INTRODUCTION
You have been diagnosed with an acute nerve palsy due to an injury to the nerve. Palsy refers to weakness with the loss of muscle function, but there is also a loss of sensation with areas of skin numbness or tingling. The injury may range from mild to severe, but unfortunately there are not good tests to know the extent of the damage or to predict the potential for recovery. Most of the time, the nerve will recover well without surgery, but can take many months depending on the type and location of the injury. In general, nerves that are damaged with fractures or by stretching are intact and will heal at a rate of roughly 1 inch per month. While the nerve is healing, therapy is important to avoid muscle atrophy and joint stiffness and maximize functional recovery. If there are not clear clinical signs of recovery, nerve tests called EMGs can be done every 6 weeks to follow the healing process.

BACKGROUND
Nerves come from the brain, down into the spinal cord, and then branch out into the limbs. After they leave the spinal cord, the spinal nerves join together in the shoulder and the pelvis to form the brachial plexus and the lumboscaral plexus. Each plexus then divides to form the primary nerves into the arm and into the leg. The primary nerves into the arm are the radial, median, and ulnar nerves. The primary nerves into the leg are the femoral and sciatic nerves. The sciatic nerve branches into the tibial and peroneal nerves.

Nerve injuries are not common but do happen in a variety of accidents, including birth trauma, car accidents, falls, and gunshot or knife wounds. The mechanism of the nerve injury may be obvious with a knife injury but are often unclear after a fall or stretch injury.

The severity of the injury is a function of what parts of the nerve are damaged. The primary nerve cell is called a neuron which has very long arms called axons that carry the nerve signals. The axons are surrounded by supporting cells that create a coating of a special substance called myelin. Nerves are made up of multiple large groups of myelin coated axons, which are surrounded and protected by tough fibrous tissue.
Mild stretch injuries are the most common and are called neuropraxia (new-rah-PRAK-see-ah). The nerve is damaged enough to block function, but the nerve is not structurally damaged or torn. Neuropraxia is like being stunned or knocked unconscious. Within a short time, the nerve wakes up and gets back to doing what it is supposed to be doing. This type of injury recovers quickly, usually within a few days or weeks.

If the nerve is stretched more, the axon will be structurally damaged, but its fibrous sheath and myelin coating will stay intact. This type of injury is called axonotmesis. The part of the axon that is below the point of injury will die, but the upper part of the nerve cell will regrow the axon within the existing sheath and myelin coated pathway. This process is slow but quite reliable. The rate of growth is about 1 inch per month, so for an injury just above the elbow to the radial nerve, it may take 2-3 months for the radial nerve to regrow to the muscles of the forearm to restore wrist and finger extension strength and 8-12 months to regrow down to the back of the hand to recover sensation. If the injury is to the peroneal nerve at the knee, it may take 3-4 months for the nerve to regrow down to the muscles at the side of the leg to recover strength at the ankle to prevent the foot from dropping as you walk, and 8-12 months for the nerve to regrow down to the foot to recover sensation.

Severe stretch injuries disrupt the axon, the myelin coating, and sometimes the fibrous sheath. This type of injury is called a neurotmesis and has less chance of recovery. The degree of disruption can be complete with the 2 ends separated by a gap or the 2 ends may still be partly connected. Like the axonotmesis injuries, the part of the axon that is below the point of injury will die and the upper part of the nerve will attempt to regrow the axons. The recovery of nerve function depends on how well the new axons can cross the point of disruption. If the 2 ends of the nerve are still partly together, the axons may be able to find the pathways to regrow down to the muscles. If the gap at the disruption is narrow, some of the axons will be able to jump the gap and find pathways to regrow. If the gap is wide or blocked with scar tissue, the regrowing axons will get stuck in the gap and grow into a nest or ball called a neuroma. If at least some of the axons can cross the gap and reach the muscles, usually they can develop the capacity to control more of the muscle than normal axons. This means that even a small number of new axons can learn to control a big muscle and get fair to good recovery of muscle strength. It is also interesting that the axons don’t even need to find their original pathways. If an axon that used to control the biceps ends up growing down a pathway that controls wrist motion. The brain has the ability to adapt. This is called remapping and is part of the brain’s amazing "plasticity".
Other problems that limit how well the arm recovers relate to the muscle and joints. Muscles need nerve stimulation to stay healthy. If the muscles don’t get nerve stimulation within 12 to 18 months they may become fibrotic and they will not recover function even if the axon regrows down to it. Also, joints are dependent on motion to maintain the cartilage and smooth motion. If a joint is not moved appropriately, it can be stiff or may not grow properly. It is important to manually moving the joints and massage the muscles to prevent stiffness and fibrosis in the joints and muscles, while the nerves are recovering.

**DIAGNOSIS**

An acute nerve palsy will typically lead to weakness and some loss of sensation in the arm or leg. The location and severity of the nerve injury will determine the extent and location of the weakness and loss of sensation. The diagnosis is made by physical examination. The doctor may order an X-ray or magnetic resonance image (MRI) to see if there is any damage to the bones and joints. During the treatment process additional testing may use an electromyogram (EMG) or nerve conduction studies (NCS) to see if any nerve signals are present in the upper arm muscle.

**TREATMENT**

Most acute nerve palsies will show fair to good spontaneous recovery with time. While it can be difficult to wait and watch, this is typically the best first course of action. Early tests often do not provide any additional diagnostic or prognostic information. While waiting for signs of nerve recovery, supportive care is important. Initial treatment is to gently stretch and move the arm or leg to keep the joints and muscles in good shape, while waiting for signs of nerve recovery. If the site of injury is known, such as a fracture site, often the doctor can measure the distance from the site of injury to the nearest muscle and make a guess at the time for recovery of function in the muscle.

Within a few weeks, neuropraxia type injuries will be showing good to full recovery, but the more severe types may not. If there is not evidence of some recovery by 4-6 weeks, a nerve test should be done to further localize the injury and document current function. By that point, the test will show the loss of nerve function and denervation changes in the muscles, which will help to localize the injury, but will still not quantify the severity of the injury. Supportive care with physical therapy should continue to maintain the joints and muscles as well as possible.

If there is not evidence of recovery by 3-4 months, it is recommended to repeat the nerve test. If there is no evidence of progress between the first and the second nerve tests, surgery is sometimes recommended to visualize the nerve and remove any scar tissue that may be blocking the healing process. If there is a densely scarred area or the nerve is severed, some times the area will be resected and healthier nerve ends re-approximated or a nerve graft can be inserted between the ends. Removing the scar tissue or inserting a graf doesn’t fix the nerve, but by removing barriers, the nerve can more effectively regrow the axons and gradually recover. This
The type of nerve surgery is best done 6-9 months after the injury. The reason for this is that muscles need nerve stimulation to maintain their integrity and function. If the muscles go for more than 12-18 months without nerve stimulation, they will often become scarred and not recover function even with recovery of the nerve. This means that surgery at 6-9 months after the injury still leaves 6-9 months for nerve recovery reaching the muscle in time for the muscle to maintain function.

**EXPECTED OUTCOMES AND COMPLICATIONS**

Because your arm or leg cannot move normally, it is important that you take an active part in keeping the joints limber and the functioning muscles as fit as possible. Your doctor will recommend physical therapy and range of motion exercises. Do these exercises every day, two or three times a day. The exercises will maintain a range of motion in joints and prevent the joints from becoming permanently stiff, a condition called a joint contracture.

The timing and extent of nerve recovery depends on the location and severity of the damage. Most of the time there is good functional recovery. Prior to recovery, the muscle will get weaker and smaller. Sometimes, the affected arm or leg will be noticeably smaller until the muscle gets back in shape or sometimes permanently if nerve recovery was not complete.

**MORE INFORMATION**

Further information can be obtained on the internet. Your local public library can help you explore these sources if you are interested. Two good sites for expert and peer reviewed information are the American Academy of Orthopedic Surgeons at www.aaos.org and www.emedicine.com.

**FEEDBACK**

If you have questions or comments, please contact the office or submit them to the web site at www.pedortho.com.