

**Learning About and From Post-Poliomyelitis:  
A Seminar for Physical and Occupational Therapists and  
Physical and Occupational Therapist Assistants**

## Physical Therapy Examination and Treatment of the Polio Survivor

Marianne T. Weiss, MS, PT

---

### The purpose of this document is twofold:

- **To describe the examination and treatment intervention that a physical therapist (PT) should be able to provide a polio survivor.**
- **To inspire PT professionals to count themselves among those who possess the caring attitude, knowledge base, confidence level, and desire to provide skilled and appropriate examination and intervention services for polio survivors.**

Certainly many health professionals other than PTs can help to lessen the impact of the late effects of polio. In some cases, the services of other professionals overlap those of the PT. However, this document will primarily address PT services.

### WHY SHOULD A PT ACCEPT A POLIO SURVIVOR AS A PATIENT?

#### Treatment of polio survivors is within the scope of PT practice.

Since 1997, *The Guide to Physical Therapist Practice*,<sup>1</sup> published by the American Physical Therapy Association, has served as the standard by which PTs measure their practice. In this document, PTs can find preferred practice patterns labeled with titles known as "PT Diagnoses" that describe accepted methods of practice for virtually any disorder able to be treated by our profession. In the chapter containing

information about the neuromuscular practice patterns, two patterns in particular seem to most appropriately apply to the treatment of polio survivors. These are:

*PATTERN A:* Impaired Motor Function and Sensory Integrity Associated with Congenital or Acquired Disorders of the Central Nervous System in Infancy, Childhood and Adolescence

*PATTERN B:* Impaired Motor Function and Sensory Integrity Associated with Acquired Nonprogressive Disorders of the Central Nervous System in Adulthood

These practice patterns seem most appropriate because:

- Polio is an acquired, viral disease that can infect either children or adults.
- The disease itself is non-progressive (although the symptoms of the late effects of polio can be progressive); additionally, other practice patterns that include progressive disorders specifically list polio in the exclusion list for those patterns.
- In the acute phase, the disease affects all aspects of the central nervous system, not just the spinal cord (even in survivors who apparently have no residual effects of the disease except in the spinal cord).
- *The Guide* emphasizes that people who are appropriate for treatment using applications from a given practice pattern may not have all of the symptoms listed as common to those individuals for whom the pattern is intended to be used. Therefore, although impaired sensory integrity is not a common

residual deficit after polio, application of these patterns to the treatment of polio survivors should still be more appropriate than any of the other patterns that clearly apply to patients with disorders far removed from polio or patterns that specifically list polio as an exclusion.

The components of examination and treatment intervention in these two practice patterns are virtually identical, except for the fact that Pattern A includes examination of ventilation, respiration, and circulation (and intervention for impairments of these functions), while Pattern B, for some unknown reason does not. However, *The Guide* states that, "physical therapists also may decide to use other tests and measures that are not described in *The Guide*<sup>1</sup>," and also that "direct interventions vary because they are selected, applied or modified according to data and anticipated goals for a particular patient/client in a specific diagnostic group.<sup>1</sup>" Therefore, PTs should feel free to include examination of ventilation, respiration and circulation (and intervention for impairments of these functions) when using Pattern B, as well as when using Pattern A.

***The Guide* describes three elements of physical therapy intervention, all of which could be of potential benefit to polio survivors.**

### **1. Coordination, Communication and Documentation**

PTs may serve as case managers, coordinators of communication amongst health professionals, careful documenters of patient function, and referrers to other health professionals.

### **2. Patient/Client-Related Instruction**

PTs can serve as educators for polio survivors, their families, significant others, and care givers. Whether a survivor's symptoms are stable, fluctuating, or worsening, PTs can provide instruction in a variety of areas, including, but not limited to:

- pathophysiology of the late effects of polio;

- particular impairments identified;
- methods of adhering to interventions that have been established;
- ways to minimize the effects of polio problems on the body; and
- secondary prevention of future disability.

### **3. Direct Intervention**

A PT may intervene with any of the therapeutic modalities available within the scope of physical therapy services to assist in meeting goals of treatment directed at alleviating impairments and functional limitations. Also within the realm of direct intervention are prevention services apart from simple instruction, such as providing a well-rounded baseline examination against which future problems might be measured, recommending assistive devices or adaptive equipment, or establishing a maintenance home exercise program.

**There is a potentially large number of polio survivors who may actively seek PT services or could benefit from services if they knew they were available and accessible.**

Estimates place the number of polio survivors in the US at between 600,000 and 1,600,000.<sup>2,3</sup> Potentially all of these individuals could benefit from the prevention services that a PT could initiate for them. Of these survivors, it is estimated that based on report of symptoms, as many as 50% of them may develop post polio syndrome<sup>10</sup> and subsequently may benefit from a PT's therapeutic intervention services.

**The polio survivor population has been underserved by physical therapy.**

Some polio survivors have had no contact with a PT since their acute phase of polio. Others have seen several PTs and several physicians during their years of dealing with their puzzling and disturbing symptoms in their quest to find someone knowledgeable

about the late effects of polio and how physical therapy can adequately assist survivors in coping with these late effects. Often polio survivors in this latter category express significant frustration and even signs of depression.<sup>3,7,8</sup>

Polio survivors need thoughtful, knowledgeable, competent PTs who wish to treat them and have the expectation that treatment can yield valuable results. PTs who make their services known to polio survivors could open their practices to a niche market that other PT practitioners do not seek to serve.

## **THE PHYSICAL THERAPY REFERRAL FOR POLIO SURVIVORS**

It is well known that in many states, PTs are permitted to examine, or to examine and treat patients without referrals from physicians. In a few states, referrals from physicians are still required by law. In either case, almost always a referral from a physician to a PT is needed for third party payers to cover physical therapy services. It is important that polio survivors be fully assessed medically to rule out other possible causative factors besides their polio history that may be contributing to their symptoms. PTs should be informed enough about medical resources in their geographic areas to act in advisory capacities to polio survivors who are seeking referral to physicians knowledgeable about polio.

For people who live in relatively close proximity to one of the established post-polio clinics around the country, examination by a physician at one of these clinics is certainly ideal. A physician from one of these clinics can thoroughly assess a patient and write a referral for physical therapy. However, if polio survivors do not live in close proximity to one of these established post-polio clinics, or must wait a long time to obtain an appointment at such a clinic, referrals from their primary care physicians can certainly be appropriate.

Primary care physicians are sometimes hesitant to write physical therapy referrals for polio survivors because of lack of knowl-

edge about polio and the late effects of polio. PTs should act as advisors to physicians regarding the late effects of polio and the need to provide a thorough medical examination of the patient. If a physician feels comfortable making the diagnosis of the "late effects of polio", this diagnosis, of course, should be written on the referral. Otherwise, descriptive diagnoses such as "postural dysfunction," "back pain," "gait disturbance" or "muscle weakness," etc., may be listed. Often, third party payers are familiar with diagnoses such as these that describe the particular impairments for which the patient is seeking treatment; thus they may be more likely to reimburse for physical therapy services provided for such diagnoses, rather than for the less familiar, "late effects of polio."

PTs should also act as advisors to primary care physicians for ongoing needs that polio survivors may develop. For example, PTs may advise primary care physicians regarding patients' orthotic needs, requirements for durable medical equipment, etc.

## **REASONABLE EXPECTATIONS**

Every polio survivor comes to health care providers initially with the hope – whether clearly evident or secretly buried – that someone will be able to "make me as I was at my peak recovery from polio." Initially, survivors usually are hesitant to assimilate recommendations about lifestyle modifications, equipment options, etc. They usually are quite fearful of anything that remotely reminds them of their polio past.

Consenting to use a device that they may previously have relied on earlier in life – or that they had refused earlier in life – usually symbolizes to them the act of "giving up."<sup>3,7,8</sup>

Survivors and their friends/families/caregivers must be educated about the late effects of polio with sensitivity. Suggestions for treatment options must be made with equal sensitivity. PTs may wish to emphasize to polio survivors that the only true act of "giving up" is the decision to refuse to participate in activities and retreating from

society. Any suggestions for changes in lifestyle or use of equipment should be viewed as recommendations for how to "get on with life." PTs should encourage survivors to attempt to look at these suggestions as methods of continuing their participation in life to the fullest extent possible.

Reasonable goals that may be possible to achieve via physical therapy intervention can include the following. However, as with any patient, none of the goals should be attempted without the survivor's consent. In order for treatment intervention to be successful, survivors, as well as their families and significant others, must all lend their full support and cooperation to participating in treatment.

- pain reduction
- edema reduction
- improved skin integrity
- improved endurance for activity
- improved ROM
- improved ability to move in bed/transfer
- stabilization of balance/gait
- possible reduction of rate of strength loss and improved ability to use existing strength; possible small gains in strength

Polio survivors' bodies are usually sensitive to even subtle changes. Sometimes small interventions result in huge positive benefits. For example, the provision of a ¼ inch internal heel lift in one shoe may be enough to greatly minimize low back pain. Other times small interventions result in negative outcomes. For example, stabilizing the pelvis with a low back support to minimize back pain may negate the patient being able to use the pelvis to initiate swing phase of gait in the presence of weak hip flexors. This may render the patient essentially non-ambulatory. The solution to the back pain may need to be as dramatic as use of a motorized wheelchair or scooter.

The "take home message" of these stories is that PTs should assess their treatment recommendations and the potential consequences of these recommendations careful-

ly. PTs should take every precaution to avoid causing secondary physical problems or undue emotional stress in their patients who are polio survivors.

## **WHAT SHOULD A PHYSICAL THERAPY EXAMINATION FOR POLIO SURVIVORS ENTAIL, AND HOW SHOULD THE RESULTS BE INCORPORATED INTO TREATMENT?**

### **Comprehensiveness**

In physical therapy school, students are taught all the components of the following type of examination. They are instructed to complete all of the components of the following examination on any body part that is affected by problems that the patient is being sent to physical therapy for.

Because polio is a systemic disease that initially invades the body from head to toe, polio survivors are at risk for impairments (and possible subsequent functional limitations) of any visible body part and potentially of many body systems. Therefore it follows that all the components of a physical therapy examination should be performed on all body parts for polio survivors. Most polio survivors envision that certain of their body parts were minimally or not at all affected by polio. It is very helpful to survivors when a PT can examine the whole body and possibly confirm that certain body parts were relatively spared from dysfunction. Conversely, the PT may need to truthfully point out to survivors that certain body parts exhibit more impairment than they thought. Such a revelation can be quite disconcerting to polio survivors, and PTs must discuss such findings carefully, completely, and with sensitivity, so as not to overwhelm patients.

Comprehensive examinations of this type can take as long as three to four hours spread out over three to four visits. Some PT departments are not set up to allow this much time per patient. If PTs are unable to perform examinations of this type, they should refer polio survivors to other colleagues who are free to do so.

After an examination such as that described below, the PT should sit down with the survivor (and family or other significant people, if the survivor so desires) to explain the results. A thorough explanation with a proposal of treatment options can take up to an hour. The survivor and others in attendance should be encouraged to ask questions they may have regarding the results and the proposed treatment options. The survivor should then decide which options to pursue.

The therapist should compose a report to send to the referring physician detailing the specifics of the examination and the therapist's recommendations. The therapist should work in conjunction with the physician to implement a program based on the results of the examination.

### **Interview Prior To Physical Examination**

*The Guide to Physical Therapist Practice* delineates a comprehensive list of topics to cover during the patient interview. These include the following, noted with particular emphasis on aspects applicable to the polio survivor:

- **General demographics**
- **Complete medical/surgical history**
  - Data obtained from patient/significant others
  - Data obtained from tests and measures performed by other health professionals
  - Family history
- **Growth and developmental history**

Although this category is important to investigate in all polio survivors, all aspects of this category are of particular importance to examine in polio survivors who became disabled as children. Therapists should be especially sensitive to the impact of the disease on the psychosocial development of the polio survivor. For all patients, therapists should note the highest physical capacity achieved at maximum recovery from polio.

- **Vocational/social history**
  - Past and current work ability
  - Social habits, including behavioral health risks, level of fitness, leisure activities
  - Cultural beliefs/behaviors
  
  - Family/caregiver resources; support systems
  - Social interactions/activities
- **Living environment**
- **History of current condition**
  - What factors have led to the survivor seeking help?
  - What is the survivor's perception of function in each major body part?
  - Has any decline of function occurred in recent years?
- **Health status**
  - General health perception
  - Are there symptomatic areas of pain?
  - Are there body parts at circulatory risk, i.e., is there cold intolerance, presence of swelling, discoloration of skin, etc.?
  - Are there any problems with sleeping?
  - Are there any problems with breathing or swallowing?
- **Functional status and activity level**
  - What activities are common for the survivor on a regular basis?
  - How is endurance for activities?
  - How are the survivor's abilities to move in bed, transfer, or ambulate?
  - Does the survivor use any special equipment? (i.e., braces, crutches, canes, wheelchairs, feeding devices, breathing devices, etc.) Have these devices changed in recent years? Are there any problems using the current equipment?

Of course, information uncovered during the patient interview should guide the therapist in implementing the physical examination, creating a list of impairments and functional limitations, fabricating goals and suggesting treatment interventions.

## Specific Tests and Measures and Recommendations for Treatment Intervention

Just as with the specifics regarding topics to include in the patient interview, *The Guide to Physical Therapist Practice* is specific and comprehensive with regard to its recommendations for categories of tests and measures to include in the physical examination of the patient. Please note that the categories described below are in alphabetical order, as they are listed in *The Guide to Physical Therapist Practice*; as such, the order of listing does not necessarily reflect the order in which a therapist would choose to implement the tests and measures.

### Aerobic Capacity and Endurance

*(Inclusive of Exam of Ventilation, Respiration and Circulation)*

**EXAMINATION:** The components of a basic cardiopulmonary examination should be under consideration throughout the physical assessment. The survivor's resting blood pressure, heart rate and respiratory rate should be evaluated. Peripheral pulses should be assessed. Some description should be made of the survivor's ability to adequately oxygenate each lung lobe and of the survivor's ability to cough and breathe deeply. In conjunction with coughing and deep breathing, a description of the use of abdominal muscles and intercostals for force should be included. The PT should also describe any abnormal use of the neck or trunk muscles for breathing purposes. Examination using a pulse oximeter can be very helpful.

During the rest of the physical examination, repeat measurements of the vital signs should be periodically recorded to let the therapist, survivor, and attending physician know how the survivor responds to activity such as is conducted during a physical examination. The PT should assess whether any autonomic response to positional changes occurs.

If vital sign response to low-level activity is within normal limits, therapists may choose to give the survivor a modified aerobic exercise test using a treadmill or a stationary upper extremity or lower extremity cycle. (Of course, if the survivor has a history of cardiopulmonary disease, it is not wise to do a test of this kind without proper cardiopulmonary monitoring in an office with access to a physician.) An 8 to 12 minute test of this type (during which, vitals are monitored typically every two minutes) may be performed to determine how the survivor responds to this kind of more vigorous, sustained activity, as compared to the intermittent, lower-level activity performed in the rest of the examination.

A cautionary note is inserted here regarding the fact that performing a sustained aerobic activity before knowing the survivor's true muscle strength as noted below under "MUSCLE PERFORMANCE" could be hazardous. Survivors can overexert themselves in the cardiopulmonary testing and suffer pain, muscle tremors, or temporarily increased muscle weakness as a result afterwards.

**TREATMENT:** If cardiopulmonary abnormalities are found in the examination, vital signs should be monitored during any treatment involving exercise. Therapists should also teach polio survivors to monitor their own vital signs and signs of exertion. Almost all polio survivors will show a generalized deconditioned cardiopulmonary response to exercise.<sup>12,15</sup> They can benefit from instruction in work simplification techniques, energy conservation techniques, body mechanics, etc., to reduce their daily cardiopulmonary demands. Teaching the concepts of pacing of activities can also equip polio survivors to conserve their cardiopulmonary endurance.<sup>22,23</sup> Referral to other professionals for more formal cardiopulmonary testing may be needed.

If survivors are medically cleared for cleared for cardiopulmonary pathology that precludes aerobic exercise, therapists may consider initiating with them a cautious program aimed at achieving aerobic condition-

ing. Please see below under **MUSCLE PERFORMANCE** for specifics.

All polio survivors, even in the absence of true pulmonary diagnoses, can benefit from instruction in abdominal-diaphragmatic and segmental breathing. Many survivors have trunk/abdominal weakness that results in fascial adherence and tissue immobility. Proper breathing techniques can help address these problems. Using these techniques will also help survivors who have postural impairments that impair oxygenation. Soft tissue mobilization or manual costovertebral mobilization may additionally be helpful. Finally, normalizing respiration is known to reflexively activate the parasympathetic nervous system, thereby facilitating the relaxation response, something any patient with the stress of dealing with disability can benefit from.

Of course, for survivors who do have true respiratory impairment, learning all the above can be potentially life-saving or life prolonging. These survivors should also learn assisted coughing techniques. If necessary due to the severity of the pulmonary impairment, and the patient does not already know the technique, instruction in glossopharyngeal breathing may be useful.

### **Anthropometric Characteristics**

**EXAMINATION:** It may also be necessary to measure limb length and girth. Measurement of height/weight/percent body fat may yield useful information. Therapists should always keep in mind the therapeutic implications of functioning in life with a less than normal ratio of lean muscle mass to total body weight.

Polio survivors may have had damage from their acute polio episode to the sympathetic nervous system, resulting in impaired ability for peripheral vasoconstriction.<sup>12</sup> This puts them at risk for peripheral venous disease and peripheral edema. Therefore, the therapist should assess for the presence of edema by palpating and taking volume or girth measurements, as appropriate.

**TREATMENT:** The PT should instruct in edema control measures, skin care, turning schedules, skin inspection, etc. In some cases, the use of pneumatic pumps or pressure gradient garments is helpful in controlling edema or improving skin quality. Referrals to other professionals for assistance in weight loss may be necessary.

As mentioned earlier, use of internal or external shoe lifts to correct leg length discrepancies may be helpful in alleviating pain or minimizing postural impairments. Shoe lifts should be implemented gradually in incremental amounts so the patient's tolerance can gradually be increased and assessed.

### **Arousal, Attention, Cognition**

**EXAMINATION:** PTs should assess these parameters carefully if they suspect that high stress or hypoventilation are present to such a degree that arousal, attention or cognition may be significantly affected. PTs should assess factors that influence the patient's motivation level. PTs should also assess arousal, attention and cognition to screen for the possible influence of disorders other than polio, since polio survivors certainly are not immune to other pathologies.

Impairments involving arousal, attention and cognition are also related to the complaints of fatigue that many polio survivors experience. Bruno<sup>27</sup> postulates that damage to the reticular activating system during acute polio infection may be responsible for the exhaustion reported by many polio survivors who also complain of problems with mental alertness and concentration.

**TREATMENT:** PTs should refer patients back to their physicians for further diagnostic testing if impairments are identified in the above parameters of function. Other health professionals may assist with helping patients improve motivation if needed. Therapists should implement the interventions noted above under **AEROBIC CAPACITY AND ENDURANCE** if hypoventilation is suspected or if the PT suspects that problems with arousal, attention and cognition are related to fatigue.

## Assistive And Adaptive Devices, Including Orthotic, Protective and Supportive Devices

**EXAMINATION:** Survivors should bring all special equipment they have used in the preceding five years to the examination, if possible. The PT should check the fit, alignment, and safety of the equipment. The PT should observe the survivor's and/or caregiver's ability to use and care for this equipment, as well as evaluate the effectiveness of the equipment for its intended purpose.

**TREATMENT:** The PT should comment on whether modification of the equipment may be helpful or whether alternative devices may be necessary. Referral to other health professionals may be necessary for assistance in repairing or modifying existing equipment or in obtaining new or alternate equipment.

## Community and Work (Job/School/Play) Integration or Reintegration (Including ADL)

**EXAMINATION:** Many polio survivors complain of difficulty maintaining their roles both within and outside the home. The PT should examine as closely as necessary how the survivor functions in his various roles. Close examination sometimes reveals significantly worse function while attempting to perform tasks associated with role maintenance than is evident in the protected environment of the PT clinic.

**TREATMENT:** The PT should intervene in whatever manner is appropriate to assist the patient to improve function in daily life. If the polio survivor permits, sometimes communication with employers, instructors, or friends/others results in significant cooperation to assist patients to function more effectively in their various roles. Sometimes it is necessary to draw the survivor's attention to the factors that contribute to reduced functioning in various roles and to then suggest treatment interventions that may result in improved functioning. Improved functioning may result from such simple things as pacing of activities and using work simplifi-

cation techniques, along with correct ergonomic principles and body mechanics.<sup>11,12,23</sup>

At other times, it may be necessary to inform the survivor that continuing to attempt to function in a given role, regardless of whatever is done to make functioning in that role easier, puts the patient at risk for developing further impairments and possible further functional limitations. The PT may need to assist the survivor to seek fulfillment in alternate roles, including possibly alternate vocational pursuits or even retirement from the work force. Certainly, often referral to other professionals is necessary to assist the patient to effectively adapt to changed methods of fulfilling existing roles or to adapt to functioning in new roles.

## Cranial Nerve Integrity

**EXAMINATION:** Therapists should assess function of all the cranial nerves carefully with standard techniques. Doing so may shed light on the source of some seemingly odd complaints that the patient has. Identification of or confirmation of oral-facial weakness may lead to establishing treatment goals related to these strength impairments.

**TREATMENT:** Often identification of problems associated with cranial nerve integrity requires referral to other health professionals for implementation of appropriate intervention techniques. Sometimes PTs can address muscle weakness in treatment. Certainly PTs should educate patients on methods to avoid secondary problems that could result from impairments related to lack of cranial nerve integrity. If impairments related to lack of cranial nerve integrity are uncovered, PTs should be especially vigilant about screening for bulbar involvement during the ventilatory, respiratory, and circulatory examination.

## Environmental, Home, and Work (Job/School/Play) Barriers

**EXAMINATION:** PTs can play an important role in inspecting and analyzing physical space used by the polio survivor. Thorough attention to all spaces frequently used by the patient can yield valuable information.

**TREATMENT:** Therapists can make recommendations for alteration of home, work, or school environments to minimize barriers to function. With the survivor's permission, PTs should closely communicate with persons within these environments with whom the polio survivor functions regularly to achieve optimal results in improving the polio survivor's ability to physically function.

## Ergonomics and Body Mechanics

**EXAMINATION:** The therapist should analyze polio survivors' abilities to safely perform the activities common to their daily lives. Sometimes using videotape analysis is helpful in having survivors realize the extent to which they are using abnormal patterns that are contributing to (or could result in) pain or injury. If videotape analysis is used, therapists should be sensitive to the fact that watching images of themselves can be very threatening to polio survivors. Some survivors cope with their altered bodies by never looking at the impaired body parts in the mirror. Therefore, PTs should approach the topic of videotaping very carefully.

**TREATMENT:** PTs should teach polio survivors (and their significant others, if given permission) the principles of body mechanics, ergonomics, and work simplification techniques. Therapists should help patients to apply these principles to as many activities as possible.

## Gait, Locomotion and Balance

**EXAMINATION:** Again, videotape analysis may be very helpful in assessing these parameters, if therapists are attentive to the cautions previously noted. If polio survivors are able to ambulate, it is important to

examine their gait on level surfaces, inclines, curbs, and stairs if possible. While sophisticated gait analysis equipment may be available and certainly helpful in some clinics, simple observational gait analysis can also yield significant examination information. Examination using standardized gait, balance, or locomotion profiles may also be useful.

Examination of a person's gait is often emotionally traumatic for polio survivors. Survivors are surprised and sometimes dismayed when confronted with the deficient quality of their gait. Sometimes it is the examination of gait that is the deciding factor in a polio survivor's mind as to whether or not to accept assistance from a PT or whether or not to consider positively suggestions for use of assistive devices.

The biomechanic stress resulting on the survivor's body from abnormal gait must be pointed out. For example:

- the stress on the back during a profound forward/sideways/backward leaning of the trunk;
- the repetitive stress on the lower extremity joints and muscles that results from severe genu recurvatum;
- trauma to the upper extremities resulting from using crutches, etc.

The PT may identify how a person may be compensating with one muscle for weakness in another muscle. Correlating the strength, ROM and pain examinations with the gait examination is helpful to assist the polio survivor to recognize compromises in safety and to identify risk for falls.

Because of muscle weakness, often endurance for ambulation is compromised in polio survivors. Therefore, a thorough gait exam should include observations of how, if at all, the survivor's gait and cardiopulmonary function changes as the patient fatigues. Fewer functioning muscle fibers means that each fiber has to take a turn at contracting more often than it would otherwise, thus leading to earlier fatigue than would otherwise be expected. Additionally, studies have indicated that

because of muscle overuse, in polio survivors, there is a transformation of Type II muscle fibers to Type I fibers.<sup>13,14</sup> This phenomenon results in fewer muscle fibers to sustain repetitious movement during gait.

If survivors are unable to ambulate, the PT should assess their ability to use wheelchairs or scooters. Again, observation on more than flat surfaces is helpful. Therapists should assist survivors who use manual wheelchairs to assess the biomechanic trauma that ultimately results from years of propelling chairs with the upper extremities. Just as with the examination of gait, correlating the strength, ROM and pain examinations with the alternative locomotion examination is helpful in assisting the survivor to recognize impairments that may lead to functional limitations.

**TREATMENT:** If most lower extremity/trunk muscles grade 4-/5 or greater, low-level exercise (see below) and instruction in gait normalization may be sufficient to significantly improve gait. For significantly weaker muscles, orthotic devices or canes/crutches, etc., might be recommended. (Note precautions under POSTURE.)

Often upper body weakness or pain is so pronounced that use of assistive devices for gait must be discouraged. To prevent secondary upper body complications and to conserve energy, it is also usually wise to discourage the use of manual wheelchairs. Therefore, for persons having significant problems with gait or pain with locomotion, encouraging the use of power wheelchairs or scooters is essential.

The PT may also point out the energy expenditure necessary for ambulation or propulsion of manual wheelchairs and the implications of this energy expenditure on fatigue and cardiopulmonary functioning. It is essential for therapists to also educate the polio survivor to realistically understand the severe risk to continued independence, physical health, and even life itself that falls impose.

Shumway-Cook 25 cites the following minimum standards to retain safe independence in community ambulation:

- Ability to ambulate 1000 feet without excessive fatigue.
- Ability to achieve a speed of 80 meters/minute for 13-27 meters to cross a street in the standard time provided by stoplights.
- Ability to negotiate 7"-8" curbs independently with or without assistive devices
- Ability to turn the head while walking without loss of balance
- Ability to recover stability in response to unexpected challenges to balance
- Ability to avoid loss of balance in response to expected challenges.

### Integumentary Integrity

**EXAMINATION:** A PT should do at least a gross assessment of the easily visible skin. The PT should comment on the presence of edema, skin color, temperature, and quality (scaly, moist, dry, thin, etc.). As mentioned earlier, some polio survivors have impaired ability for peripheral vasoconstriction, which puts them at risk for skin problems. They also often complain of cold intolerance as a result of this impairment.<sup>12</sup>

The PT should pay special attention to any areas of skin in contact with assistive and adaptive devices. If the survivor sits the majority of the time, the PT may wish to request permission to look at the skin over the buttocks. The PT should also assess any other positions or postures that may result in a threat to skin integrity.

**TREATMENT:** Some of the same interventions noted above under ANTHROPOMETRIC CHARACTERISTICS are appropriate here. Specifically, the PT should instruct in edema prevention/control measures, skin care, turning schedules, skin inspection, etc. In some cases, the use of pneumatic pumps or pressure gradient garments is helpful in controlling edema or improving skin quality. The use of the principles of pacing activities can again be used, this time as a means of minimizing time spent in activities or postures that put the skin at risk for trauma.

## Joint Integrity and Mobility

**EXAMINATION:** The therapist should assess whether joints are hypomobile or hypermobile, as well as whether there is any swelling/inflammation. The chronic use of abnormal movement patterns to accomplish daily activities results in polio survivors having a high incidence of joint problems.

**TREATMENT:** Treatment of joint integrity problems should be performed cautiously and conservatively. If mild laxity is present, the therapist should instruct the patient in joint protection techniques, including the use of normal movement patterns to the degree that they are possible. If muscles surrounding a lax joint are tolerant of strengthening activities, gentle exercises should be initiated (see below under MUSCLE PERFORMANCE) with the goal of attempting to increase dynamic support for the joint. More severe problems may require the use of orthotic devices.

Certainly hypomobility due to surgical fusion is not an indication for PT intervention. Additionally, hypomobility of joints may have developed to compensate for the lack of stability normally provided by strong muscles. Thus it may be inappropriate to initiate joint mobilization procedures. If joint mobilization does seem to be indicated, therapists may also need to recommend orthotic devices if weak muscles surround the affected joint.

## Motor Function (Motor Control and Motor Learning) and Muscle Performance (Including Strength, Power, and Endurance)

**EXAMINATION:** As noted above for many of the other items examined, it is important that polio survivors be evaluated by physicians for factors that may be contributing to new strength problems other than their history of polio. If this type of medical testing has not been done, therapists should refer patients to the appropriate medical sources to undergo additional diagnostic examination.

Physical therapy examination should include analysis of movement, dexterity and coordination. Many polio survivors have difficulty with slow, smooth, coordinated movement. In the presence of weakness, they often move quickly to take advantage of momentum. Alternately, they may have incurred damage during their acute polio infection to brain structures responsible for smooth, coordinated movement.<sup>5,6</sup> They may give the appearance of the stereotypical "bulls in the china shop." In fact, many polio survivors describe themselves as, "clumsy," or they report that others have labeled them as "clumsy." Their movement patterns may contribute to propensity for injury or to easy muscle fatigue.

Close, specific testing of the strength of as many skeletal muscles as possible is important. Therapists who are trained to do so should include examination of the strength of the pelvic floor muscles. Gross testing of muscle groups is not appropriate in polio survivors. Specific testing is necessary because a hallmark of polio was the fact that it skipped about the body in seemingly random fashion, affecting parts of a muscle here and parts of a muscle there, sparing parts of muscles here and sparing parts of muscles there. The specific manual muscle testing protocol advocated by Florence P. Kendall, PT, is best suited to test polio survivors.<sup>9</sup> Testing with Kendall's methods is easiest if the survivor is clothed in a manner to allow the examiner to see the muscles being tested.

Some clinicians think that muscle strength testing should be done only with sophisticated exercise equipment. While certain muscles in polio survivors may lend themselves to testing with such equipment, it would be very difficult, indeed to test all the skeletal muscles in this manner.

Additionally, many polio survivors with significantly compromised strength cannot be adequately tested by machines such as this due to using abnormal substitutive movements that can potentially cause harm.

Using a hand-held dynamometer to augment Kendall's manual muscle testing technique can yield additional valuable informa-

tion to a manual muscle test. For example, one muscle that grades 3+ on a 1 to 5 scale might be capable of producing only 6 lbs. of force (as measured on a dynamometer) while another muscle grading 3+/5 might be capable of producing as much as 13 lbs. of force. A difference such as this has implications for recommendations for exercise, activity, and assistive devices.

A word of explanation here in regards to the grading of muscles is appropriate. Kendall lists a descriptive scale (normal, good, etc.), a 1-10 scale, and a 1-5 scale. The majority of clinicians use the 1-5 scale to label the grades of muscles, and physicians who are familiar with muscle grading relate well to the 1-5 scale. Therefore, the 1-5 grading scale is the one recommended.

On a 1 to 5 grading scale, a grade of 3 would be approximately 50%. However, it is important for health professionals and polio survivors to understand the concepts documented in 1961 by Beasely.<sup>4</sup> After studying cadavers of polio survivors, he found that polio survivors' muscle grades do not correspond with the above ratios. His study cited the fact that the number of functioning motor fibers in polio survivors with a given muscle test grade is significantly less than would be expected from simple percentage calculations.

**Muscle Grade in Polio Survivors % of Functioning Muscle Fibers in Muscles Having This Muscle Grade**

5	53.5% to 100%
4	42.5%
3+	9.5%
3	9.1%
3-	6.3%
2	2.5%
2-	1.9%
1	1.0%
0	0.7%

Given Beasely's study, it is important for polio survivors to understand that even though their best muscles may grade in the vicinity of 3+ on the 5-point strength scale,

their percentage of normal muscle strength may only be 20%. Recommendations for activity and exercise must then be correlated with this limited percentage of normal strength.

Another factor important to consider in strength testing is endurance.<sup>17</sup> If the survivors can tolerate it, examiners should ask them to attempt three to four trials of a given motion before recording the final grade. Not infrequently, the first trial is significantly better than the third or fourth trial. In fact, in some cases a survivor may be unable to even initiate a movement after three or four attempted repetitions. If a discrepancy of muscle grade is apparent on successive trials, the PT should record the value on the first trial, then the value on the third or fourth trial, and label them as such.

**TREATMENT:** Given all the factors above, there is a fair amount of controversy in the literature regarding the utility of treating strength impairments in polio survivors. Some sources say low-level, non-fatiguing exercise is helpful and indicated.<sup>11,12,20,21</sup> There is, however, definite danger in over-exercise. Some researchers have shown increased weakness to non-specific, intensive exercise.<sup>17</sup> A limitation of many of the research protocols that have studied exercise in polio survivors is that usually the response of only a few muscles or muscle groups have been studied. If exercise is to be effective in a polio survivor, it must be applied to all the skeletal muscles in some manner that is specific and appropriate for the individual.

Based on cautious application of the literature and based on my experience with treating approximately 100 polio survivors since 1982 (all of them for many months, and many of them for many years) I suggest the following recommendations for treatment of strength impairments:

- "Strengthening" exercise seems most useful in assisting survivors to learn more normal movement patterns.<sup>12</sup> While some actual strengthening may occur, survivors certainly seem better able to use their available strength as a result of exercising. In all the patients

for whom I have recommended "strengthening" exercises who have been compliant with their exercise programs over time (N= ~50), at minimum, their muscle grades have remained stable over at least a two-year period. I have followed a few of these patients over a period of five years, and their muscle grades have still remained stable. In a few cases, certain muscles have shown improvement of one to one half grade in strength.

- All "strengthening" programs should be implemented only in the context of a person's ventilatory, respiratory, and circulatory function.<sup>11,12,15,16,18-21</sup>
- If a person cannot perform a given motion without substitution patterns, it is rarely useful to attempt to "strengthen" muscles performing that motion. Doing so would only further stress over-worked muscles and further reinforce abnormal movement patterns.
- If the muscles of a given extremity grade 3+/5 or better for 3 to 4 repetitions without substitution patterns, they may respond to a low-level "strengthening" program. Characteristics of this program designed for home use might include:
  - 0-3 lbs. of free weight resistance (Some professionals prefer to use exercise band resistance if polio survivors can be taught to perform the exercises correctly without substitution.)
  - Hold count of 2-5 seconds followed by 2-5 seconds' rest (this allows for adequate rotation of muscle fiber firing without fatigue)
  - 2-5 repetitions performed 2-3 times per week. Avoid muscle fatigue, pain or quivering at all costs. Many research reports advocate encouraging progression to 30 repetitions. I have never had a polio survivor who was able to get beyond 10 repetitions of any given exercise without compromising endurance for other activities or without incurring pain.
  - Emphasis on use of abdominal-diaphragmatic breathing with

sustained exhalation as a means of eliminating Valsalva and activating abdominals to stabilize the trunk/pelvis during exercise.

- Emphasis on "setting" scapular stabilizer muscles during all attempts at upper quarter exercise.
- If the muscles of a given extremity grade 3+/5 or better without substitution patterns BUT the extremity has compensated for years for a significantly weaker contralateral extremity, in general, it should not be stressed by further attempts at "strengthening" exercise.<sup>11</sup> This is especially true in the upper extremities. Attempts should be made, however, to teach normalization of movement patterns, e.g., normal scapulohumeral rhythm, pelvic-trunk disassociation, etc.
- Isometric exercise may be useful for muscles grading 2-3/5 to promote circulation in that body part. Isometrics may also help retain some joint stability in body parts with this degree of weakness.
- Low level aerobics may be useful for people 18-21.
  - without severe cardiopulmonary compromise
  - who have either both upper extremities grading 3+/5 or greater or both lower extremities grading 3+/5 or greater
  - having adequate trunk strength.

Lap swimming or using a cycle ergometer for upper extremity/lower extremity biking seems to be best tolerated. In general, 15 to 20 minutes total aerobics (including warm-up/cool down time) 3 times weekly is the maximum recommended. Often interspersing 2-5 minute bouts of exercise with one minute of rest assists polio survivors to avoid muscle fatigue, pain or quivering at all costs.<sup>20</sup> Minimal resistance for biking is recommended at speeds no greater than 30 MPH. Walking is less often recommended because of the trauma produced by gait abnormalities.

Yarnell recommends initiating aerobic exercise at a level that is 20% of a polio survivor's maximum capability.<sup>21</sup> As the polio survivors tolerate, they should then increase their intensity of aerobic work by 10% per month.

Survivors should recognize that, in general, weak muscles have lower endurance than strong muscles and are more prone than strong muscles to developing pain syndromes and repetitive motion injuries. With each injury, a weak muscle has the potential for losing further function and putting the survivor at risk for loss of independence. If a person desires to avoid pain and further impairment and possible functional limitations, consideration should be given to properly splinting or bracing weak muscles.

Sometimes physicians or survivors are reluctant to recommend or accept orthotic intervention because they fear that, "whatever strength is there will decline." People who are concerned about this potential problem must remember that within a few repetitions of any activity, a very weak muscle usually becomes only weaker. Implementing a simple program of isometric exercise or anti-gravity exercise without weighted resistance will go a long way towards retaining the existing strength, even in the presence of orthotic support. At all costs, remember that the trade-off for not using adequate orthotic support in the presence of significant weakness is further pain and dysfunction.

## Neuromotor Development and Sensory Integration

### EXAMINATION AND TREATMENT:

Many of the parameters listed in this section in *The Guide to Physical Therapist Practice* are duplicative with those in other areas of tests and measures. Areas not duplicated include

- analysis of voluntary and involuntary movement;
- analysis of reflex movement patterns;
- analysis of sensory integration tests;

- assessment of behavioral response;
- assessment of gross/fine motor skills.

In the absence of significant neurological diagnoses beyond that of polio, some of these parameters of measurement may be of limited utility in the polio survivor.

## Pain

### EXAMINATION AND TREATMENT:

The PT should evaluate the presence of pain and use the results of the rest of the examination to determine contributing factors to the pain. Sometimes correction of posture, movement patterns, ROM, etc. can decrease pain. Other times use of orthotic/assistive devices, reduction of ambulation time, or pacing of activity will reduce pain.

If polio survivors experience pain secondary to acute injuries, often treatment with traditional physical therapy physical agents is helpful. However, physical agents may be less effective for chronic pain. Chronic pain in polio survivors that is not sufficiently minimized with the correction of biomechanical problems often responds to techniques such as myofascial release, soft tissue mobilization, craniosacral therapy, etc.

## Posture

**EXAMINATION:** As with gross strength testing, gross posture assessment yields little useful information. However, using the results of a very specific posture and strength assessment can be the basis for important recommendations for assistive devices. Readers are again referred to Kendall's text<sup>9</sup> for an excellent, detailed description of posture examination.

Posture assessment should encompass examination of bone angulation and length and joint abnormality, along with the more traditional concept of posture that includes alignment of the major body parts with one another. It is important to evaluate both sitting and standing posture. It is important to make some conjecture on the posture examination as to whether a specific pos-

ture deviation is a fixed, permanent type of deformity or a flexible one that might be possible to change with appropriate intervention.

**TREATMENT:** Addressing posture can be very helpful in minimizing or preventing pain and increasing endurance for sitting/standing/walking. Sometimes simple instructions in posture correction techniques, both in sitting and standing, are helpful. Other times, selective strengthening exercises are helpful in normalizing posture.

In the presence of more pronounced weakness, foot, trunk, or extremity orthoses may be necessary. Correction of leg length (even slight differences) may make the difference between the presence of pain and being pain-free. Devices that assist in achieving neutral sitting postures may be useful.

### Range of Motion (ROM) (Including Muscle Length)

**EXAMINATION:** ROM tests should be performed on all major joints in all planes, including the spine. Special consideration should be given to muscle length tests. Kendall's text<sup>9</sup> is again a very good reference for muscle length testing. These measurements should be taken accurately with a goniometer. Simply "eyeballing" the available movement at the joints is not acceptable.

**TREATMENT:** The importance of adequate ROM in polio survivors cannot be overstressed. It is well-documented by people active in the acute phase of polio treatment during the epidemics of the 20th century that muscles affected by polio easily become "stiff", and must undergo continual stretching to maintain adequate flexibility.<sup>12,20 26</sup> Without adequate flexibility, it becomes very difficult for a person to use whatever strength is available in that body part. Poor flexibility can also cause pain and deformity.

In general, the "normal" ROM values (although the norms vary considerably depending on the source consulted) should

be firm targets to shoot for in most survivors to assure as functional a biomechanical force at joints as possible. Certainly surgeries, arthritis or bony deformities may impair a person's ability to achieve "normal" ROM. However, a good passive stretching program performed by a friend or family member several times weekly goes a long way towards minimizing pain and normalizing movement patterns. Self-stretching is usually difficult to perform due to pain, weakness and substitution patterns.

In certain cases amongst polio survivors, some degree of "tightness" in certain muscles may assist function. For example, in a survivor with weak wrist and finger flexors, a certain degree of tightness selectively permitted in these muscle groups can allow the survivor to have a tenodesis grip if wrist extensors have functional strength. Another example might be if a survivor has weak quadriceps muscles and weak gluteal muscles, a certain amount of tightness in the hip adductor group may make it easier for the survivor to retain knee extension. However, these examples are quite variable and extremely dependent on all the symptoms that present in a given survivor. Only with practice can a well-trained therapist discern if certain areas of selected tightness might be adaptive for a particular person.

### Reflex Integrity

#### EXAMINATION AND TREATMENT:

The therapist should assess for the integrity of normal reflexes and for the presence of abnormal reflexes. Treatment interventions should reflect accommodation for any impairments revealed in testing.

### Self-Care and Home Management (including ADL and IADL)

**EXAMINATION AND TREATMENT:** The therapist can evaluate patient self-reports, reports of significant others, daily activity logs, etc. The PT may also wish to use ADL or IADL scales or indices to examine the patient's abilities. A home visit (if not already treating the patient in the home)

can be quite revealing in uncovering the polio survivor's use of abnormal movement patterns that may be pain or injury producing or that may put the patient at risk for secondary disability.

During this segment of the examination, the PT should look closely at the survivor's ability to move in bed and to transfer. The PT can then use this as a teaching time for offering suggestions as to positioning for comfort to minimize pain-producing or skin-irritating stress on body parts. Evaluating the survivor's ability to rise from a chair and to sit from standing can yield valuable information about how a person is able to functionally use his/her strength. This information can be used to point out painful biomechanic stresses on the body that result from the methods used and to suggest possible alternative movement patterns or assistive devices that may be helpful (e.g., lift chair, tub seat, etc.).

### Sensory Integrity (Including Proprioception and Kinesthesia)

**EXAMINATION AND TREATMENT:** As a rule, polio survivors do not have impairments in combined cortical sensations or superficial sensations as a result of their acute polio. However, they certainly may have acquired sensory impairments from other pathologies, and it is also important to perform a gross screen of their vision and hearing. Treatment interventions should reflect accommodation for any impairments revealed in testing.

### Summary

Physical therapists can offer valuable comprehensive evaluative services to polio survivors. Based on the results of the examination, treatment plans may be developed and implemented that may significantly improve the quality of life for polio survivors.

Physical therapists can also serve as educators of both polio survivors and their referring physicians.

### References

1. American Physical Therapy Association. *Guide to Physical Therapist Practice*. American Physical Therapy Association, Alexandria, VA; 1999.
2. Trojan DA and Cashman NR. *Current Trends in Post Poliomyelitis Syndrome*. NY, NY: Milestone Medical Communications; 1996.
3. Halstead LS. The lessons and legacies of polio. In: Halstead LS and Gimby G, eds. *Post Polio Syndrome*. St. Louis MO: Mosby; 1995.
4. Beasley W. Quantitative muscle testing principles and applications to research and clinical applications. *Archives of Physical Medicine and Rehabilitation*, 1961; 42: 398-425.
5. Bodian D and Howe HA. The pathology of early arrested and non-paralytic poliomyelitis. *Bulletin JHH*. 1941; 69: 135-146.
6. Bodian D. Poliomyelitis - neuropathologic observations in relation to motor symptoms. *JAMA*. 1947; 134(14): 1148-1154.
7. Gould T. *A Summer Plague: Polio and Its Survivors*. New Haven, CN: Yale University Press; 1995.
8. Munsat TL, ed. *Post-Polio Syndrome*. Boston: Butterworth-Heinemann; 1991.
9. Kendall FP, McCreary EK, Provance PG. *Muscles, Testing and Function*. 4th ed. Baltimore, MD: Williams and Wilkins; 1993.
10. Post-Polio Task Force. *Post-Polio Syndrome Slide Kit*. NY, NY: Bioscience Communications; 1999.
11. Dean E. Clinical decision making in the management of the late sequelae of poliomyelitis. *Phys Ther*. 1991;71: 752-761.
12. Smith LK and Mabry M. Poliomyelitis and the post polio syndrome. In: Umphred D, ed. *Neurological Rehabilitation*. 3rd. ed. St. Louis, MO: Mosby; 1995: 571-587.
13. Grimby G and Einarsson G. Muscle morphology with special reference to muscle strength in post-polio subjects. *Birth Defects*. 1987; 23: 265-274.
14. Grimby G and Einarsson G. Post-polio management. *Crit Rev Phys Rehabil Med*. 1991; 2: 189-200.
15. Birk T. Poliomyelitis and the post -polio syndrome: exercise capacities and adaptation - current research, future directions, and widespread applicability. *Medicine and Science in Sports and Exercise*. 1993. (continued)

16. Jones DR, Speier J, Canine K, Owen R, Stull, GA. Cardiopulmonary responses to aerobic training by patients with post-poliomyelitis sequelae. *JAMA*. 1989; 261: 3255-3258.
17. Peach P. Overwork weakness with evidence of muscle damage in a patient with residual paralysis from polio. *Arch Phys Med Rehabil*. 1990; 71: 248-250.
18. Dean E. and Ross J. Modified aerobic walking program: effect on patients with postpolio syndrome symptoms. *Arch Phys Med Rehabil*. 1988; 69: 1033-1038.
19. Dean E. and Ross J. Effect of modified aerobic training on movement energetics in polio survivors. *Orthopedics*. 1991; 14: 1243-1256.
20. Owens RR. Rehabilitation medicine: adding life to years. *West J Med*. 1991; 154: 557-558.
21. Yarnell SE. Non-fatiguing general conditioning exercise program. *Polio Network News*. 1991; 7: 3.
22. Agre JC and Rodriguez AA. Neuromuscular function in polio survivors. *Orthopedics*. 1991; 14: 1343-1347.
23. Young GR. Energy conservation, occupational therapy, and the treatment of post polio sequelae. *Orthopedics*. 1991; 14: 1233-1239.
24. Bruno RL, Johnson JC, Berman WS. Motor and sensory functioning with changing ambient temperature in post polio subjects. In: Halstead LS and Wiechers DO, eds. *Late Effects of Poliomyelitis*. Miami, FLA.: Symposia Foundation; 1985.
25. Shumway-Cook A and Woollacott MH. *Motor Control -- Theory and Practical Applications*. Philadelphia, PA.: Williams and Wilkins; 1995:316.
26. Cohen V. *Sister Kenny --The Woman Who Challenged the Doctors*. Minneapolis, MN: University of Minneapolis Press, 1975.
27. Bruno RL, Frick NM, Cohen J. Polioencephalitis and the Etiology of Post-Polio Sequelae. *Orthopedics*. 1991; 14: 1269-1276.