9 Pain Associated with Poliomyelitis

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Acute poliomyelitis has been successfully eradicated from the American continent since 1991 (1), but it still occurs in some parts of the world—most notably on the Asian subcontinent. In addition, every year in the United States eight to ten cases of acute poliomyelitis may occur in children after receiving the oral Sabin vaccine or, more exceptionally, in unvaccinated children who have been in close contact with a vaccinated person during the excretion phase of the live vaccine virus.

In 1987, there were an estimated 1.634 million survivors of poliomyelitis in United States, of which 0.641 million had residual paralysis (2). Patients with paralytic polio are at risk of developing post-poliomyelitis syndrome (PPS). The current prevalence of PPS is estimated at 100,000 to 300,000. Synonyms for PPS include *progressive neuromuscular disease*, *progressive post-polio muscular atrophy*, and *late sequelae of poliomyelitis*.

Post-polio symptoms were reported in the nineteenth century by Carriere and Lepine (3), and by Raymond and Charcot in 1875 (4). C.S. Potts described "progressive muscular atrophy" in 1903 (5). A few other publications before 1980 reported on the late effects of poliomyelitis as summarized (6) in the article by Alter et al. (1982).

Currently, in the United States, numerous survivors of poliomyelitis—contracted years ago—consult specialists in physical medicine and rehabilitation because of a constellation of symptoms, which are typical of PPS. PPS is a well recognized clinical entity, which has generated an abundance of scientific literature since the 1980s. (A recent Medline search yielded 220 references from 1981 to 2001; 34 of these publications included *pain* as a keyword.) The clinical manifestations of PPS are either very specific (e.g., increasing muscle weakness on previously affected or unaffected muscles, muscle fasciculations) or somewhat unspecified (e.g., fatigue, pain).

PAIN IN POLIOMYELITIS

During the acute stage of poliomyelitis, a great majority of patients present with excruciating pain, regardless of the extent of the muscle involvement. This pain occurs in practically all muscle groups, not only those that eventually become per-

Table 9.1. Prevalence of Joint and Muscle Pain in Subjects with Paralytic Poliomyelitis

	Joint Pain	Muscle Pain
Codd et al., 1985	74%	48%
Halstead et al., 1985	71%	71%
Chetwynd et al., 1993	60%	52%
Agre et al., 1989	77%	86%
Ramlow et al., 1992	42%	38%
Halstead et al., 1987	80%	79%

manently paralyzed, but in those that show complete or incomplete recovery of muscle function after the acute phase. Such pain probably is caused by severe myofasciitis secondary to the muscle breakdown that occurs as a result of anterior horn-cell neurolysis.

The pain reported by post-polio patients falls generally into two major pathophysiologic categories: myofascial, which can be elicited in various muscle groups; and arthritic, which is evident on active or passive mobilization of several joints (7). The initial Halstead et al. report on post-polio syndrome (1985) indicated that the prevalence of pain among polio survivors who responded to a questionnaire was 75.5 percent (8). Subsequent reports confirm that the types of pain experienced by post-polio patients are multiple, but mostly include diffuse muscle and joint pain (7,9–11). The prevalence of pain in patients with paralytic polio is reported from 42 percent to 80 percent (12–17) (see Table 9.1). In our experience with over 1,200 patients diagnosed with PPS at The Institute for Rehabilitation and Research (TIRR) Post-Polio Clinic, Houston, Texas, pain is reported by practically all patients.

Joint pain, muscle pain, muscle cramps, and back pain are common complaints in postpoliomyelitis patients (14–17). Knee and shoulder joint pains are common sites for pain in these patients. Pain in the joints is thought to be the result of degenerative arthritis, caused in part by age but more because of the long-standing asymmetrical load placed on specific joints because of the paresis or paralysis of scattered skeletal muscle groups. This paresis or paralysis is a permanent sequela of poliomyelitis. Frequently, pain is reported not only in the joints of the affected extremities but also in the low back area, the cervical column, and the sacroiliac joint. Much less common, because of the low prevalence of bulbar poliomyeltiis survivors, is pain in the temporo-mandibular joint which might be detected in those patients who in the acute phase of polio had involvement of the muscles of mastication innervated by the V cranial nerve.

JOINT PAIN

Knee Pain

Knee pain is more common in patients with genu recurvatum and in those who either have no orthoses or ill-fitting orthoses. Many of these patients have a lurching gait pattern, using a forward weight shift to move the center of gravity ante-

rior to the axis of the knee joint to assist with knee extension. In patients with foot drop, a side-to-side gait pattern is implemented to circumduct the leg. For example, in the study by Perry and Flemming (1985), 54 of 193 patients had problems with genu recurvatum (18). Of these 54 patients, 40 (74 percent) reported knee pain. This problem was essentially resolved with the fitting of an appropriate orthosis. Waring et al. (1989) reported similar findings. A significant reduction in knee pain is achieved in subjects receiving an appropriate orthosis (19).

Shoulder Pain

Agre et al. (1989) reported that about 30 percent of 79 patients with a history of poliomyelitis had shoulder pain (16). Patients with significant lower limb weakness, who either ambulate with assistive devices or use a wheelchair and need frequent in and out transfers, are more prone to shoulder pain secondary to degenerative joint disease and rotator cuff problems.

Back Pain

Back pain is a common complaint in patients with a history of poliomyelitis. Back pain is usually multifactorial in nature. Two factors that may contribute to the problem of back pain include scoliosis and biomechanical stresses placed on the back during ambulation and transfer activities. A poorly fitted seating system may aggravate back pain. A careful assessment is needed to identify the causative factors. Pain originating from sacroiliac joints may be described as diffuse low back pain; it can be readily localized through palpation of specific painful spots located in the subcutaneous tissue adjacent to one or both sacroiliac joints. A recent analysis of patients evaluated at the TIRR Post-Polio Clinic yielded a prevalence of sacroiliac pain of 80 percent in women and 50 percent in men. In the majority of patients, sacroiliac pain is elicited bilaterally but with different intensity at each side.

Muscle Pain

Muscle pain may either be related to muscle overuse or to myofascial pain. Muscle overuse pain can be diagnosed from the patient's history. In these patients muscle pain is aggravated with activity and relieved by rest. It is not uncommon for patients to experience muscle overuse pain in the lower limb that was not involved with poliomyelitis. This is probably caused by excessive stresses secondary to poor gait patterns or owing to lack of the use of an appropriate orthosis.

The muscular pain of PPS can be objectively elicited by palpating the reported sore muscles and identifying discrete painful spots or specific trigger points associated with referred pain. The atlas of trigger points included in Travell and Simons is of great aid in the search for such trigger points (20,21). Symptomatic cervical arthritis may be accompanied by a considerable degree of tightness of the neck muscles, causing painful spots in the sternocleidomastoid, scalenus, and trapezius areas.

Muscle cramps in the legs are a common occurrence in post-polio patients, especially in those who have new weakness of the previously unaffected muscle

groups or those who were affected in the initial stage but recovered to almost complete function in the early stages of convalescence. Cramps may be the consequence of excessive physical activity, but they may equally occur in patients who have adopted a more sedentary lifestyle as a result of PPS.

PATHOPHYSIOLOGY OF JOINT PAIN IN POLIOMYELITIS

The underlying factors that produce osteoarthritic pain are not well understood in either the post-polio or general population. Only a portion of patients with radiographic signs of osteoarthritis (OA) presents with pain (22–25), whereas others with typical symptoms of degenerative joint disease may not show radiologic changes. Postulated direct causes of OA-related pain include synovial inflammation, stretching of nerve endings in the joint capsule, ischemia in the subchondral bone, muscle spasm, stress or depression, and sleep deprivation (26). Other factors leading to pain are thought to be associated with fragmentation of cartilage (shedding of surface layers of cartilage), crystal or enzyme release from cartilage, inflammatory mediators, torn or degenerated menisci, and changes in synovial fluid (27). In approximately 50 percent of patients with radiographically assessed mild to moderate OA, synovitis may be a factor in reported pain, although it is not a predictor of such pain (27). In advanced OA, most patients with joint pain have synovitis (27).

Studies in post-polio patients show a decreased blood flow in the extremities most affected by paralysis, but this decreased blood flow is sometimes detected in apparently unaffected extremities (28). This is not surprising, because it is known that the poliovirus may cause lesions in the neurons of the lateral column of the spinal cord; these lesions send impulses to the sympathetic nerves (29,30). As a result, it has been hypothesized that there is an imbalance between the sympathetic vasoconstrictor and the parasympathetic vasodilator mechanisms, although some studies have not confirmed this hypothesis (31). The impact of autonomic imbalance on blood flow may aggravate the decreased blood flow in atrophied muscles and may explain a patient's intolerance to low environmental temperatures, with associated pain and discomfort (32).

Regardless of the type of pain, it is well demonstrated that post-polio patients have increased sensitivity to nociceptive stimuli (33), so it is not surprising that pain is reported so often by polio survivors.

MANAGEMENT OF PPS

It is important to review several general recommendations that are made to PPS patients because of their potential contribution to the alleviation of pain. Many patients do not receive optimum support for their unstable joints. It is desirable that a thorough assessment of gait abnormalities and a comprehensive muscle strength examination be carried out. Appropriate orthoses should be prescribed. A common example of orthotically correctable gait patterns are the forward weight shift and the side-to-side pattern (in patients with footdrop) described

earlier (19). In patients who ambulate relatively long distances with crutches and complain of shoulder pain, the use of a wheelchair and of a motorized scooter can be quite helpful in controlling pain. Appropriate modification of transfer techniques may be helpful. In some cases a lift device is indicated to prevent excessive stresses on the shoulder.

Some poliomyelitis patients have difficulty sleeping because of muscle, back, or joint pain. These patients may benefit from the use of a tricyclic antidepressant (TCA).

Energy Conservation Program

Curtailment of energy demands is the primary management tool in PPS. Patients who perform physical exercises hoping to strengthen the weakening muscle groups aggravate their weakness and experience even more pain. On the other hand, patients who decrease their level of physical activity slow down the rate of progression of their weakness and eventually notice a reduction of the frequency and intensity of their pain episodes.

An energy conservation program includes decreasing excessive walking or self-propelling of manually operated wheelchairs. The use of a motorized tri-wheeler for ambulation at the workplace, home, supermarkets, shopping malls, and airports is strongly recommended. Tri-wheelers are preferable to electric wheelchairs because of their maneuverability, especially at home. Patients who either work or stay at home should have periods of rest, especially in the afternoon and preferably lying down on a sofa or reclining chair. Even if the patient does not fall asleep, the supine or semisupine position can be very relaxing and provide much needed preservation of energy.

Selective Exercise Program

The role of exercise is to prevent contractures and to increase muscle strength. Appropriate exercise programs must be prescribed to prevent the deleterious effects of inactivity and immobilization. Range-of-motion exercises are prescribed to prevent contractures. Precautions should be taken not to overstretch the weak muscles. Attempts should be made to maintain proper posture and correct or minimize gait abnormalities.

Some controversy exists as to the beneficial effects of muscle strengthening programs. Earlier studies yielded conflicting results, some reporting beneficial outcomes (34,35), and others indicating that exercise was detrimental (36–38). It appears that the key difference among these studies has to do with the intensity of the exercise program (32). Recent studies report increased muscle strength, improved general well-being, and improvements in the activities of daily living without adverse affects (39–42).

Although some of these studies report benefit from exercising unaffected muscle groups, the problem is in identifying such groups either in the trunk or in partially affected extremities and ensuring that the selective exercise of seemingly

unaffected muscles be done without activating adjacent muscles that were definitely affected by poliomyelitis. The ubiquitous dissemination of the polio virus throughout the lower motor neurons of the spinal cord in the acute stage may have left residual damage even in muscle groups that were unaffected in the acute stage or had recovered their function during early convalescence.

Weight Reduction

Because of the relatively sedentary life style imposed by extensive residual paralysis, many post-polio patients have increased their body weight. Adoption of energy conservation techniques after the diagnosis of the PPS may aggravate weight problems. Low-fat consumption and adherence to the prudent heart diet advocated by the American Heart Association may be beneficial. Halstead (1998) recognizes the value of the proteins contained in lean mean because they may help increase the energy level in patients with PPS (32).

Correction of Posture and Gait Deviations

Ambulatory patients should adopt adequate postures that minimize the biomechanical consequences of paralysis and the stresses caused by the uneven forces of gravity on one or several joints. This posture correction may be achieved through lightweight orthotic devices (either AFO or KAFO) that stabilize the lower extremities during ambulation. Patients who have poor sitting posture should use simple devices such as a lumbar roll or an inflatable low back support while seated. The use of a custom-made corset may be too restrictive in some patients but quite helpful in others. Upper extremity involvement may require elbow or wrist supports such as those used by typists to prevent fatigue and typical carpal tunnel pain.

Analgesics

Complaints of excruciating pain by post-polio patients may require the prescription of analgesics and, in the case of degenerative joint disorders, antiinflammatory drugs. The pharmacologic management of pain in these patients is a major challenge and is discussed in greater detail later.

Special Precautions with Drugs or Substances Affecting the CNS

Post-polio patients may report enhanced responses to sedatives or other medications or substances (e.g., alcohol) that act on the central nervous system (CNS). This is probably caused by the overall decrease in neuronal population and lean body mass with a concomitant greater availability of drug levels per unit of neuronal population. At the TIRR Post-Polio Clinic we usually recommend that sedatives or psychotropic drugs be administered at doses of about 50 to 60 percent of those usually prescribed for persons of similar age or body weight. These considerations are particularly relevant to post-polio patients who need to undergo surgery under general anesthesia (43).

MANAGEMENT OF PAIN IN ACUTE POLIOMYELITIS

The pharmacologic management of the excruciating pain of acute-stage poliomyelitis is limited to the administration of analgesics, especially antiinflammatories. The administration of opioids should be used only in exceptional circumstances.

Because the pain may persist for several days or weeks throughout the convalescent phase, it is important to institute other appropriate measures to alleviate the pain as soon as the febrile period is over. The most common approach is bed rest and the application of hot packs to all muscle groups. These constitute the hallmark of the old Sister Kenny treatment. As soon as the patient is able to be moved out of bed, whirlpool therapy with hot water is indicated at least twice a day.

To prevent the eventual development of contractures during the earliest stages of the acute phase of the illness, all joints must be kept in a neutral position with appropriate lightweight splints. As soon as the patient can tolerate it, institution of gentle range-of-motion (ROM) exercises and manual muscle stimulation is very important to facilitate recovery of function and preserve joint mobility.

MANAGEMENT OF PAIN IN PATIENTS WITH PPS

Currently, the widely recommended pain treatment for PPS consists of a decrease in physical activity, application of traditional modalities of physical therapy, administration of muscle relaxants (at doses approximately 50 percent below those recommended for young adults), and analgesics or antiinflammatory agents (at normally prescribed doses). The effectiveness of the majority of pharmacologic agents, including the newly developed cyclooxygenase inhibitors, is generally poor in our post-polio population.

Although the cyclooxygenase inhibitors are apparently well tolerated (44), virtually all drug treatments for arthritic pain are known to have side effects that may result in other health problems for the patient. The risks for side effects with pure analgesics, such as acetaminophen, are fairly low (45,46), but the use of aspirin or NSAIDs has been associated with gastritis or ulceration of the gastrointestinal tract, often independent of dosage or frequency of treatment (47–49).

Adjuvant antidepressants, muscle relaxants, or anticonvulsant drugs may have fewer side effects than analgesics but their use in conjunction with other drugs to manage pain may increase the potential for adverse drug reactions, particularly in the elderly. As stated earlier, all drugs with neurotropic action (including sedatives and antihistaminics) should be prescribed at lower dosages than recommended for the general adult population. A prudent approach is to start with doses approximately 25 to 50 percent lower than those recommended for young adults who do not have PPS.

Although some suggest that the problem of opioid drugs has been exaggerated, fear of drug dependency and addiction often inhibits practitioners from prescribing these drugs to manage chronic pain, particularly in elderly patients (50). Tramadol, a centrally acting synthetic analgesic with opioid activity may be useful at doses of 50 mg (exceptionally, 100 mg) three or four times daily. Even though

it is less addicting than traditional opioids, it has the potential to cause psychologic and physical dependency, and it is not recommended for patients who are already dependent on opioids.

Muscle cramps are difficult to control, but may be significantly decreased through the administration of clonazepam at a dose of 0.5 to 1 mg at bedtime; this dose can be repeated 4 hours later, if needed. Quinine water or tablets of quinine sulfate have not been effective in the TIRR post-polio patient population.

Other techniques for managing the pain of PPS include traditional physical modalities (e.g., heat, cold), direct neural pathway interventions (e.g., nerve blocks, trigger point injections, transcutaneous electrical nerve stimulation [TENS]), mobilization and manipulation, and surgical treatment (51). Unfortunately, many interventions (e.g., inactivity, surgical intervention, narcotic medications) that are effective in treating acute pain are not effective in managing chronic pain. Also, when used improperly, as in the case of too much current with TENS therapy, these treatments can exacerbate pain rather than relieve it (52).

Nontraditional therapeutic tools, such as relaxation and meditation, hypnotherapy, acupuncture, biofeedback (BF), and cognitive-behavioral therapy (CBT) are increasingly used in the general population. The benefits of acupuncture, when administered by a well-trained practitioner, have been documented in managing some types of pain (e.g., back pain), with results thought to be caused by the release of humoral substances, such as bradykinins, substance P, and leukotreines (53). Although there is some evidence of the efficacy of several behavioral and relaxation interventions in the treatment of chronic pain, available data are insufficient to conclude that one technique is usually more effective than another for a given condition (54). Cognitive-behavioral therapy (CBT) is cited by the National Institutes of Health (NIH) as being more effective than placebo and routine care in dealing with OA-related pain (54). Both relaxation and biofeedback (BF) are considered effective in treating many types of chronic pain, although OA and related conditions were not specifically mentioned in the NIH report. Hypnosis appears to be most beneficial in treating cancer-related pain and some other conditions, including irritable bowel syndrome, oral mucositis, temporomandibular disorders, and tension headaches (54).

There is no evidence in the scientific literature that any of these approaches are superior to others in the management of pain in PPS. Several of our post-polio patients have reported equivocal and disappointing results with acupuncture and other behavioral approaches such as meditation, yoga, or biofeedback. However, this does not negate the proven beneficial effect of these techniques as mood elevators and stress control helpers.

MAGNETIC FIELDS TO CONTROL PAIN

The limited success of pain control in post-polio patients prompted us to explore alternative methods of pain management. Static and fluctuating electromagnetic fields have been applied with apparent successful pain relief in a variety of orthopedic conditions, most commonly traumatic bone fractures or surgical osteotomies

(55–57). As early as 1938, Hansen reported on a study of the effectiveness of electromagnetic fields (which had "a carrying power of from 8.5 to 14 kg") applied for a period of 1 to 15 minutes duration (58). Twenty-three out of twenty-six patients with complaints of "sciatica," "lumbago," and "arthralgia" reported a rapid and significant relief of their pain. The study was not double masked, but the author reported no pain reduction in two patients to whom the electromagnetic device was applied without the electricity being turned on (58).

The therapeutic application of magnets appears to offer promise in alleviating chronic articular or musculoskeletal pain. However, there is a paucity of data from clinically sound studies of magnet therapy. One proponent, George J. Washnis (1998), has published a fairly comprehensive book on clinical applications of magnets, but he provides very few references of well-conducted clinical trials (59). As Washnis notes, federally supported research on the therapeutic benefits of magnets has recently started, but few reported results are available in the scientific literature. Lawrence, Rosch, and Plowden (1998) also cite several studies, but few were randomized double-masked clinical trials (60). Washnis also cites a number of studies that report good results from use of magnet therapy for fibromyalgia, postoperative healing, traumatic injury (gunshot wound to the hand), and soft tissue damage (ligament tear) to the hand (59). Unfortunately, many of these studies were supported by commercial vendors whose products were used in the studies, raising questions about the appropriateness of the methods used and the objectivity of the interpretation of results. With the exception of our own research, none of the research cited by Washnis or Lawrence and colleagues could be found in refereed journals.

Pulsating Electromagnetic Fields

Pulsating electromagnetic fields (PEMF) have been in use as therapeutic modalities for at least 40 years (61). A well recognized and standard use of PEMF is for enhancing the rate of healing in nonunion fractures (62,63). PEMF also have been shown to be effective in treating osteoarthritis of the knee and spine (64,65). The biological phenomenon that is responsible for alternations in wound healing rates and chronic disease processes upon exposure to PEMF is not well understood. However, both human and animal studies indicate that increased peripheral blood flow results from such exposure (66,67). One study found that human exposure to PEMF resulted in changes in fibroblast concentration, fibrin fibers, and collagen at wound sites, which was attributed to increased blood flow (68). Most recently, researchers reported good results in both an open and double-masked placebo-controlled study of PEMF in treating migraine headaches (61). The small sample sizes (eleven patients in the open study and twelve in the controlled study) preclude generalizing the results (61). A study by Richards et al. (1998) reports the benefits obtained in the management of multiple sclerosis patients (69). The therapeutic application of electromagnetic shocks have been well researched and were reported by several authors in a special issue of *CNS Spectrum*, edited by George (70).

An excellent overview of the biological effects of electromagnetic fields may b found in a two-volume publication edited by Carpenter and Ayrapetyan (71,72 The body of literature continues to grow and is built on further efforts to scientifically document the impact of magnetic fields on biological systems (73–79). Th safety of application of these electromagnetic fields is attested by the Worl Health Organization, which reported "the available evidence indicates th absence of any adverse effects on human health due to exposure to static magneti fields up to two Tesla" (1 T = 10,000 gauss) (80).

Static Magnetic Fields

Holcomb (1991) is a pioneer in the use of static magnetic fields to control pain He acquired considerable experience with the use of static magnetic fields generated by a block of four magnets of alternating polar configuration (Magnabloc®). His early experience reporting significant relief of back pain in a double-masked trial dates from 1991 (75), but no new data on the use of the Magnabloc® have been reported in the peer-reviewed literature. In attempting to clarify the mechanism of pain relief, McLean (1995), a collaborator with Holcomb, demonstrated that under the influence of a magnetic field, it is possible to block the action potentials produced by stimulating cultured sensory neurons (78). A more recent paper by Weintraub (1999) reports on a single-masked, active-placebo crossover study of a static magnetic insole of multipolar configuration that was considered effective in controlling foot pain in diabetic neuropathy patients (77). Mann (1999) reports the benefits of static magnetic fields in a randomized study to evaluate wound healing and pain control in patients who underwent liposuction (81).

On the other hand, Borsa et al. (1998) report on a lack of protective pain relief with static magnets in a single-masked study of healthy athletes who were instructed to keep a device (active or placebo) in the nondominant arm for several hours after repetitive strenuous muscular activity of the same arm (82). It should be noted that the exercise in these subjects produced a very small increase in pain scores, and it is not surprising that static magnetic fields applied to those subjects may not have produced detectable changes. Certainly, the pain scores of all Borsa's subjects are not comparable to the pain intensity exhibited by untreated patients with chronic musculoskeletal problems. Hong et al. (1982) performed a double-masked evaluation of a loose, magnetized necklace on the cervical pain manifested by otherwise healthy young persons (83). Although he did not observe any effect, contrary to the benefit reported by Nakagawa (1976) with an identical device (84), Hong admits that the distance between the loose necklace and the painful neck structures may have interfered with the close delivery of a sufficiently intense magnetic field (85). In a more recent study, Callacott et al. (2000) reports that static magnetic fields applied to patients with chronic deep back pain failed to produce significant benefits, but the authors admitted that the distance between the magnet surface and the pain area may have interfered with the penetration of the magnetic field (86).

Static magnets for the management of pain are widely available in various configurations, sizes, and types of magnetized material (i.e., rigid, flexible, made with metal or with various alloys). The most important issue is the configuration of the magnet according to two prototypes: dipole or multipole.[1] Claims are made by manufacturers about the superiority of one prototype versus the other.

Investigators of Baylor College of Medicine's Departments of Family and Community Medicine, Physical Medicine and Rehabilitation, and Molecular Biology and Biophysics conducted a randomized double-masked clinical trial of magnet therapy in the treatment of arthritic or muscular pain in patients diagnosed with PPS (87). The study was designed to test the efficacy of using static magnets of known surface strengths (measured in gauss) to treat localized pain. A total of fifty patients participated. Of these, twenty-nine received a magnetized device applied over a painful spot and twenty-one received a nonmagnetized device of identical appearance. A specific localized area of pain was selected for treatment. An active pain response was grossly elicited by finger palpation and then more precisely identified by firm application of a blunt object approximately 1 cm in diameter. In nonpainful areas, the blunt object elicits a sense of pressure, but no pain. Each subject was asked to grade the pain at the response point using a 10-point visual analog scale (VAS), with a subjective rating of 1 being least painful and a rating of 10 being most painful. If palpation elicited pain in more than one area, then the area with the most painful score (i.e., closest to 10 on the scale) was selected.

Each patient with an attached device was required to remain in the immediate clinic area in whatever position was most comfortable for him or her (e.g., sitting, standing, or walking) for 45 minutes. After this interval, and prior to removing the device from the skin, the patient was asked to describe any sensations felt while the device had been in place. After removal, each patient was asked to use the same 10-point scale in subjectively rating the amount of pain felt upon palpation of the treated point by the research clinician. Although exact pressures applied with the blunt instrument before and after "treatment" were not measured, efforts were made to use the same amount of pressure in eliciting responses to palpation. No systematic follow-up of patients was done after the treatment visits, but in many cases follow-up information was obtained during later clinic visits.

Following each treatment, the device code and the scores obtained before and after each individual treatment were entered into a database for subsequent analysis using standard descriptive analytic methods. The pre- and posttreatment pain score results are summarized in Table 9-2.

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[1] We use the term "dipole or dipolar" to refer to magnets that have one pole of the magnetic field applied over the skin (most manufacturers label this pole as "N" because it attracts a North-seeking compass needle), and the other pole not attached to the skin. Confusion exists because manufacturers usually refer to these magnets as "unipolar." The term "multipole or multipolar" refers to magnets which, at the surface applied over the skin, deliver magnetic fields from multiple alternating North or South poles in a concentric ring or grid pattern. Manufacturers usually refer to these magnets as "bipolar."

Table 9.2. Pre-Treatment and Post-Treatment Pain Scores

Measure	Active Magnetic Device	Inactive Device	Significan
Number of subjects	29	21	N/A
Pre-treatment pain score (mean ± SD)	9.6 ± 0.7	9.5 ± 0.8	NS
Post-treatment pain score (mean ± SD)	4.4 ± 3.1	8.4 ± 1.8	$p < .0001$
Change in score (mean ± SD)	5.2 ± 3.2	1.1 ± 1.6	$p < .0001$

Source: Vallbona C, Hazelwood CF, Jurida G. Response of pain to static magnetic fields in post-poli patients: A double-blind pilot study. *Arch Phys Med Rehab* 1997; 78:1200-1203.

Those patients who reported at least a three-point decrease in pain after treatme were categorized as "improved." The three-point decrease was selected because represented the average placebo effect (plus 1.6 standard deviation). Patients wl reported a decrease in pain of less than three points following treatment were categ rized as "not improved." The results are summarized in Table 9-3.

The results of this pilot study suggest that static magnetic fields may inde provide measurable relief for people who have localized muscoloskeletal pai The study was done on a group of patients who are representative, with respect demographic characteristics, of the larger patient population seen in the pos polio clinic. Additional studies should look more closely at magnet configuratio surface strength, and other magnetic field properties as factors in pain relief, ar should include more systematic follow-up of patients to determine how long ar beneficial effects may last following an active treatment session.

The magnetized devices were effective in controlling pain over the applied are within 45 minutes, but we did not systematically assess the duration of effe beyond the post-magnet treatment. Anecdotal evidence gathered from some o our experimental patients indicates that pain relief lasted for several hours, day and even weeks (one patient, who had been randomized to receive the magnetize device, reported to be pain free two years after his participation).

After having demonstrated the effectiveness of static magnetic fields in PP through a randomized double-blind clinical trial, we offer an open-label treat

Table 9.3. Proportion of Subjects Reporting Pain Improvement by Magnetic Activity of the Treatment Device

Measure	Active Magnetic Device (n = 29)	Inactive Device (n = 21)
Pain improved	N = 22 (76%)	N = 4 (19%)
Pain not improved	N = 7 (24%)	N = 17 (81%)

$X2$ (1 df) = 20.6 ($p < .0001$)

Source: Vallbona C, Hazlewood CF, Jurida G. Response of pain to static magnetic fields in post-polio patients: A double-blind pilot study. *Arch Phys Med Rehab* 1997; 78:1200–1203.

ment with magnets to Post Polio Clinic of The Institute for Rehabilitation and Research patients who have elective painful spots. We use the same criteria as that of our randomized study and apply either multipolar or dipolar magnets over one or several painful spots if the intensity of perceived pain exceeds a score of 5 points on the McGill pain scale. If there is a significant effect, it is usually noticed within 30 minutes, at which time we remove the device. To those patients who exhibit a benefit we recommend that they acquire similar magnetic devices and use them on a PRN basis. We have not yet carried out a systematic post-treatment interview of all these patients, but there seems to be a general pattern of satisfaction at the time of a subsequent follow-up. The overwhelming majority of patients are very pleased with the PRN use of magnets for periods that vary from a few hours to a few days. Muscular pain seems to respond much more rapidly and for longer periods of time than articular pain. Patients who use magnets may use them as a complement to other medication, but in general their need for pharmacologic treatment is much less when using magnets. A few of our patients have reported that over a period of several months, the magnetic fields seem to lose effectiveness, but they have seldom stopped using the magnets altogether. Only a few patients have reported benefit from sitting or sleeping on magnetized pads, but we have not carried out any scientific evaluation of these devices in our patient population.

We do not have a clear explanation for the significant and rapid pain relief observed in the post-polio patients who participated in our study. It is possible that the effect could result from a local or direct change in pain receptors, but it is also possible that there was an indirect central response in pain perception at the cerebral cortical or subcortical areas, or a change in the release of enkephalins or opioids at the reticular system. If the magnetic fields have an impact on the subcortical level of the brain, it is possible that the application of a magnetic device in one painful area may benefit, to a greater or lesser extent, the pain elicited in other trigger points. Bruno has pointed out that poliomyelitis lesions exist in various areas of the brain of survivors, and he believes that these lesions may explain the hypersensitive response to painful stimuli that he has observed in post-polio patients (88). This should not be interpreted to mean that the relief of pain produced by magnetic fields that we observed in our study was specific for post-polio patients, because similar responses to magnetic fields have been reported in patients without identifiable lesions of the CNS (89).

CONCLUSIONS

Pain in the acute stage of poliomyelitis is excruciating and requires application of hot packs to relieve muscle spasm and facilitate recovery of muscle function. Analgesics should be used if needed.

The institution of an integral plan of management for PPS is important to facilitate control of pain. The plan that we use in the Post-Polio Clinic of TIRR includes adherence to an energy conservation program, a selective exercise program (only if possible), weight reduction, correction of posture and gait deviations, and the

administration of analgesics (acetaminophen, nonsteroidal antiinflammatories [NSAIDs], cyclooxygenates inhibitors, and muscle relaxants).

Despite these general and well-accepted modalities of treatment, the management of pain in PPS patients represents a major challenge because it seems to be refractory to the majority of measures that are available.

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September 21, 2004

Disclaimer: The following are unofficial notes which have not been read by or approved by the speaker.

Points of discussion:

- Since everyone received a copy of Dr. Vallbona's chapter, he did not summarize it. After reading the chapter, the group will be up to date on the treatment used by The Institute for Rehabilitation and Research in Houston.
- The use of magnets to control pain in post-polio patients was discussed. Results are disappointing for long-term use. Results are good for patients with sacroiliac pain.
- Neurontin given to patients with parasthesias responded better than those with arthritic type of pain. Although a lot of practitioners are using Neurontin as a pain medicine, some polio survivors say it makes them drowsy. It is recommended to start patients on a low dosage and titrate up. Above 1800 mg a day is not recommended as the benefits are minimal.
- In the clinic in Houston, pain patients notice that on weekends they have less pain. This leads us to believe that increased rest and a decrease in physical activity should be highlighted to patients. It was also mentioned that not sleeping well during the week can have an effect on pain issues.
- A related question: the controversy of the role of exercise and muscle strengthening to address pain issues.
- The clinic in Houston recommends a lot of pool exercise. A warm temperature is recommended because cold is not tolerated well by post-polio patients. Temperature in the 80's is tolerated but fatigue gets to be a factor in higher temperatures.
- For Watsu, some practitioners recommend 90o or 95 o due to the inactivity of the patient.
- The timing of discussing pain and the importance of power mobility with patients was discussed. There is a tendency to look at it as an avenue to pursue when someone is limited by pain. At the Houston clinic, the topic is introduced during the initial evaluation. However, they are careful not to upset the patient as many are not ready to go into power mobility. By the third or fourth visit, the patient is ready for a scooter or power chair.
- Discussion followed on the criteria used by Medicare to cover a power chair or scooter. One of the criteria is that it must be used inside only. Another is a person needs it so they do not use their arms.

- The importance of sleep as it pertains to pain in both non-post-polio and post-polio patients was discussed. Dr. DeMayo addresses the sleep issue before making any progress on the pain issues. He believes many patients have developed very poor sleep hygiene habits and are sleeping poorly with awakenings at night. He addresses sleep fairly aggressively.

- The Houston clinic also sees a number of patients with sleep apnea. Some patients have said they sleep better on a mattress with magnets.

- Body pillows are recommended as a low cost and no side effects way to help patients sleep better by making a neutral spine.

- Post-op pain in post-polio patients was discussed. Some post-polio patients feel they are unique in having increased incision pain post-op due to post-polio but that may not be the case. Pain management in the hospital may be inadequate. It is also possible the patients are not verbalizing their pain. The JCAHO pain scale may be a very important tool in helping patients express pain severity.