

# Understanding peripheral nerve injuries of the arm and hand

The purpose of this information leaflet is to help you understand the implications of your nerve injury and the pattern of recovery you can expect. The recovery from nerve damage is a long slow process – you need to become an expert in your own condition in order to achieve the best possible outcome in the long term.

Note:

For the purposes of this leaflet, your therapist will be described as “she”.

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The evidence used in the preparation of this leaflet is available on request. Please email: [patient.information@salisbury.nhs.uk](mailto:patient.information@salisbury.nhs.uk) if you would like a reference list.

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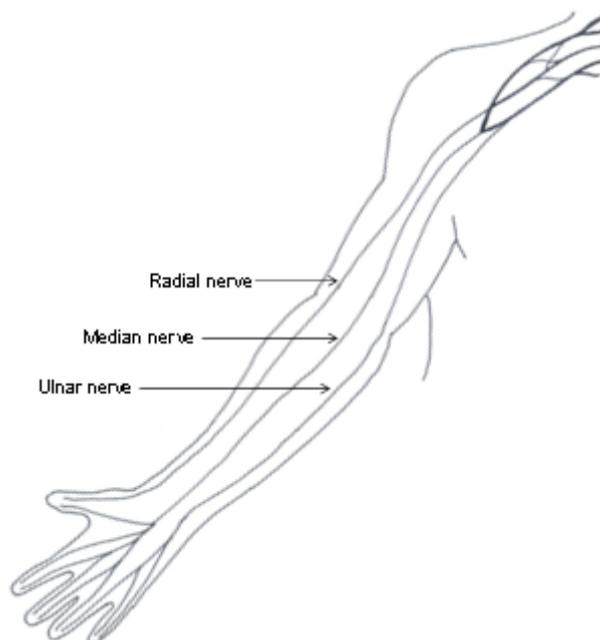
## Peripheral nerve injuries of the arm and hand

The peripheral nervous system refers to the nerves of your body beyond the nerves of the brain and spinal cord. The peripheral nerves branch out from the spinal cord and travel down your arms and legs to your hands and feet.

There are three main nerves in the arm.

These are:

1. the radial nerve
2. the median nerve
3. the ulnar nerve

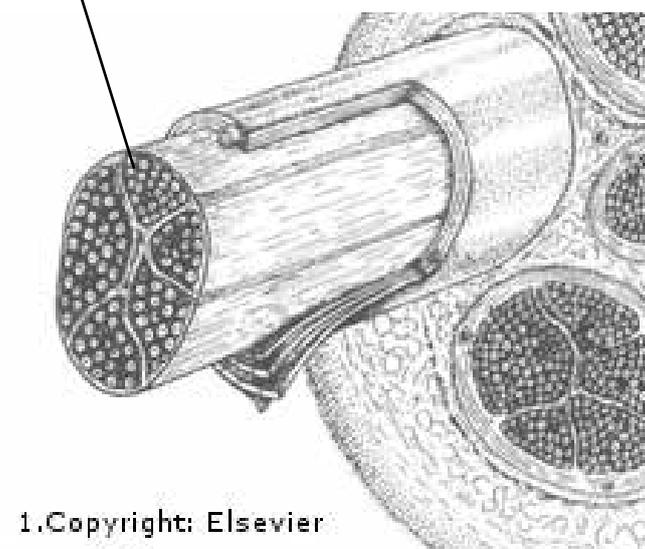


Each nerve supplies a particular group of muscles to give movement, and a particular area of skin to give feeling. If there is damage to any of these nerves we know what the pattern of loss in movement and feeling (sensation) will be. This will be different for each nerve and will also vary depending where along the length of the nerve the damage occurred. The nerve may be damaged at the level of the fingers – this is known as a digital nerve injury. Injuries can occur to one or more nerves. You need to understand from your hand surgeon and therapist which nerve, or nerves, you have injured.

### What is a nerve?

Nerve fibres

Within the nerve there are nerve fibres which are around the same thickness as human hair and form the ‘telephone wiring system’ that carries electrical impulses back and forth between the brain and different parts of the body. Each nerve fibre has its own insulation layer – a tube-like structure, called the myelin sheath.



The structure of a nerve is well illustrated by an electric cable. The nerve fibres are similar to the copper wires, grouped together into bundles. These bundles are covered in an insulation layer, like the blue, brown and green/yellow bundles in an electric cable. The bundles are grouped together and are also covered by an outer insulation layer – similar to the outer black or white insulation layer in an electric cable - which protects the millions of individual nerve fibres grouped inside.

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**Motor nerves** carry electrical impulses to the muscles to make them contract and move – the electrical supply is plugged into the muscle by nerve endings which are called motor receptors.

**Sensory nerves** carry electrical impulses to the brain and send information about sensation, pain, temperature and pressure; they are connected to the skin by nerve endings called sensory receptors. While an individual nerve fibre can carry only one type of message - motor or sensory - most of the main nerves in the arm are made up of a mixture of these types of fibre.

## What happens when a nerve is damaged?

Nerves are fragile and can be damaged by crushing, stretching or cutting. There are three basic types of injury to a nerve:

1. The nerve is bruised or squashed but the outer layer of the nerve and inner nerve fibres remain intact. The nerve stops working properly for some time – usually only a few weeks. This is called a neurapraxia.
2. The nerve is crushed, damaging the inner nerve fibres but leaving intact the outer layers in both the nerve bundles and the nerve. This is called an axonotmesis.
3. Both the nerve fibres and the outer layers of the nerve bundles and nerve are cut. This is called a neurotmesis.

When the nerve is damaged, the nerve fibres above the injury (that is the ones closer to the brain) continue to work as normal but the nerves below the injury die, leaving empty myelin sheaths. Over time nerve fibres should re-grow from the undamaged nerve back down the empty myelin sheaths. For the hand to work well the nerve fibres have to grow until they reach a muscle or sensory receptor in the arm and hand.

## Our brain's response to a nerve injury

Your hands are one of the main sensory areas within your body, being used every day to give you information about your environment and as a protection mechanism against potential harm, such as sharp objects or heat. The brain makes sense of the sensations that the hand is feeling and then responds as necessary. An example of this would be if your hand touched a hot iron; a message would be immediately sent via sensory nerves to your brain, which would interpret this as threatening and respond by sending a message to the muscles in your hand, causing you to withdraw it from the hot iron, to prevent injury.

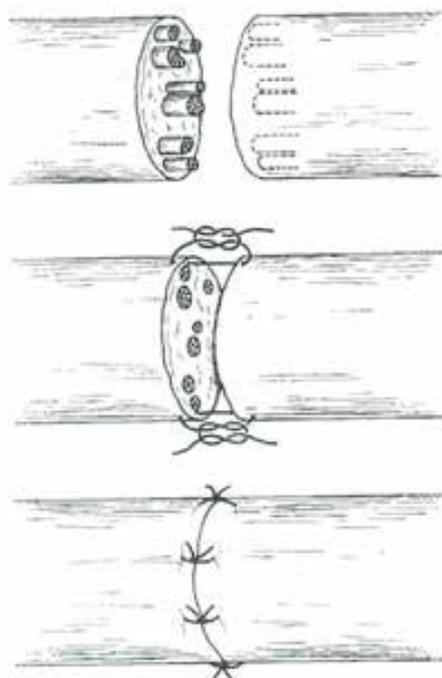
All of these messages are dealt with on the motor and sensory area of the brain called the cortex. Each part of the body has a dedicated space on the cortex – your hands use a large area of this cortex – much larger than the area used by your legs. This is especially so on the sensory cortex, because your hands provide you with so much touch information about your world. If we were to draw a picture of our brain's impression of our body, it would look like the image to the right.



When the nerve fibres to your hand are damaged and are not working properly then the messages stop going to your brain. Your brain is very adaptable and will re-organise the cortex when this occurs, resulting in a reduction of the hand area. This allows the surrounding areas on your virtual body to 'invade' this area of the cortex. During the recovery period, your therapist will want you to keep the hand area of the cortex active and alert to keep this space active so that it is available for use once your nerve fibres have re-grown. To achieve this, your therapist will teach you exercises to help to prevent the shrinking of your virtual hand area in the cortex. However, as your nerve fibres start to recover the original electrical pathways will be muddled and the new sensory messages confused. An example of this is that patients often report that when touching or washing their hair it feels very rough and bristly rather than smooth, as it should. Over time, your brain will re-learn how to use your hand again and make sense of these new sensations. This re-learning is a normal process and with the right training you can learn how to help your brain to correctly interpret sensations. This training will be directed by your therapist and will take place during the early and later phase of nerve recovery.

## How is a nerve repaired?

The outer layer of the damaged nerve ends will be sewn together. The surgeon will line up the ends of the nerve repair so that the fibres and empty sheaths match up with each other as well as possible. This repair may need to be protected in a splint for a few weeks after surgery to allow proper healing.



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## How do nerves re-grow and recover?

The nerve fibres start to re-grow across the repair site after three to four weeks. They grow back down the length of the empty myelin sheaths at a rate of about 1mm per day (1 inch per month).

The series of pictures below demonstrates the process of nerve injury and recovery in an ideal situation:

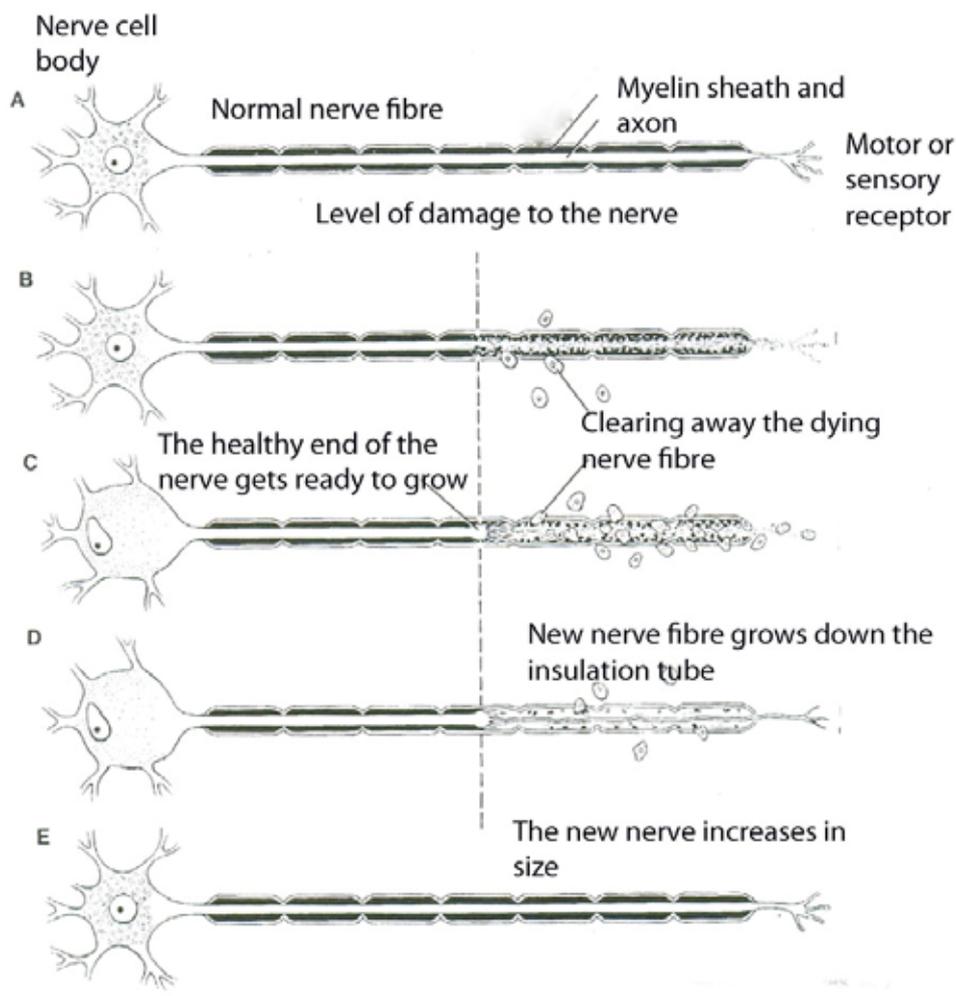
A. A normal nerve fibre with outer myelin sheath intact.

B. The same nerve fibre shortly after injury. The inner nerve fibre is starting to die back and specialist cells clear away the debris.

C. Several sprouts of new nerve fibres can be seen emerging from the site of injury.

D. Over time one fibre grows down the myelin sheath to reach the motor or sensory receptor.

E. After successful contact with a receptor both the outer myelin sheath and inner nerve fibre increase in bulk and fully regenerate.



However, re-growth of the nerve fibre is a difficult and hazardous process. The fibres do not necessarily grow down the correct myelin sheath, leading to a mismatch of the pre-injury connections. Very few people achieve a 100% recovery. Progress can be hindered by a number of factors including:

- **Scar tissue** – scar tissue can prevent the re-growth and passage of new nerve fibres. The more scar tissue you have the more likely the nerve fibre is to get lost.
- **Your age** – children can expect a very good recovery, especially before the age of six. After the age of twenty years, recovery will be reduced. The likelihood of recovery reduces as you get older and is very poor after the age of sixty .
- **The level and type of injury** i.e. how much of the nerve has been damaged. The more nerve damage that has occurred, the worse the outcome. This means that the extent of

nerve damage and the higher up the arm the level of injury is, the worse will be the long-term outcome.

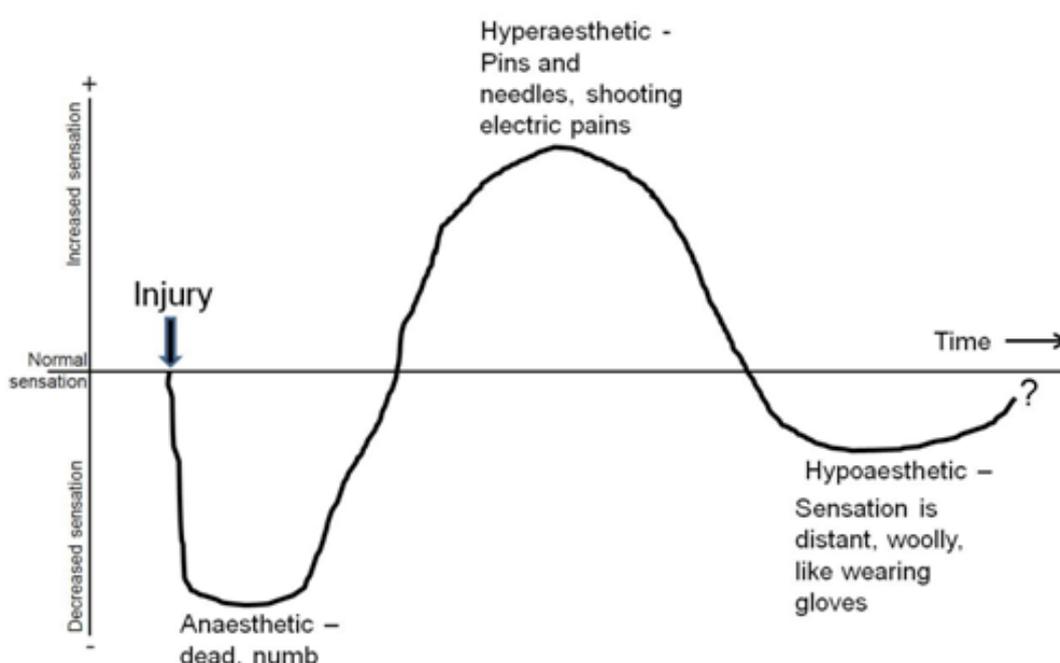
- **Smoking** reduces the blood supply to the hand and arm resulting in less oxygen and nutrients for the recovering nerves.
- **Poor diet and nutrition** affects healing. Make sure you eat a good healthy balanced diet with protein, fruit and vegetables.
- Recovering nerve fibres may form into a ball at the site of the cut nerve, creating a nerve scar called a '**neuroma**' – this can be painful and cause an electrical tingling feeling when touched.

However, you can help your nerve to recover by:

- Not smoking
- Eating a good healthy balanced diet
- Learning how to use your hand, even though you cannot feel anything.

A famous hand surgeon called Göran Lundborg, describes learning to use the hand again following a nerve injury as like having to learn a new language – the hand “speaks a new language to the brain”.

As your sensory nerve fibres re-grow you will experience many different sensations in your hand



from numbness to pins and needles and ‘electric shock’ type sensations. These are common, and whilst they can be uncomfortable, they are a good sign of sensory recovery. The diagram below helps to illustrate patients’ experiences of the process of sensory recovery:

Motor function allows you to move your muscles and

use your hand; recovery of this ability will be a slow process following nerve injury. Initially the muscles which are supplied by your damaged nerve will not work at all, but as the nerve starts to recover you will notice gradual flickers of movement returning. Your therapist will teach you exercises to help you re-learn how to use these muscles effectively and may also make specialist splints which will help you to continue to use your hand for everyday tasks.

The whole process of nerve re-growth and recovery is extremely slow. We expect most of the recovery to have happened after five years. However there are many therapeutic tools and everyday activities which you can use to make the best possible recovery.

## How do we assess nerve damage?

Nerves have three main functions:

1. **Motor** – providing an electrical supply to the muscles.
2. **Sensory** – receiving feelings from the hand and arm – sensation.
3. **Autonomic** – these are best described as the ‘automatic’ functions in the hand and arm and cover tasks such as blood flow, hair growth and sweating.

At the beginning of your treatment your therapist will want to assess your nerves to find out which nerves are working and how much they are working. This is very much like an electrician trying to find an electrical fault in your house. This first assessment forms a baseline from which the recovery of your nerve can be charted. Your therapist will expect to see evidence of slow but steady recovery in your nerve over a long period of time.

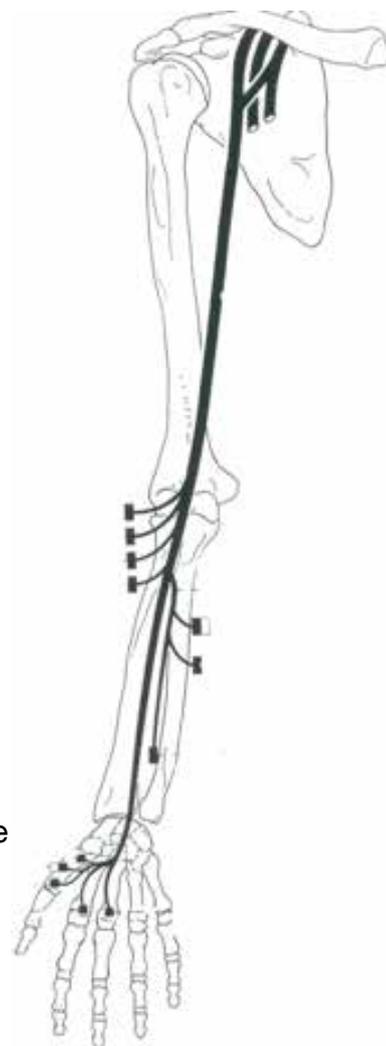
It is quite common for some of the functions of the nerve to return before others, such as sweating function to return before muscle activity. Your therapist can assess all of these functions.

## Assessment of motor recovery – movement

Your therapist will have a ‘road map’ of the muscles that are supplied by your nerve. Different muscles are supplied with nerve impulses along the length of your nerve – these are known as the motor points along a nerve. The muscles that are supplied above the level of damage (that is nearer the brain than the injury site) will have normal movement and strength. The muscles below the level of damage will not. An example of the “road map” for the median nerve is shown here.

As the nerve recovers, there will be evidence of muscle activity progressing down the arm and hand. A useful way of imagining this is to think about a train travelling along the railway line from London to Exeter. London is equivalent to the spinal cord, and Exeter to the small muscles of the hand. A signal man would be able to track the progress of the train along the railway line – clearly seeing when the train has passed through each station. The signal man could measure the speed of the train or see if the train was stopped part way along the line.

In the same way, your therapist can chart the re-growth and recovery of nerve fibres along the length of your nerve, by looking for the activity of each muscle along the nerve. This is a painless examination but it can be very frustrating, because your therapist will



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ask you to attempt the specific movement that is performed by each muscle. Your therapist will first use your uninjured hand or arm to teach you how to perform the movement. She will also use the uninjured arm to assess your normal muscle strength. Your therapist will then ask you to attempt the movement in your injured hand or arm. She will be feeling the muscle, trying to detect muscle contraction and watching any movement that you can perform. In the early stages of recovery the muscle contractions can be very small – it is like feeling for the movement of a mouse under a blanket!

Your therapist will grade the muscle activity using a system of measurement called the Oxford Muscle Grading. For your information the grading is described below:

- 0 No contraction
- 1 Flicker or trace of contraction
- 2 Active movement with gravity eliminated
- 3 Active movement against gravity
- 4 Activity movement against gravity and resistance
- 5 Normal power.

This assessment demands good concentration from both you and your therapist. It is quite normal for you to try to use the muscles that are working but this can hide the level of activity in the muscles affected by the nerve damage. Your therapist may need to keep repeating this test until she is sure that she has been able to make an accurate assessment. The results of this assessment will be documented on a chart. It is useful to reassess you every 3 – 6 months in the early stages and then every year. Assessment is usually stopped after five years as no more recovery is likely after this length of time.

## **Assessment of sensory recovery – sensation**

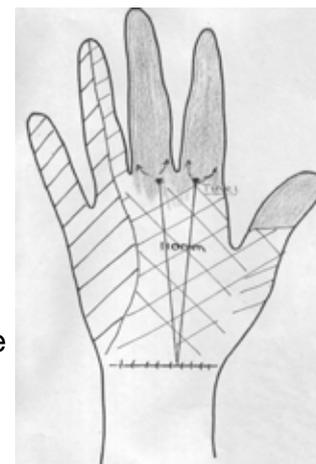
Sensation is a complex experience involving many factors such as awareness of pressure, temperature, shape, texture, joint movement. Sensation gives us the ability to recognise objects that are hidden from view. This is very important in many aspects of daily life for example working behind a screen or working in the dark. Craftsmen such as plumbers and car mechanics frequently have to rely on what they can feel rather than what they can see. Full appreciation of sensation also relies on the ability to manipulate objects in the hand so that the hand can explore different aspects of an object. A famous hand surgeon called Moberg said that “without sensation the hand is blind”.

When we think about recovery of sensation we use the concept of ‘quantity’ and ‘quality’ of sensation. In the early stages we can assess the quantity of sensory recovery; in the later stages of recovery we can assess for the quality of sensory recovery. Your therapist has a range of assessment tools available that can assess all these levels of complexity.

In the early stages of treatment and recovery, the easiest method of assessing quantity is to measure your ability to recognise pressure on your hand. This is



a painless examination in which your therapist uses small nylon filaments of different thicknesses, which are touched against your skin. The test is performed with you blindfolded and you are asked to say whether or not you can feel the different filaments. At the end of this assessment the therapist converts the results into a coloured diagram of your hand which clearly illustrates your level of sensation. It is helpful to repeat this test every 3 – 6 months in the early stages. In the later stages when sufficient sensation has returned, it may be possible to start using the more advanced sensory assessment tools. As with muscle charting, sensory assessment is usually stopped after five years as no further recovery is likely after this length of time.



## **Assessment of the autonomic nerve function**

There is no quick practical way to measure sweating function, hair growth or blood flow in the hand. Your therapist will therefore not measure these factors but will comment on them. One of the aspects she will be especially interested in is cold intolerance. Cold intolerance is a painful response to cold environments. She will ask you to rate your experience of cold intolerance on the following scale:

- 3 None or a minor problem
- 2 Moderate problem
- 1 Disturbing problem
- 0 Severe problem - it stops you from doing what you want to do.

Your therapist will use other assessments to measure your range of movement, grip strength and hand function. All of these assessments enable you and your medical team to monitor you against your expected recovery.

Nerve conduction studies can also be used to assess recovery of the nerve. This procedure will be performed by a neurophysiologist. It involves placing an electric stimulator over a nerve and measuring the time taken for an impulse to travel over a specific segment of the nerve. Some patients find this procedure quite uncomfortable. Nerve conduction studies would probably only be used if there was concern that your nerve recovery was not progressing as well as expected.

## **Therapy treatment for nerve injuries**

The therapy for your nerve injury will also take into consideration any other injuries you may have sustained at the same time such as injury to the tendons, ligaments, joints and bones. The healing of these other structures may govern the treatment of your hand in the early stages. After 6 – 12 weeks these other structures will have healed. However, your nerve will take much longer, with healing taking place over 1- 5 years. After major hand injuries most patients regain good recovery in the tendons, giving movement and grip. For most patients, the long term

problems relate to the damage that has occurred to the nerve. This often results in problems with:

- Loss of dexterity and manipulative skills in the hand.
- Loss of full sensation in the hand.
- Cold intolerance.

The therapy in relation to the nerve injury is directed towards five main goals:

1. Maintenance of the soft tissues around your joints, such as ligaments, tendons, and small muscles, whilst waiting for possible recovery of muscle activity.
2. Learning how to care for a hand that has little or no sensation.
3. Learning how to encourage every possible sensory recovery.
4. Learning how to use your hand again.
5. Learning how to live with cold intolerance.

All of these therapy goals rely on you understanding about nerve function, nerve damage and the process of recovery. This understanding is a key factor in your treatment so that you become an expert in your own condition.

## Goal 1: Maintenance of your joints

Based upon the nerve damage that has occurred, the changes in your joints and muscles that you will notice, are easy to predict. Your therapist will be able to describe these for your specific case. However, given below are some basic principles in the maintenance of joints following nerve injury.

When there is damage to a nerve, the muscles supplied by that nerve will be paralysed, until (and if) the nerve recovers sufficiently to restore an electrical supply to the muscle. There is no therapy that can be used to maintain muscle strength during the period that the muscles are paralysed. We expect to see the muscles waste away. You may notice that your arm becomes thinner and hollows develop in your hand where the small muscles used to provide shape and bulk. This is more evident in people who have naturally skinny hands. You will lose movement in the joints worked by those muscles – this is called loss of active range of movement. Active range of movement is the movement that can be achieved by unassisted voluntary movement.

You will, however, continue to use the muscles that are working normally. This will result in an imbalance between the normal muscles and the paralysed ones. This can lead to some typical patterns of deformity. For example; after damage to the radial nerve it may become impossible to raise the wrist. However, the wrist can still bend down and the fingers are still able to grip. This leads to a pattern of deformity called 'wrist drop'.

Whilst the joint is unable to move actively through its normal full range of movement, there is a risk that the ligaments, which support the joint, could become

shortened. If the joint itself becomes stiff and cannot move freely this is known as loss of



passive range of movement. Passive range of movement is movement of the joint by an external force. It is important to keep the joints supple so that if, and when the muscle recovers, the joint is able to return to normal active movement. You will be taught by your therapist how to apply this external force to yourself, so you can keep the full passive range of movement in your joints. These are known as passive stretches. It is helpful if someone else can also do this for you occasionally. In this case your therapist will teach your partner or friend how to do these stretches.

In the same way that joint ligaments are at risk of becoming tight, paralysed muscles and skin can also become contracted and shortened – especially around the thumb web space. As well as being taught passive stretches for your joints, you will also be taught passive stretches for muscles and other soft tissues.



Joints, muscles and other soft tissues can also be maintained by using splints. These are usually made for you by your therapist, with very specific treatment goals. For example, following an ulnar nerve injury, the ring and little fingers can rest in a bent posture, due to muscle imbalance. As a result the finger joints are at risk of becoming stiff and unable to fully straighten. A simple splint used

at night can ensure that the full range of movement of these joints is maintained.

## Goal 2: Learning how to care for your hand

Without sensation you are at considerable risk of damaging your skin by burning, pressure and friction. You will lack the normal warning signals of pain that alert you to tissue damage. Clearly this is a big problem, especially if there is an extensive loss of sensation in the hand, such as following an injury to both the median and ulnar nerves.

Because of the loss of normal autonomic nerve function in your hand, you will also notice changes in the texture of your skin. Skin that has no nerve supply loses normal sweating and becomes dry. In your finger tips you will notice that you lose your finger prints. It will become difficult to pick up small items which will feel slippery – everything will feel like trying to pick up silk. The loss of sweating increases the risk of injury from burning as dry skin will burn even quicker. This means that everyday activities that you used to be able to do safely, now become a risk of burning, such as holding a mug of hot coffee, eating fish and chips by hand.

You will need to learn to think about the risks of every activity. You will need to check your skin condition regularly, looking for signs of redness or blisters. If you have areas of intact sensation in your hand you will need to learn how to use these as a clue to the possible risk of developing tissue damage in areas without sensation. Sadly, most people with a significant amount of sensory loss in the hand experience one deep burn before they truly appreciate how easy it is to burn skin that has no sensation. Due to the changes in autonomic function, any burns will take much longer to heal than normal.

Dry skin can be helped by regularly moisturising. Many creams are suitable for this task, especially those with reduced perfumes such as E45 cream, aqueous cream. To avoid burning, be sure to use sun creams (50 factor plus) when going out in the sun.

Depending on your nerve damage, you may notice other changes in your hands and nails, which cannot be controlled. This is most common in people with injuries to the median and/or ulnar nerves. You will lose the natural fat pads in your hand, especially around the pads of your fingers – you will notice this as your fingers become thinner. It is common for nails to become ridged and brittle. You may notice that the skin in the area of your hand without sensation is a different colour – it may appear red or mottled. These are common observations and nothing to worry about. It is often possible to ‘see’ the area of sensory loss, by these changes in skin texture and appearance. All these changes are due to the alteration of the autonomic nerves in the hand and skin.

In the normal course of recovery, one of the first aspects of sensation that returns is an awareness of pain and recognition of cold. Recognition of heat comes a little later. Many people recover enough sensation to give them at least some ability to protect their hand from damage – this is known as protective sensation. Many people learn how to assess that, if an object does not feel cold, it could well be hot and therefore they need to check.

### **Goal 3: Learning how to encourage sensory recovery**

The aim of sensory re-education is:

- To help maintain the area on the sensory cortex in the brain that is dedicated to the hand.
- To maximise and encourage sensory recovery of the hand.

Much of the re-learning process is achieved by using your hand in everyday activities, using your eyes and vision to guide your hand and to help you to understand your sensations. However, to enhance this process further there are specific exercises for sensory re-education, which you can use with guidance from your therapist.

**Early Phase – when you have little or no sensation in the injured area of your hand.** To keep the image of the hand within the brain’s sensory cortex you need to give your brain the illusion that your hand has sensation. During this period, your hand may be in splints and you will be unable to move it. These exercises focus on imagining feeling and movement. You can do this with the following exercises:

- Imagined movements – imagine moving your hand into different positions and grips to create a strong visual picture in your head.
- Watch other people using their hands during everyday tasks. Think about the feeling of normal touch when handling different textures, objects, shapes, weights and temperatures.
- Whilst watching and concentrating on your hand, use your uninjured hand to touch or tap the areas of your injured hand or arm that have no sensation.
- Whilst watching and concentrating on your hand, ask someone else to touch the areas of your injured hand or arm that have no sensation.
- Stroke different textured materials across your hand and think about how each one feels, such as soft, fluffy, scratchy, rough.

Your therapist may also teach you how to use mirrors to trick your brain into thinking your injured hand can feel.



The ability to manipulate and move small objects within the hand is a big problem after injury to the ulnar nerve. This injury results in loss of dexterity in the hand. This makes tasks such as handling money and sorting out change very difficult. If this is your problem you will need to use change how you do things, for example swapping money into a different pocket. Many people have to learn to undertake dexterous tasks with their non-dominant hand and find themselves becoming ambidextrous after injury to their dominant hand.

Sometimes special hand splints can be used to help improve hand function. In some cases a simple splint can lead to a great improvement. For example, after damage to the radial nerve, which results in a wrist drop, a simple wrist brace will significantly improve hand function. However, splints have limited value in restoring complex dexterity skills to a hand. Splints may be useful in helping to solve hand function in relation to a specific activity. You should discuss this with your therapist.



It has to be said that the best way for you to learn to use your hand again is through determination and practice from the beginning. You will have to accept that at first it will take longer to do activities and you will get frustrated by how clumsy and slow your hand has become. However, your brain has a tremendous capacity to relearn. But, be warned – your brain can also learn how not to use your injured hand. If you do not learn how to use your injured hand from the very beginning, it is very difficult to do this later. We strongly believe that the earlier you learn to use your hand; the better will be your long term outcome.

Most patients return to their original job after nerve injury, although they may need some adaptations, possibly special equipment, and general support from their employer at first. Your therapist will be able to help you consider the specific tasks you need to do at work and how to solve any difficulties. It may well be helpful for you and your therapist to visit your place of work. This will enable you to discuss possible problems with your employer. It will also help your employer to understand the nature of your injury and what you will and will not be able to do.

Some people cannot return to their original job, especially where the physical demands are high, for example the need to work at speed or in cold environments. In these situations it may be necessary to explore options for alternative work within the same company. For a few people, this may mean a new career and taking advantage of retraining opportunities. If this is necessary, you can get help from The Disability Employment Advisor at your local job centre. Your local training college will be able to tell you about access to an adult careers advisor.

## **Goal 5: Learning how to live with cold intolerance**

Cold intolerance is a common complication of nerve injury. On exposure to a cold environment you may experience pain, discomfort, stiffness, pins and needles, tingling or changes in skin colour. One or more of these symptoms may be present. Cold intolerance is an abnormal reaction to cold and an exaggerated response to a cold environment. Some patients report

that these symptoms can occur with mild cold, when handling cold objects or with a change of temperature. Examples of this are standing under a shady tree on a hot day or wind blowing over the hand.

Most patients experience cold intolerance problems during the first winter following their injury. For some people, this may be some months after the original injury and can come as an unpleasant surprise. Patients need to be reassured that it is a common problem and does not indicate that anything is going wrong with the recovery of the hand.

## **How long will cold intolerance last for?**

It is very difficult to predict how long you will suffer from cold intolerance. For some patients cold intolerance may be a problem for only the first winter after their hand injury. Other patients may continue to experience cold intolerance for many years or even the rest of their life, although possibly with some reduction in the severity of symptoms. Smoking is more likely to make the problem worse, because smoking reduces the blood supply, especially to the hand.

## **What can I do to help myself?**

The main way that you can help to reduce the symptoms of cold intolerance is by keeping warm – keeping both your hand and your body warm. It is important to wear enough clothes to keep your body warm, such as body warmers, thermal vests, wool jumpers. This may be more than you would normally wear. If you keep your body warm, your body will not need to divert the blood supply from your arms and hands to keep your internal organs warm. This will ensure that the blood supply to your hand is maintained.

Thermal insulating gloves will help to keep your hands warm. There are many types of gloves available, especially from outdoor shops such as garden centres and fishing shops. However, there are also specialist gloves including silver gloves, neoprene gloves (used by divers) and electrically heated gloves. You will need to experiment with all the different options to find a type that works for you.

Heat pads can be a very convenient way of warming up your hand. There are different styles of heat pads that are readily available from outdoor shops and chemists. Most of the heat pads work by pressing a small button on the pad which sets up a chemical reaction. The chemical reaction releases heat for a period of 20 – 30 minutes, which can be enough to give some relief from pain symptoms. The pads are usually designed to be re-useable for example by boiling them up in a pan of water. However, caution must be taken to avoid burning areas of skin that lack feeling.

Cold intolerance can have a major impact on the use of your hand. If the problem is persistent and long term you may need to reconsider your employment and hobbies.

## **Long-term expectations and outcome**

We have already discussed the factors that will determine your long term outcome and recovery from your nerve injury. All these factors mean that it is very difficult to predict the outcome and that recovery from nerve injury is an individual journey. However, there are some milestones along this route, although the timings given here are very approximate.

**Anaesthetic Stage:** In the early stage of recovery, your hand or area of skin affected by the nerve injury, will feel completely numb – patients often describe this as ‘feeling dead’. However, you should expect to see signs of nerve regeneration about six weeks after surgery. To begin with you may experience pins and needles or shooting electrical type pains. The shooting pains are most likely to happen when you are resting or tired. They often occur when your brain is not busy with other tasks. Whilst these may be painful and uncomfortable, they are a good sign that the nerve is beginning to regenerate.

**Hyperaesthetic stage:** During this stage, you will gradually note the return of sensation to the affected skin – patients often describe this as ‘life returning’ to the hand. However, the sensation that returns first will not be normal, but will feel like pins and needles. Patients often describe this as similar to the sensation you have as feeling returns to a ‘dead’ limb such as after you have sat awkwardly on your leg or slept awkwardly on your arm. Over a period of time the pins and needles will increase until they are at their worst. It must be stressed that although this is unpleasant, it is a normal stage in the process of nerve recovery. It is almost as if the nerve is sending electrical impulses along a fibre that has no insulation and the nerves are ‘shorting out’. It is very important that you learn to touch and use your hand during this period, despite the disturbing sensations. You must learn to view these feelings as your friends – they are giving you the chance to begin to communicate with your hand.

During this stage you will probably begin to develop the awareness of items that are cold such as metal spoons. However, be warned – that does not mean you will be able to detect objects that are hot or feel degrees of heat. Many patients learn to work out that if an object does not feel cold, it may be hot. You will need to take great care during this time that you do not burn your skin. During this stage you should also develop the perception of pain. This should give you protective sensation and enable you to respond to tissue damage. However, be warned - these pain responses are much slower than in a normal hand, so you can still damage the areas of skin that cannot feel.

The hyperaesthetic stage is usually worst about one year after injury. It may last from around 6 months to two years.

**Hypoaesthetic stage:** This stage often occurs from about two years onwards. During this stage the intensity of the pins and needles reduces and patients often describe the feeling in their hand as ‘distant’ or ‘woolly’ – rather like feeling everything whilst wearing gloves. We hope that during this stage the quality of your sensation will improve. However, as time goes by the sensory receptors in your skin will have deteriorated. Even if the electrical supply has been restored, the receptors may no longer be in a good condition to work fully again.

Sensory recovery in this stage will start to give you the ability to identify different textures such as rough or smooth. However you will find that you naturally learn to use all sorts of tricks to identify objects for example by the sound they make. Slowly you will learn to identify objects that are similar in shape, such as a coin and button. You will also get better at identifying heat and the shape of objects. As your sensation improves it will get easier to use your hand without sight such as in the dark or behind an obstacle.

The quality of sensation gradually improves up until about five years after injury and repair of the

nerve. You are unlikely to get a completely full recovery in sensation.

**Muscles:** All the factors that apply to recovery of the sensory receptors in the skin also apply to the muscles in the hand and arm. In the early stages the muscles without a nerve supply will wither and waste. As time goes by, the muscle tissue is gradually replaced by fibrous tissue. After about three years after injury, it is very difficult for muscles to recover from this process, even if the nerve supply to the motor receptors is restored.

If the muscle is re-innervated, recovery will be shown, by very small flickers of activity (twitching) in the muscle tissue. Gradually the muscle will be able to move the joints more, although without any strength – movement will come back before power. Slowly the power will return to the re-innervated muscle, although restoration of full power is unlikely. We can generally be more hopeful about getting back normal movement in the muscles of the forearm – giving wrist and finger/thumb movement, than in the small muscles of the hand, which give dexterity.

Likewise, after five years any further improvement in muscle activity is unlikely.

In the longer term it may be useful to consider reconstructive hand surgery to help compensate for permanent loss of movement. It is possible to take uninjured muscles or tendons that are working normally and transfer them to take over the action of the paralysed muscles. However, it is very difficult to fully restore normal movement and you have to consider what you would also lose by doing this. Your therapist and hand surgeon would help you to consider the issues involved, based on careful assessment.

## Conclusion

You will now begin to understand that recovery from a peripheral nerve injury is a complex and slow process. You will be the most important person in determining your long term outcome, although you will have to work within the limitations imposed on you by nature. For this reason you need to fully understand the process of recovery so you can become an expert to manage the journey ahead.

However, don't forget there are other people to help you along the way. You will need to seek support from family, friends, and your hand surgeon and hand therapist.

## Contact details

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1. Nerve injury and repair 2E, 2004, (ISBN 9780443067112), Lundborg Ed, pp 32, Fig 3-5.
2. Principles of hand surgery, 1990, (ISBN 9780443034664), Burke Ed, pp 149, Fig 8.5.
3. Neuroscience: a clinical perspective, 1980, (ISBN 9780721691169), Werner Ed, pp 172, Fig 14-2.
4. Aids to the examination of the peripheral nervous system 4/E, 2000, (ISBN 9780702025129), pp 24, Fig 35.