A Statement about Exercise for Survivors of Polio

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Advising all polio survivors not to exercise is as irresponsible as advising all polio survivors to exercise.

Current evidence suggests that exercises are often beneficial for many polio survivors provided that the exercise program is designed for the individual following a thorough assessment and is supervised initially by knowledgeable health professionals. Polio survivors and their health professionals who are knowledgeable about the complete health status of the individual survivor should make the ultimate decision on the advisability of exercise and the protocol of the exercise program.

Clinical research studies support exercise programs that are prescribed and supervised by a professional for many polio survivors, including those with the symptoms of post-polio syndrome. (See References.)

Acute paralytic polio can result in permanent muscular weakness when the viral infection leads to death of anterior horn cells (AHCs) in the spinal cord. Recovery from paralysis is thought to be due to the re-sprouting of nerve endings to orphaned muscle fibers creating enlarged motor units. Recovery is also attributed to exercise that facilitates the enlargement of innervated muscle fibers. For example, some polio survivors regained the use of their arms and have walked for years with crutches. Others regained the ability to walk without the aid of braces, crutches, etc., and have continued to walk for decades.

The increased muscle weakness recognized in those with post-polio syndrome is believed to occur from the degeneration of the sprouts of the enlarged motor units. The premature death of some of the AHCs affected by the poliovirus is speculated to also cause new weakness, and some new weakness is caused by disuse, or a decline in activity or exercise.

There is agreement that repetitive overuse can cause damage to joints and muscles, but can repeated overuse and excessive physical activity accelerate nerve degeneration or nerve death? This is the crux of the physical activity/exercise debate.

Physical activity is movement occurring during daily activities. Exercise is defined as planned, structured and repetitive body movement.

Therapeutic exercise is conducted for a health benefit, generally to reduce pain, to increase strength, to increase endurance and/or to increase the capacity for physical activity.

Polio survivors who over-exercise their muscles experience excessive fatigue that is best understood as depletion of the supply of muscle energy. But, some polio survivors' weakness can be explained by the lack of exercise and physical activity that clearly leads to muscle fiber wasting and cardiovascular deconditioning.

The research supports the fact that many survivors can enhance their optimal health, their range of motion and their capacity for activity by embarking on a judicious exercise program that is distinct from the typical day-to-day physical activities. These same polio survivors need not fear "killing off" nerve cells, but do need to acknowledge that the deterioration and possible death of some nerve cells may be a part of normal post-polio aging.

Exercise programs should be designed and supervised by physicians, physical therapists and/or other health care professionals who are familiar with the unique pathophysiology of post-polio syndrome and the risks of excessive exercise. Professionals typically create a custom-tailored individualized exercise program that is supervised for two-four months. During this period, they will monitor an individual's pain, fatigue and weakness and make adjustments to the protocol, as needed, to determine an exercise program that a polio survivor can follow independent of a professional.

When designing a program, these general principles are followed to achieve specific goals and/or maintenance levels.

- The intensity of the exercise is low to moderate.
- The progression of the exercise is slow, particularly in muscles that have not been exercised for a period of time and/or have obvious chronic weakness from acute poliomyelitis.
- Pacing is incorporated into the detailed program.
- The plan should include a rotation of exercise types, such as stretching, general (aerobic) conditioning, strengthening, endurance or joint range of motion exercises.

Polio survivors who experience marked pain or fatigue following any exercise should hold that exercise until contacting their health professional.

Researchers and clinicians cannot make a more definite statement until additional studies on the long-term effects of exercise and the effects of exercise on function and quality of life are undertaken.

Criteria for diagnosis of post-polio syndrome

Prior paralytic poliomyelitis with evidence of motor neuron loss, as confirmed by history of the acute paralytic illness, signs of residual weakness and atrophy of muscles on neurologic examination, and signs of denervation on electromyography (EMG).

A period of partial or complete functional recovery after acute paralytic poliomyelitis, followed by an interval (usually 15 years or more) of stable neurologic function.

Gradual or sudden onset of progressive and persistent new muscle weakness or abnormal muscle fatigability (decreased endurance), with or without generalized fatigue, muscle atrophy, or muscle and joint pain. (Sudden onset may follow a period of inactivity, or trauma or surgery.) Less commonly, symptoms attributed to post-polio syndrome include new problems with breathing or swallowing.

Symptoms persist for at least a year.

Exclusion of other neurologic, medical and orthopedic problems as causes of symptoms.

SOURCE: Post-Polio Syndrome: Identifying Best Practices in Diagnosis & Care. March of Dimes, 2001.

References

Agre, J., Grimby, G., Rodriquez, A., Einarsson, G., Swiggum, E., & Franke, T. (1995). A comparison of symptoms between Swedish and American post-polio individuals and assessment of lower-limb strength - a four-year cohort study. *Scandinavian Journal of Rehabilitation Medicine,* 27, 183-192.

Agre, J., Rodriquez, A., & Franke, T. (1997). Strength, endurance, and work capacity after muscle strengthening exercise in postpolio subjects. *Archives of Physical Medicine & Rehabilitation,* 78, 681-685.

Agre, J., Rodriquez, A., & Franke, T. (1998). Subjective recovery time after exhausting muscular activity in postpolio and control subjects. *American Journal of Physical Medicine & Rehabilitation,* 77, 140-144.

Agre, J., Rodriquez, A., Franke, T., Swiggum, E., Harmon, R., & Curt, J. (1996). Low-intensity, alternate-day exercise improves muscle performance without apparent adverse affect in postpolio patients. *American Journal of Physical Medicine & Rehabilitation,* 75, 50-58.

Agre, J.C., Rodriquez, A.A. (1997). Muscular function in late polio and the role of exercise in post-polio patients.*Neurorehabilitation,* 8, 107-118.

Ernstoff, B., Wetterqvist, H., Kvist, H., & Grimby, G. (1996). Endurance training effect on individuals with postpoliomyelitis. *Archives of Physical Medicine & Rehabilitation,* 77, 843-848.

Grimby, G., Stalberg, E., Sandberg, A., Sunnerhagen, KS. (1998). An 8-year longitudinal study of muscle strength, muscle fiber size, and dynamic electromyogram in individuals with late polio. *Muscle & Nerve,* 21, 1428-1437.

Jones, D.R., et al. (1989). Cardiorespiratory responses to aerobic training by patients with post-poliomyelitis sequelae. *Journal of the American Medical Association*, 261(22), 3255-3258.

Kriz, J.L., Jones, D.R., Speier, J.L., Canine, J.K., Owen, R.R., Serfass, R.C. (1992). Cardiorespiratory responses to upper extremity aerobic training by post-polio subjects. *Archives of Physical Medicine & Rehabilitation,* 73, 49-54.

Prins, J.H., Hartung, H., Merritt, D.J., Blancq, R.J., Goebert, D.A., (1994). Effect of aquatic exercise training in persons with poliomyelitis disability. *Sports Medicine, Training and Rehabilitation,* 5, 29-39.

Spector, S.A., et al. (1996). "Strength gains without muscle injury after strength training in patients with postpolio muscular atrophy. *Muscle and Nerve,* 19, 1282-1290.

Selected References about exercise post-2003 in chronological order

Effects of resistance training in combination with coenzyme Q10 supplementation in patients with post-polio: a pilot study; Author: Skough, K., Krossén, C., Heiwe, S., Theorell, H., Borg, K.; Journal/Publisher: *Journal of Rehabilitation Medicine; I*ssue: October, 2008 : 40(9), 773-5; http://www.ncbi.nlm.nih.gov/pubmed/18843432

Short-term effects of aerobic exercise on functional capacity, fatigue, and quality of life in patients with post-polio syndrome; Author: Oncu, J., Durmaz, B., Karapolat, H.;;Journal/Publisher: *Clinical Rehabilitation,* Issue: February, 2009: 23(2), 155-63; http://www.ncbi.nlm.nih.gov/pubmed/19164403

Exercise therapy and cognitive behavioral therapy to improve fatigue, daily activity performance and quality of life in post-poliomyelitis syndrome: the protocol of the FACTS-2-PPS trial; Author: Koopman F., Beelen, A., Gerrits, K., Bleijenberg, G., Abma, T., de Visser, M., Nollet, F.; Journal/Publisher: BMC Neurology, Issue: Jan 2010: 10: 8; http://www.ncbi.nlm.nih.gov/pubmed/20082714

No effects of whole-body vibration training on muscle strength and and performance in persons with late effects of polio: A pilot study; Author: Brogårdh, C., Flansbjer, U.B., Lexell, J.; Journal/Publisher: *Archives of Physical Medicine and Rehabilitation;* Issue: Sept 2010: 91(9): 1474-7; http://www.archives-pmr.org/article/S0003-9993(10)00361-8/fulltext

Determining the Anaerobic Threshold in Postpolio Syndrome: Comparison With Current Guidelines for Training Intensity Prescription; Eric L. Voorn, MSc, Karin H. Gerrits, PhD, Fieke S. Koopman, MD, Frans Nollet, MD, PhD, Anita Beelen, PhD; Presented to the Netherlands Society of Physical and Rehabilitation Medicine, November 4, 2011, Ermelo, The Netherlands.

The effects of a home-based arm ergometry exercise programme on physical fitness, fatigue and activity in polio survivors: protocol for a randomised controlled trial; Author: Murray, D., Meldrum, D., Moloney, R., Campion, A., Horgan, F., Hardiman, O.;;Journal/Publisher: BMC Neurology, Issue: Dec 2012: 12(1): 157, http://www.biomedcentral.com/1471-2377/12/157

Muscle strength is only a weak to moderate predictor of gait performance in persons with late effects of polio; Flansbjer UB1, Brogårdh C, Lexell J, NeuroRehabilitation. 2013 Jan 1;33(3):457-64. http://www.ncbi.nlm.nih.gov/pubmed/23949084

Relationship between self-reported walking ability and objectively assessed gait performance in persons with late effects of polio; Brogårdh C1, Flansbjer UB, Espelund C, Lexell J.; NeuroRehabilitation, 2013;33(1):127-32; .http://www.ncbi.nlm.nih.gov/pubmed/23949039

Basics of Exercise

Muscle stretching and joint range-of-motion exercises are important whenever there is muscle weakness. Preventing tightness, where muscles are weak, is important to maximize function and is

particularly important in the chest wall and abdominal musculature if there is a limitation of breathing capacity. Preventing tightness in the hip and knee is important to maximize walking ability when there is significant weakness of the hip and thigh musculature.

General conditioning exercises or aerobic exercises, specifically to maintain or improve cardiovascular endurance, are good for many polio survivors and have been shown to be effective (Owen & Jones, 1985; Kriz et al., 1992). The best endurance exercise is swimming, because it minimizes mechanical stress on tendons and joints, but beneficially stresses the cardiovascular system.

Conditioning exercises or any repetitive activity, including walking, which causes pain or a sense of excessive muscle fatigue and increased weakness should be discontinued. The primary focus of any exercise program should be on building endurance, not strength (Agre et al., 1997; Ernstoff et al., 1996).

In general, muscles that are significantly weakened by previous polio respond poorly to vigorous strengthening exercise programs. Very gradual strengthening exercises which are guided in intensity and duration by the individual's level of fatigue and/or pain can lead to modest but significant improvements in strength (Agre et al., 1996). Exercise should be focused on functionally important muscles.

An appropriate exercise program will help to maintain the strength of previously involved muscles, and also avoid overloading those muscles which previously were not recognized as having been affected. An adequate exercise program will help to minimize loss in strength and endurance associated with the aging process. Professional advice may be needed to design a feasible and effective personalized exercise program.

Sample Exercises

NON-FATIGUING GENERAL CONDITIONING EXERCISE PROGRAM (THE 20% RULE)
Stanley K. Yarnell, MD (retired), California

The non-fatiguing general conditioning exercise program using the 20% rule was designed to restore stamina or endurance for those individuals who have continued to be bothered by profound fatigue following surgery, illness or trauma.

The program begins by determining the polio survivor's maximum exercise capability with the help of the clinic physical therapist. The type of exercise can be in a pool or on dry land, using an arm erqometer or an exercise bicycle, depending on the individual's abilities and preferences. If one prefers swimming, the maximum number of laps that the patient can swim is used as the maximum exercise capability. If the survivor has considerable residual weakness and is only able to swim one

lap in half an hour, then the amount of time actively swimming can be used as the maximum exercise capability rather than the number of laps.

Having established the maximum exercise capability, the polio survivor is instructed to begin his aerobic swimming program at 20% of the determined maximum exercise capability. He can swim three to four times per week at that level for one month, and then he is instructed to increase by 10%. For example, if an individual is able to actively swim in a pool for half an hour, then one-half hour would be his maximum exercise capability. He would begin swimming just six minutes per session three to four times per week for a month before increasing the amount of time actively swimming to nine minutes three to four times per week for another month. Then he would increase by 10% once again so that he was actively swimming 12 minutes per session three to four times per week for another month, and so on. After three to four months, our patients have reported that they feel an increase in their general stamina or endurance.

Alternatively, if an arm ergometer or exercise bicycle is used, the same basic principle can be utilized, calculating distance pedaled or time spent actively pedaling. The individual begins his aerobic or non-fatiguing general conditioning exercise program at 20% of maximum exercise capability three to four times per week for one month before increasing the distance by 10%. He continues with that level of activity for another month before increasing by another 10%, so that he is exercising at 40% of maximum exercise capability.

For example, if an individual is able to pedal an exercise bicycle for one mile or is able to actively pedal the bicycle for up to 20 minutes, then that is his maximum exercise capability. He is instructed to begin his exercise program at one-fifth of a mile (or, if time is used, then four minutes is the beginning exercise time). This is repeated three to four times per week for a month before increasing the distance to one-third of a mile or six minutes. Our patients are encouraged to maintain that for an additional month before increasing by another 10%, and so on.

Individuals are cautioned to stop if they become fatigued during their exercise program, or if they experience pain or aches in their muscles. Most polio survivors are able to continue increasing their exercise program to nearly the maximum exercise capability, though it clearly would take a full nine months if this program were strictly followed. Conditioning or aerobic exercise at this submaximal level allows the individual to regain a healthier sense of stamina without damaging delicate old motor units.

It is imperative to incorporate the concept of pacing and spacing within the non-fatiguing general conditioning exercise program, meaning that rests are to be taken every few minutes.

The 20% rule is sometimes also applied to polio survivors when they are given instructions in a home flexibility and stretching program so they do not exercise too vigorously.

This exercise program can be modified with the supervision of a physical therapist, depending on the progress made by the polio survivor. This program may not eliminate fatigue, but we have found it effective for those who have a significant element of deconditioning contributing to their sense of fatigue.

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BASIC BEGINNING EXERCISE FOR POLIO SURVIVORS AND MORE

"Exercise admonitions: Take these exercises to your doctor and ask your doctor if it is all right for you to complete this routine. Do not exercise within one hour of a meal (before or after). Do not exercise within two hours of the time you plan to go to bed. Do not continue to exercise if you feel very tired or are unable to talk easily. Remember that if you are more fatigued after exercises you should not increase the frequency of exercises and you may want to break up the exercises so that you complete five of the exercises in the morning and five in the afternoon. Stop any exercise that causes any sharp pain. If possible, exercise when someone else is close by. Start by completing the exercises once daily. After two weeks of daily exercises, and depending on how tired you are after exercising, you may increase the exercises to twice daily." David Guy, MS, CPT USA (ret). ***Guy is a retired physical therapist who has worked in multiple settings from the Army to universities. He has worked with polio survivors throughout his career. He now helps out with a polio support group in Arizona.***

Beginning Exercise

1. Seated on a chair with arms, place your hands on your knees, then, simultaneously, raise your arms overhead and breathe in deeply. Lower your arms and exhale. Complete five repetitions.

2. Seated in a chair with arms, stretch your arms straight in front of you and then, slowly twist your arms and your body to the left and then, to the right. Complete five repetitions.

3. Seated in a chair with arms, grasp the arm rests, lean forward and pushing down on your hands on the chair arms, try to lift your bottom off the chair. Complete five repetitions.

4. Seated in a chair with arms, lean back into the chair and try to lift your right knee up. Lower the right knee and do the same with the left knee. Complete five repetitions with each leg.

5. Seated in a chair with arms, lean back and try to straighten out your right knee and lift your foot up as high as you can. Lower the right foot and do the same exercise with your left leg. Complete five repetitions with each leg.

6. Rest for 20 to 30 minutes after completing the exercises.

Additional Exercises

1. Lying on your bed, lift one leg straight up as you are able without bending the knee

2. Lying on your bed, place a small rolled towel behind your knee and then try to straighten that knee.

3. Lying on your bed, bend both legs and place your feet so that they are flat on the bed. Reach with your hands up toward your knees and lift your head and shoulders.

4. Lying on your bed, bend both legs and place your feet so that they are flat on the bed. Move both knees as far as possible to the left and then to the right as far as possible.

5. Lying on your bed, bend both legs and place your feet so that they are flat on the bed. Reach with your hands up toward the left and twist your body to the left also. Do the same to the right.

6. Turn over and lie on your stomach. Put your arms at your sides and try to lift your head and shoulders up as far as possible.

7. Seated, pick up your leg and hold it up and then try to move your foot to the left and then to the right. If possible, keep your knee up without holding it up.

8. Seated move your knees apart and then together but keep your feet together and in place as you move your knees.

9. Standing and holding onto a counter, move the right leg as far as possible to the right. Make sure that the toes are pointing straight forward throughout the exercise. Do the same the left leg.

10. Standing and holding onto a counter, bend both knees about 30 degrees and no further. Straighten both knees.

Do all the exercises above 20 times, twice daily if you can. Remember to not get fatigued.

In addition, try to lie on your stomach and up on your elbows. Keep your hips down and in contact with the bed. Stay in this position for 20 minutes.

Flexibility and Breathing Exercises for Polio Survivors

1. Seated, reach first as far forward as possible and, then, simultaneously exhale and bend forward as far as possible. After bending forward, simultaneously reach up overhead and breathe in as deeply as possible. Very slowly complete 5 repetitions.

2. Seated reach up toward the ceiling and simultaneously inhale as deeply as possible. Exhale and bend to the right as far as you can. Straighten up again inhaling as you reach up. Then, exhale and bend to the left as far as possible. Complete three repetitions resting between each repetition.

3. Place both hands on your right knee. Keeping your hands together and elbows straight, reach with both hands up and out to the left side twisting your body to the left as far as possible. Lower your hands to your left knee and then, complete the exercise moving to the right. Complete three repetitions resting between each repetition.

4. Fold a tissue in half and then in thirds. Grasp the tissue at the top and hold the tissue three inches in front of the mouth. Purse your lips and blow out as hard as possible against the tissue attempting

to bend the tissue 90 degrees and to keep it bent at 90 degrees for a count of six. Complete 5 repetitions of this exercise and then rest for several minutes.

5. Place your hands below the ribs across the upper abdomen. Simultaneously exhale and compress the upper abdomen. Then, breathe in as deeply as possible and attempt to force your hands out. Release pressure on your abdomen as the downward movement of the diaphragm is felt. Complete 5 repetitions and rest for several minutes.

6. Seated fold your arms across your chest. Rotate your body to the right as far as possible and then to the left. Complete 10 repetitions.

7. Seated, pull your chin straight back and flatten the back of your neck pulling the ears directly over the shoulder joints. Relax after each repetition. Complete 10 repetitions.

8. Seated hold both arms straight ahead with the elbows slightly bent. Pinch your shoulder blades together toward your spine. Hold for a count of five and then relax. Complete 10 repetitions.

9. Sit in a chair with arms. Place both your hands on the arms of the chair and holding the head, neck and trunk still, straighten your arms and lift your buttocks 2-3 inches above the seat of the chair. Relax. Complete 5 repetitions.

10. Seated, try to blow up a balloon.