

Orthopedic and Physical Therapy Objectives in Poliomyelitis Treatment

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The problem of poliomyelitis treatment in the early stages of the disease and in the later stages of convalescent care is a complex one. Cases vary in severity of symptoms, extent of paralysis, and rate and degree of recovery to the extent that no two are alike.

Individuals who treat the disease are handicapped in their understanding of the entire problem because few, if any, have the time and experience which permit them to follow through the day by day care of cases from time of onset to final recovery.

Yet one must see clearly some objectives in his treatment, or he is lost in the confusion of what should be done for the patient. It is the purpose of this paper to present some simple objectives in a common-sense approach to the problem of poliomyelitis treatment.

To discuss treatments relating to poliomyelitis and to evaluate results in the final stages, there must be a common denominator. Correct terminology and a uniform understanding of the descriptive words employed is essentially the common denominator we need. We cannot add together the number of patients who show paralysis unless we agree on what the term paralysis means; nor can we add together the number of patients who have slight weakness, unless we agree on what constitutes such weakness. We cannot add together the number of patients who have "spasm" unless we all agree on what the term "spasm" means.

Two things must be carefully analyzed in preparing correct terminology for a condition: (1) The established meaning of the term. (2) The exact condition of the patient to which the term is being applied.

Many terms are used and loosely applied in relation to poliomyelitis. In defining terms in regard to muscles, the term "affected" must be clarified. At the onset of poliomyelitis the involvement may be so extensive that the entire musculature is "affected". Any muscle which

exhibits hypertonicity is "affected" by the irritation of the disease. But the mere fact that the muscles exhibit this hypertonicity means that they are not affected to the extent that they are paralyzed. Muscles showing truly flaccid paralysis are so seriously "affected" that they are incapable of demonstrating hypertonicity. In using the term "affected", it should be applied to the muscles residually weak or paralyzed.

TREATMENT

An intelligent approach in regard to treatment must be based on an understanding of the basic pathology in poliomyelitis.

Surprising as it may seem there is much present day discussion in regard to whether poliomyelitis is primarily a disease of the nerve tissue or of the muscle, fascia and skin. Scientific descriptions of poliomyelitis have consistently placed emphasis on the fact that the primary lesion is in the nerve tissue. Secondary changes do occur in the muscles and all associated tissue, either as a direct result of the loss of nerve impulse, as a result of the loss of motion, or interference with circulation.

If the fact is accepted that poliomyelitis is primarily a disease of the nerve tissue, one will appreciate more fully the limitations of treatment. He will not maintain false hope either for himself or for the patient he is treating by presupposing that the actual nerve paralysis can be diminished by early and constant treatment of the muscle.

In discussing poliomyelitis treatment it should first be emphasized that the words "method of treatment" should never be applied to poliomyelitis care. To speak of poliomyelitis treatment as a method is an injustice to any intelligent approach. There can be no mass treatment nor can there under any circumstances be an established routine.

Factors Influencing Treatment:

When someone asks "How do you treat poliomyelitis?", there is no specific answer because

every patient requires a different approach in treatment. In considering the treatment of the individual case, the following questions must be answered:

How long since onset?

How old is the patient?

What is the extent of involvement at present?

What was the extent of original involvement?

How much improvement has there been in individual muscles?

What kind of treatment has the patient had thus far?

Time since onset is important because treatment varies in many respects with the stage of the disease. The relation between duration of the disease and improvement aids in determining prognosis.

Age of the patient is very important because underlying bony and ligamentous structural variations must be considered in relation to treatment.

A comparison between the extent of the *original and present involvement* is important in considering further course of treatment.

The kind of treatment to date is important for various reasons:

Treatment which has allowed unnecessary contractures to develop distorts the poliomyelitis picture. Such contractures create a superimposed stretch weakness on opposing muscles. Neither an accurate diagnosis nor prognosis can be made until such secondary superimposed factors are corrected.

Treatment which causes stretch and relaxation of joint structures superimposes an even more serious problem than muscle contracture. It is more difficult to restore normal tightness to stretched ligaments than it is to restore joint motion in cases of some muscle tightness. One cannot determine accurately the power of a muscle if the joint is so relaxed that the muscle does not have a stable joint on which to act.

Early excessive and prolonged heat treatment tends to distort the degree of involvement. The basic reason for the use of the heat, in itself, explains this phenomenon. Heat is used to relax muscles and to act as a general sedative. When continuous and prolonged heat is applied, muscles lack their normal contractility. We observed an unusual situation in many 1944 poliomyelitis patients transferred from an isolation hospital where heat and stretching movements were employed in the early stage of the disease. Upon admission to the orthopedic hospital, more rest and less active treatment was instituted. There occurred a sudden, unexpected amount of improvement that was not at all typical of the usual

course of progress in poliomyelitis muscles. Our explanation for this rapid improvement is that on top of the poliomyelitis weakness, which was not pronounced, there was superimposed a weakness due to too much heat and manipulation, which cleared up when such treatment was stopped.

Prolonged immobilization, which permits joint stiffness or unnecessary disuse atrophy to develop, also distorts the poliomyelitis picture and prolongs recovery.

Treatment Categories:

Early examinations of poliomyelitis cases will classify muscles or extremities or patients as a whole into three categories:

1. Essentially normal.
2. Weak (with or without imbalance).
3. Completely or almost completely paralyzed.

Each type requires a different approach in treatment.

All three problems may be exhibited in one individual, or there may be three individuals each exhibiting a single treatment problem.

Category I:

Patients who, from the time of the first examination, show no weakness below 60 per cent or fair plus, fall into the first category. Such patients usually require no support or protection other than would be given in the form of good nursing care which maintains correct postural alignment in bed. Any muscle imbalances within this range of 60 to 100 per cent (i.e. fair plus to normal) must be watched in order to avoid an early tendency toward muscle tightness in the stronger of the two opponents. Passive or active motion through the full range of motion of the normal muscle is indicated. But, if restriction tends to develop in spite of passive or active movements, a support is indicated which places tension on the strong and lessens the tension on the weak.

Some patients show no muscle weakness but exhibit hypertonicity of the posterior neck muscles, erector spinae and hamstrings. If one regards this hypertonicity as a symptom of the disease, rather than as a result, he will hesitate to treat the symptom, except insofar as relief of pain is concerned. The presence of this symptom indicates that the disease process is still present in the cord, and early flexion motions which are directed toward treating the symptom are, in the minds of many people, contraindicated so far as treatment of the disease is concerned.

One has only to examine a large series of cases

in whom no effort was made to treat the hypertonicity to realize that this symptom usually disappears as the acuteness of the disease subsides. In a few cases posterior muscle tightness does persist, and treatment to restore normal mobility is indicated. The knowledge of what constitutes normal movements is of prime importance and will be discussed in detail later in this paper.

Patients who fall into the category of essentially normal will tend to get well regardless of the therapist or the technic, unless the muscles are overtreated. Danger lies in attempting to force recovery or in insisting on weight bearing during the early stage.

For the moment, let us skip Category 2 in regard to weak muscles and go to Category 3, the paralyzed muscles.

Category 3

Some muscles on early examination may appear to be completely or almost completely paralyzed. Until sufficient time has elapsed to determine accurately the degree of paralysis of these muscles, it is necessary to treat them as weak muscles as discussed below.

The recovery during the first few weeks indicates the prognosis, and if muscles fail to show any significant increase in power during the first twelve weeks of treatment, little, if any, changes will occur. Once the status of the muscle strength is established the treatment indications become clear. Of prime importance is the maintenance of good body alignment and the preservation of joint stability. The range of motion and the position of fixation of each affected part are problems which should receive individual consideration.

Before discussing specific indications for treatment, let us carefully consider the chronic poliomyelitis patient.

If a youth or adult with a flail foot comes to an orthopedic surgeon two or more years after his illness, the logical procedure is to consider some type of foot stabilization. Stability is functionally more important than motion in the foot.

If a youth or adult comes to an orthopedic surgeon with a paralyzed wrist but good finger flexors, fixation in a position of wrist extension is indicated.

If a youth comes to an orthopedic surgeon with a disabling scoliosis which is progressing rapidly, and if conservative measures are inadequate, a spinal fusion is indicated. A straight rigid spine is far more desirable than a flexible spine which collapses.

These three examples show that free motion,

uncontrolled by adequate muscle strength, is in each instance disabling. Stabilization of these parts restores function to as nearly normal degree as possible under the abnormal circumstance of muscle weakness. If we consider what this reconstructive treatment means, we may retrace our course from the chronic poliomyelitis to the early poliomyelitis patient, and it will become evident what we should do in early treatment. Just as soon as we can be sure that muscles of the foot, wrist or trunk are remaining paralyzed or very weak, we should direct our treatment toward a stabilization of that part in the position of best functional alignment.

Knees are not in the same category as the three examples above, because motion to 90 degrees is necessary for sitting. Most people would rather wear a brace that unlocks for sitting than have a stiff knee. Likewise hip joint motion must be kept free for the best function.

Treatment of a weak or paralyzed shoulder depends on the condition of the hand, the elbow and the scapular muscles and no general statement can be made except that the joint structures should be preserved as far as possible. With weak or paralyzed muscles, the load of the arm weight or the strain of passive movement is thrust on the joint capsule and ligaments, and unless care is taken to prevent injury to these joint structures, the shoulder tends to subluxate. Once this occurs further improvement in muscle strength just does not occur. The cosmetic effect, too, is very bad.

The discussion thus far in regard to Category 3 (paralyzed muscles) has stressed the indications for orthopedic care for the best end result in the youth or adult stricken with poliomyelitis.

Children are flexible and their ligamentous structures have not tightened, making the age of the patient an important factor in regard to treatment. Flail parts require extreme care and consideration to avoid deformities. Bony formation is not sufficiently established under ten to justify arthrodesis. The fact that the bones of the child are not completely formed makes them extremely susceptible to stress and strain in weight bearing. If a child walks with a foot in a position of varus or valgus the weight bearing will influence the formation of the bones of the foot and make it more difficult to perform a satisfactory arthrodesis at a later date. The practical application of these facts to the early treatment requires that if a child has a paralyzed foot, treatment should be directed toward maintaining good alignment both in weight bearing and nonweight bearing. A brace will probably be necessary until the

child reaches the age when stabilization may be done.

In the care of paralyzed or very weak muscles, it is not logical to advocate full and unrestricted motion of all joints of the body.

Category 2 Weak muscles and muscle imbalance.

This category has been left until last because treatment of weak muscles overlaps the treatment of essentially normal (Category 1), as well as the treatment of paralyzed muscles (Category 3). Many weak muscles will recover good or normal strength. Treatment that will nurse these weak muscles back to good strength is indeed worthwhile. Only a survey of cases with muscle tests, recorded at frequent intervals, and over a period of several years, can determine the effect of treatment on weak muscles.

The application of treatment in weak poliomyelitis muscles is based not alone on care of poliomyelitis patients but also on experience with the effects of exercise, strain, fatigue, weight bearing, etc., on patients with a wide variety of orthopedic disabilities. Observation of instances of weakness associated with stretch and strain of nonparalytic muscles in purely postural cases impresses one with the serious importance of proper care in treating muscles weakened by poliomyelitis.

In order to discuss treatment indications for weak muscles, it is necessary to analyze the causes of muscle weakness in poliomyelitis. There are five types of muscle weakness encountered in poliomyelitis.

1. Weakness due to the nerve pathology.
2. Disuse atrophy.
3. Weakness due to mechanical strain.
4. Weakness due to overfatigue which results from overactivity or overtreatment.
5. Muscle-stretch weakness.

Weakness due to the nerve pathology cannot be influenced by treatment. But during the very early stage of the disease when there is the possibility of reversal of disease process and spontaneous recovery¹ one must avoid activity which superimposes other types of weakness on the actual pathological condition. To this end, early weight bearing and movements which cause fatigue must be avoided.

Disuse atrophy may occur by restriction of activity but should be no more alarming than the disuse atrophy encountered in other orthopedic problems in which rest is imperative. Activity will restore muscle strength lost as a result of disuse atrophy.

Very little laboratory work has been done to

determine the relationship of mechanical strain to muscle weakness. One must rely on clinical observations to guide in treatment of weakness due to strain. Mechanically a muscle is subjected to strain when it attempts to lift or carry a weight which the strength of the muscle cannot tolerate. Mechanical strain must be avoided during the period of early weakness to allow time for treatment directed toward hypertrophy of remaining muscle fibers. When weakness is present due to mechanical strain, the addition of heat, massage and exercise will only aggravate the condition of strain and increase the weakness.

Weakness which results from overfatigue is prevented by avoiding overactivity or overtreatment. Exercises must be graduated according to the patient's tolerance.

Arc of Motion and Muscle-stretch Weakness

In treatment of weak muscles we exercise through partial range of motion. As strength improves, arc of motion is increased so that after a muscle reaches 50 per cent (or fair) it is given full arc of motion in exercise. If, on the other hand, strength of some very weak muscles does not improve, we have gained stability and preserved alignment by not using full range of motion.

We adhere to the belief based on clinical observation of many cases that best recovery of strength occurs in weak muscles if arc of motion is limited in exercise.

This reasoning is best explained by considering clinical observations common to all of us. We have all seen cases of muscle stretch-weakness or paralysis. In its simplest form it is seen in dorsiflexors of the foot on nonparalytic bed patients. The foot is not dropped beyond normal range—but nevertheless, dorsiflexors weaken because they remain in a state of physiological elongation. The foot need not be down for twenty-four hours a day in order for such weakness to develop. Cared for during the day without any care at night, or vice versa, the muscles will begin to weaken.

"Muscle stretch paralysis" has been observed in cases of peripheral nerve injury in which, for example, wrist and finger extensors have failed to function although nerve regeneration has occurred. The return of function following application of a cockup splint in such cases is little short of spectacular.

In poliomyelitis patients this "muscle stretch paralysis" has been observed by many orthopedic surgeons who have found that either by application of splints or subsequent to some operation

there has been an unexpected return of power in a muscle seemingly paralyzed.

Even in a present day concept of poliomyelitis which has received much attention, there is described a pseudoparalysis or muscle stretch paralysis (or alienated muscle—in one of the several uses of the word "alienated"). The weakness or paralysis is described as being due to the fact that the muscles are maintained in a stretch position by an opposing group of muscles in "spasm". Again this does not mean a position of stretch beyond normal arc of motion.

In poliomyelitis patients, muscle imbalance often exists between opposing muscles in which the weak is subjected to constant tension by the pull of the normal or stronger opponent.

The important underlying factor in all these examples may be summarized: Muscles will weaken if maintained in a stretch-position (beyond the position of physiological rest) for a sufficient length of time. This stretch need not be beyond the normal range and need not be constant to cause weakness of the muscle.

The common observations in regard to muscle stretch weakness are interpreted in various ways. Some maintain that there is no reason to believe that repeated exercises through full range of motion can elongate muscle and cause weakness. They advocate stretching muscles in movement but at the same time claim that muscle stretch position is bad to the point of being paralyzing.

Stretch weakness is a weakness superimposed on the weakness due to nerve pathology. Recognizing the existence of this stretch-weakness in many poliomyelitis muscles, we avoid its occurrence in two ways:

1. Use of proper supports which maintain a physiological rest position to avoid *stretch positions*.
2. Restriction of arc of motion to prevent *stretch movements* during treatment periods.

This not only avoids unnecessary tension on the muscle, but avoids undue stress and strain on joint capsules and ligaments.

Muscle Imbalance Between Opposing Muscles and Within Muscles:

Poliomyelitis patients exhibit the phenomenon of muscle "cramps". These cramps are of two types and should be handled in two different ways.

Some muscle "cramps" occur in normal muscles which are unopposed or opposed by weak muscles. In this condition the entire muscle when contracting, as in exercise, shortens beyond its normal physiological limit. To relieve such a

cramp in a muscle the part is pulled in the opposite direction to stretch out the over-all contraction. This fact that muscles may contract beyond normal is another point in favor of restricting arc of motion in exercise to avoid positions in which this contraction occurs.

Some muscle cramps occur in weak poliomyelitis muscles. There is no indication that an actual rupture takes place, but the uneven pull within the muscle creates an imbalance that puts a strain on one part and allows a transverse section to contract more than normally. Over-all heat and stretching motions will only aggravate this type of condition. If you watch a patient trying to relieve this type of cramp, you will find that he rubs over the "knot" in the muscle.

We should carefully analyze the type of muscle-contraction encountered in treatment of poliomyelitis muscles. An over-all muscle tightness needs stretching. Heat applied specifically and locally to the tight muscle is indicated. A transverse, segmental contraction within a muscle requires careful handling.

Evidence of segmental imbalance in muscles has been interestingly portrayed in pictures of operative exposure of poliomyelitis muscles by Hipp.² His article helps to clarify, in a way physiologists have not done, the clinical picture we see in weak poliomyelitis muscles.

Bracing:

The problem of treatment for weak and paralyzed muscles cannot be left without a discussion of indications and contra-indications in regard to the use of splints and braces.

When anyone says he does not use and does not believe in the use of such devices, he frankly admits that he does not know their indications. Information cannot be obtained from one who has never used such devices but must come from one whose experience and training have established the fundamental usefulness of such modalities.

Because orthopedists know more about the indications for such treatment than any other group of specialists, we went to one of the country's outstanding men in this field—Dr. George E. Bennett. We asked Doctor Bennett, "Why do you use splints and braces?" His answer was direct and to the point: "Braces are applied to protect weak muscles, to hold joints in alignment, to prevent deformity, and to facilitate function."

The need for bracing, or a check on whether bracing has been correctly applied, can quite well be determined by checking against the four points here outlined.

- (1) Is the brace needed to prevent deformity? In growing children with generalized weakness

or muscle imbalance, the answer is almost certainly "yes". In adults, the answer usually is "no", because the bony and ligamentous development is sufficiently well established and strong enough to offset the danger of deformity.

Permitting a child to develop a hyperextended knee to compensate for quadriceps weakness can cause serious complications. A unilateral hyperextension may lead to lateral pelvic tilt with spinal deviation as well as anterior and rotary pelvic displacement.

The choice in bracing may be one of two: If free joint motion is to be permitted, the child must have stability by locking the knee. A brace then is designed to permit the desired mobility and extension, without permitting hyperextension which unavoidably becomes more and more deforming in unprotected weight bearing. If strength and stability of the knee are required more than free motion, a brace with a knee lock is used. This type of bracing carries with it the disadvantage that walking must be accompanied by a certain amount of pelvic motion; but the over-all effect is not as serious as the deviations associated with no bracing.

(2) Does the brace maintain joints in alignment? If alignment is distorted or parts are held in a faulty position, then a brace is helping to maintain a deformity rather than a normal alignment. Such should not be the case. If one waits until a deformity has developed before applying a brace, he has failed in the proper use of bracing.

(3) Does the brace facilitate function? If a brace handicaps an individual more than it helps him, surely it is not facilitating function. But the "pros" and "cons" must be carefully considered. Present restriction may mean prevention of future disabling deformities.

(4) Is the brace indicated for protection of weak muscles? In cases of known peripheral nerve lesions in such cases as wrist-drop or foot-drop, the application of a splint is a well established orthopedic procedure. The splint serves a dual purpose. First it prevents adaptive shortening or contractures from developing in the unaffected muscles, and secondly, it prevents stretch of the temporarily paralyzed group. The need for such splinting is determined by the muscle imbalance and the degree of weakness, and the procedure is applicable in cases of imbalance regardless of whether the pathology is in the peripheral nerve or the anterior horn cell.

As professional people let us help educate the patient specifically and the layman in general in an understanding of the basic principles involved in the use of supportive measures.

NORMAL FLEXIBILITY ACCORDING TO AGE GROUP

Before anyone attempts to treat abnormal conditions, he should have a thorough knowledge of what constitutes "normal". A survey has been completed which attempts to determine normal flexibility in relation to certain movements currently employed in the treatment of poliomyelitis.

With the cooperation of Elmon L. Vernier, Ph.D., Director of Health and Physical Education in the Baltimore Public Schools, and his staff of physical education instructors, we have obtained measurements on over 4500 school children between the ages of five and eighteen (kindergarten through twelfth grades). To this number have been added test results on 582 young adults between the ages of eighteen and twenty-two.

*Summary of Study**

The ability to touch finger-tips to toes, sitting with legs extended, is a known infant normal and from the study appears to be an adult normal. There is a decline in the ability to perform this movement from the infant and early school age to a low point at the age of twelve and thirteen (for boys and girls, respectively) at which approximately only 30 per cent can touch. There is a gradual increase in the number able to perform this movement up to 90 per cent for the adult males, and 95 per cent for the adult females.

The ability to touch forehead to knees, sitting with legs extended, is also a known infant normal, but drops suddenly so that by the age of six, only two out of 100 boys can perform this movement. Beyond the age of nine, only one out of 100 boys can do this movement. In girls, four or five out of 100 can perform this test, but approximately half of those who can touch have had early training in acrobatic or ballet dancing to make this ability acquired rather than innate.

REACTION TO PRESENT-DAY TREATMENT

Our own interpretation of what we see in much present-day treatment of poliomyelitis is this:

With the basic concept that "spasm" can cause an apparent paralysis, the reasoning goes on that if we rid the patient of spasm we will avoid the paralysis that might come as a result of such spasm. With curare, hot packs and early motion, the spasm is "reduced", no stiffness results, and without stiffness there will be no fixed deformities. The sum total of such reasoning is: (1) less paralysis, (2) no deformity, and (3) no stiffness

*Study complete with graphs and charts is being submitted by George E. Bennett, M. D., to the JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION.

nor contractures. And what more could one ask for in poliomyelitis treatment?

If the original premise is accepted, the rest seems logical, easily understandable, and extremely convincing. But the original concept distorts the entire problem in regard to poliomyelitis, and leads to false conclusions in regard to treatment. The early so-called muscle spasm is a symptom of the disease, not a cause of the true nerve paralysis.

There is no scientific evidence to prove that treatment directed toward relieving "spasm" lessens the paralysis or prevents disabling deformities.

Such treatment does tend to prevent stiffness and muscle contractures, so long as the patient is under treatment, and indeed in many instances, the extreme stretching is sufficient to stretch joint structures to the extent that they will never return to "normal". Patients frequently are more flexible than before they had poliomyelitis, but this factor often is a serious handicap to one with extensive involvement.

Treatment directed toward stretching muscles will delay fixed deformities in some parts of the body but will hasten disabling deformities in other parts.

On our firm belief that weak muscles must be nursed back gradually to allow return of maximum function, we challenge present-day "stretch treatment" with the prediction that end-results will show more apparent paralysis, as well as deformities, than should occur in good poliomyelitis after-care.

We are all treating poliomyelitis patients; we are all seeing the same symptoms, the same disease, the same problems in muscle imbalance

and deformity, and, to a very great extent, the same type of end-results. The extent to which different forms of treatment influence end-results will determine the relative value of each form of treatment.

Discussions all too often center about differences between "new" and "old" forms of treatment. Let us instead discuss what is *good* and *bad*, using scientific medical knowledge and clinical experience as the basis for our reasoning.

SUMMARY

Uniform terminology is essential for common understanding of poliomyelitis problems.

Treatment indications are based on a variety of factors: Age of the patient, time since onset, severity of involvement, rate of improvement, and type of treatment thus far administered.

An understanding of the purpose of treatment is best approached by an analysis of muscles (or cases) according to three categories: (1) Essentially normal, (2) weak, with or without imbalance, and (3) completely or almost completely paralyzed.

Indications and contraindications in regard to the use of braces is discussed from an orthopedic standpoint.

Test results on over 5000 individuals show age group differences in flexibility movements involving the back and posterior leg muscles.

Much present-day poliomyelitis treatment is based on concepts which lack sound orthopedic basis.

REFERENCES

1. Howe, Howard A., M.D., and Bodian, David, M.D.: Paper (unpublished) read before joint meeting Orthopedic Sections, Medical Societies, Baltimore, Md., and Washington, D. C., April 1946.
2. Hipp, H. E., M.D.: J. Bone and J. Surg., Jan. 1942.
Southern Med. J., Vol. 34, 1941.

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