimum speed (rate of artificial respiration) of the machine can be determined. Most respirators can be operated at only two or three possible speeds determined by the suitable arrangement of the gears. Others are more flexible. In most cases great variations in the speed of the respiration induced by the machine can be made with little apparent disturbance to the patient. The ability of the patient to adapt himself to various rates of respiration seems to depend on (1) a free air passage, (2) the absence of pneumonia, and (3) an absence of irregularly initiated, spontaneous respiratory efforts. The presence of an obstruction to the passage of air due to foreign matter, such as mucus in the air passages, laryngitis, or the presence of pneumonia, all factors that limit deep inspiration, apparently demands a more rapid rate of respiration, variable only within narrow limits which must be determined for the individual patient. If a rate suitable to the patient is not obtained, the efficiency of the respirator is greatly reduced or lost. Synchronism between the patient's efforts and the rhythm of the machine in such cases must be made by adjustments of the machine.

It is wise to initiate the treatment of any patient at respiration rates between 15 and 20 per minute for adults and between 20 and 30 per minute for children.

The usual normal intrapleural negative pressure on inspiration has been found to lie between 7 and 10 mm. of mercury or 9 and 13 cm. of water. In experiments on normal adults, Drinker and Shaw originally found that alternating negative and positive pressure approximately within this range* was necessary

* The pressures were measured by the height of a water column under conditions of use, *i.e.*, rhythmically alternating pressures. The momentum of this water column makes this somewhat different from the actual pressures.

before the subject's respiratory rhythm was synchronous with the machine, but that considerably greater pressure could be used before there was any evidence of distress or evidence that the patient was resisting the action of the respirator. By actual observation of the reaction of many paralyzed patients, however, "thresholds" of minimum adequate pressure slightly higher than this are usually found, and a negative pressure of 14 cm. of water most commonly has been found necessary before a patient seems completely comfortable and ceases to use the accessory muscles of respiration.*

Experience has shown that there appears to be little relation between the size of the patient and the degree of negative pressure required to be effective, a premature baby apparently requiring as great pressure as an adult.

Greater pressure than 14 cm. of water can be used with very little danger, but it is probably wise to keep the pressure used under 20 cm. of water. If a negative pressure of 20 cm. of water is not sufficient to prevent cyanosis or to prevent additional respiratory efforts on the part of the patient, it can fairly be concluded that factors exist other than the lack of mechanical force to ventilate the lungs (obstruction in air passages, pneumonia, circulatory failure, abdominal distention, etc.).

* Further experiments have demonstrated that the component of pulmonary ventilation induced by the use of positive pressure during the expiratory phase of the machine amounted to only a very slight fraction of the total, and so the use of positive pressure has been largely discontinued. The use of positive pressure, moreover, is usually disagreeable to the patient. Occasionally, positive pressure is of value in bringing about a more forceful expiration in patients with paralysis of the abdominal muscles who cannot effectively cough. Such patients have difficulty in removing secretion from the bronchi or pharynx, especially in cases of poliomyelitis with pharyngeal paralysis. By the use of positive pressure in a respirator, it is possible to teach a patient to cough who cannot do so without its aid. This requires on the part of the patient, however, a deliberate effort, nicely synchronized with the rhythm of the machine. Often it cannot be accomplished with any definite success. A machine running with the use of positive pressure would not aid, of course, in a spontaneously induced reflex cough unless the opening of the glottis can be made to coincide with the time of maximum pressure in the respirator.

Control of Respirator by Observation of Patient

In spite of the fact that the respirator seems a crude device when compared with the intricate and delicately balanced mechanism for respiratory control of the body, experience has shown that it can be properly and satisfactorily controlled by simple observation of the patient.

Cyanosis. Cyanosis is an evidence of markedly insufficient oxygenation of the blood but in itself it is not an indication for increasing the pressures used in the machine. If a patient is breathing synchronously with the rhythm of the machine and with unobstructed air passages, it should not be necessary to use pressure greater than 20 cm. of water to ventilate the lungs adequately. Cyanosis existing with the respirator running at this pressure may usually be taken as an indication that some factor other than muscle weakness is present.

Synchronization of Machine and Breathing. For efficient action of the respirator it is necessary that there be synchronism between the patient's own respiratory efforts and the rhythm of the machine. Inspiratory efforts on the part of the patient in addition to those induced by the respirator may sometimes be abolished by increasing either the rate or the force of the machine. If these "extra" inspirations are irregular, the possibilities of mucus or vomitus in the larynx or trachea should be considered and, if present, they should be removed. The "extra" respiratory efforts may be of central origin. In these cases, respiratory sedatives may be justified, thus putting even

greater dependence on the use of the respirator. Sedatives are definitely contraindicated in uncomplicated respiratory muscle paralysis.

Use of Alae Nasi. Use of the alae nasi or of the accessory muscles of respiration in the neck may call for increasing rate or depth of respiration if these signs are due to inadequate expansion of the thorax.

Examination With Stethoscope. By listening with the stethoscope held over the nose and mouth of the patient, one can obtain a rough idea of the amount of air passing to and fro. More important, obstructions to the passage of air by secretions or aspirated material can often be detected in this way. Often when too great pressures are used, obstruction to the passage of air by partial closure of the glottis can be detected. On lowering the pressure the sound produced by this obstruction will disappear.

Observation of Respiratory Movements. Considerable information as to the efficiency of the action of the respirator can often be obtained by watching the patient's body inside the respirator. However, with the patient perfectly relaxed and breathing easily in synchronism with the respirator, it is sometimes difficult to detect the motion of the chest. A very diffuse general swelling of the entire thorax and abdomen of the patient, quite different from the wave-like inspiratory motion seen in natural breathing, is apparent. It is often difficult to detect the part played separately by the diaphragm and the thoracic muscles. A patient with intercostal paralysis often demonstrates this in a striking manner. When he is lying in the machine with the power turned off, vigorous diaphragmatic efforts causing the abdominal wall to move forward and outward with each inspiration will be strikingly apparent, a movement which

will suddenly become much less marked as the power of the machine is turned on and the entire thorax begins to expand and contract in a much less forceful and more diffuse manner.

Dangers in Use of Respirator

Subcutaneous Emphysema. There are certain dangers involved in using too great negative pressures in the respirator. Occasionally, subcutaneous emphysema around the neck has occurred while patients were being treated. This has subsided without apparent harm. Pulmonary emphysema of considerable extent has been discovered at autopsy in patients who died in the respirator. Most such patients had been subject to very great pressures in an understandable though futile effort to prolong life, and had been subjected to this vigorous treatment for varying periods after death.

Alkalosis and Tetany. It is possible to produce a state of alkalosis and even tetany as a result of hyperventilation of the lungs by the use of excessive pressure in the respirator.

It should be pointed out that few patients with poliomyelitis are in such a state of complete paralysis or unconsciousness that all reflexes are abolished and that they are completely subject to the action of the respirator. The machine is apparently never quantitatively substituted for the patient's own respiratory mechanism. The patient frequently has considerable ability, if not to aid himself by expanding his own thorax, at least to prevent excessive ventilation of his lungs. This is probably accomplished by simple closure of the glottis during the inspiratory phase of the machine. This is similar to the finding of Henderson, that it was difficult by the Schäfer method of artificial respiration to overventilate the lungs of a patient and to produce a state of apnea because of protective reflexes on

the part of the subject.

Hyperventilation can, of course, be easily accomplished by the co-operation of the subject. However, small children with paralysis of the thoracic muscles but otherwise healthy, who have become quite familiar with the respirator, have been many times subjected for an hour continuously to inspiration pressure of 30 cm. of water without evidence of distress and with only a momentary period of apnea following the experience. These children resisted the action of the machine for short periods apparently with considerable amusement and, having no idea that they were subjected to experiment, they did not try to "co-operate."

Post-mortem Evidence of Damage to Lungs

Evidence of damage to the lungs by the action of the respirator as determined by autopsy needs to be considered. It should be remembered that most patients who die have had bulbar, that is, pharyngeal paralysis.

Grossly, the lungs show emphysema of the anterior portions and varying amounts of congestion, bronchopneumonia and hemorrhagic areas in the dependent parts. Sometimes bronchopneumonia is very extensive.

Histologically, there is congestion of the blood vessels, transudation of serum and red blood corpuscles into the alveolar spaces and, in sections from the anterior parts of the lung, emphysema. The emphysema is sometimes marked, with large air spaces occasionally the extent of an entire low power field. In some areas a narrow rim of serum precipitate and red blood corpuscles was seen apparently compressed against the sides of the alveolar walls by air bubbles. The amount of serum and red blood cells is much greater than is consistent with the amount of evident inflammatory reaction. It is also noteworthy that the amount of serum exudate and the extent of capillary

engorgement is much greater in the dependent portion of the lungs than in the anterior emphysematous areas where often the alveolar walls seem pressed out and thin.

A large amount of the serum transudate and of the emphysema we must attribute to the use of the respirator. However, it is important to recognize that similar, though usually less extensive changes occur in patients dying without treatment with the respirator.

Thus, there is evidence that the respirator may do harm but harm that may be considered justifiable and not regrettable. It is probable that the patient himself, had he the strength to do so, might well have brought about similar changes in the lungs in his last efforts to maintain life. It is to be remembered that each patient is apt to be subjected to vigorous artificial respiration immediately before and for varying periods after death. The exact moment of death is often difficult to determine, and there is a quite justifiable tendency to increase the power of the machine in a final effort to prolong life. After death the glottis apparently relaxes so that the protective spasm of the larynx no longer prevents excessive pulmonary distention. Much of the damage apparently caused by the machine may be due to an excessive use of the respirator just before and immediately after death.

Treatment of Patient with Pharyngeal Paralysis

Because of the frequent and confusing overlapping of the type of respiratory disturbance due to different causes in the same patient, it is desirable to include here a discussion of the treatment of pharyngeal paralysis.

Frequently, patients with pharyngeal paralysis, because of the secretions around the glottis which prevent deep inspiration, breathe

in a manner simulating paralysis of the respiratory muscles. A deep inspiration tends to aspirate fluid into the larynx and is frequently interrupted by a forced expiration. Patients cannot or will not take a deep breath on request and often little motion of the intercostal muscles can be detected. Because of the continual interruption of respiratory efforts by the pharyngeal secretions, it is often difficult or impossible to determine whether a true involvement of the respiratory centers has occurred. This is even more difficult after the aspiration of foreign material into the bronchi.

There appear to be three dangers from pharyngeal paralysis, though these are often difficult to distinguish:

First, a choking attack may occur with temporary severe anoxemia resulting in deep cyanosis which often seems to have a serious result in itself on the course of the disease.

Second, the patient may aspirate mucus or vomitus into the bronchial tree and bring about bronchial obstruction, or even sudden complete cessation of respiratory effort.

Third, the condition may bring about excessive fatigue to a degree that is very serious in itself. This is particularly evident in the type of patient whom we call "nervous." As soon as a patient relaxes for a moment's sleep he is immediately awakened by the aspiration of secretions and subsequent choking and coughing attack.

Therapy in these patients should be directed primarily toward *keeping the pharynx free from food, vomitus and secretions.* Although a patient cannot swallow, it may be easy to feed him by gavage; but these patients have such a tendency to vomit that this method of feeding is dangerous. *It is wisest to give neither food nor fluids to patients with any evidence of pharyngeal paralysis* until the temperature is normal and the patient is hungry. Vomiting

can best be prevented by keeping the stomach empty. An attack of vomiting is associated with nausea, and nausea brings about greatly increased pharyngeal secretions which in themselves may produce as much distress or danger as vomiting itself. Salts, water and carbohydrate in adequate amounts can be administered parenterally and by rectum. The pharynx should be kept drained as far as possible by *postural drainage carried out to an extreme degree.* The patient should be tilted to an angle of 30 or 40 degrees; he is frequently aided by being kept on his face. In attacks of choking, the head may be put even lower. Postural drainage frequently results in a surprising amount of mucus and saliva flowing from the mouth. *Aspiration of the secretions from the throat is often of life-saving value.* In treating any patient with pharyngeal paralysis, apparatus* for aspiration of the throat should be at hand. Aspiration should be carried out as infrequently as possible as in certain excitable patients it, in itself, may irritate the pharynx and increase the production of mucus. In more phlegmatic patients, such great relief by aspiration is obtained that they request it and sometimes can carry out the procedure themselves.

Adequate administration of fluids by rectum or parenterally is important. Both excessive thirst and thick tenacious pharyngeal secretions difficult to remove can often be remedied by parenteral fluids. *Continuous intravenous infusions are often indicated, though great care should be taken that too much is not given. There is definite risk in too liberal hydration in the presence of cerebral oedema.*

Atropine in an effort to dry up secretions is usually not satisfactory. It may result in the production of thick, sticky secretions which are difficult to remove and cause much irrita-

* An effective emergency suction apparatus can be derived from an ordinary vacuum cleaner connected by a suitable arrangement of rubber stopper and tubing to a water bottle trap.

tion of the glottis, and may exaggerate an already excessive tachycardia.

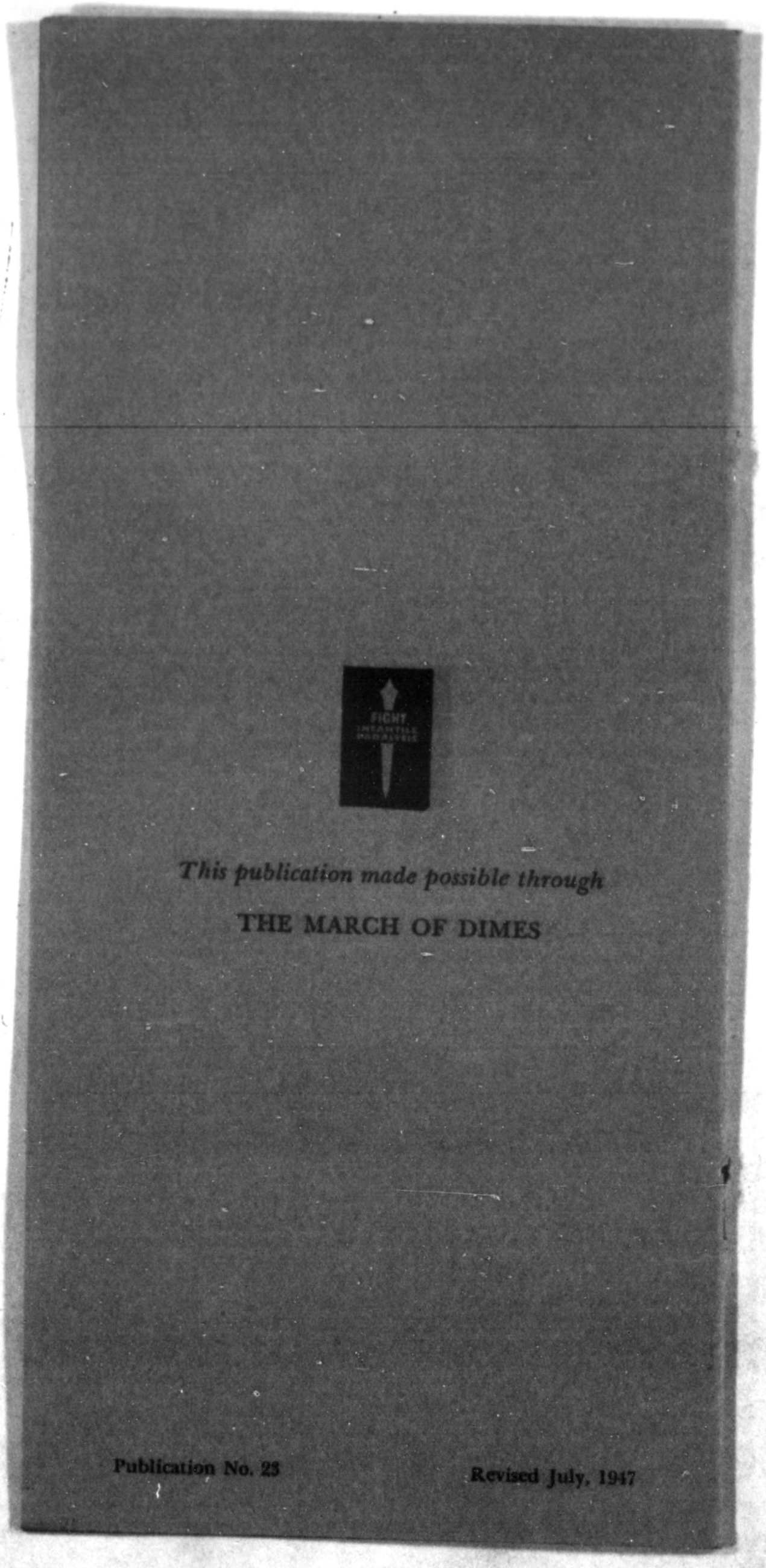
The handling of the "nervous" type of patient needs further comment. Anxiety and fear of choking make patients with pharyngeal paralysis much more difficult to treat and a "vicious circle" is started. The more they struggle the more their secretions bother them, and the more fatigued they become. Aspiration of the throat may be carried out only with such a struggle as to nullify its value. The careful use of sedatives is here justified even in spite of our fear of using them in patients with brain stem involvement. A calm reassuring attitude on the part of the doctor and nurse and the avoidance of a state of confusing bustle and hurry are of great importance. Although in most cases of pharyngeal paralysis, it can be avoided, a *tracheotomy is indicated sometimes in the "high-strung" nervous patient.*

Ideally, if a tracheotomy is to be done, it should be carried out before aspiration of foreign material has taken place and before choking attack occurs. Actually, however, it is impossible to determine ahead of time which patients are going to need tracheotomy. This is a radical procedure; the majority of patients with pharyngeal paralysis develop no such serious situation, and, unquestionably, many patients who have aspirated foreign matter into the bronchial tree, who have been subject to severe choking attacks and have become dangerously fatigued, have survived without any such operation.

Tracheotomy, however, enables the patient to be fed with much less fear of choking attacks due to vomiting. It prevents the aspiration of the pharyngeal secretions. It allows the patient to sleep, uninterrupted by choking attacks. It is quite easy to keep the trachea itself free from secretions by direct aspiration through the tracheotomy tube. Sometimes, when an emergency tracheotomy is performed on children who have collapsed after a choking attack, large amounts of mucus can be removed directly from the trachea with dramatic relief of symptoms. This procedure may offer considerable assistance in a few selected cases. Tracheotomy will be ineffective, of course, when the irregularity of respiration is due to central medullary disease.

Administration of oxygen may be benefic and has been enthusiastically advocated by some. The physiological basis for oxygen therapy is the same here as for other conditions. Oxygen therapy will not control an obstructed air way; it will not satisfactorily substitute for ineffective action of the respirator; it will not aid in carbondioxide excretion. Oxygen administration must not be given in such a manner as to prevent easy aspiration of the throat. When tracheotomy has been done, oxygen can be administered with great ease through the use of a small cone over the opening of the tracheotomy tube.

So far as these patients have respiratory disturbances due to the presence of unswallowed pharyngeal secretions, the use of a respirator seems for the most part illogical and even contraindicated. Sometimes, however, complete failure of respiration suddenly occurs following a choking attack. In those cases prompt use of the respirator, if it is immediately at hand, may prove life-saving.



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THE MARCH OF DIMES

Publication No. 25

Revised July, 1947

Polio *and* People

By

MARION O. LERRIGO, PH.D.

for

THE NATIONAL FOUNDATION
FOR INFANTILE PARALYSIS

FIGHT INFANTILE PARALYSIS

Polio and People

The NATIONAL FOUNDATION

Franklin D. Roosevelt, Founder

120 BROADWAY, NEW

for INFANTILE PARALYSIS

YORK 5, NEW YORK

This is the story of how an American family, like yours or mine, secured aid for their child who was ill with infantile paralysis.

As this disease may threaten the health and happiness of any family, you will want to know how you can help and how you can be helped in case of need.

In your county there is a Chapter of the National Foundation for Infantile Paralysis pledged to secure the best available medical and hospital care for every polio patient.

After you have read this story, get in touch with the Chapter chairman in your county and offer your help in this co-operative effort to combat infantile paralysis.

Basil O'Connor

President

Polio at Anderson's

MR. ANDERSON had turned his cows out to pasture and was starting unhappily to town.

"Don't be so glum," his wife said. "If we have to get a new mortgage, we can pay it off; we've done it before. Nothing else matters if John gets over the polio and can walk once more."

Mr. Anderson smiled at his wife's effort to cheer him up, but by the time he reached the bank in the small town some miles away his troubles made him frown again.

"I'm afraid I'll have to take out another mortgage on the farm," he said to Mr. Brown, president of the bank. "About fifteen hundred dollars."

"But you just paid off your mortgage recently! Are you making some improvements?"

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"You don't need a mortgage!" Mr. Brown interrupted, suddenly.

"You mean I can't have it?"

"What you need is to talk with the Chairman of the local Chapter of the National Foundation for Infantile Paralysis. The Chapter can help you with your boy's expenses."

"I don't take charity," Mr. Anderson replied, looking offended.

"This isn't charity. The National Foundation and its Chapters are supported by the American people, who give each year to the March of Dimes. This fund provides needed aid for all polio patients,

The National Foundation for Infantile Paralysis was founded in 1938, dedicated to the conquest of this disease. Before that, there was no national organization to fight infantile paralysis.

The March of Dimes Gives Needed Help

regardless of age, race, creed or color."

"Do I tell all my private affairs to some welfare officer and let him decide if I'm poor enough?" Mr. Anderson asked bitterly.

"Nothing of the sort!" Mr. Brown declared positively. "Why, look here. Very few families can afford to pay all the bills for caring for a polio patient. They can easily reach from $1000 to $2500 or more."

"It would take years to pay that out of my income," Mr. Anderson said.

"Most folks, if they don't have help, may do as you planned; mortgage the home place. They use all their savings, take children out of school, and have nothing left for another rainy day. It isn't good for the community when families lose their security like that. When our Chapter helps with the cost of treatment, the community is better off, because the

The 2718 Chapters of the National Foundation serve the 3070 counties in the U. S. Volunteer workers in the Chapters carry on the fight against polio the year round. Each Chapter keeps half the money it raises in the March of Dimes.

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Your Chapter Aids Polio Patients

Trust Fund American Style

polio patient gets the best of care with a better chance of getting well without a handicap. He can return to normal life as a useful member of society, while his family is not buried in debt.

"Our local Chapter is working now with the other health organizations around here on a plan to prepare our county to give better service if another polio epidemic strikes. National Foundation Chapter funds are being used to equip more infantile paralysis units in hospitals, and money has been set aside for salaries of additional hospital personnel, when needed. The Chapter may also take care of transportation of patients to hospitals, clinics and doctors' offices.

"Everyone in this area should know that if there is polio in his family, he can get needed help for the patient through our county Chapter," Mr. Brown continued. "This service is for everyone."

"You see, we look on the money raised by the March of Dimes as a trust fund, to bring back health, strength and usefulness to those stricken by polio."

"You make it sound all right," Mr. Anderson said. "I would do a better job if I could electrify my farm and get that tractor."

* * * *

The Chapter agreed to pay for John's expenses which amounted to $1500. Now he gets about normally, except for a slight limp, and with his doctor's approval helps his father with the milking and is learning to ride a new bicycle. He reports to his doctor regularly for check-ups.

His interest in the Chapter aroused, Mr. Anderson began to look into its activities in earnest. He discovered that the physical therapist who had cared for John at the hospital had taken special training

Year-round services paid by the National Foundation Chapters, working in co-operation with local medical and health authorities, include hospitalization, professional services such as salaries of nurses, physical therapists, and other professional personnel, transportation, purchase of respirators (iron lungs), orthopedic appliances and other special equipment; also scholarships for local personnel and refresher courses for professional workers.

Education Fights Polio

at the Chapter's expense. By her skill, she had helped John regain the use of his weakened muscles through exercises which trained him to use them correctly.

Mr. Anderson found that Dr. Stevens, John's doctor, had also taken special training in the modern treatment of polio, at the expense of the county Chapter of the National Foundation.

"Hundreds of health workers have had such training in the past few years," Dr. Stevens told Mr. Anderson.

Mr. Anderson read some of the leaflets given him at the Chapter headquarters. He soon found out that back of the National Foundation's program of giving facts to the public, there is another program — that of finding new knowledge.

"My boy has always been so healthy," he remarked to Dr. Stevens one day. "I often wonder how he caught polio."

The national headquarters of the National Foundation for Infantile Paralysis receives half the money raised in the March of Dimes, using it for research, education and epidemic aid. The public gave nearly $16,000,000 in 1946.

Polio is Caused by a Virus

"You and a lot of other folks wonder how people catch it," the doctor replied. "In many of the laboratories of the country they are doing research on that question right now."

"What do they have to work with?" Mr. Anderson wanted to know. "You can't experiment with humans, can you?"

"Of course not, but research scientists can use monkeys. In 1908 it was found that they came down with the disease when they were injected with infective material taken from people who had polio. It was discovered that the disease is caused by a virus, of which there are many types, or strains. Lately, we have found that one of the strains of the virus, taken from monkeys, will also grow in cotton rats and even in white mice."

"What is this virus?" Mr. Anderson asked Dr. Stevenson.

The National Foundation has authorized more than $6,000,000 for the training of doctors, nurses, physical therapists and other health workers in modern methods of fighting polio, and for the education of the public.

Millions for Research

"It is a disease-agent, much smaller than a germ, which we can't see even under our most powerful microscope. We're not even sure that anyone has seen it under the new electron microscope. Unlike a germ, too, it will grow only in living cells, and it grows more readily in the nerve cells of human beings and monkeys."

"I begin to see what the difficulties are," Mr. Anderson said, "and why after all the years we have known about polio, we still can't put a stop to the disease."

"There is no question about the need for a quick and simple way of identifying the polio virus, so that we may know who is infected with it and how it spreads," the doctor said. "Although we call it infantile paralysis, we believe now that thousands of persons, some of them adults, have had mild polio without being

The National Foundation for Infantile Paralysis has authorized over $6,000,000 for research in grants to universities, laboratories, hospitals and other institutions, to study the cause, prevention and cure of this disease.

Polio Without Paralysis

paralyzed at all, or even knowing they have had it. Perhaps they think they've had a stomach upset, or some other mild illness. But the virus may be present in their throat discharges for a few days, and in their bowel discharges for two months or so, just as it is in the body discharges of known cases. And about three-fourths of the *well* members of a household where there is a polio case also have the virus in their bowel discharges for some weeks. If we could identify the virus quickly and simply, we would have a better chance of blockading the virus and stopping epidemics. But we don't know how to stop an epidemic."

"That idea of polio is new to me," Mr. Anderson mused. "I thought everyone who had it was paralyzed."

"Not at all. Polio is probably a fairly widespread infection, at least during epidemics, but only a few of those infected

In an average group of 100 cases of polio:
50 will recover completely
25-30 will show slight after-effects
15-20 will be seriously crippled
5-10 will die.

Most Patients Get Well

will have any recognized symptoms and still fewer will be paralyzed. Most of them will get over it."

"How do you explain that, Doctor?"

"We don't explain it fully. But you remember that the virus grows in the nerve cells. If it injures or destroys enough of them, the muscles connected with those nerve cells cannot move; they are paralyzed. But in some cases so few nerve cells are injured that there is no paralysis, or it is temporary. We need a drug that will destroy the virus, or keep it from growing in the nerve cells, and at the same time not injure the human body."

"Isn't there any such drug?"

"Scientists have tested hundreds of drugs, but have not found any that will cure polio. Fortunately, we have learned something about how to treat it to prevent unnecessary crippling."

In early summer, a few cases of polio

Children are most likely to catch polio, but grown people get it, too. In 1946, studies of cases in a number of states indicated that about 75 per cent are under 15 years of age; 25 per cent are over 15 years.

When Polio Strikes Keep Clean

appeared in the next town, and Mrs. Anderson asked the doctor what preeautions to take.

"You can't be sure of protecting your family, but there's common sense in some things. Personal cleanliness and the habit of washing the hands before eating are more important than ever. You see, the virus probably enters the body through the mouth and digestive tract. Unclean hands, soiled by body discharges, may pass the virus along to food, drink or other objects. Moral — clean hands!

"Possibly the virus gets into the air in droplets from coughing and sneezing of patients, and by this means contaminates food or even enters other persons' bodies through their noses.

"But frankly, we don't know the whole story. These facts don't explain why polio epidemics are most common in summer

During the polio season, be sure to: Wash hands before eating. Keep flies and other insects away from food. Help keep your community clean. Waste and exposed garbage may be sources of infection. Don't swim in polluted waters.

Watch for Symptoms

and fall. Do summer insects spread it? We are trying to find out. We know that the virus has been carried by flies from epidemic areas, but no one has yet proved that flies are to blame for an epidemic.

"But look here, Mr. Anderson, are you and your wife worrying because of those cases reported in the next town?"

"Well, of course, since John had it ——"

"Did you ever stop to think how relatively few people get polio? For example, 1946 was a big year for polio, with 25,240 cases. But over 600,000 people caught measles, another communicable disease over which we have little control. My point is that most people develop a natural immunity to polio, probably because the polio virus is so widespread that everyone has been exposed to it. That would explain why so few grown persons have it; they have become immune."

"Can you be vaccinated against it?"

"Unfortunately, no. But scientists are

If polio strikes, watch for these symptoms: headache, unexplained fever, a cold, even an upset stomach. They may be the first symptoms of infantile paralysis.

Early Care Helps Prevent Crippling

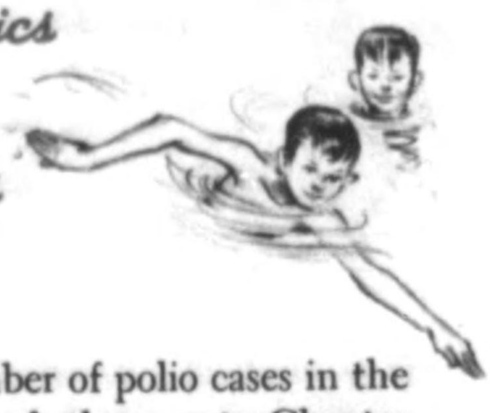
trying to find a way to do so."

"There's one thing I worry about, Doctor," Mrs. Anderson said. "Could we have kept John from having polio by doing something we didn't do?"

"No. There's no sure rule for preventing anyone from having it. In an epidemic, perhaps the most important thing is to call the doctor at once, if suspicious symptoms appear. Watch for such signs as sore throat, unexplained fever, a cold, a stomach upset, vomiting, diarrhea or constipation. Or the child may be irritable, complain of stiffness or soreness in arms, legs, back and neck. They may be symptoms of something else, or of nothing important, but be on the safe side and call the doctor anyway. The right kind of care, with rest in bed, from the very first day, and preferably in a hospital, gives the person who does have polio a better chance to get well without serious and lasting injury."

If polio strikes, call your doctor at once if any of these symptoms appear. Call him even for a slight illness. Expert medical care may help prevent crippling.

In Epidemics Take Precautions



When the number of polio cases in the next town increased, the county Chapter of the National Foundation asked for volunteers to take a short training course and help the overworked hospital nurses. Mrs. Anderson was one of the first to sign up. She attended faithfully, and learned facts about polio that she hadn't known, even though John had had it.

One evening she phoned her married sister. "Look, Bessie, I know you'd like to have Alice's tonsils out before school opens, but ask the doctor first whether it's advisable during this polio epidemic. Keep the children away from crowds, too, and from people they haven't been associated with right along. . . . You want to know if they can go swimming? That's all right if they go in places which have been approved by the Health Department. And don't let them get chilled or

During the epidemic months, consult your family doctor before having mouth and throat surgery. Avoid crowds and new contacts. Don't stay too long in cold water; chilling and extreme fatigue may make you an easier victim.

Improved Methods of Treatment

over-tired. That's bad, too, you know."

Through the course, Mrs. Anderson learned that methods of treating polio are better today than a few years ago. Heat is now used almost always to relieve the pain and sensitiveness of muscles, and physical therapy is given in the early stages of the illness, helping to prevent unnecessary crippling.

Mrs. Anderson learned how woolen packs are cut to fit the part of the body that is affected, how to put the packs in boiling water, wring them dry, and place them on the arms or legs, the chest, or any other part where they were needed. Other tasks she performed for the comfort of patients gave the professionally trained staff more time for their specialized duties.

Among the patients Mrs. Anderson

It may take years for the person seriously crippled by polio to regain the greatest possible use of his body. Sometimes surgery is necessary. Local Chapters often help pay expenses for such cases for many years. Chapters cannot provide aid for crippling caused by anything but polio.

Re-educating Injured Muscles

helped to care for was young Tommy, aged three. She watched with anxious eagerness when the physical therapist began to move the little boy's weakened limbs, as soon as the soreness was gone so that he could stand it. She saw that in Tommy's case, and in many others, the gentle exercise helped to keep the muscles in good condition so that they did not waste away for lack of use. By keeping the muscles strong, the exercises helped to prevent deformities caused when strong muscles pull weak ones aside.

As weeks and months went by, Mrs. Anderson did her part in helping the physical therapist as she taught and helped Tommy and other children to move their own limbs again. She had her reward when Tommy walked on his own two feet.

As winter came, John came home from high school one day, bursting with news.

"I'm elected Chairman of the March

In 1946, Chapters enrolled more than 5,000 Polio Emergency Volunteers (PEV) in 150 communities, to train volunteers to assist physicians, nurses and physical therapists in the bedside care of polio.

Passing the Benefits Along

of Dimes campaign in our class," he announced. "A lady from the Chapter spoke at school, and said the Chapter wants to give the hospital enough money to hire another physical therapist. So we voted right away to give up candy during the March of Dimes, and we're planning other things, too. Do you want to know our slogan? 'I can do so much—for so many—for so little'!"

And so, like thousands of families who have been helped, the Anderson family passed on to others the benefits they had received from the March of Dimes.

The Andersons' story is but one of many in the fight against polio. Many persons wage that fight. For example, in Utah, in 1945, the National Foundation's Chapters initiated meetings with health officers and other health organizations to plan what to do if a polio epidemic came. When it did come, the state was ready,

Over 55,000 volunteers helped in the 1946 March of Dimes. More than 13,000 theaters participated in the collections. The press, radio, the sports world, industry and labor solidly backed the campaign.

Preparedness is a Weapon

with 100 needed new hospital beds. Women volunteers, 158 of them, were quickly trained, and gave 10,000 hours of service. Respirators, hot pack machines, and other equipment were ready. When the Chapters had used the $20,000 they had set aside, the National Headquarters sent more, in all $160,000. No polio patient went without needed medical care.

Or a story could be told about the state-wide series of preparedness meetings, held in 1946 in 14 states. State and county health officials, and representatives of the National Foundation and its Chapters, met to plan how to use the resources of the area, its health agencies and volunteers, in fighting polio. These preparedness meetings are one of the best available weapons against polio outbreaks.

And there are action stories. One day the National Headquarters had an emergency call from the Children's Hospital in

Because of the March of Dimes, our knowledge of polio, of viruses, of surgery, of muscles, of cells, has increased; many hospitals are better equipped; many health workers have had special training.

For the Nation's Total Health

Denver. Where could they get a desperately needed iron lung? One was crated in Des Moines, Iowa, put aboard the Rock Island Rocket, and reached the Denver hospital in less than 24 hours.

And success stories: the widow, aged 36, crippled by polio at the age of six months, but the mother of three children. She walked for the first time without crutches after her county Chapter underwrote expenses for necessary treatment.

And stories of courage: young Madeline, who won victory after nine operations, enabling her to swim, dance, ride a bicycle, and climb the steps unaided to her third-floor dormitory room at college.

And stories of thousands of other polio patients who have been helped to regain health and independence. Millions of people help to write these stories by giving to the March of Dimes. In so doing, they give to a healthier, happier nation.

Because of the March of Dimes, many polio patients have been spared unnecessary crippling; many lives have been saved. These things contribute to the nation's total health as well as to the fight against polio.

Is Your Chapter Ready?

Does your community have a unified program for meeting a polio epidemic? Has your Chapter met with other health agencies in your area to answer these questions?

How many hospitals are there?

How many admit acute or early polio cases?

How many beds have they?

What is the maximum number of cases that can be admitted during summer and early fall?

Are beds available for convalescent and orthopedic cases in later stages of the disease?

Do existing public health laws and regulations need revision to provide sufficient beds to handle 20, 50, 100 patients per 100,000 population?

What can be done to make more beds available?

The National Foundation is always alert and ready to combat epidemics whenever and wherever they occur. It also evaluates new methods of treatment and makes such knowledge available to the public and the medical profession.

Is Your Chapter Ready?

Do your hospitals admit cases regardless of age, race, creed or color?

Are diagnostic services available for all patients? If not, can they be provided by the Health Department?

Are there specialists in your area available for consultation—pediatricians, orthopedic surgeons, doctors of physical medicine?

Are these physicans experienced in modern methods of treating polio?

If there are no polio specialists in your area, where are the nearest ones? Can their services be obtained in an epidemic?

How many registered nurses are there?

How many nurses have had special training in nursing care of polio?

How many physical therapists are there?

If Chapters exhaust their funds in epidemics, the National Foundation advances money to cover expenses; mobilizes trained personnel; locates and sends needed equipment; sends trained teams of polio fighters to assist local health officers, if requested.

Is Your Chapter Ready?

How many of them have had special training in the treatment of polio?

How many volunteers have been trained in your Chapter's Polio Emergency Volunteer program?

Are hot pack machines on hand and do you know where to get additional ones?

Are washing machine wringers available as substitutes for hot pack machines for emergency use?

Are there respirators available for hospitals that admit acute cases, and where can additional ones be obtained quickly if needed?

Are these respirators in good working order? Where can emergency service for them be obtained?

Are physicians, nurses and hospital staffs familiar with their operation and maintenance?

Are ambulances available for transporting patients to hospitals?

Do ambulance drivers know how to handle infantile paralysis patients? Information about transportation of polio patients is available upon request to National Headquarters.

Free Publications

Number

34 **DOCTOR... WHAT CAN I DO?**

Facts about Infantile Paralysis

DON W. GUDAKUNST, M.D.
Revised 1946 by HART E. VAN RIPER, M.D.
Medical Director

Describes in popular terms what is known as to the cause and symptoms of infantile paralysis; its treatment; how it may be spread; precautions to be taken by parents during epidemics, and availability of aid.

107N **INFANTILE PARALYSIS — HOPES, FEARS, FACTS**

MARION O. LERRIGO, Ph.D.
In co-operation with The National Foundation for Infantile Paralysis.

Personal Growth Leaflet, published by the National Education Association for the high school student. Suitable also for adult groups. Distributed free by the National Foundation.

67 **WHEN YOUR CHILD HAS INFANTILE PARALYSIS**

Suggestions for Parents *Illustrated*

Answers questions most frequently asked by parents of polio patients; gives facts about the disease; offers suggestions for carrying out the physician's orders when the child returns home; discusses his psychological readjustment, plans for his future.

Free Publications

Number

51 A MESSAGE TO PARENTS ABOUT INFANTILE PARALYSIS

Brief statement of facts about the disease; precautions to take during an epidemic; services provided by county Chapters of the National Foundation.

56 ESSENTIALS OF CHAPTER SERVICE IN AN INFANTILE PARALYSIS EPIDEMIC

Outlines the services of National Foundation Chapters in preparing for and during an epidemic.

48 LIST OF PUBLICATIONS OF THE NATIONAL FOUNDATION — 1947

Describes current publications available upon request.

Visual Aids

For Loan

FILMS

"*Your Fight Against Infantile Paralysis.*" In sound. 15 minutes. 16 mm and 35 mm.

Vividly portrays the purposes and the work of the National Foundation. Suitable for meetings of public-health and civic groups; can be used for high school students.

"*Accent on Use.*" In sound. 20 minutes. 16 mm and 35 mm.

Shows how the forces of nature—heat, cold, light, water and electricity—are utilized as one of the great adjuncts to the art of healing. Makes clear the part played by PHYSICAL THERAPY in restoring patients to health. Suitable for public-health and civic groups, as well as for high schools.

"*A New Horizon.*" In sound. 20 minutes. 16 mm and 35 mm.

Technical film on physical therapy restricted to the medical profession.

"*In Daily Battle.*" In sound. 20 minutes. 16 mm and 35 mm.

The members of a county Chapter of the National Foundation take part in this true-to-life story of how a Chapter aids infantile paralysis patients, and utilizes community facilities in the fight against the disease. For use by Chapters to inform local groups: fraternal and civic organizations, high schools, hospitals and other professional organizations.

Visual Aids

DISPLAY: Three-panel folding screen 36″ x 46″ when open. Panels contain sketches of medical care, professional training and research, and facsimiles of National Foundation publications. Suitable for small lay or professional group meetings. Best displayed on table with publications.

ELECTRICAL EXHIBIT: Large three-panel exhibit. 12′ x 8′ x 18″. Figure of human body is illuminated by electricity to show where polio virus may lodge in central nervous system. Eight sculptured scenes depict services of National Foundation Chapters. Total cases for past year in each state are indicated on a map of the United States. Suitable for large gatherings, such as conventions and fairs.

POSTERS: "*Home Again.*" Illustration in color, 33″ x 49″.

"*Back with Us.*" Figures in silhouette against colored background. 18″ x 24″.

Order by number or title from:

The National Foundation for
Infantile Paralysis

120 Broadway, New York 5, N. Y.

FIGHT
INFANTILE
PARALYSIS

This publication made possible through

THE MARCH OF DIMES

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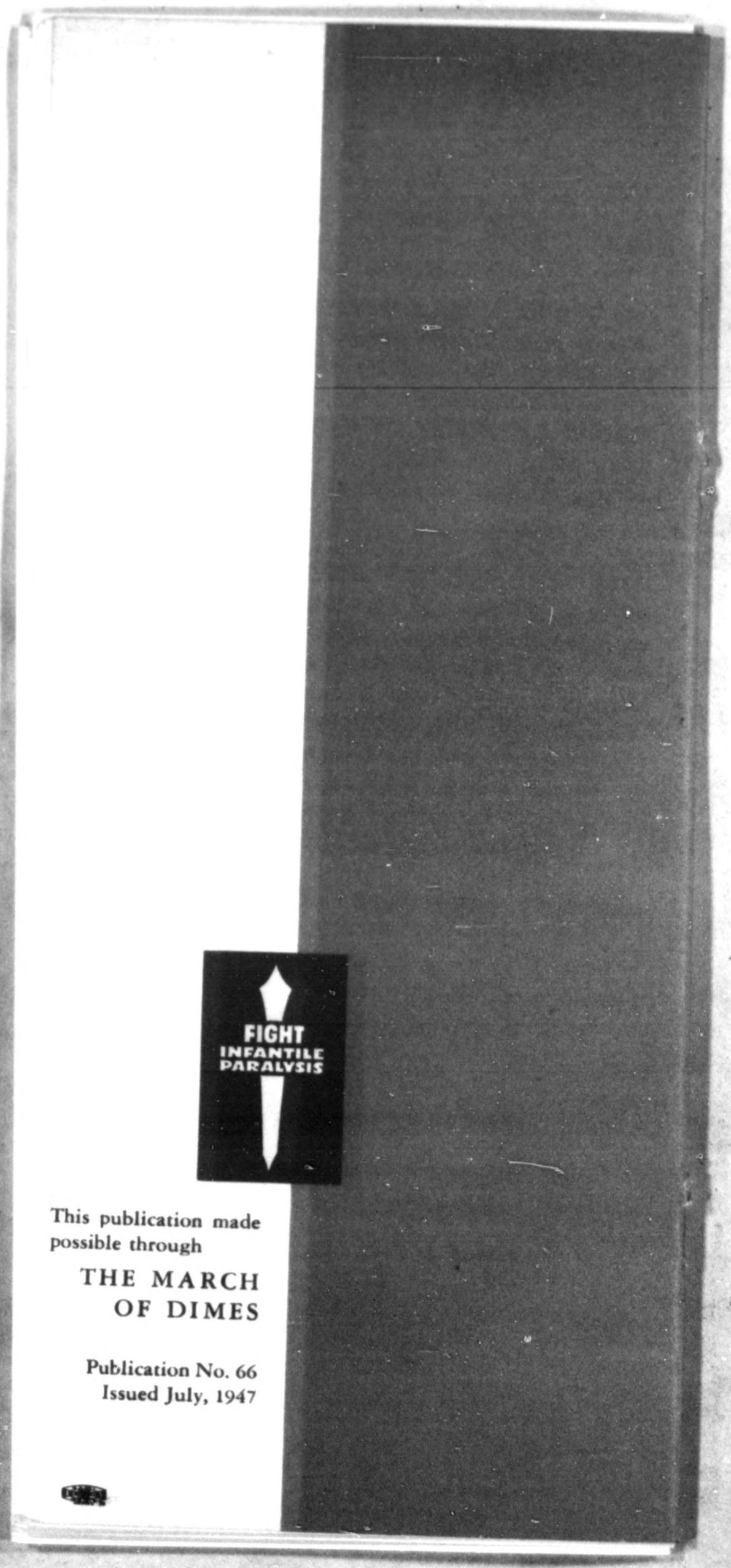

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INFANTILE PARALYSIS

Hopes-Fears-Facts

Prepared by:
MARION O. LERRIGO, PH.D.
in cooperation with
THE NATIONAL FOUNDATION
FOR INFANTILE PARALYSIS

Copies of this leaflet available upon request to The National Foundation for Infantile Paralysis, 120 Broadway, New York 5, N. Y.

PERSONAL
GROWTH
LEAFLET *Number* 107N

PERSONAL GROWTH LEAFLETS

PGLS, published under the Hugh Birch-Horace Mann Fund are one cent each in quantities of 25 or more, cash with order. No orders accepted for less than 25c. Send self-addressed, stamped envelop for latest list of titles; or send 25c for "Special Ten," 25 PGLS; or send a $1 bill for "Special One"—a get-acquainted collection of more than 100 PGLS. Both Specials "One" and "Ten" include all of the 16 Memory Selection PGLS. Order from:

National Education Association, Washington 6, D. C.

AN OFFER FROM

THE NATIONAL FOUNDATION FOR INFANTILE PARALYSIS

120 Broadway, New York 5, N. Y.

No. 61. Poliomyelitis—*A Source Book for High School Students.*
ONE TO A STUDENT

No. 62. Teacher's Guide.
ONE TO A TEACHER

For loan
Set of 2" x 2" film slides *showing cells attacked by "polio" virus.*

These two booklets with the slides form a Unit on Poliomyelitis and are free to high school teachers of biology and general science, also to health educators.

Chances Are Brighter

SAFETY-PINS, monkeys, washing machines, and wool salvaged from discarded materials of the paper-making industry—these make an odd assortment of objects to play a part in the conquest of one of mankind's dreaded plagues. All of them were used to combat the 1946 epidemic of infantile paralysis, or poliomyelitis. The story of how these objects came to be used begins long ago. It is not finished, for there is much that we do not know about this disease. Yet enough is known so that in hospitals or homes where children are being treated for infantile paralysis by modern methods, they are far more happy and cheerful today than they would have been a few years ago. And with good reason, for they and their parents know that now there is a reasonable chance that most of them will regain normal health and activity. What has changed the outlook?

Two Important Events

TWO EVENTS are mainly responsible for the brighter outlook—the organization of The National Foundation for Infantile Paralysis in 1938, which marked the beginning of the first nationwide coordinated effort to combat this disease, and improvement in the methods of treatment. The National Foundation now has local Chapters which serve 3000 of the 3070 counties in the United States. Money is raised each year thru the March of Dimes. Half of it is used by the National Foundation for its program of research, education and epidemic aid. The other half stays with its Chapters and is used to help infantile paralysis victims regardless of age, race, color, or creed. Since the care required by a patient may easily cost $1000 or more a year, very few families can bear the whole expense.

Treating the Patients

NO MEDICINE so far tried has markedly affected infantile paralysis. We have to depend on external treatment. Woolen cloths wrung out of very hot water and applied at frequent intervals to the affected parts of the body, relieve the pain and hardness. Just as soon as the patient can bear it, the physical therapist—a specially trained person—begins very carefully to move the weakened or paralyzed limbs. There is a double purpose in this: to prevent their wasting from disuse and to keep the muscles in the best possible condition; the strong muscles are apt to pull the weak ones aside. Later she teaches and helps the patient to move his own limbs. It is due to the efforts of Miss Kenny, the Australian nurse, that heat is now much more generally used and that physical therapy is given in the early stage of the illness. This often prevents unnecessary deformities.

The Epidemic of 1943

WHEN A SEVERE EPIDEMIC of infantile paralysis struck in 1943, this country was better prepared than ever before. What happened in Chicago shows how foresight and planning can minimize the damage. There were 1255 cases in the Chicago area. No one of them had to go without needed medical care for lack of money. The people of Cook County had given nearly $260,000 in the 1943 campaign for funds, and half of this sum had remained with the Cook County Chapter of the National Foundation. The Chapter received 715 applications for help, and arranged for whatever was needed in the way of doctors, hospitalization, or care at home. Doctors and hospitals sent their bills to the Chapter, which paid them. Many families could pay only small sums for the expensive care required; the National Foundation helped pay these bills also.

Cooperation Gets Results

WHEN more hospital space was needed in the Chicago epidemic, it was readily found because many hospitals worked on a cooperative plan for such an emergency. Doctors and nurses skilled in the treatment of infantile paralysis were available because the Cook County Chapter had financed their training. When there were not enough such trained people, more were brought, some by plane, from Warm Springs, from St. Louis, from New Jersey, from Michigan. Then more nurses were needed, and the Red Cross and the Illinois State Nursing Association recruited them. The Visiting Nurse Association took over the care of home cases, and its nurses gave training to mothers in the application of hot packs. The hot packs had to be pinned in place with safety-pins—one of wartime's scarce items. But the Chapter turned to and found a large quantity of them.

Help Wanted—and Given

ALL KINDS OF PEOPLE HELPED. There were volunteer stenographers in the Chapter office. When hospitals needed more electric washing machines with wringers, to speed up the process of wringing out the heavy blanket wool packs, business men familiar with government regulations secured priorities from the War Production Board for the purchase of fifty machines—all in three days. Because of the thousands of telephone calls at the Chapter headquarters, a larger telephone switchboard was needed. It was installed in two days thru the help of a member of the Chapter's Executive Committee who was also an official of the telephone company. The National Foundation sent nearly 5000 pounds of wool to Chicago from its free source of supply, the discarded materials from the paper-making industry. The Foundation also sent fifty monkeys.

How the Monkeys Served

THE MONKEYS were the humble but necessary associates of the expert research workers sent by the National Foundation to study the epidemic in Chicago. Monkeys have a long and honorable history of such service. More than fifty years ago, scientists realized that infantile paralysis was communicable. But research was limited because they were unable to find animals which could be given the disease. In 1908, several scientists injected monkeys with the spinal cord of dead infantile paralysis victims. The monkeys came down with the disease. We know now that infantile paralysis is caused by a virus, a living organism something like bacteria, which is about twenty times too small to be seen under a good microscope. It will pass thru a filter so fine that all ordinary bacteria are removed. The virus grows best in human beings and monkeys.

Research Must Go On

MANY OTHER SCIENTISTS, as well as those who went to Chicago, are given funds by the National Foundation to try to solve the riddles of this disease. They are looking for, but have not yet found, a drug which will cure infantile paralysis, and vaccines and serums which will create immunity against it. They are seeking more knowledge about how to prevent or reduce its crippling effects. They are seeking clues to the ways the virus travels from one sick person to another and causes epidemics. In trying to find some commoner laboratory animal than the monkey, scientists discovered that the southern cotton rat was susceptible to some strains. Wild rats were trapped and sent to the laboratory, but they could not be bred, until some one discovered that when they were dipped in creosote so that their odors were alike, they mated. Now these rats are available to laboratories.

How Does Infantile Paralysis Spread?

SCIENTISTS test the presence of the invisible virus in a substance by injecting it into laboratory animals to see whether they get the disease. Research shows that the virus leaves the body in throat and bowel discharges. Following this clue, scientists have found virus in sewage. In epidemic areas the virus has been found in the bodies of flies. The role of mosquitos is being studied. People who have been in contact with a case may be carriers of the virus, tho not themselves affected. But no one knows whether these facts explain how epidemics start. It was formerly thought that the virus entered the body thru the nose and olfactory nerve, but entrance thru the mouth and digestive tract now seems more likely. This question too must be answered before we know what methods of spreading the virus are most dangerous.

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Epidemic Precautions

UNTIL MORE FACTS ARE KNOWN, the most important precaution during an epidemic is to keep children away from crowds and new groups of people. Whether children are safer in school, with their usual companions, or with schools closed, will be decided by local health officials, all of whose suggested precautions should be followed carefully. Care should be taken that no member of the family puts into his mouth anything that could have been soiled by body discharges, and special cleanliness of hands and food is advisable. Screening the house protects against possible infection from insects. Swimming should be given up if it means mingling with crowds, or if the water is polluted with sewage. Nose and throat operations should be put off until after the epidemic. Prompt reporting of cases and observance of quarantine help to control the disease.

The Importance of Early Diagnosis

CHILDREN have a better chance for recovery if treatment is begun promptly. The treatment should begin on the first day. For this reason, during an epidemic, a doctor should be called at once for any suspicious sign of illness. The early signs of infantile paralysis vary, but are much like those of many other illnesses, starting with headache, slight fever, head cold or sore throat. Even if the signs seem trivial, it is safer to call a doctor. In every epidemic, there are many cases in which parents treat children for "colds," only to find later that the children have poor muscle coordination, and have had infantile paralysis. Other early symptoms to watch for are poor appetite, fatigue, irritability, nausea, vomiting, diarrhea, or constipation, trembling, and pain or stiffness in the back or neck. Any of these symptoms may be lacking.

The Promise of a Useful Life

No METHOD of treatment always restores the power of motion, but good treatment does help. Paralysis results from damage to nerve cells in the spinal cord or other parts of the central nervous system. In some cases, so few nerve cells are damaged that there is no paralysis, or it is temporary. About half of the cases with paralysis get over it spontaneously, and many others are helped by proper treatment. If so much damage has been done that paralysis is permanent, a surgeon can often transplant muscles so that parts of healthy ones can do the work of those injured. Braces can sometimes be fitted to support a paralyzed back or legs. The case of Louise, who wears braces, but has learned to typewrite and is learning to walk, is one of many which prove that infantile paralysis victims can do things for themselves and lead happy, useful lives.

A Challenge To All

ALTHO it is greatly dreaded because it may cripple its victims, infantile paralysis attacks relatively few people. In 1943 there were 12,429 cases and 1151 deaths, but in the same year there were 150,222 cases of pneumonia with 72,896 deaths. In a usual year about 10,000 cases of infantile paralysis are reported in the U. S. Nevertheless infantile paralysis has crippled some one hundred thousand of our nation's children, and to care for them and prevent further tragedies is the challenge that the American people are answering today. No infantile paralysis victim, no community afflicted by an epidemic now needs to struggle alone. Teachers and students who want to know more about it may obtain publications and uptodate information by writing to The National Foundation for Infantile Paralysis, 120 Broadway, New York 5, New York.

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President Roosevelt Said

THE DANGER OF EPIDEMIC IN WARTIME makes this fight an actual military necessity. The tireless men and women working night and day over test tubes and microscopes—these are workers on the production line in this war against disease. The gallant Chapter workers, the doctors and nurses in our hospitals, the public health officials, the volunteers who go into epidemic areas to help the physicians—these are front line fighters. And, just as in war, there is that subtle weapon that, more than anything else, spells victory or defeat. That weapon is morale—the morale of a people who know that they are fighting 'the good fight'—that they are keeping the faith, the only faith thru which civilization can survive, the faith that man must live to help and not to destroy his fellowman.—*Birthday Address, Jan. 30, 1944.*

[*Eleventh printing 200,000. Total copies 970,000*]

1946 ISSUE

D 19

The Commonwealth of Massachusetts

DEPARTMENT OF PUBLIC HEALTH

INFANTILE PARALYSIS

Anterior Poliomyelitis

PUBLICATION OF THIS DOCUMENT APPROVED BY THE COMMISSION ON ADMINISTRATION AND FINANCE

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INFANTILE PARALYSIS

(Anterior Poliomyelitis)

Do Many Persons Catch Infantile Paralysis?

Infantile paralysis occurs much less frequently than many of the usual contagious diseases, like scarlet fever or whooping cough. Even in epidemic seasons it seldom attacks more than one person in a thousand in a recognizable form.

Is the Unrecognizable Form Frequent?

Many times as frequent as the recognizable form. Examination of the blood of persons in adult life discloses that many have been attacked by the infantile paralysis germ. For some reason, as yet unexplained, these individuals failed to develop paralysis. It is believed that such persons are protected against a future attack of the paralytic form of the disease.

Do All Patients With Infantile Paralysis Become Paralyzed?

Only a certain percentage of patients with infantile paralysis become paralyzed. Many show no muscular paralysis or weakness at all. Of those who do develop muscular difficulty, many recover promptly, while others show a marked degree of improvement with proper treatment.

How Is Infantile Paralysis Spread?

The virus has been recovered from the nose and throat of perfectly healthy persons as well as from those ill of the disease. There is evidence that the virus can enter the body through the nasal passages. It is well to remember that healthy carriers and unrecognized cases play a large part in the spread of the disease. Very few cases can be traced to another paralytic case.

What Are The Symptoms Of Infantile Paralysis?

The early symptoms of this disease are the same as those observed in many common childhood illnesses. In a typical case the patient develops fever, headache, and some intestinal disturbance such as vomiting, constipation, or diarrhea. The fever is not often over 102°F. The most common complaint is stiffness of the neck and spine. The child has difficulty in bending the head forward, and when sitting up the back is kept in a rigid position. Paralysis may appear early in the disease or anytime thereafter as long as

the fever persists. Once the temperature has subsided, paralysis is not likely to develop or progress.

Should Patients With Infantile Paralysis Be Isolated?

They should be isolated in the acute stage in much the same way as those with diphtheria or measles. Cases may be isolated in a hospital or at home. It must be borne in mind that hospitalization is much more important for the treatment and the after-care of the patient than it is valuable in limiting the spread of the disease.

What Can Be Done To Prevent Infantile Paralysis?

Despite our increasing knowledge of infantile paralysis, we are as yet unable to limit its spread effectively. Vaccines and serums have not been found beneficial. Experience with nasal sprays advocated by some as a method of prevention has been disappointing. The best measure is to keep children out of crowds and to limit to the very minimum the number of persons with whom they come in contact.

How Important Is After-Care In Paralyzed Cases?

All cases of infantile paralysis with muscular weakness should have immediate attention. During the acute stage of the disease, all affected muscles must be put at rest in order to protect them against further injury. After all muscle tenderness and soreness have disappeared, active treatment should be started to help in recovering as much muscle power as possible. Thus, constant medical attention is necessary throughout the entire course of this disease.

How Long Should After-Care Be Continued?

While the most rapid recovery in muscle power will take place during the first year, muscles will continue to gain power almost indefinitely if treatment is continued. Cases with paralysis must be followed carefully for years in order to prevent deformities.

Is Care Available To All Children Crippled By Infantile Paralysis?

In many communities clinics are maintained either by local hospitals or other organizations to provide proper care of those crippled. When such local arrangements are lacking, the Department of Public Health makes treatment available, for those financially unable to procure such care elsewhere, through its services to crippled children.

REMEMBER

1. When a child becomes ill with symptoms of fever, intestinal complaints, headache, stiffness of neck or back, call your physician at once.

2. Children ill with infantile paralysis should have constant medical attention during the acute stage and throughout convalescence.

3. After-care in paralyzed cases is of extreme importance. Continuous treatment will often restore considerable muscle power.

4. When infantile paralysis is prevalent, do not let your children go where there are crowds.

5. Infantile paralysis is not a common disease. Take proper precautions, but do not be unduly apprehensive that your child will get it.

PUBLICATIONS

OF

The National Foundation for Infantile Paralysis

Franklin D. Roosevelt, Founder

June 1946

120 Broadway
New York 5, N. Y.

Publication No. 48

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The National Foundation for Infantile Paralysis

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FOR THE PUBLIC

Number

34 DOCTOR... WHAT CAN I DO?
Facts about Infantile Paralysis
DON W. GUDAKUNST, M.D.
Revised 1946 by Hart E. Van Riper, M.D., Acting Medical Director

Describes in popular terms what is known as to the cause and symptoms of infantile paralysis; its treatment; how it may be spread; precautions to be taken by parents during epidemics, and availability of aid.

INFANTILE PARALYSIS — HOPES, FEARS, FACTS

MARION O. LERRIGO, PH.D.
in cooperation with The National Foundation for Infantile Paralysis.

For description, see under "FOR EDUCATORS."

46A A GUIDE FOR PARENTS *in the Nursing Care of Patients with Infantile Paralysis in the Home* — 1944

Helps the parents of an infantile paralysis patient to follow the instructions of the doctor and nurse; lists the equipment needed for care in the home. Diagrams illustrate the cutting and fitting of packs.

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51 IF POLIO STRIKES — *Revised 1946*

Gives practical precautions to take during an epidemic.

Available also in slightly different form in French, German, Hungarian, Polish, Spanish and Yiddish.

FOR PROFESSIONAL WORKERS IN THE HEALTH FIELD

Number

23 USE OF THE RESPIRATOR IN POLIOMYELITIS — *Revised 1946*

JAMES L. WILSON, M.D.

Technical advice for physicians. Indicates types of cases in which respirator treatment is beneficial; when to initiate and when to cease use; importance of early diagnosis of weakness of muscles of respiration; care of patient while in respirator; mechanics of machine; dangers.

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24 RESPIRATORS—*Locations and Owners*

Revised 1946

Lists by states and counties the locations and owners of adult cabinet-type respirators approved by the Council on Physical Medicine of the American Medical Association. A useful guide during an epidemic or for those contemplating the purchase of an "iron lung." Foreword points out that the National Foundation loans adult respirators under certain conditions.

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45 A GUIDE FOR NURSES — *Revised 1946*

Describes in detail the nursing care of patients with infantile paralysis, including diagrams which illustrate the cutting and fitting of packs.

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49 THE NURSING CARE OF THE PATIENT IN THE RESPIRATOR—1944

CARMELITA CALDERWOOD, R.N.

Illustrated.

This pamphlet, written expressly for nurses, describes the nursing techniques involved in the care of the respirator patient. It also includes instructions for the operation of types of approved respirators.

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56 SERVING THE COMMUNITY IN AN INFANTILE PARALYSIS EPIDEMIC.

Revised 1946

Outlines the services of National Foundation Chapters in anticipation of and during an epidemic.

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59 FACTS AND FIGURES ABOUT INFANTILE PARALYSIS — *Revised June 1946*

Statistical charts and tables for physicians, health workers and centers where students are being prepared for a career in medicine, public health, bacteriology, nursing, physical therapy, medical social work and allied fields.

Enlarged charts from above book available for display purposes in size 17" x 22". Indicate by number charts desired.

FOR EDUCATORS

Number

INFANTILE PARALYSIS – HOPES, FEARS, FACTS

MARION O. LERRIGO, PH.D.
in cooperation with The National Foundation for Infantile Paralysis.

Personal Growth Leaflet 107N. Published by the National Education Association. Distributed free by the National Foundation. Prepared for the high school student. Suitable also for adult groups.

A HIGH SCHOOL UNIT ON POLIOMYELITIS:

61 **POLIOMYELITIS** – *A Source Book for High School Students* – 1945
Illustrated

62 **TEACHER'S GUIDE** – *Revised 1946*

These two booklets are for distribution to high school teachers of biology, general science and health education. This material will aid in teaching the facts about infantile paralysis in connection with the study of communicable disease.

One copy of No. 61 can be furnished for each student in science classes.

SET OF 2" BY 2" FILM-SLIDES depicting normal cells and those attacked by poliomyelitis virus. *For loan.*

48 **LIST OF PUBLICATIONS OF THE NATIONAL FOUNDATION – 1946**
Content of each pamphlet indicated.

REPORTS

57 **ANNUAL REPORT – 1945**

Outlines the purposes of the National Foundation; reviews its local and national activities during the fiscal year; lists recipients, purposes and amounts of grants and appropriations, Officers, Trustees and members of the Medical Committees. A financial statement is included.

Annual Reports 1939-1944 are also available.

THE INFANTILE PARALYSIS FIGHT AT TUSKEGEE – 1945
Illustrated

Reviews the accomplishments of four years at this Infantile Paralysis Center for Negroes. Child patients are introduced.

VISUAL AIDS
For Loan

FILM: *"Your Fight Against Infantile Paralysis."* In sound. 15 minutes. 16mm and 35mm.

Vividly portrays the purposes and the work of the National Foundation. Suitable for meetings of public-health and civic groups, as well as for high schools. *Sale price for 16mm – $18.50.*

FILM: *"Accent on Use."* In sound. 20 minutes. 16mm and 35mm.

Shows how the forces of nature – heat, cold, light, water and electricity – are utilized as one of the great adjuncts to the art of healing. Makes clear the part played by PHYSICAL THERAPY in restoring patients to health. Suitable for public-health and civic groups, as well as for high schools. *Sale price for 16mm – $20.75.*

Both films have been approved by the Committee on Medical Motion Pictures of the American College of Surgeons.

EXHIBIT: Three-panel folding screen.
Center panel contains slogan, "Quick Action Often Prevents Crippling" and fan of covers of National Foundation publications. Side panels show photographs of patients in different stages of recovery. Suitable for small lay or professional group meetings. Measures 36" x 46" when open. Best displayed on table with publications.

PORTFOLIO
A loose-leaf book carrying National Foundation publications – one in a pocket on each page. Can be used, if desired, in connection with above exhibit.

There is no charge for publications.
PLEASE ORDER BY NUMBER
where number is given.

NATIONAL FOUNDATION FOR INFANTILE PARALYSIS
120 Broadway, New York 5, N.Y.

At the request of Lt. Col. Merle E. Smith, MC, of 8th Army Headquarters, we are sending you National Foundation publications and a selection of reprints on poliomyelitis.

Whenever you desire an additional supply of our material we will gladly send it.

Sincerely,

Sally Lucas Jean

Sally Lucas Jean
Consultant in Health Education

Poliomyelitis

(Infantile Paralysis)

EARLY SYMPTOMS

At the start, poliomyelitis is often hard to distinguish from a cold, influenza, or various diseases of childhood. It begins suddenly, usually with fever of over 100 degrees, headache, vomiting, and sometimes sore throat. Stiffness and pain in the neck or back may give warning of poliomyelitis.

These symptoms may last only a few hours or a few days, and the disease often goes away with no ill effects. Probably a great many cases are never recognized as polio. In more serious cases, the fever lasts from 3 to 10 days, and may come back; paralysis often begins with the second attack of fever.

WHAT ARE ITS EFFECTS?

The danger of poliomyelitis is in the effect the virus may have on certain parts of the brain and spinal cord. It attacks and sometimes destroys the motor nerve cells, which control the muscles. When these cells are destroyed, the

muscles cannot receive impulses from the brain, and so are paralyzed.

If all of the motor cells controlling a particular muscle are destroyed, the paralysis is complete and permanent. However, less completely damaged cells often recover, and recovered cells may gradually learn to take over the job of the permanently injured cells. This explains why cases of paralysis may recover partially or completely over a period of about two years after the disease.

The muscles themselves are not directly damaged by poliomyelitis, but a muscle which cannot be used will gradually weaken and atrophy. Such treatment as massage, hot packs, and electrical stimulation are used to keep up the strength of the paralyzed muscles, so that they will be ready for use if and when the nerves begin to recover.

TYPES OF POLIOMYELITIS

The most common and least dangerous type of poliomyelitis is the so-called "abortive" attack, which is simply a brief infection without serious effects. Such cases may not be recognized as poliomyelitis. If the patient continues his normal activities during a mild attack, he may develop a more serious form of the disease. He may also spread the infection to others.

If the poliomyelitis virus seriously injures the brain or spinal cord, the symptoms become much more serious. Some form of paralysis often results.

The most common type of paralytic poliomyelitis affects muscles of the arms, legs, and trunk. This is the crippling type. It is not ordinarily dangerous to life unless the muscles of breathing are paralyzed. If this happens, the patient may have to be placed in a respirator, or "iron lung."

Less common, but most dangerous of all, is the bulbar type of poliomyelitis affecting the nerve centers at the base of the brain. These include the master centers which control breathing, swallowing and coughing. Most of the deaths from poliomyelitis are due to paralyses of these centers.

DANGER AND OCCURRENCE

It is difficult to get accurate statistics on poliomyelitis, since many patients may not call a doctor or report to health departments. Serious cases, however, are more likely to be reported, and this makes the percentage of deaths and paralysis appear greater than it is. The best figures are based on direct surveys of the population, rather than official reports; but even these are inadequate.

According to these survey figures, almost half of all recognized poliomyelitis cases recover completely, although three out of four develop at least some temporary paralysis. About one in five is seriously crippled, and one in 20 dies of the disease. Poliomyelitis epidemics are unpredictable but, in general, the most vulnerable areas are those of the temperate zones which have not had a major epidemic within five years. Epidemics do not sweep the country. An "epidemic year" is simply one in which there are a large number of local outbreaks of the disease.

Children about three years of age seem to be most susceptible to the disease but it may attack persons of any age. Some doctors believe that many persons, without even knowing it, have had a mild case which renders them immune. It occurs most frequently in temperate zones in the late summer.

WHAT CAUSES POLIOMYELITIS

Poliomyelitis is caused by a filterable virus - so called because the virus is small enough to pass through the finest filters. It has been photographed by means of the electron microscope and is estimated to be about one half of one millionth of an inch in diameter. Despite this small size, it can be identified and studied in various ways, so that scientists have been able to learn a good deal about it.

HOW IS IT SPREAD?

No one is certain how the virus is transmitted from one person to another. There is considerable evidence which suggests that it may be spread by direct contact with either recognized or unrecognized contact cases.

The virus has been found in the nose and throat and in the intestinal entrails of contact cases. It also has been found in sewage and in or on flies. Polluted drinking water, polluted swimming places, and contamination of food by flies have all been blamed, but final proof is lacking. Polio may be spread in all of these ways, or possibly in some other way not yet suspected.

Most authorities believe that the virus enters the body through the nose or mouth. It may be that in some instances it enters the central nervous system by way of the olfactory nerve of smell in the nose, but it is no longer believed that this is the only route. The virus is also found in the lower intestinal tract, where it usually remains for three weeks or more after an attack. Some healthy persons -- mostly children -- carry the virus and may play a part in spreading the disease. A large proportion of cases have been found to follow the removal of tonsils by a few days or weeks. Cases following tonsil operations are apt to be of the dangerous bulbar type.

POLIO RESEARCH

The U. S. Public Health Service, the National Foundation for Infantile Paralysis and numerous local centers are constantly searching for methods of control and for cures.

Virus research was formerly handicapped by the fact that the disease could be transferred only to monkeys. The expense of these animals made extensive research impossible. In 1939, the U. S. Public Health Service successfully transmitted certain strains to the cotton rat and the mouse. This gave impetus to virus research and increased our chances of finding an immunizing agent or curative drug.

Most progress to date has been made in developing methods of minimizing the after-effects of the disease. Now, when the motor nerve is killed and a muscle paralyzed, a surgeon can, in some instances, transplant the tendon of a healthy muscle and cause it to do some of the work of the damaged one. Weakened joints can be treated, unequal leg lengths corrected, and muscles retrained.

WHAT TO DO DURING AN EPIDEMIC

Since there is no sure protection against infantile paralysis, all that can be done when an epidemic comes is to observe simple precautions:

1. Do not get over-tired.
2. Avoid sudden chilling - don't plunge into very cold water on a hot day.
3. Pay careful attention to personal cleanliness.
4. Do not undergo a tonsil, adenoid, or any other operation of the nose or throat that can safely be postponed.
5. Be sure the milk and water you drink is pure.
6. Keep food away from flies.
7. Do not swim in polluted water.
8. Avoid unnecessary contact with other people.
9. Stay away from persons who have any symptoms of the disease.
10. Call a doctor at the first development of a fever, symptoms of a cold, or digestive upset.

JUNE 1947

FEDERAL SECURITY AGENCY
U. S. PUBLIC HEALTH SERVICE
HEALTH EDUCATION SERIES NO. 8

The Nursing Care of The Patient in The Respirator

By
CARMELITA CALDERWOOD, R. N.
Consultant in Orthopedic Nursing
NATIONAL LEAGUE OF NURSING EDUCATION

A Publication of
THE NATIONAL FOUNDATION FOR INFANTILE PARALYSIS, INC.
FRANKLIN D. ROOSEVELT, FOUNDER
No. 49

THE NURSING CARE OF THE PATIENT IN THE RESPIRATOR

The type of respirator most commonly used is the cylindrical metal tank equipped with a cot and mattress. One end of the tank has an opening which is surrounded by a metal plate and a soft rubber collar. The patient's body lies on a mattress within the tank and his head rests on a pillow outside the machine. The rubber collar around the neck seals off escaping air.

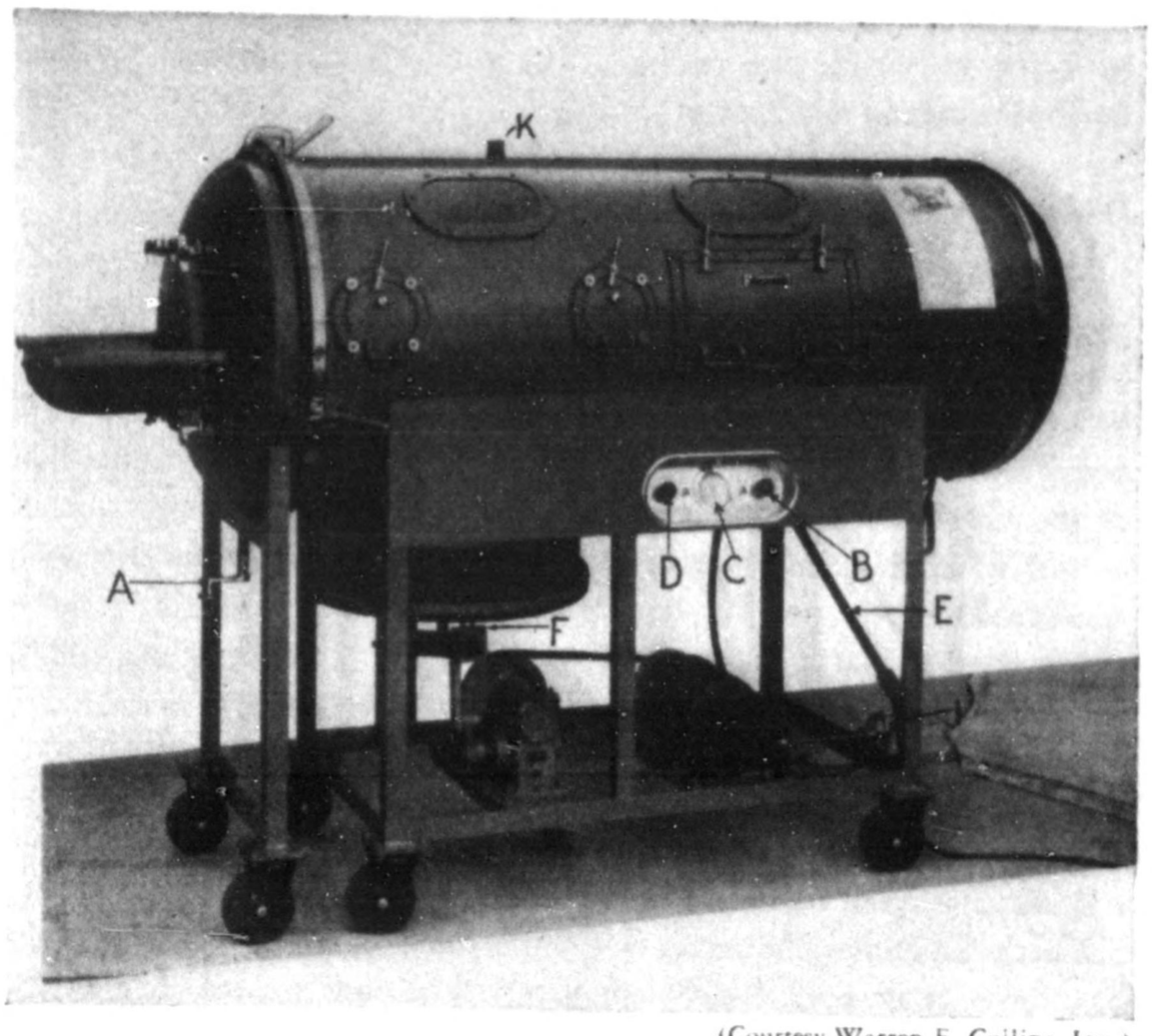
Mechanism of breathing

Normally when an individual inhales, the chest cavity, or thorax, enlarges and air rushes into the lungs through the nose and mouth. The enlargement of the chest cavity is accomplished by the muscles lying between the ribs (intercostals) whose contraction raises the rib cage; and by the diaphragm whose contraction depresses or lowers the floor of the chest. Both of these muscular actions are vitally necessary for normal inhalation. Exhalation is considered by many physiologists to be almost completely passive. It is accomplished largely by the effect of gravity on the elastic walls of the expanded chest, aided by the upward push of the abdominal viscera on the relaxing diaphragm.

If these muscles — the intercostals and diaphragm — were paralyzed there would be no way in which the patient himself could enlarge his rib cage to allow air to flow into the lungs. It is in these cases that the respirator is often necessary to save life.

There are times, however, when the same effect — difficulty of inhalation — may prevail although paralysis is not present. Inability to raise the chest wall has been ascribed to the fact that the large pectoral muscles which cover much of the ventral portion of the ribs are in spasm, that is, clamped down so tightly on the ribs that movement of the chest is impossible. In this type of involvement, continuous hot packs may be used, and the respirator resorted to only long enough to spare the patient exhaustion from the fatigue of trying to breathe against this obstruction.

If the intercostal muscles or diaphragm are in spasm the patient will not be able to exhale satisfactorily. Pressure exerted externally on the chest wall (manually in teaching breathing exercises or through positive atmospheric pressure in the machine) assists in compressing the chest wall. The respirator is not infrequently used for this type of patient, also. However, hot packs to the chest, back, neck, and upper abdomen, combined with such bed positions as will relieve strain on the painful muscles, should be attempted before placing the patient in the machine.



(Courtesy Warren E. Collins, Inc.)

Fig. 1

The handwheel (J) at the end of the motor should be turned clockwise as far as it will go. This permits a respiratory rate of around 14 per minute. Turning in the opposite direction will increase the rate. The knob (B) controls depth of respiration. Turn it clockwise to increase depth, counter-clockwise to decrease it. The gauge (C) shows depth of respiration. The control (D) which is for positive pressure should be completely shut off.

How the respirator works

The Collins respirator (Fig. 1) has a bellows made of tire-tread rubber attached to the under surface of the tank. (Older models may still have the dual installation type of bellows — rubber inside, leather outside.) When the bellows expands to maximum capacity, the air pressure in the tank is lowered. This is "negative" pressure, and will be registered on the gauge of the machine to the left of the zero symbol. As a rule a negative pressure of from 14 to 20 is adequate for pulmonary ventilation. Negative pressure exerts a mild suction or lifting effect on the thorax and abdomen, and air will rush into the lungs from the nose and throat causing the lungs to expand in the manner of normal respiration. This is the stage of inspiration. The patient, aided by the machine, is drawing in a breath at this time and he is taught not to swallow or attempt to speak. When the bellows collapses or folds up, air is being forced back into the machine and the pressure in the tank is raised to about that of outside atmospheric pressure. This is the stage of expiration, and the patient soon learns to talk, to swallow and, when necessary, to cough at this time.

The Emerson machine operates by means of a leather diaphragm. When the diaphragm is concave to the external view (drawn in to the tank) the air in the tank is compressed. This is the stage of expiration. When the diaphragm is convex externally (pushed outward) the air pressure in the machine is lowered and the patient inhales. This is registered as negative pressure on the gauge.

More than normal atmospheric pressure is called "positive" pressure, and is seldom required in the treatment of patients with poliomyelitis. Therefore the needle on the pressure gauge as a general thing should not make an ex-

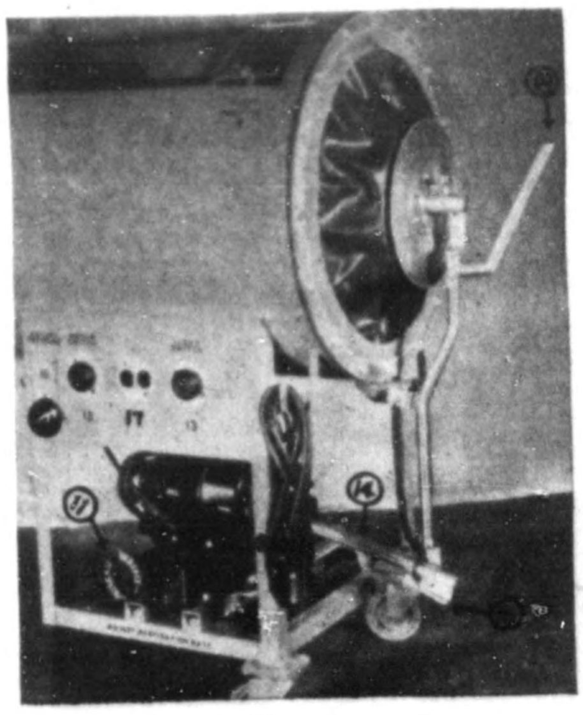


Fig. 2

The Emerson Respirator

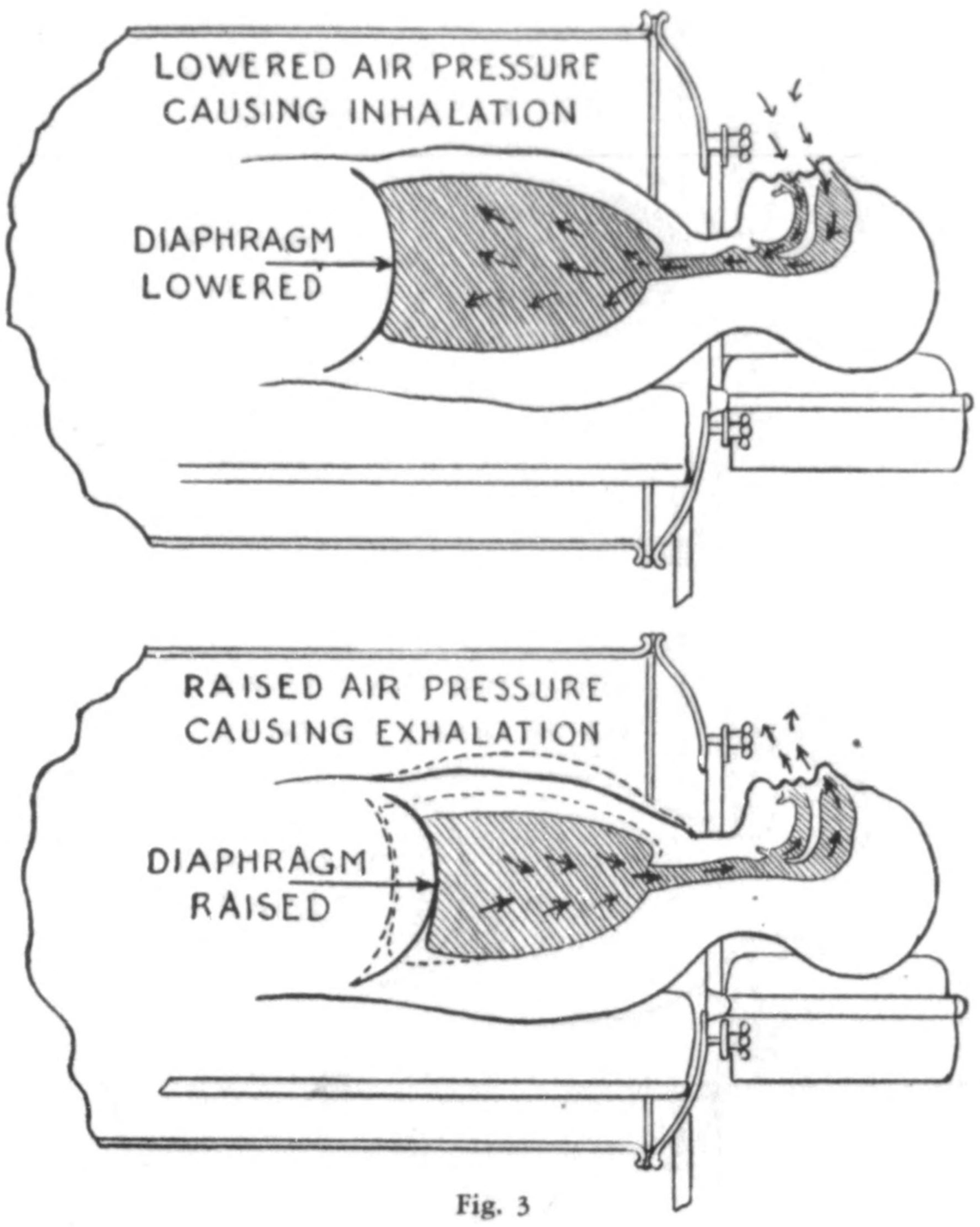


Fig. 3

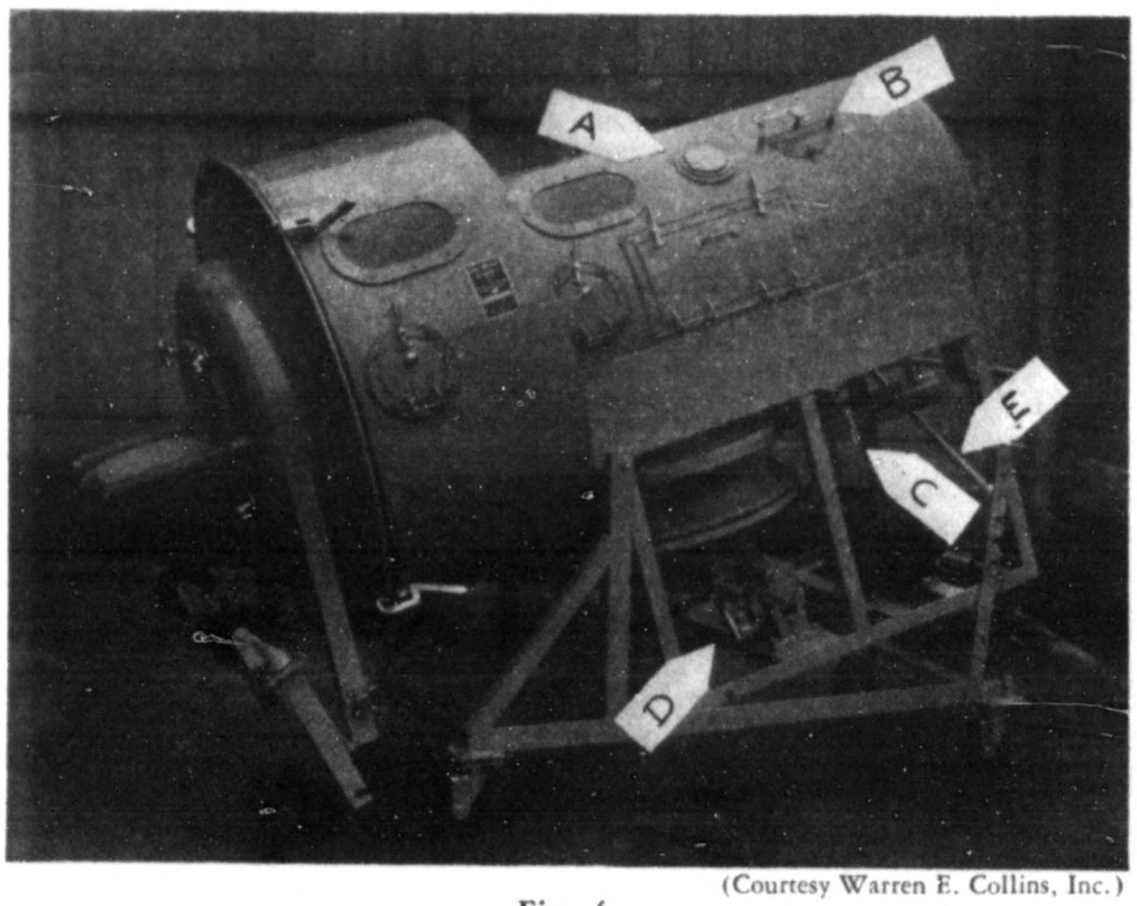
cursion to the right of the zero symbol. (Diagrams showing mechanism of breathing. Fig. 3)

Depth of respiration

The *mechanism* for controlling pressure varies with different respirator models. The pressure *gauge* which indicates the amount of pressure within the tank is located in different places on the various machines.

It resembles a clock in appearance, is covered with glass, and has a needle-like indicator. (Fig. 1, C.) In the machine pictured in figure 1, depth of respiration is controlled by use of a knob which is located in a central control panel. By turning the knob clockwise it is possible to increase the depth of respiration; while turning it counterclockwise decreases the depth of respiration. The control valve (Fig. 1, D) is left completely turned off, as this controls positive pressure which is seldom used.

In the orthopedic respirator pictured (Fig. 4), control of pressure is managed through use of a lever. (Fig. 4, C.) Even a minute amount of change in the position of this lever accomplishes considerable change in pressure. It is a delicately adjusted mechanism and should be treated as such. The positive pressure is controlled by the valve (Fig. 4, B). The screw cock here should be completely free to avoid positive pressure.



(Courtesy Warren E. Collins, Inc.)

Fig. 4

Orthopedic, tilting-rotating model respirator. Note that pressure gauge (A) and positive pressure control (B) are located on the tank. Pressure is controlled through lever (C). (D) Lever bars and handwheel for attaching handle for manual operation. (E) Handle.

Rate of respiration

Most respirators are so constructed that they may be operated at several speeds, usually varying from 14 to 36 respiratory excursions a minute. Some models have a handwheel near the motor which controls the rate of respiration (Fig. 1, J). On other models, where only two or three rates are possible, it is necessary to adjust the rate of respiration by turning off the motor and transferring the belt to the required grooves on the motor and gear box pulleys. Instructions for doing this are explicitly recorded on the machines which require this type of adjustment.

A respiratory rate of from 14 to 18 a minute is usually desirable unless the patient has some type of respiratory infection or obstruction in the trachea. Care must be taken to synchronize the rhythm and depth of the machine's operation to the patient's own voluntary efforts. Frequently after the patient has been put in the machine the rate of his respiration becomes more normal and the rate of the machine may be decreased. As a general rule little good is obtained by operating the machine at an increasingly higher rate or pressure in an effort to overcome the apparent inability of the patient to cooperate with the machine. But Dr. James L. Wilson states that use of the alae nasi or of accessory muscles of respiration *may* indicate a need for increasing rate or depth of respiration, as these signify inadequate expansion of the thorax. Such increase of rate or depth must be carefully estimated and not used in a hit-or-miss fashion. In these cases it is wise to make an investigation to ascertain if mucus or a foreign body in the respiratory passage is interfering with the rate of breathing.

Care of the machine

The respirator deserves good care. It should be stored in an easily-accessible spot for quick moving. The casters should be tested frequently to see that moving the machine can be accomplished without difficulty.

The tank should be kept clean with soap and water and an occasional airing. Care should be taken, however, not to get water into the bellows chamber or into the control valve tubing. Alcohol should never be used to clean the tank or windows.

The bellows should be fully opened when the respirator is not in use.

In the collapsed stage, considerable deterioration may take place at the folds. Otherwise the bellows needs no special attention. The diaphragm of the Emerson machine should be wiped with neat's foot oil once yearly, but no other oil should be allowed to come in contact with it or deterioration may occur.

Once a year the respirator should be checked by an expert. A new sealing gasket should be cemented into the head of the machine at this time. This is an important item and should not be overlooked. This gasket is vitally necessary to insure an airtight tank.

Manufacturers of respirators issue specific directions for the care of their machines. *These instructions should be placed in the hands of the hospital engineer who must assume responsibility for supervising the operation and care of the machine at all times.*

Rubber collar and port cuffs must be inspected frequently. This is particularly true where sponge rubber is the material in use for this purpose. Constant contact with the metal of the machine tends to rot the rubber. In some hospitals it is the custom to remove the collar and keep it inside the machine on the cot when it is not in use since collar-openings vary in diameter and must be changed according to the size of the patient who will be using the machine. Because of war-time shortages it is recommended that all rubber parts be removed from the machine, properly labeled, and stored at a low temperature in a refrigerator. If this is not done screws holding the cuffs to the ports should be loosened to lessen deterioration of the rubber from pressure when the machine is not in use. It must *never* be forgotten that the rubber cuffs and collar *must* be in good condition or it will not be possible to secure sufficient vacuum inside the machine. In an emergency this can be a matter of the greatest seriousness. An extra set of collars and cuffs should always be available.

Nursing care will be greatly facilitated if special linen is available to use as drawsheets. A full-size sheet, folded in the middle, lengthwise, and applied to the cot in double thickness, may be used for the undersheet. A small, light rubber sheet, 18 to 24 inches in width, which can be tucked under the mattress, is used for the buttocks. The fabric drawsheet for covering the rubber can be made of old sheeting — 20 to 28 inches in width and only long enough to tuck securely under the mattress. The ordinary drawsheet is usually too bulky for this purpose; it is

harder to change inside the machine, and it occasionally is the cause of excessive pressure on the patient's back. A folded drawsheet or narrow, firm pillow used under the lumbar spine often affords considerable relief for the patient's back.

The patient's skin must be protected from the rubber collar. Sheet wadding is used routinely in some hospitals, and chamois has been found useful in some instances. However, washable materials such as old diapers or linen have definite advantages because of the frequent changes which can be made without waste.

Indications for use of the machine

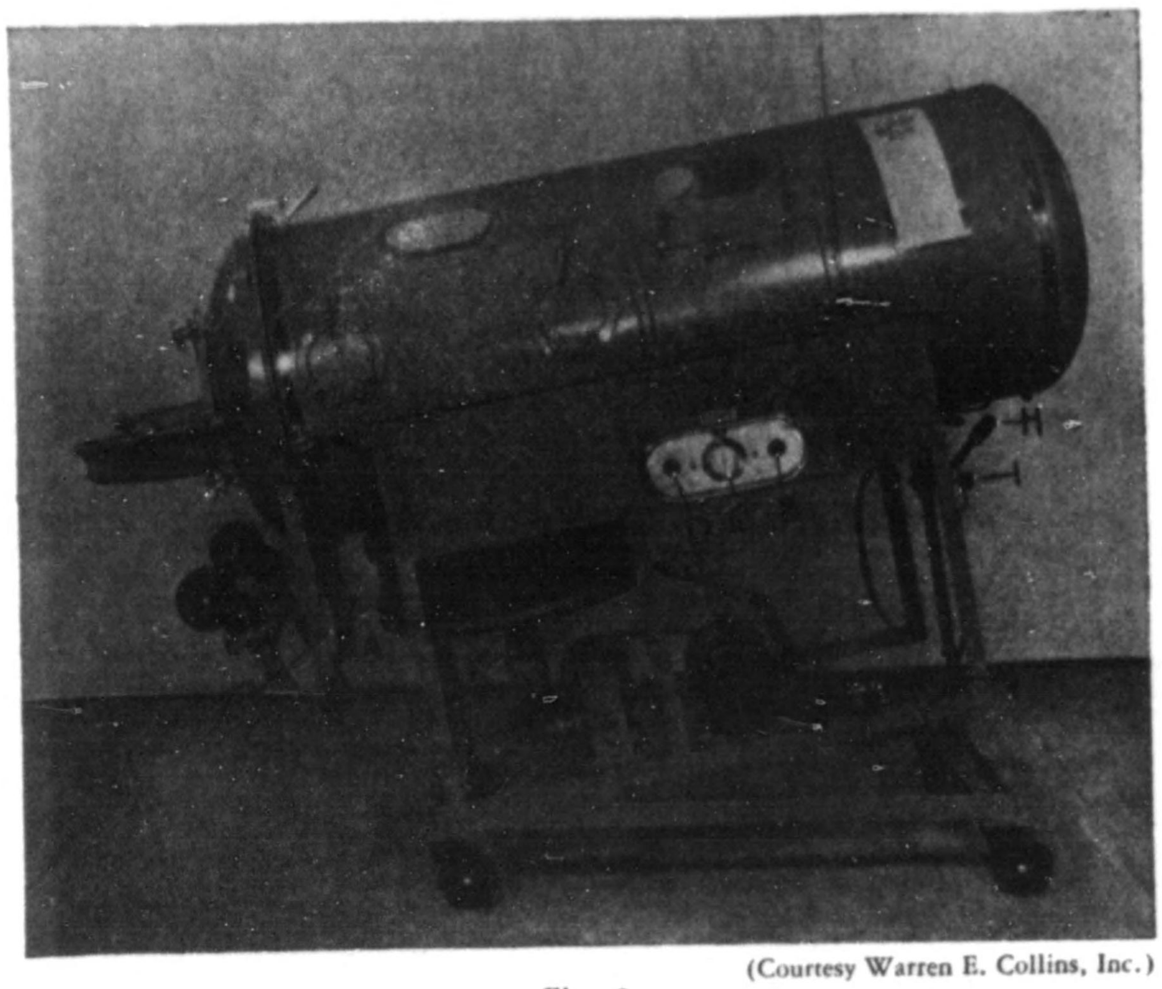
Indications for use of the respirator are set down in Dr. James L. Wilson's pamphlet, "The Use of the Respirator in Poliomyelitis." The decision to place the patient in the machine must be made by the doctor, but the nurse should recognize early symptoms of approaching respiratory embarrassment so that she may report the condition to the doctor *before* symptoms of exhaustion appear. This means before cyanosis or overt dyspnea are in evidence.

Patients with weakness of the arms and shoulders should be watched carefully for the onset of respiratory symptoms. The patient's efforts to speak may be significant. Speech may be interrupted or monosyllabic, and the patient cannot usually count to ten without taking a breath. Wakefulness, restlessness, and increasing anxiety are significant and often indicate approaching paralysis of the muscles of respiration. Increase in the rate of breathing combined with shallowness and a definite limitation of movement in the chest wall may be observed. Use of auxiliary muscles such as the sternocleidomastoids to lift the rib cage, and dilatation of the nostrils are danger signals which mean that treatment must be swift and intensive.

It must always be borne in mind that spasm of the pectoral muscles may cause the same set of symptoms. In these cases, hot foments may bring about swifter relief than the use of the respirator. The physician will be able to distinguish between the types of involvement and to institute the proper treatment.

Frequently bulbar complications may occur with paralysis of the muscles of respiration, making the choice of treatment a most difficult one. Mucus and dysphagia may further complicate the picture. In any

case it is well to have a suction apparatus and equipment for administering nasal oxygen on hand. Many of the newer machines are equipped so they may be tilted and thus provide postural drainage for the patient who is troubled with mucus. (Fig. 5.)



(Courtesy Warren E. Collins, Inc.)

Fig. 5

Directions for tilting machine:
Unscrew 2 handwheels (G) on the sides of front legs. Grasp crosspiece between the two front casters and lift it up and attach to hook. Then operate hydraulic lift handle (H) as pump until tank is tilted desired amount. To lower, open release valve (I). Close this valve after lowering, otherwise lift will not operate.

Preparation of the patient for the experience

A severely involved patient, gasping and cyanotic, is a desperate emergency to handle in any circumstance. The respirator in these cases is purely a life saving device and the all-important necessity is speed. The less severely afflicted patient who is conscious should be carefully prepared for the experience of being placed in the respirator. The ten-

dency at present is to use the machine on less severely involved patients in whom it is suspected exhaustion and apprehension may increase even though the pathological involvement does not. The patient should be told that the respirator, in his case, is used solely to provide him with rest and a chance to get through the most taxing period of his illness without depleting his strength. He should understand that it is a temporary measure and will be dispensed with as soon as the acute stage of the disease is passed.

If he is told what is expected of him and why his cooperation is so urgently needed, difficulties of placing him in the tank will be greatly reduced.

To place the patient in the machine

At least four, and sometimes five, people should be on hand to place an adult in the respirator. The neckpiece is prepared in one of two ways: In the Collins machine the four handwheels which control the collar are loosened one at a time, and the rubber collar is pulled out at that point as far as it will go. Each handwheel is tightened before the next one is loosened. It is necessary to be very careful in handling sponge rubber collars not to tear them with the fingernails. In the Emerson machine the collar straps are tightened and attached in their respective pins until the opening is large enough for the patient's head. (Fig. 6.) A silk hairnet or cap of stockinette may be kept in the machine to place on women patients' hair before pulling the head through the machine, a feature which makes the procedure more comfortable for the patient.

Unfasten the clamps at the head of the machine and pull out stretcher and mattress to its full length. Cot and mattress should always be as low as possible before patient is put in machine. Inspect the rubber gasket around the head of the machine. If it is loose at any point, call the engineer at once. Negative pressure cannot be secured inside the machine if this is faulty.

The patient, clad in the minimum of easily-removable clothing, is carefully lifted to the mattress of the machine. His head is turned slightly to one side, and his chin is kept down. This frequently is an uncomfortable position for a patient who has spasm in his posterior neck muscles. To avoid unnecessary pain, the patient's body should be *lifted* from the cot as the head is pulled through the opening. One nurse stands at the

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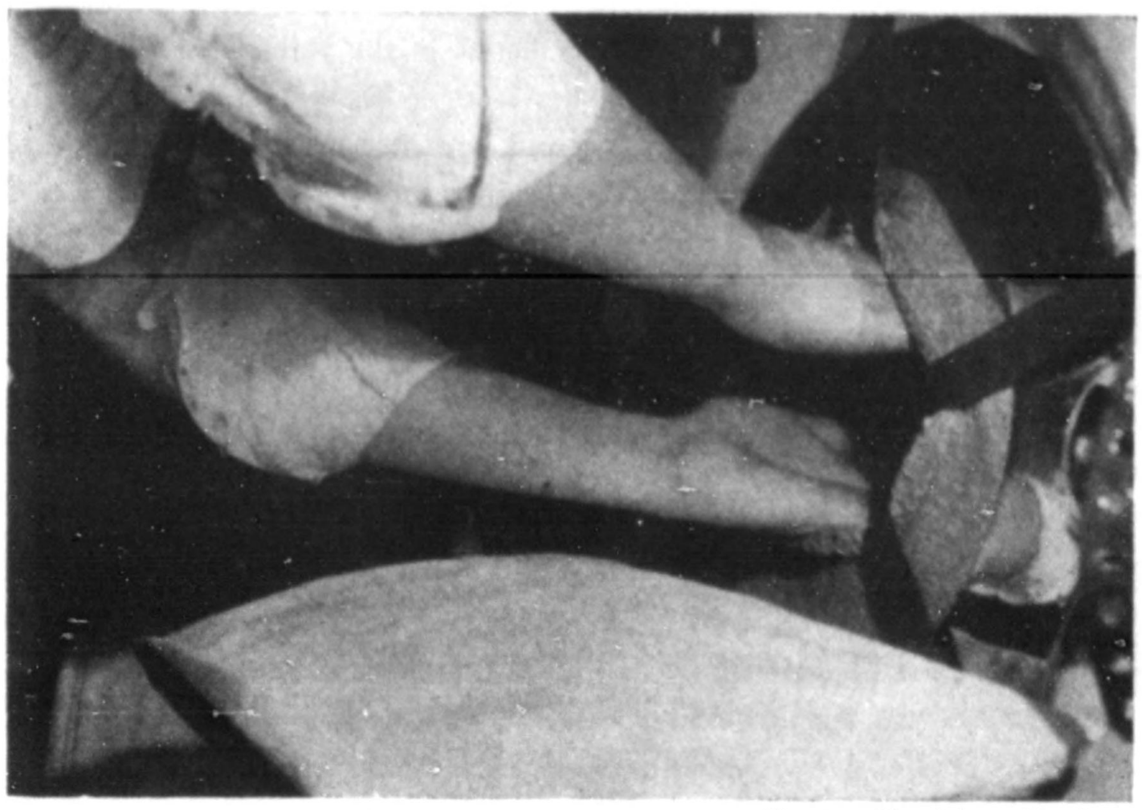
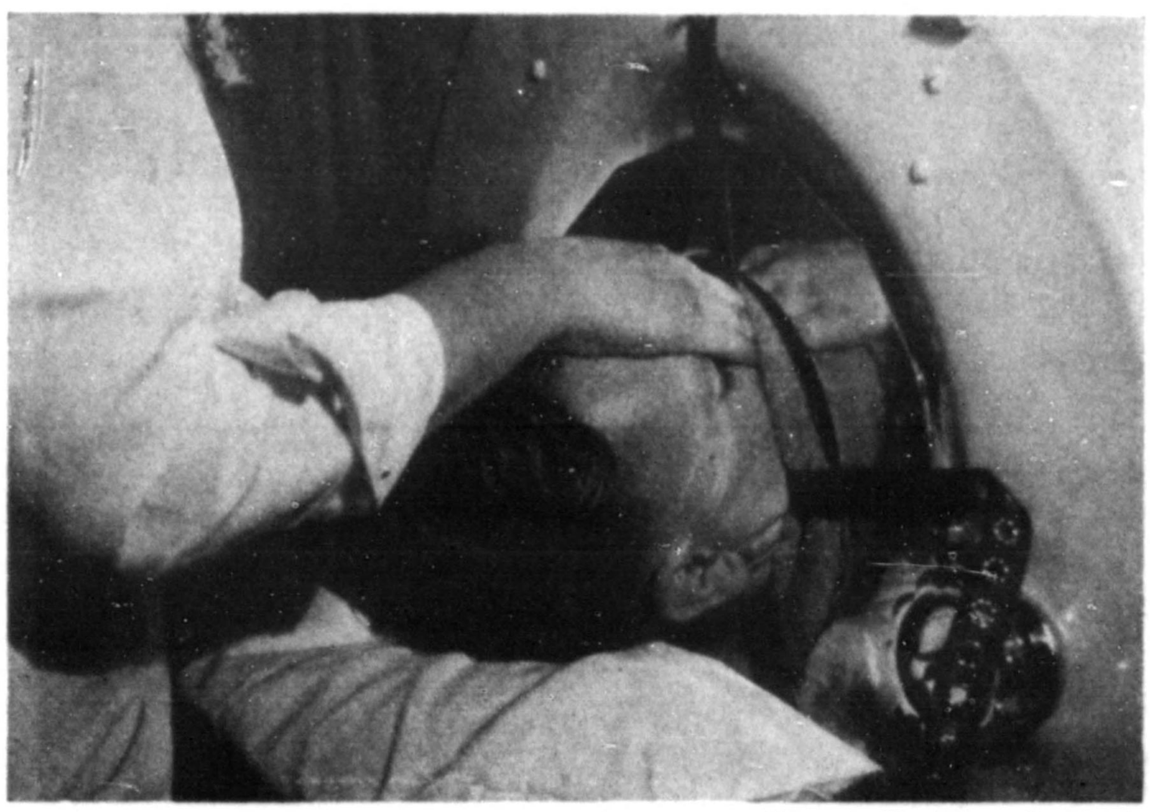


(Courtesy Clay-Adams Co., Inc.)

Fig. 6
Position of nurse's hands to pull patient's head through collar.

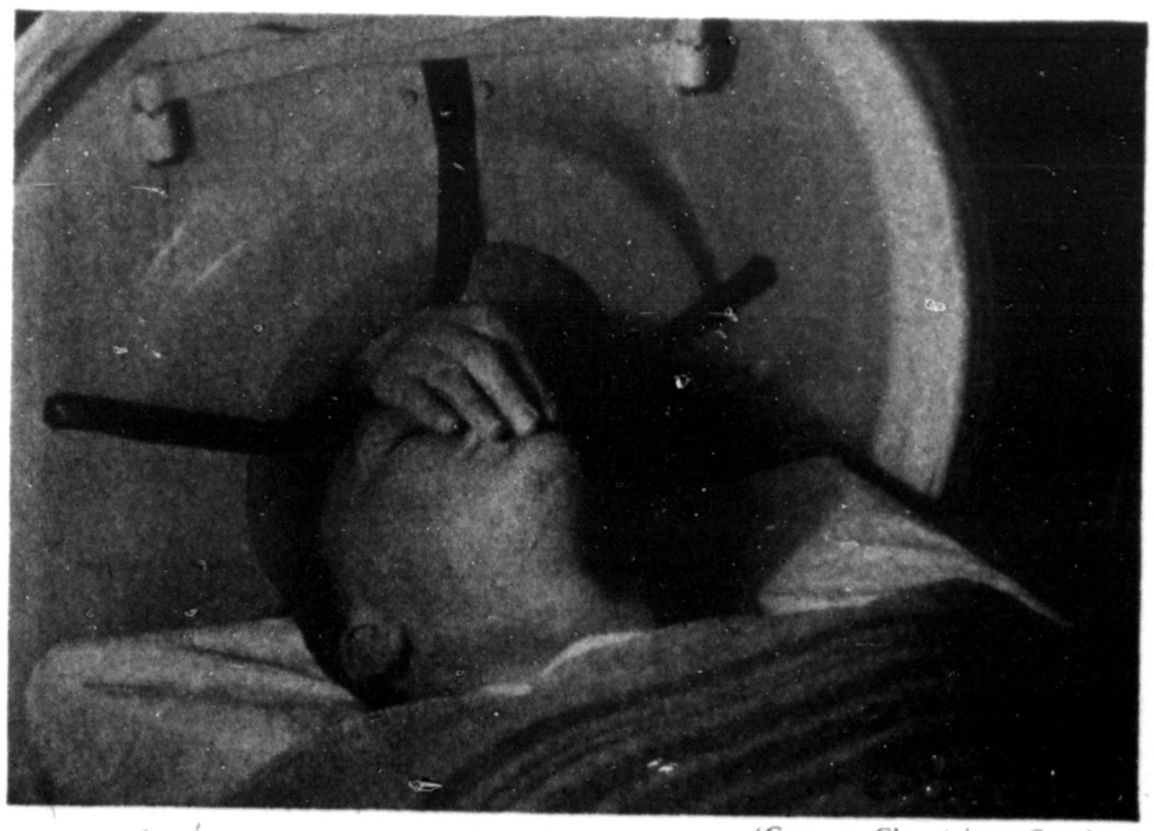


(Courtesy Clay-Adams Co., Inc.)

Fig. 7
Nurse's hand protects patient's nose as head is pulled through machine.

head of the respirator, inserting her hands in the collar lengthwise, and spreading the collar further with the backs of her hands as she does so. (Fig. 6.) This nurse grasps the occiput with her lower hand and covers the face and nose of the patient with the upper hand momentarily as she gently pulls the head through the opening. (Fig. 7.) (Fig. 8.) The crew of nurses or attendants at the other end of the respirator lifts the patient's body toward the head of the machine. There must be no dragging or pushing. Only practice makes this kind of teamwork possible.

If the case is a grave emergency, the machine must be closed at once, all clamps secured, and the mechanism turned on immediately. Two things are essential, however, in spite of the necessity for speed. The patient's arms must be protected securely by crossing them on his chest as the machine is closed, and such covering as is placed in the machine with him must be watched to see that it does not hang down in the tank. Jamming of the apparatus may occur if this is allowed to happen. The mattress of the cot should always touch the upper end of the tank, otherwise the patient will have considerable strain and discomfort under his inadequately-supported neck and shoulders.



(Courtesy Clay-Adams Co., Inc.)

Fig. 8

Nurse's hand protects patient's nose as head is pulled through machine.

The rubber collar is now released so that it touches the neck all around. This is done by use of the hand screws in the Collins machine or, in the Emerson respirator, by letting out the leather straps. The anterior straps are released last, great care being taken to prevent excess pressure on the anterior surface of the neck. The collar should just touch the throat during inspiration. In small children who tend to be frightened this is an exceedingly important point.

The necessity for having the patient's shoulders in contact with the head-end of the tank cannot be over-emphasized. If this is not done, the rubber collar will be immediately under the patient's chin where it will be a source of great annoyance. The proper place for the collar is as near the clavicles as possible. The patient's head can be centered in the collar by raising or lowering the head-end of the cot by means of the screw or handle provided for this purpose directly under the front of the machine.

As has been stated, a negative pressure of from 14 to 20 is usually sufficient. However, some authorities prefer to begin with much less negative pressure, particularly where the patient himself is still able to breathe with a fair degree of comfort. As he becomes accustomed to the machine, the pressure is increased just enough to secure adequate pulmonary ventilation with minimal effort on the part of the patient. It is not wise to increase the pressure where cyanosis seems to persist, or where cooperation seems incomplete. If inability of the patient to cooperate with the machine is manifest, the likelihood of foreign bodies or mucus in the trachea should be borne in mind. Suction or oxygen may be indicated rather than an increase of pressure. Excessive negative pressure is uncomfortable for the patient and emphysema has been found to develop in both superficial and deep tissues after prolonged periods of such hyperventilation.

Positive pressure is unpleasant and the patient will usually complain of it if he is conscious. It is not in common use, although Dr. Wilson states that occasionally it is of value in helping the patient to exhale more forcefully when abdominal muscles are paralyzed and coughing is impossible. It may in this way help the patient to bring up phlegm and mucus, but it should not be used without medical direction.

Skilled hands, self-control, and poise on the part of the nurse are necessary to minimize the patient's nervousness. These attributes will best be assured if the nurse and her assistants know exactly what they are doing.

Practice alone makes this possible, but it is not necessary to wait until there is a patient in the respirator in order to learn more about its operation. A classroom situation, where a student acts as a patient, is ideal for improving skill in respirator care. All nurses who periodically care for patients in the respirator should themselves undergo the experience. They will thereby be more cognizant of the patient's problems and discomforts. Remember that synchronization between the patient's own breathing efforts and the rhythmic action of the machine is indispensable. Nurses should note extra efforts to inhale which do not coincide with the action of the respirator. Mucus or vomitus may be occluding the glottis, and suction rather than a change of rate or depth of respiration may be indicated. Suction is only used as the patient exhales.

Daily care of the patient in the respirator

It is usually possible to remove the patient from the tank for short intervals during which time the bath, change of linen, and care of the back may be accomplished. The head, of course, is not removed from the collar, so that it is possible to return the patient to the tank and start the mechanism speedily in case of emergency. Where care is given in this manner, good teamwork is essential, and since everyone must work at high speed each task must be assigned before the machine is opened so that no confusion occurs. A crew of four people working together with good teamwork may give adequate care to an adult patient in a little over two minutes. Sometimes a preceding period of hyperventilation (25 to 30 cm. of negative pressure) may enable the patient to remain out of the machine for a longer period than he would be able to tolerate otherwise.

If the patient cannot do without the aid of the machine even for short intervals, bath and nursing care are given through the arm ports. The rubber cuffs surrounding the ports seal off escaping air by their contact with the nurse s arms. The patient will usually not be disturbed by the slight change of air pressure in the tank if only two ports are opened at one time. However, when two nurses work at the same time, and four portholes are therefore kept open for a considerable period, it may be necessary to increase the negative pressure briefly in order to compensate for leakage around the cuffs. If this is not done the patient is frequently exhausted at the end of the bath. Both the pressure gauge and the patient's face should be watched closely. Pressure should always be ad-

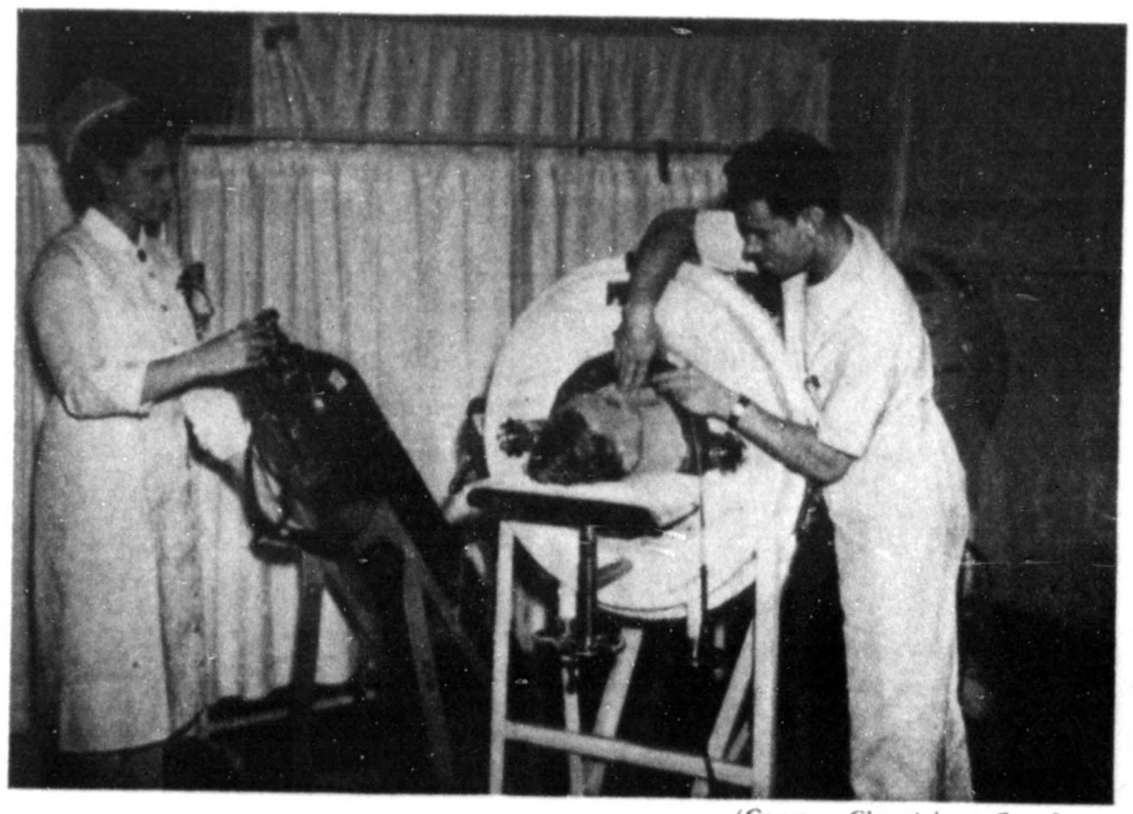
justed back to the customary level when nursing care is completed and the ports closed.

On the whole, it is quicker and less tiring for the patient to be cared for by two nurses or a nurse and an attendant, working on either side of the machine simultaneously. The arm reach inside the respirator of any nurse is of necessity very limited, and by handing equipment back and forth between them, two nurses can give more adequate care than one nurse working alone, and much time can be saved.

When two work together, a small bath basin which can be reached by both nurses is placed between the patient's legs. All equipment for the bath and change of linen is placed in the machine before the procedure is begun by way of the large bedpan port. This port should be opened and closed with the greatest possible speed and should be timed to follow an inhalation. When the anterior portion of the body has been bathed a third person, preferably an orderly, is summoned before turning the adult patient for his back care and change of linen. The trio works together deftly and very swiftly during the next steps. One nurse assists the patient to turn his head as the body inside the machine is turned by the orderly. The bath basin is placed *outside* the machine on a high stool near the ports through which the nurse giving back care intends to work. The orderly reaches across the patient and grasps the opposite shoulder and hip, gently turning the patient toward him. This enables the nurse on the other side of the machine to give a thorough rub to the patient's back, shoulders, buttocks, and heels. She then loosens the soiled drawsheet and tucks a clean one under the mattress on her side, fan-folding it as far under the patient's back as it will go. The patient is then returned to his back where he is allowed to rest a moment before the next step is undertaken. The nurse who is watching the head sees to it that it is always turned with the body in order that no twisting or torsion occurs. The process is now repeated on the other side so that the entire back is well cared for. The undersheet is tightened but is not changed every day. Change is made only when necessary. It is usually possible to release the patient from the machine for 30 seconds to do this. The sheet, folded in half, length-wise, is changed from the bottom as attendants lift the patient's body. It can be done inside the machine in the same fashion, but it is something of an ordeal for the adult patient. When changing the undersheet, care should be taken to see that it is

tucked in carefully at the top of the mattress and that no wrinkles remain under the shoulders. Frequently patients in respirators have more pain at this point than in any other section of the body. Before leaving the patient, the attending nurse should assure herself that the mattress is touching the upper end of the tank.

Enemas may be given, either by elevating the common type of irrigating can and bringing the tubing down through the small opening, (Fig. 1, K) in the top of the machine provided for this purpose; or a small enema may be given with a funnel and rectal tube inside the tank. Catheterization is difficult in the respirator on female patients, although it is occasionally necessary. Every effort should be made to remove the patient from the machine for this purpose. Satisfactory catheterization may be performed on a male patient in the respirator if the operator wears a pair of sterile gloves over scrubbed hands. The gloves may be removed inside the machine without contaminating the hands after they have passed through the ports; or, sterile towels may be used to cover the gloves as the nurse puts her hands through the ports.



(Courtesy Clay-Adams Co., Inc.)

Fig. 9
Nasal catheter for oxygen administration.

Meticulous care must be taken to prevent the nostrils from becoming sore or irritated when a nasal catheter is in use for suction or oxygen administration (Fig. 9). The catheter should be lubricated, but excess oil must be carefully eliminated.

The Kenny techniques and the respirator

If hot foments are being used concurrently with the respirator and the patient cannot be out of the machine, the moist blanket wrapped in a piece of waterproof material is slipped quickly through the bedpan port. A second nurse with her hands through the arm ports applies the packs quickly to the chest and shoulders, tucking them under the axillae, around the upper arm, and under the neck as far as they will go. Waterproof material may be placed over these packs, but the dry outer pack is omitted. Very little success has been obtained in trying to pack the back or posterior neck muscles of these patients. Occasionally thighs and legs are packed with the same "lay-on" type of foment.

Body alignment is given careful attention. The feet are supported by a small box or pillow, and outward rotation at the hips is prevented by a long sandbag or trochanter roll. A rolled towel is kept under the knees. Except in the orthopedic type of respirator little can be done in regard to the position of the upper arm. Passive motion for the shoulder joint should therefore be given when the patient is out of the machine for bath or morning care. The forearm can be positioned in the machine by the use of small pillows, with the elbow in the neutral position, the wrist in dorsiflexion, and the fingers slightly relaxed over a ball or thickly rolled bandage. Early, painless, passive motion should be instituted in all possible joints while the patient is in the respirator in order to minimize stiffness of joints and contractures of soft tissues.

There is variation of opinion among doctors in regard to the teaching of breathing to patients in respirators. Attempts have been made to remove patients from the machine for short intervals of instruction and practice in breathing so that complete alienation of the function will not occur. The patient is taught to breathe in through the nose while the doctor or nurse places both hands on the rib cage and asks the patient to fill out the chest at that spot. The patient is then told to breathe out through the nose, pull the ribs together and tighten the abdominal muscles.

However, many doctors are pessimistic about the whole process of reeducation in breathing for patients as long as they are relatively dependent on the machine. These doctors point out that the very nature of the respirator works against the system of treatment outlined by Miss Kenny inasmuch as "alienation" is bound to occur if the patient's breathing is taken care of by the machine without any effort on his part. They feel that by reducing negative pressure and allowing the patient to put forth increasingly more effort to do his own breathing in the machine they accomplish satisfactory results without attempts at actual breathing exercises. Prolonged dependence on the machine in either case is considered inadvisable.

Changing the patient's position

Provision for rotating the cot and mattress from side to side is available in some machines. Before attempting this rotation the machine must be in the horizontal position — not tilted. The front legs are hooked up off the floor and clamps at the head are loosened slightly. The head disk is then rotated to the side. This rotation turns the cot with the patient's body to a semi-side-lying position. The head must, of course, be turned at the same time. The clamps to the head disk are then fastened again. Where mechanism for rotating is not provided in the machine the patient may be turned on his side manually. Some hospitals have developed "teams" for this work composed of hospital personnel or of volunteers. These "teams" call at scheduled times to perform the necessary turning of such patients.

Frequent alteration of position is essential for several reasons. The danger of hypostatic pneumonia is, of course, always present. Less well recognized is the threat of renal calculosis which so frequently complicates the progress of long-term respirator cases. And, as is always the case with completely recumbent patients, the skin tends to break down over bony prominences. Heels, scapulae, and sacrum must be given particular care; the skin of the neck and occiput, too, will need regular attention. Frequent shampoos are helpful in preventing pressure areas on the occiput, and the neck must be washed gently, massaged, and powdered twice daily. In any use of talcum near the patient's face, care must be taken to prevent aspiration of the powder.

All people coming in contact with individuals in respirators should

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wear masks. These patients must be protected at all costs from upper respiratory infection. Such infections are a threat to the life of *any* patient with involvement of chest muscles, but with respirator patients even a mild cold may bring about a fatal pneumonia.

Fluid intake should be generous and both intake and output should be recorded. Frequent urinalyses are often ordered, and the specimens should be inspected for signs of occult blood. However, the first indication of the formation of renal stones may appear with a complaint of discomfort or pain in one of the lower quadrants.

When nasal feeding is necessary this should preferably be done by the physician. The danger of introduction of fluid into the lung is so serious that it would seem advisable for nurses not to take the responsibility for such a procedure. If, however, no physician is available the nurse must take great precautions to assure herself that the tube is in the stomach before introducing fluid. This may be done by aspirating stomach contents with a syringe, or the end of the tube may be placed in a bowl of water during the exhalation phase of the breathing cycle and observed carefully for air bubbles. If air bubbles occur the tube must be withdrawn immediately.

Hand operation

All hospital ward personnel, professional and non-professional, should know how to change the respirator from electric to hand operation. The accompanying illustrations show two methods by which this is done.

1. The Emerson Respirator. (Fig. 2.) Push down lever (16) at lower end of rocking beam, so that rod (14) slides freely in sleeve. Stand close to foot of machine, hold handle (18) with both hands and sway alternately backward and forward. It will generally be found best to close valve (10) when operating machine by hand.

2. The Collins Respirator. (Fig. 4.) The handle (E) for manual operation is usually located underneath the foot-end of the machine and is fastened with a thumb nut which may be unscrewed. The respirator bellows is operated by means of two lever bars (D) which are connected at the forward end by a box-shaped clamp and handwheel. When the clamp is loosened and pulled forward to the stop-pin on the longer of the two levers these are disconnected and the handle for manual operation can then be inserted into the box clamp and the handwheel tightened.

Hand operation is not an easy assignment and the person performing it will need frequent relief periods. An alarm bell operated by a separate battery is indispensable. It should be planned so the bell will ring loudly in case the motor of the machine fails or the current is shut off or if, for some reason, a port window or door opens and pressure is lost in the tank. The patient is thus assured immediate attention if the machine fails him. The ears of nurses working nearby soon become attuned to the peculiar type of sound made by the respirator when it is in operation, and they should recognize any sudden alteration in rhythm which may mean the machine is operating at less than optimal efficiency.

Weaning the patient from the machine

Every effort should be put forth to prevent complete dependence on the respirator. In developing independence the moderately involved patient may be helped by a gradual decrease of negative pressure before he is actually taken out of the machine. This will provide a test of his endurance and ability to perform his own respiratory function unaided. These trials should be carefully observed and recorded by the nurse. Occasionally the trial may be made as the patient sleeps, but if badly involved, his confidence is sometimes sacrificed by this type of experiment.

The severely involved patient who has been confined to the respirator for a longer period may be treated in the same fashion. This situation, however, is not quite so simple. The long-term respirator patient may be expected to have periods of apprehension and panic when he is actually taken out of the machine, even though he has been able to lie in it with the current turned completely off quite comfortably.

The attitude of the nurse in combating this nervousness is all important. She must be confident, reassuring and sympathetic in order to establish the desired sense of security which such a patient absolutely must have in order to fight his way back to complete independence of the machine. An increase of time spent each day out of the machine must be worked for.

The problem of diversional therapy for the long-term respirator patient is one which cannot be overlooked. Much ingenuity has been demonstrated by nurses who have cared for these patients. Frequently the occupational therapist is of great assistance to the nurse in figuring out a

means of providing entertainment or diversion. Every respirator patient should have a mirror attached to his machine to enlarge his range of vision. (Fig. 10.) A glass shelf attached above his head at a suitable distance provides a rest for books, newspapers, or magazines. Pages must of necessity be turned by attendants. Phonograph music is good entertainment for these patients; also chess and checker games for which the patients call out the moves. Respirator patients are often considered in the light of a "cooperative enterprise" in hospitals, and adult ambulatory patients frequently donate a portion of their time each day for reading and playing games with them.

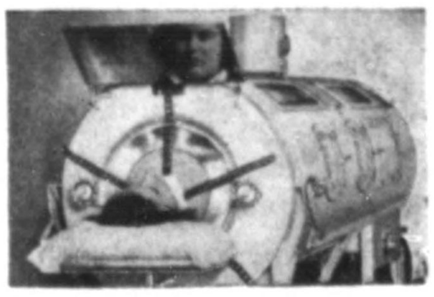

Fig. 10

The commercial respirator never seems to have quite enough ports or windows for the nurse caring for the full-grown patient. Hospital engineers and carpenters have been very ingenius in adding to these to provide space for more adequate care. (Fig. 11.)

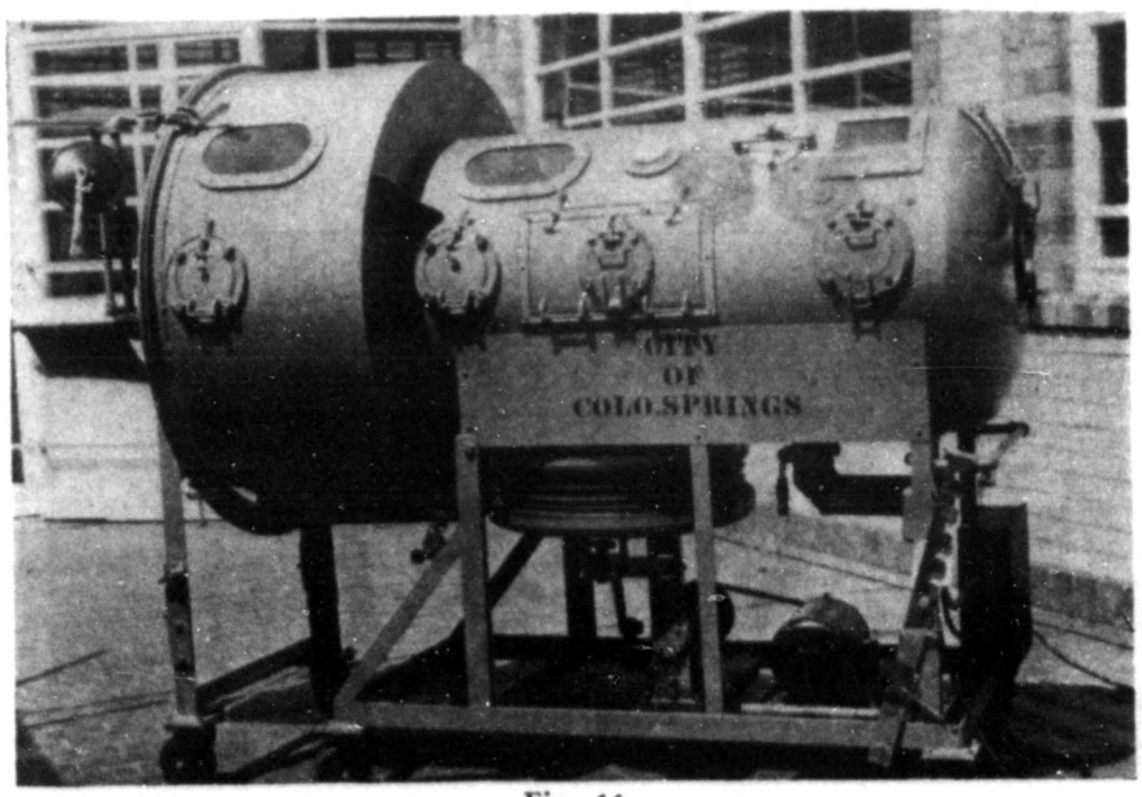

Fig. 11

Showing additional parts and windows added by hospital engineer. (From "The Patient in the Respirator — Some Suggestions for Nursing Care," by Hulda Helling. American Journal of Nursing.)

During epidemic seasons when a considerable number of respirator patients are hospitalized in the community, graduate nurses should be encouraged to return to the hospital for a few days to acquaint themselves with the care of patients in these machines. Ideally, all nurses should know these techniques before graduation from the school of nursing, but unfortunately opportunity is sometimes lacking. Generous use should be made of the educational opportunity when it *is* available.

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THE ROLE OF PHYSICAL MEDICINE IN POLIOMYELITIS

ROBERT L. BENNETT, M.D.
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THE PSYCHOLOGIC AND PSYCHIATRIC IMPLICATION OF POLIOMYELITIS

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THE PEDIATRICIAN'S RESPONSIBILITIES IN THE DIAGNOSIS AND TREATMENT OF EARLY POLIOMYELITIS

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THE pediatrician's responsibilities in the diagnosis and early care of poliomyelitis are extensive, varied, and manifold. In this paper an attempt will be made to discuss some of the more important.

Many of the diagnoses are easily made by any doctor. Although no symptom, sign, or test proves the diagnosis, there is usually enough circumstantial evidence in headache, fever, vomiting, stiffness in neck, back, hamstrings, and other muscles, and also apparent muscular disability, to lead a physician at least to suspect the disease. The diagnosis is strengthened, in fact pretty much confirmed, by the finding in the spinal fluid of a slight or moderate increase in cells. Since the proportion of cases is increasing in young adults who are first seen by internists or general practitioners, the pediatrician is not always called upon to make the diagnosis. But these adult patients are apt to be admitted along with children to poliomyelitis services where a pediatrician is usually in charge and thus has the opportunity and responsibility to confirm the diagnosis and initiate treatment.

For each such new case, the responsibility at once arises for checking over the rest of the patient's family to seek out other possible illnesses that might be overlooked instances of infantile paralysis. Where there are small children it will be usual to find such cases, most commonly in the nonparalytic form. Multiple family cases are more and more being recognized, and it is now a well-known fact that the case of poliomyelitis with recognizable loss of strength is the infrequent case—the so-called "medical accident."

When poliomyelitis has been identified and the patient usually hospitalized, the pediatrician becomes the coordinator and often the initiator of all types of care: pediatric, nursing, physical therapy, occupational therapy, morale building and social rehabilitation, and finally orthopedic support and reconstruction. There are few if any illnesses in the treatment of which so much must be done by so many different specialists. It is obvious that one person must be responsible for the proper coordination of all these efforts being made in the patient's behalf.

In the average spinal case with involvement of a leg or an arm, the coordination of care becomes a matter of routine. A schedule of rest and relaxation, of proper nursing care, and of measures to combat increased muscle tension can be quickly and adequately instituted by any doctor at all familiar with the infection. But there are special manifestations of the disease the management of which requires experience, judgment, and skill. In general these are associated with bulbar cases and those with respiratory difficulties. Here the proper

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coordination of efforts may be lifesaving, or at least may help to minimize the aftereffects of the disease—to lessen the irreparable destruction found after the tidal wave of the acute infection has passed away.

Bulbar involvement is not usually difficult to determine. In addition to considerable fever, prostration, and a look of toxicity, there may be nasal regurgitation of fluid, a change in the quality of the voice, a lag in the motion of the palate with loss of the gag reflex; also accumulation in the pharynx of mucus, often sticky, increasing difficulty in swallowing, an increased rate and thready quality of the pulse; at times a temporary increase in the blood pressure, and then too often the development of a dusky pallor as the respiratory and cardiac centers fail to produce enough oxygenation.

The care of bulbar cases, especially those with extensive manifestations, involves many measures; among others being first reassurance of the patient, then the prevention of aspiration of food or mucus into the lungs, the provision of adequate oxygenation, the support of the heart, and if possible, the reduction of intracranial edema. It is of special importance that these patients be handled no more than is absolutely necessary. In case of uncertainty as to what to do, it is better to do nothing than to do something not needed: that is, "In case of doubt, don't." Or as the fracture surgeons say: "If you can't help, don't hinder." However, the bladder and bowel must not be allowed to remain distended, and attempts must be made to meet, at least to some extent, the patient's requirements for fluid, calories, and nitrogen balance.

In the care of these bulbar cases, an important part of the treatment is concerned with attempts at combating with dehydration the edema of the central nervous system. While the immediate result of the intravenous injection of markedly hypertonic solutions such as 50 per cent glucose, or those containing electrolytes, may appear beneficial in lowering blood pressure, lessening headache, and in general improvement of the patient, we have been told that there may be a "rebound" a few hours later to a worse state than before. We have been using intravenous injections of 10 per cent glucose, but there may be better measures, such as giving by mouth or gavage repeated small amounts, for instance 1 ounce, of a saturated solution of magnesium sulfate which is not absorbed from the alimentary canal and which promotes fluid elimination by the bowel.

In poliomyelitis patients with any form of respiratory difficulty, the responsibility of the pediatrician is great. He must first determine for each patient which factors are responsible for the inefficient breathing and what are their relative importance. These may be: first, damage of the respiratory center in the medulla—a very grave condition; second, pharyngeal involvement with accumulation of mucus in the airways mechanically obstructing breathing; third, any muscular tightness which may interfere with expansion or contraction of the thoracic cage; fourth, impairment of innervation of the muscles of breathing; and, fifth, a factor often not considered adequately, emotional disturbances—fear, panic, hysteria. Two or more of these five factors are usually present together, but for purposes of treatment it is of the utmost impor-

tance to recognize which factors should have primary consideration. For example, a bulbar patient who can neither cough nor swallow and who has much mucus in his pharynx will practically invariably do badly in a respirator, which, on the other hand, may save the life of a spinal patient who has so extensive a loss of innervation of the muscles of breathing that he will die of suffocation unless he is given prolonged artificial respiration.

The emotional disturbances that are always present in patients struggling for air often receive inadequate consideration. Time and again a panicky child, or even adult, who seems unable to get enough oxygen, can be calmed and steadied and enabled to breathe more efficiently by the inspiring and soothing influence of an expert doctor or nurse. Similarly, a patient who is obviously going to need a respirator will more rapidly relax and let the machine do the work if he is told in advance what to expect, and that he is merely to be given a little rest for a while, thereby allaying his fears.

Such decisions as when to put a patient in a respirator, and when not, when to take him out, when and how to give him oxygen, when and what fluids to give him, and what stimulation to use are all responsibilities the pediatrician must shoulder. Nor can one be dogmatic in stating what should be done. We believe there are good reasons for being very slow about putting a patient in a respirator so we usually wait until it is obvious that he cannot go longer without it, and we try to take him out later in the same day. We know there are those who advocate putting immediately into a respirator a patient with even a minimum of respiratory difficulty. We very freely give wet oxygen by nasal catheter, and we believe caffein is our best cardiac center stimulant, especially when supplemented by oxygen therapy. When we do use a respirator, we run it at the lowest negative pressure that will keep the patient oxygenated and at the rate he finds most comfortable. We believe positive pressure is contraindicated. Incidentally, any person who is going to supervise the care of a patient in a respirator should first himself experience having artificial respiration given him by such a machine.

There are a number of factors in the care of patients both while in a respirator and particularly after such a stay, that require special knowledge and consideration. Most of these patients cannot cough because of diaphragmatic weakness and there is the constant danger of a mucous plug in a bronchus, causing the sudden development of a massive atelectasis. A respiratory infection is, therefore, a serious complication in these patients. Many postrespirator patients develop hypertension, possibly due to chronic anoxia and passive congestion of the brain. Some have myocardial damage, determinable only by the electrocardiogram.

The function of the diaphragm must be carefully studied, as with a fluoroscope. Sometimes one half is found to be immobile, presumably in spasm; the other half flapping up and down, and therefore of no help to such intercostal breathing as may be present. We are finding the use of blow-bottles very helpful in aiding postrespirator patients to increase the use of their diaphragms and thus to increase their vital capacities.

Aside from the management of poliomyelitis itself, a ward full of such patients offers a pediatrician many interesting problems. In one small series of thirty or so cases this fall, we have had patients allergic to wool and to food, problems of over- and undernutrition, and a diabetic patient whose insulin dosage was disturbed by physiotherapy. We have had behavior problems, upper respiratory infections, kidney conditions—notably hematurias—and a number of skin abnormalities and single instances of various other problems.

The pediatrician must also constantly guard against cross-infections among the patients, and especially strive to prevent the spread of poliomyelitis itself to those not yet afflicted. Rigid individual isolation at least for the first week is observed, because washings of the nasopharynx of patients have been shown to contain the virus during that period, but precautions against fecal contamination should be observed for a much longer time; some authorities say for at least two months.

When poliomyelitis has struck, three great responsibilities in the matter of education belong to the pediatrician. Inasmuch as there is pretty general agreement that the sooner a poliomyelitis patient is put to rest the better is his prognosis, it is highly important particularly in the presence of the disease that parents be educated to put to bed at once any person who has acute illness, no matter how trivial. An apparent attack of indigestion, a head cold, or more especially a fever and headache may be an oncoming poliomyelitis. Many illustrations may be quoted of such patients who tried to continue normal activities and then developed serious, even fatal cases of this malady.

In the second place, parents need to be taught the nature of the disease and the aims of physiotherapy so that they can better cooperate in the treatment of muscle tightness and the re-education of muscle functions.

Perhaps the most important aspect of education, however, is in the field of morale. Parents need to be taught that patients left with weakened muscles must learn to be as self-sufficient as possible; must be encouraged to overcome their restrictions and to press on to achieve lives of usefulness to others and satisfaction to themselves. The pediatrician can find in this realm of morale-building his finest and most rewarding opportunities of service.

Thus, a group of poliomyelitis patients offer a pediatrician unusually varied and challenging responsibilities. In cases with bulbar and respiratory difficulties his skill may save life. For the many exigencies and complications that may arise, his constant supervision is essential. For tieing together the work of the many specialists who help in the treatment, his coordination of their efforts, and consideration of the patient as a whole are vital. For protecting and informing the community his duty is clear. Thus, although one's sympathies are constantly being aroused and one's emotions stirred, a pediatrician can well find satisfaction in serving the poliomyelitis patient.

THE RELATIONSHIP OF INFANTILE PARALYSIS EPIDEMICS TO COMMUNITY RESOURCES IN THE TREATMENT OF PATIENTS

R. PLATO SCHWARTZ, M.D.
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SINCE the severe epidemic of 1916 certain areas in the United States have had a relatively low incidence of infantile paralysis, despite frequently recurring major epidemics in adjacent areas. The city of Rochester, N. Y., and the surrounding countryside for a radius of approximately one hundred miles was one of those regions which remained relatively immune to attacks during the annual recurrence of this disease for a period of nearly thirty years.

For a period of twenty-eight years following the 1916 epidemic there was an average of 11 cases reported in Rochester, N. Y., 31 cases in Syracuse, N. Y., 38 cases in Buffalo, N. Y., and 82 cases in Toronto, Ontario, Canada. For this same time interval the median for Rochester was 7; Syracuse, 11; Buffalo, 13; and Toronto, 36. During this time the relatively low incidence of infantile paralysis in Rochester was repeatedly discussed although the recognized discrepancy was never explained.

On the basis of confirmed admissions to the Strong Memorial and Municipal Hospitals, the epidemic totaling 259 infantile paralysis patients began on May 25, 1944, and ended on December 28 of the same year. The incidence was thirty-seven times greater than the median for the past twenty-eight years.

The rapidly increasing number of cases in July and August revealed that the Strong Memorial and Municipal Hospitals combined under the School of Medicine were the only institutions which could provide the resources necessary for serving the community in this emergency, which was characterized by demand for care of patients during the acute and convalescent stages.

The difficulties thus suddenly created were more readily resolved because of the past two years of research under grant in aid from the National Foundation for Infantile Paralysis, Inc. During that time-interval a close correlation had been established for cooperation between the Department of Pediatrics, Department of Medicine, and the Division of Orthopaedics in the Department of Surgery.

Early in the emergency it became quite clear that the background of common interest thus created was a great advantage. Those responsible for making decisions were already aware of the need and able to agree upon an effective plan based upon known requirements dictated by the characteristics of infantile paralysis in the absence of specific treatment for the control of disabilities which follow in its wake.

From The Department of Surgery, Division of Orthopaedics, University of Rochester School of Medicine and Surgery.

Presented before the Fourteenth Annual Meeting of the American Academy of Pediatrics, Detroit, Mich., Jan. 15-18, 1946.

Aided by grant from the National Foundation for Infantile Paralysis, Inc.

The plan was as follows: During the two weeks of isolation, the care of the patients was directed by the Department of Pediatrics, or the Department of Medicine in consultation, and with cooperation of the Division of Orthopaedics. All patients were transferred to the Orthopaedic Service at the end of two weeks after admission.

The latter service evaluated all patients on the basis of distribution and degree of muscle weakness or paralysis and determined the disposition, the duration, and the form of treatment to be given. Provision was made for following of these patients for a period of two years after the acute onset.

But, such an emergency demanded something more than beds, diagnosis and good treatment for patients. Simultaneously it was necessary to provide special resources in addition to those through which the hospital maintained contact with the community. Pertinent information regarding each patient was made available for parents, referring physicians, City and State Health Bureaus, social agencies, including daily reports to the hospital administration, and Visiting Nurses Association which provided trained personnel for the care of patients at home as directed by the hospital staff.

Muscle examinations were made within seventy-two hours following admission on all patients except when contraindicated by acute illness or local discomfort. At monthly intervals these examinations were repeated until the restoration of strength in weakened muscles returned to normal or reached a "plateau" beyond which there was no further improvement. A written monthly summary of each patient's progress was sent to those parents, the referring physicians, and those agencies interested either in the further treatment of the patients or in gathering information for the purpose of studying the epidemic as such.

All patients most severely disabled were hospitalized until they were physically independent with apparatus. After the acute and convalescent stages, patients who had residual muscle weakness were followed in a special clinic held once each week.

These were the practical resources developed by the dictation of an emergency which had no memorable likeness in this community in more than two decades. Precedents were not established by previous experience, but this was not so in the epidemic of 1945. The plan developed the previous summer required no significant modification, its application again proved effective in providing most for the patient, because the various relationships which the latter bore to the community and the state were properly considered as an essential part of treatment.

To some, it may appear that this broad base is too much to be practical in many places. How frequently it has been done is not known, but the indications for activating such a plan are defined by many factors. Without it patients may be treated effectively in the acute stage, but many parents are unnecessarily worried. The referring physician is uninformed as to progress and disposition and his relationship to parents and hospital become fouled. City and State Health Bureau statistics are exposed to inaccuracy, the services which they

are equipped to render to the community cannot be effective in such an emergency. Resulting partial or complete isolation of social agencies makes them unable to serve their respective functions. Visiting nurses do the best they can without supervision. In summary: the failure to provide for correlation of all these resources makes a difficult task more troublesome; moreover, it is safe to add that patients will not be as effectively treated during the convalescent and chronic stages of the disease when they most need direction for rehabilitation and protection from overexertion.

The requirements necessary for the correlation of the respective advantages rendered to infantile paralysis patients are common to most communities. Prevailing professional interest has financial support from the County Chapter of the National Foundation for Infantile Paralysis, Inc. Personnel is thereby available to execute the plan which provides for the most effective application of professional and community resources to the interest of all patients during and after the emergency created by a severe epidemic.

THE ROLE OF PHYSICAL MEDICINE IN POLIOMYELITIS

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THE intelligent care of the aftereffects of poliomyelitis is based on the premise that the extent to which a patient's functional capacity is ultimately restored is not dependent alone on the actual number of nerve cells destroyed during the acute stage of the disease, but also on the effectiveness with which the remaining cells can be put to use. In this over-all program of rehabilitation, it is the role of physical medicine to achieve three objectives:

1. To salvage all neuromuscular units left anatomically intact after invasion of the nervous system by the virus and to train these units to function with the highest possible coordination.

2. To prevent or minimize any musculoskeletal deformity that would handicap the most efficient use of these remaining neuromuscular units or render any indicated orthopedic apparatus or surgical procedure less effective.

3. To establish patterns of functional motion that will insure the most effective use of any necessary orthopedic apparatus and the maximum value from any necessary orthopedic procedure.

To appreciate fully this responsibility of physical medicine requires a complete understanding of the over-all program of care. Careful study of the various programs of care in use today reveals an amazing uniformity of approach in their attempt to achieve maximum rehabilitation. Almost all programs proceed in orderly progression through seven blocks or steps of treatment. These steps are summarized in Fig. 1.

If we appreciate the purpose of each step, we realize that the ultimate functional capacity regained by the patient is largely determined by the ability of the attending medical staff to complete each step thoroughly before undertaking the following one. There is now, as there has always been in the past, great controversy over specific routines and techniques in the over-all program. This controversy is of great value and will, and should, continue until we know a great deal more than we do now about the pathology of acute anterior poliomyelitis and the physiology of muscles and nerves. Perhaps when all these facts are known, a single method, complete in all its details and acceptable to all experienced investigators, can be formulated.

STEP I: SAVE PATIENT'S LIFE

It may seem unnecessary to indicate that the program of rehabilitation begins by first saving the patient's life. However, it is well to keep in mind that poliomyelitis is a potential danger to life during the first few days of the acute stage. Treatment during this stage is intelligent, supportive medical and

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nursing care, with the attending personnel on the alert to recognize and care for the first evidence of any emergency that might endanger the patient's life. The application of any form of physical therapy not consistent with this plan must not be permitted. It is not unusual to find patients with hot packs applied from head to toes at a time when that patient is fighting for his life to breathe against an accumulation of mucus in his throat and the added weight of hot packs on his chest.

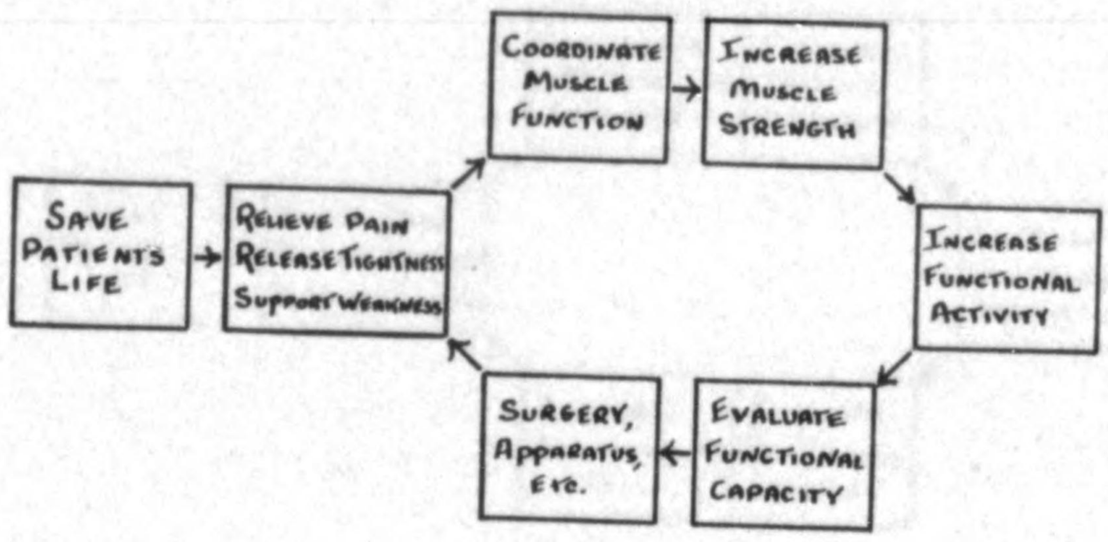

Fig. 1.

On the other hand, the judicious use of such physical agents as moist heat and passive motion may be indicated to relieve muscle tenseness and pain and thus allow the patient to rest more easily. Moist heat and gentle passive motion applied to the group of posterior neck muscles when the head is held retracted by spasm in these muscles may facilitate swallowing and breathing. In those patients where spasm and pain in the intercostal, abdominal, and back muscles are limiting breathing, careful attention to position and application of moist heat and gentle movement may be of almost specific value. It should be thoroughly understood that the application of any physical agent must be used with caution and should be specifically prescribed for each patient consistent with good medical judgment.

STEP II: RELIEVE PAIN, RELEASE TIGHTNESS, SUPPORT WEAKNESS

It is with Step II that our program of aftercare really begins. The purpose of this step is to prepare the patient for the initiation of voluntary motion. It should be readily appreciated that coordinated action of muscle groups acting on any bodily segment is impossible if motion of that segment is limited by pain and/or by limitation of joint motion. It is a basic principle of muscle re-education that restoration of effective use of muscles cannot be obtained and should not be attempted until a painless range of passive motion is possible in all segments upon which the involved muscles act. The relief of pain and release of all tightness in muscle and joint is thus the first step in muscle re-education. Until this is done, we can never fully regain the maximum use of the remaining skeletal muscles. The relief of pain and the release of tightness are accomplished by time, plus the use of intelligently prescribed sedatives, heat, and passive

motion. As in the use of all therapeutic agents, the type and frequency of application of heat and motion depend on the reaction of the patient. The immediate goal is painless passive mobility. There is no magical formula to achieve this end by physical medicine except in the intelligence and responsibility of the attending medical personnel.

It is also in this step that we begin our endeavor to prevent musculoskeletal deformities. Deformities (except for atrophy and weakness which are surely deformities but in the main not preventable) have just one cause: persistent faulty alignment of bodily segments which result in distortion of bones and joints and fibrous contractures of muscular and ligamentous tissue. In the early convalescent stage of poliomyelitis, such malalignment results from persistent, faulty posture in bed, caused by such factors as pain, muscle weakness, faulty beds, and the weight of bed clothes resting on the weakened extremities. Therefore, it is of utmost importance not only to preserve normal bodily mechanics and alignment by the early restoration of mobility in muscle and joint as mentioned, but also to prevent persistent faulty posture by the most effective methods possible. An effective support is not only one which holds the segments in proper position, but also one which in no way interferes with the other components of early care. It should be quite evident that the type of support will depend on the quality of available medical supervision. If little adequate medical supervision is available, a bivalved plaster cast is more effective than pillows or sandbags. Under intelligent supervision, an orthopedic bed, a footboard, and properly placed pillows are all the actual equipment needed to prevent deformities. Rigid supports are a poor compromise for good care.

STEP III: COORDINATE MUSCLE FUNCTION

Step III is probably the most important and certainly the most difficult step in the entire program. It is in this step that physical medicine in poliomyelitis justifies its existence. It is in this step that physical medicine has made its greatest strides in the treatment of poliomyelitis, not because any outstanding discoveries have been made in functional anatomy or bodily mechanics, but primarily because physical medicine has been given an opportunity to use its skill on bodily segments properly prepared for muscle re-education. It is obvious that the success of this step is absolutely dependent on the thoroughness with which the painless and complete mobility of the segment has been restored. The purpose of Step III is to train the patient to use every available muscle fiber with the greatest possible efficiency. It is a continued source of amazement and gratification to see the extent of functional capacity that can be developed by patients with very little muscle power but highly developed coordination. It must be stressed that coordination and power are not the same. Power without coordination may be disastrous to the patient recovering from poliomyelitis. Experience has taught us that all muscles in the involved segment do not recover with the same speed. The rate of recovery of an individual muscle group is not solely dependent on the physiologic state of the motor neuron but is influenced by many intrinsic and extrinsic factors too detailed to mention here. If, as

each of these individual muscles come under voluntary control, no attempt is made to coordinate their use, faulty habit patterns of motion will be built up by the patient through the use of these stronger and more easily available groups to the total exclusion of the weaker and thus less available groups.

The development of a truly high degree of coordination in the patient with moderate to severe involvement demands the attendance of a highly skilled physical therapist. Not all physical therapists, regardless of intelligence and training, have the qualities of personality, patience, and meticulous attention to detail so essential to good muscle re-education.

GLUTEUS MAXIMUS	N
ILIO PSOAS	P
SARTORIUS	P
TENSOR FASCIAE LATAE	N
HIP ABDUCTORS	N
HIP ABDUCTORS	P
INWARD ROTATORS	N-
OUTWARD ROTATORS	N
QUADRICEPS	P
HAMSTRINGS INNER	N-
OUTER	N-
GASTROCNEMIUS	N
ANTERIOR TIBIAL	P
POSTERIOR TIBIAL	F
PERONEALS	N
EXTENSOR LONGUS DIGITORUM	G
EXTENSOR BREVIS DIGITORUM	F+
EXTENSOR PROPRIUS HALLUCIS	G+
FLEXOR LONGUS DIGITORUM	G+
FLEXOR BREVIS DIGITORUM	N
FLEXOR LUMBRICALES	N
FLEXOR LONGUS HALLUCIS	N
FLEXOR BREVIS HALLUCIS	N

Fig. 2.

It is possible to determine the quality of the physical treatment carried out on an individual case by simply studying the functional muscle test rating of that patient. A difference of over 15 to 20 per cent in the functional rating of antagonistic muscles means one of two things: either that the early treatment was at fault and the purposes outlined in Step II were ignored, thus making good muscle re-education impossible, or that the program of muscle re-education was neglected or faulty.

Rarely a patient may be so inherently incoordinate that even the finest technician fails to attain proper muscle use. Examination of Fig. 2 reveals marked unbalance between the strength of flexors and extensors. This patient

was immobilized in a plaster cast for six months and then permitted rapid resumption of activity without supervision or guidance. If we simply recall our neuroanatomy of the spinal cord, we can readily see that such spotty involvement of muscles in each individual segment cannot possibly be the result

	8/14/43	10/30/43	1/3/44
TRANSVERSALIS			
GLUTEUS MAXIMUS	0	P+	F
ILIO PSOAS	0	P	P+
SARTORIUS	P	P+	P+
TENSOR FASCIAE LATAE	0	P	P+
HIP ABDUCTORS	Tr.	P+	F
HIP ABDUCTORS	P	P	P+
INWARD ROTATORS	0	P	P+
OUTWARD ROTATORS	0	P+	F
QUADRICEPS	Tr.	P+	F+
HAMSTRINGS INNER	0	P+	P+
" OUTER	0	P-	P+
GASTROCNEMIUS	Tr.	P-	P+
ANTERIOR TIBIAL	P	F	F+
POSTERIOR TIBIAL	P+	F+	F+
PERONEALS	0	P	P+
EXTENSOR LONGUS DIGITORUM	0	Tr.	P+
EXTENSOR BREVIS DIGITORUM	0	P	F
EXTENSOR PROPRIUS HALLUCIS	0	P+	F
FLEXOR LONGUS DIGITORUM	0	Tr.	F
FLEXOR BREVIS DIGITORUM	0	Tr.	P+
FLEXOR LUMBRICALES	0	Tr	P+
FLEXOR LONGUS HALLUCIS	0	Tr.	P+
FLEXOR BREVIS HALLUCIS	0	Tr.	P+

Fig. 3.

of poliomyelitis directly but is due to haphazard motion and development of faulty habit patterns during the convalescent period. In Fig. 3 is shown the diffuse and balanced return of strength that follows adequate convalescent care.

STEP IV: INCREASE MUSCLE STRENGTH AND STEP V: INCREASE FUNCTIONAL ACTIVITY

Steps IV and V are taken almost simultaneously. The increase of strength is obtained by carefully graduated activity, and increased activity further increases strength. While these steps are of the greatest importance to the patient, they are almost an anticlimax to the specialist in physical medicine. Actually, once the goal of maximum coordination has been reached and efficient habit patterns of motion deeply grooved, the patient's activities are limited only by his strength and endurance. I say this with full appreciation of the danger

of developing musculoskeletal deformities from faulty bodily alignment or mechanics during activity. As long as the patient remains coordinated, there can be no faulty bodily alignment or mechanics, unless the activity attempted is beyond the strength of the muscles called into action. It thus becomes the duty of the physician in charge of that patient's care to prescribe activity consistent with the ability of the patient to perform the activity and remain coordinated.

If a certain activity, walking, for example, is indicated, it must be determined if the patient can walk and still retain coordinate muscle action. If, in order to walk, a patient must resort to faulty bodily mechanics such as locking the knee in hyperextension or twisting the trunk in an unsightly manner, then walking must either be stopped or adequate assistive or supportive apparatus provided to enable the patient to carry out that activity in as nearly normal a manner as possible and with the correct coordination of muscle action.

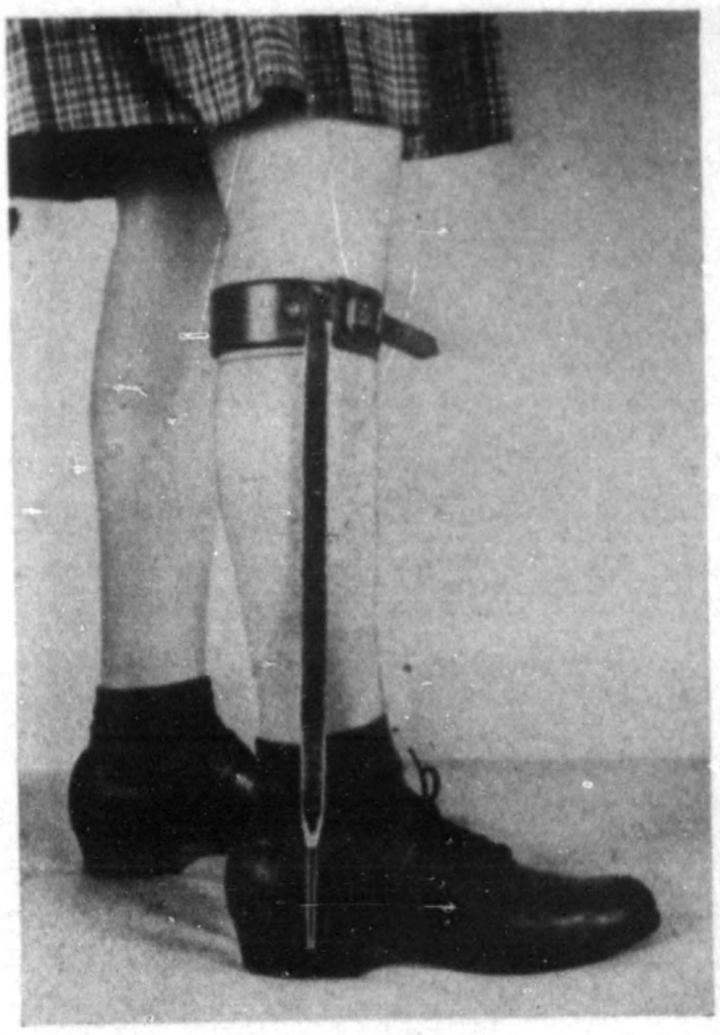

Fig. 4.

More specifically, suppose a patient has weak dorsiflexors of the feet. If walking is attempted, an abnormal gait will result from the necessity to raise the weakened foot by excessive hip and knee flexion to keep the foot from dragging on the floor. In this case, a foot-drop support (Fig. 4), and there are many simple and efficient ones, will hold the foot in correct position and allow normal mechanics of hip and knee in walking.

An overhead spring sling for a weakened shoulder girdle is probably the best example of truly assistive apparatus (Fig. 5). With this apparatus, the

arm is abducted to an angle where efficient motion of the shoulder girdle can be obtained and weakened muscles (deltoid, rotators, serratus magnus, etc.) are put in a position to act functionally and coordinately with but a fraction of their normal strength. Correct use without strain is encouraged and, with use, increased strength can be expected.

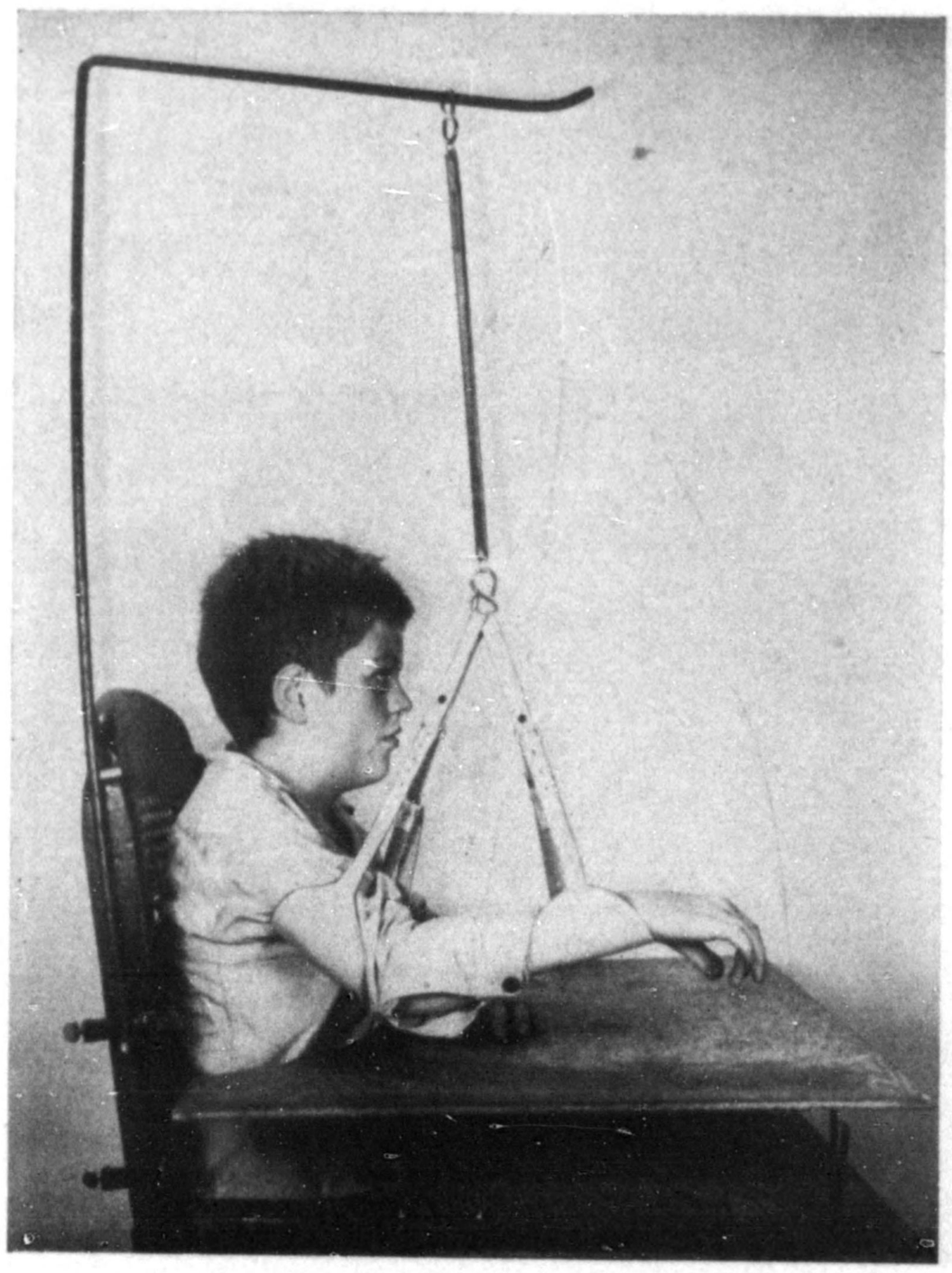

Fig. 5.

STEP VI: EVALUATE FUNCTIONAL CAPACITY

Eventually we come to a point in the program of convalescent care when we have done as much as we feel can be done by muscle re-education and graduated activity. In the mild case, this might have required but a few weeks; in the severe cases, perhaps several years. It is then that we carefully evaluate the patient's functional capacity in terms of that patient's ability to take his place in a normal environment. We want to know what that patient can do safely and practically. If his functional capacity is such that he can return to a happy and effective life, our program is complete. If, on the other

hand, his functional capacity is limited, we must determine if there is anything else that we can do. This necessitates a seventh step.

STEP VII: SURGERY, APPARATUS, ETC.

Step VII is a step of reconstruction and compromise. If an adequate program as outlined in Steps II through VI has been carried out, and the patient is still incapable of safe and practical locomotion, some reconstruction of normal musculoskeletal relationship or some compromise of normal coordination of muscle groups may enable the patient to achieve an independence of action otherwise not possible. The means to be considered are orthopedic surgery, the use of special apparatus, the development of trick movements, and the guided use of muscle substitution.

The results obtained by the orthopedic surgeon depend on the thoroughness of the conservative care during the period of convalescence. Certainly, if normal skeletal alignment and joint mobility have been preserved, the surgeon can do his work more efficiently.

To obtain the maximum value from orthopedic surgical procedures, postoperative care should revert back to Step II in the over-all program of care and proceed through Step VI for re-evaluation (Fig. 1). Patients may be taken through these steps of treatment many times before greatest possible functional capacity has been restored.

The training of patients in the use of trick movements and muscle substitution to increase functional capacity is a highly specialized phase of physical medicine.

SUMMARY

Physical medicine has an important and well-defined role in the treatment of poliomyelitis. It can be considered to have fulfilled its responsibility in the over-all program of care if:

1. All available neuromuscular units have been trained to function with the highest possible coordination.

2. All deformities that would limit the most efficient bodily mechanics have been prevented or minimized in so far as possible.

3. The most effective use of any necessary orthopedic apparatus or surgical procedure has been obtained.

THE PSYCHOLOGIC AND PSYCHIATRIC IMPLICATION OF POLIOMYELITIS

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THE general attitude of most physicians is that infantile paralysis is a simple disease characterized by permanent damage to anterior horn cells, with consequent paralysis, atrophy, and deformities in severe cases, and negligible or absent motor deficits in milder cases. It is, however, evident that any such formula ignores the possibility that emotional and intellectual components may complicate the picture. In this paper the conception that poliomyelitis is confined to anterior horn cells is challenged and evidence is presented which seems to justify reconsideration of the whole problem.

It is well known that many children have symptoms which suggest widespread involvement of the central nervous system quite comparable to that seen in other types of virus encephalitis. It is agreed that damage to tracts is rarely seen and frank convulsions or gross mental defects are practically unknown, but there is no adequate information about changes in the pattern of mental development or about emotional disturbances after the subsidence of the acute process.

The obvious approach to a problem of this sort is to bring the methods developed by psychologists into use. It is not enough to calculate intelligence quotients based on standard tests worked out on unhandicapped children. We need methods which reveal irregularities, lack of sustained attention, and lack of comprehension of form and ability to deal with abstractions.

There is abundant evidence that studies of this sort are relevant after cerebral injury from many causes. The observations of Kurt Goldstein, Elizabeth Lord, and others are conclusive.

In children the major difficulties revolve around the fact that we cannot proceed effectively until we find a method of checking deviations against a reasonably reliable curve which represents the progress which could be predicted if disease had not intervened. Every pediatrician has to consider development at every turn, but the disorders of cerebral function cannot be solved without peculiarly close attention to this element. A revision of some ordinary medical terms may be helpful.

In adult patients convalescence and recovery are easily defined. It is usual to define convalescence as a process which takes place between the end of active disease and complete restoration to a previously satisfactory general state. At the end of convalescence the patient is back where he started from. It is relatively simple to deal with the terms even when isolated phenomena such as paralysis persist by making suitable reservations.

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