



# Understanding Peripheral Neuropathy in Myeloma



INTERNATIONAL  
**MYELOMA**  
FOUNDATION

12650 Riverside Drive, Suite 206  
North Hollywood, CA 91607 USA

Telephone:

**800.452.CURE**  
(USA & Canada)

**818.487.7455**  
(worldwide)

Fax: **818.487.7454**

**TheIMF@myeloma.org**

**myeloma.org**



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**Founded in 1990, the International Myeloma Foundation (IMF) is the first and largest organization focusing specifically on multiple myeloma. The IMF's reach extends to more than 525,000 members in 140 countries worldwide. The IMF is dedicated to improving the quality of life of myeloma patients while working toward prevention and a cure through our four founding principles: Research, Education, Support, and Advocacy.**

**RESEARCH** The signature project of the IMF's Research division is the Black Swan Research Initiative®, a groundbreaking and collaborative effort to develop the first definitive cure for myeloma. Each year, the IMF also awards Brian D. Novis Grants, which promote research for better myeloma treatments, management, and practices in the field. In addition, more than 200 leading myeloma researchers comprise the IMF's International Myeloma Working Group (IMWG), a research body that has developed myeloma guidelines that are followed around the world. Finally, the IMF's Nurse Leadership Board (NLB), comprised of nurses from leading myeloma treatment centers, develops recommendations for the nursing care of myeloma patients.

**EDUCATION** The IMF Patient & Family Seminars and Regional Community Workshops are held around the world to provide up-to-date information presented by leading myeloma specialists and researchers directly to patients and their families. The IMF's library of more than 100 publications, for patients and caregivers as well as for healthcare professionals, is updated annually and available free of charge. Publications are available in more than 20 languages.

**SUPPORT** The IMF's InfoLine is staffed by information specialists who answer myeloma-related questions and provide support via phone and email to thousands of families each year. In addition, the IMF sustains a network of more than 150 myeloma support groups and offers training for the hundreds of dedicated patients, caregivers, and nurses who volunteer to lead these groups in their communities.

**ADVOCACY** The IMF's Advocacy team has educated and empowered thousands of individuals who make a positive impact each year on issues critical to the myeloma community. Working in the US at both federal and state levels, we lead coalitions to advocate for parity in insurance coverage. We also represent the myeloma community's interests before the US Congress and agencies such as the National Institutes of Health, the Food and Drug Administration, the Centers for Medicare and Medicaid Services, and the Veterans Administration. Outside the US, the IMF's Global Myeloma Action Network (GMAN) works to help patients gain access to treatment.

**Learn more about the ways the IMF is helping to improve the quality of life of myeloma patients while working toward prevention and a cure.**

**Contact us at 818.487.7455 or 800.452.CURE,  
or visit [myeloma.org](http://myeloma.org).**

Improving Lives **Finding the Cure**®

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## What you will learn from this booklet

The IMF's *Understanding* series of booklets is designed to acquaint you with treatments and supportive care measures for **multiple myeloma** (which we refer to simply as "myeloma"). Words in **bold+blue** type are explained in the "Terms and definitions" section at the end of this booklet, as well as in a more complete compendium of myeloma-related vocabulary, the IMF's *Glossary of Myeloma Terms and Definitions*, located at [glossary.myeloma.org](http://glossary.myeloma.org).

Myeloma is a **cancer** that is not known to most patients at the time of diagnosis. To be empowered to play an active role in your own medical care and to make good decisions with your doctor, it is vital for you to learn as much as possible about myeloma and its treatments. The information in this booklet will help you in discussions with your healthcare team. The more information you have about resources that are available to you, the better and more fruitful those discussions will be.

The *Understanding Peripheral Neuropathy in Myeloma* booklet is designed both to help myeloma patients who already have peripheral neuropathy (PN) and to help patients avoid developing this problem. We hope that the booklet is also a resource for caregivers and loved ones, who should recognize symptoms of PN and can help communicate them to the healthcare team treating the patient's myeloma.

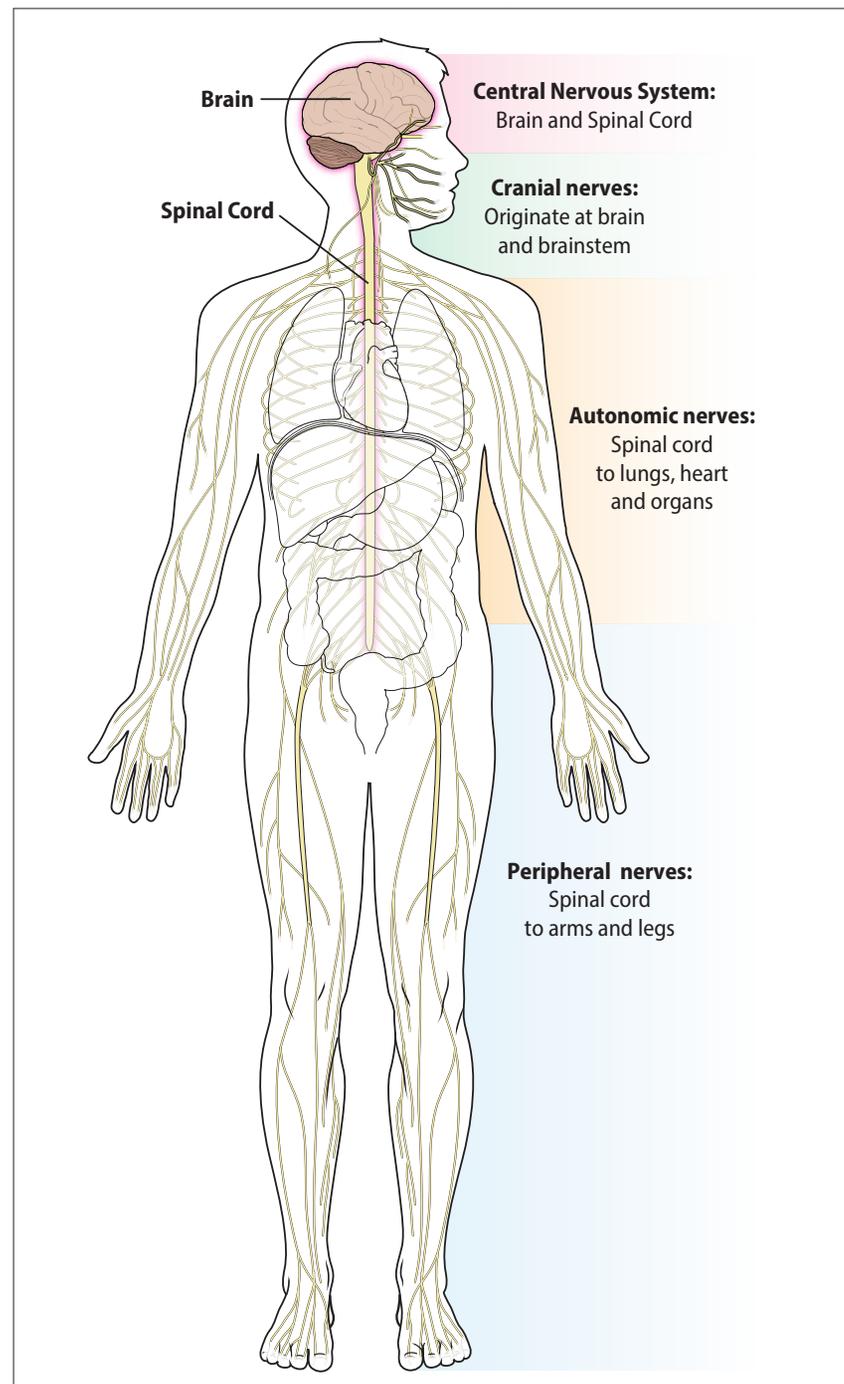
It's always best to prevent problems before they occur and to treat them early when they do occur. This is especially true for PN. Knowledge of potential problems and good communication with the healthcare team are your best tools as a patient or caregiver.

## Peripheral neuropathy and the peripheral nervous system

PN is a complication of myeloma involving damage to the nerves of the peripheral nervous system that can be caused both by myeloma and by treatments for myeloma. According to the 2011 publication in *Leukemia* by Dr. Paul Richardson of the International Myeloma Working Group (IMWG), "Management of treatment-emergent peripheral neuropathy in multiple myeloma," up to 20% of myeloma patients have PN at diagnosis, and PN symptoms can occur in up to 75% of myeloma patients after exposure to treatments that are toxic to nerve tissue.

The nervous system is made up of the **central nervous system** (CNS), which includes the brain and the spinal cord, and the peripheral nervous system (PNS), which includes all the nerves in the body beyond the brain and spinal cord.

Figure 1. Nervous system



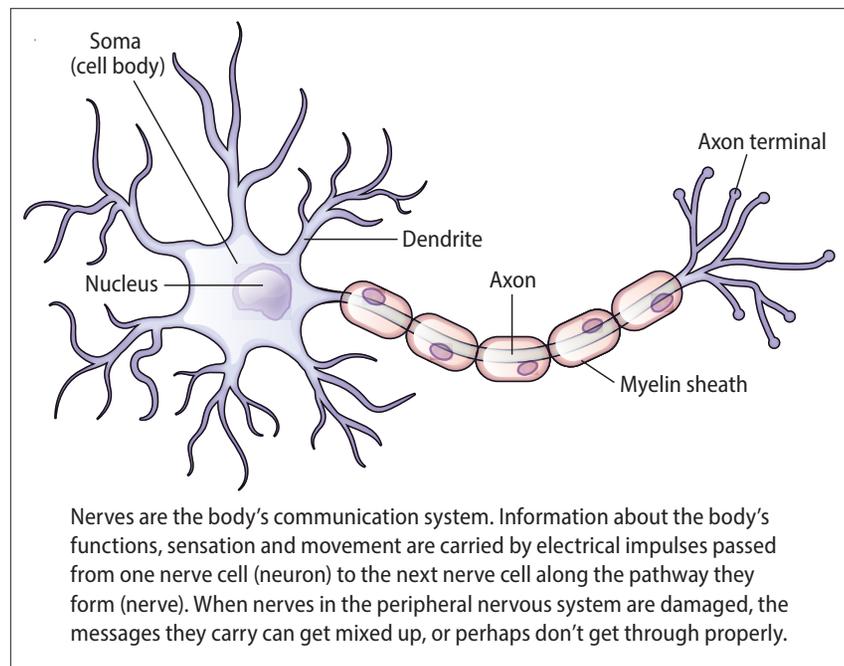
The term “peripheral neuropathy” commonly describes damage to the nerves at the body’s periphery, or outer areas, especially the arms, hands, fingers, feet, and legs. However, the peripheral nervous system also includes the **autonomic nervous system**, which regulates the function of organs over which we have no conscious control. The autonomic nerves connect the spinal cord to the internal organs, including the blood vessels, stomach, intestine, liver, kidneys, bladder, genitals, lungs, pupils, heart, and the sweat, salivary, and digestive glands.

## Which peripheral nerve pathways are affected by PN?

PN can affect each of the peripheral nerve pathways:

- **Sensory** nerves, which carry messages from receptors all around the body to the brain
- **Motor** nerves, which carry messages from the brain to the muscles to cause movement
- **Autonomic** nerves, which carry messages from the spinal cord to the organs to stimulate such functions as blood pressure control, body temperature control, breathing, digestion, heart rate, dilation and contraction of the pupils, urination, and sexual arousal.

Figure 2. Nerve cell



## What are the symptoms of PN?

PN occurs when the nerves are damaged or inflamed, or when degeneration of nerve tissue has occurred, leading to changes in the way nerves function. The symptoms of nerve damage depend on the type of nerves affected (sensory, motor, or autonomic). In myeloma patients, symptoms of PN occur symmetrically (on both sides of the body; for example, in both hands and both feet).

Symptoms of **sensory peripheral neuropathy** include:

- numbness
- tingling
- a prickling sensation
- sensitivity to touch
- lack of temperature sensation
- a burning, freezing, jabbing and/or throbbing sensation in the hands and feet
- the sensation of wearing gloves and stockings
- feeling of sand or gravel in the shoes
- loss of proprioception (the feeling of knowing where your feet are on the ground)
- loss of balance with the eyes closed
- loss of reflexes
- tinnitus (ringing in the ears) or trouble hearing

Symptoms of **motor peripheral neuropathy** include:

- weakness
- muscle cramping
- loss of muscle mass
- decrease in reflexes
- difficulty writing
- difficulty manipulating and feeling small objects
- lack of coordination and falling

Symptoms of **autonomic neuropathy** include:

- intolerance of heat, usually from decreased sweating
- difficulty adjusting to the dark (pupils not dilating enough)
- changes in blood pressure causing dizziness or light-headedness when sitting up or standing up
- digestive problems (diarrhea and/or constipation; bloating, reflux)
- a feeling of being full after eating very little
- urinary/bladder issues (urinating too frequently or too infrequently, or not being able to empty the bladder)
- erectile dysfunction

## What causes neuropathy in patients with multiple myeloma?

About 20% of patients have PN symptoms at the time their myeloma is diagnosed. Some may have developed neuropathy from pre-existing diabetes, others may suffer from neuropathy related to other

autoimmune diseases, and many have PN that developed when they had a precursor of myeloma, **monoclonal gammopathy of undetermined significance (MGUS)**.

## Myeloma-related peripheral neuropathy

- The ways in which PN occurs in MGUS and myeloma are complex and are not well understood. The general theory is that **monoclonal protein** secreted by myeloma cells directly damages motor and sensorimotor nerve cells by stripping their **myelin sheaths** and by causing degeneration of axons, the long threadlike parts of nerve cells along which impulses are conducted from the cell body to other cells.
- Myeloma can also cause PN when a fractured vertebra directly compresses nerve roots in the spinal cord.
- PN caused by myeloma may improve with treatment that controls the myeloma, although some treatments may be toxic to nerve tissue.
- In addition to MGUS, PN occurs in patients with other disorders related to myeloma, including **amyloid light-chain (AL) amyloidosis** and the rare POEMS syndrome.

## Treatment-related neuropathy

The incidence and severity of treatment-related PN in myeloma is directly related to the dose and duration of therapy, with the incidence of PN increasing over the course of therapy, and has even been reported some time after treatment has been stopped.

**Proteasome inhibitors** disrupt the process of protein recycling in myeloma cells. (Think of them as protein “garbage disposers.”) When the protein garbage disposer is disabled, myeloma cells become

overwhelmed with protein “garbage,” and they die. Unfortunately, these broken-down proteins can also accumulate in and damage the dorsal nerve root ganglia (also called spinal ganglia), special nerve cell clusters that help transmit the sensory messages of pain and touch from the spinal cord to the skin, muscles, cartilage, etc. (See Figure 3).

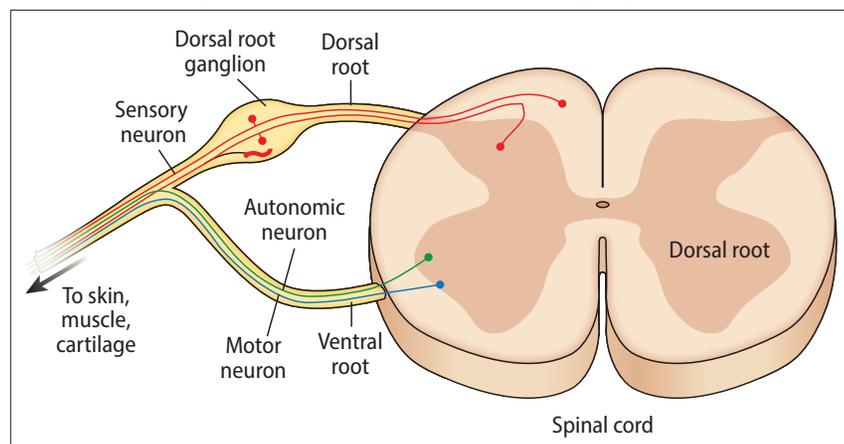
While Velcade® (generic name bortezomib) and Ninlaro® (ixazomib) can cause significant peripheral neuropathy, Kyprolis (carfuzomib), which works differently than the other proteasome inhibitors, does not.

- Velcade especially affects the sensory nerves, and can cause painful neuropathy. Given as a subcutaneous (abbreviated SC or SQ) injection (commonly called a “shot,”) Velcade causes significantly less sensory PN than intravenous (IV, into a vein) Velcade. SQ Velcade also causes fewer autonomic nerve side effects – gastrointestinal upset (diarrhea and/or constipation, nausea), low blood pressure (hypotension), and irregular heartbeat – than IV Velcade. Risk factors for PN in patients taking Velcade include obesity and pre-existing neuropathy. Velcade-induced PN is at least partially reversible in the majority of patients.
- Ninlaro, an oral proteasome inhibitor, is approved in combination with Revlimid® and dexamethasone (Rd). Like Velcade, Ninlaro + Rd causes peripheral sensory neuropathy, but the incidence of PN is lower with Ninlaro + Rd than with Velcade + Rd, and the number of severe cases with Ninlaro + Rd is the same as that with Rd alone (2% of patients). 28% of the patients in a large study submitted to the US Food and Drug Administration (FDA) for approval of Ninlaro + Rd reported PN; 18% of the reported PN was mild (grade 1 on a scale of 1–4).

**Immunomodulatory drugs** Thalomid® (generic name thalidomide), Revlimid® (lenalidomide), and Pomalyst® (pomalidomide) are oral agents that regulate or modify the immune system. They have both anti-inflammatory and anti-cancer activities. They block the activity of **cytokines**, activate **T cells** and **natural killer (NK) cells**, and inhibit the growth of blood vessels that nourish and sustain cancer cells.

- PN is one of the more common side effects of treatment with Thalomid. It is believed that Thalomid affects the dorsal root ganglia (DRG), leading to DRG degeneration, and may cause loss of myelinated nerve fibers. Thalomid can also affect the autonomic nervous system, causing symptoms such as constipation, dizziness, and erectile dysfunction. The severity of thalidomide-induced PN is related to the dose and length of time on therapy. PN develops in about 70% of patients who have been treated with Thalomid for 12 months or longer, and symptoms can occur after treatment has been stopped. The risk of developing PN with thalidomide increases if nerve damage already exists at the start of treatment. Thalomid is

Figure 3. Dorsal root and dorsal root ganglion



known to cause nerve damage that may be permanent; studies have reported that PN from Thalomid may resolve slowly or not at all.

- Patients treated with Revlimid and Pomalyst have a significantly lower risk of developing PN compared to those treated with Thalomid. Revlimid and Pomalyst are also associated with much less severe PN than Thalomid. A small Italian study of peripheral neuropathy among patients treated with long-term Revlimid was published in *Neurology* in 2016. The study authors determined that no correlation was found between PN and either the cumulative dose of Revlimid or response to Revlimid. In clinical trial data presented to the FDA for approval of Revlimid + dexamethasone (Rd) and Pomalyst + dexamethasone (Pd), rates of PN were 23% for Rd (vs 13% for dexamethasone alone) and 17% for Pd (versus 11% for dexamethasone alone). No grade 3 or 4 PN (on a scale of 1–4) was reported for either Revlimid or Pomalyst.

## Other factors that may worsen peripheral neuropathy

- Smoking interferes with circulation of the blood in the hands and feet, and blood flow is therefore cut off to nerve cells in these areas. Smoking is contraindicated in patients with PN.
- Diabetes can cause chronically elevated blood sugar, as can treatment with such steroids as dexamethasone. A high blood sugar level can damage the peripheral circulation and peripheral nerves.
- Narrowing of the arteries from high blood pressure or **atherosclerosis** (fatty deposits on the inside of the blood vessels) can decrease oxygen supply to the peripheral nerves and lead to nerve tissue damage.
- Infections that affect the nerve cells can pose additional risk of neuropathy for myeloma patients. Shingles, a reactivation of the virus that causes chicken pox (the zoster virus), can cause painful peripheral neuropathy. Patients receiving treatment with a proteasome inhibitor (Velcade, Kyprolis, or Ninlaro) should be taking an anti-viral medication such as acyclovir or valacyclovir to prevent shingles. Bacterial infections, like the one that causes Lyme disease, can also cause peripheral neuropathy. Discuss preventive use of antiviral and antibacterial medications with your doctor.
- Some drugs not used to treat cancer can also cause PN, including amiodarone, which controls heart rhythm (brand names Nexterone® and Pacerone®); hydralazine (Apresoline®, BiDil®), a vasodilator that relaxes the blood vessels to lower blood pressure; isoniazid (Nidrazid®), used as part of combination therapy to treat tuberculosis; the anti-malarial medication chloroquine (Aralen Phosphate®); the anti-bacterial drug metronidazole (Flagyl®); drugs used to treat

autoimmune diseases such as etanercept (Enbrel®), infliximab (Remicade®), and leflunomide (Arava®); and anti-seizure medications such as carbamazepine (Tegretol®), phenytoin (Dilantin®, Phenytek®), and phenobarbital (Luminal®, Solfoton®). Make sure that you consult your doctor or a pharmacist about drugs you may be taking for other medical conditions that may cause or worsen peripheral neuropathy.

- Deficiency of vitamin B12 – an essential dietary nutrient – can lead to a number of serious conditions, including peripheral neuropathy. Vitamin B12 deficiency is common in the United States, particularly among elderly people, with an estimated occurrence of 10%–25% of those over age 80. A vegan diet can also result in B12 deficiency, because animal-based foods such as red meat, dairy products, fish, poultry, and eggs are the only recognized dietary sources of vitamin B12. A medical work-up before you start treatment should include assessment of your baseline level of vitamin B12. Vitamins E, B1, and B6 are also essential to nerve health and functioning.

## Preventing peripheral neuropathy or lessening its impact

Before you start treatment with any drug that can cause peripheral neuropathy, it's important to be assessed for any existing signs of sensory or motor nerve damage. Early assessment establishes a baseline against which to measure any possible new symptoms of PN. Early PN can be treated by reducing the dose and/or schedule of the treatment that's causing it. Early recognition of PN is essential, because early neuropathy is often reversible: keep records of any symptoms and report them promptly to members of your healthcare team.

## Managing peripheral neuropathy

### Changing the dose and schedule of treatments that cause neuropathy

If your doctor is aware that you are starting to have symptoms of PN, s/he can reduce the dose and/or the schedule of the drug you're taking. If you develop more serious symptoms of neuropathy, you may be referred to a neurologist for treatment of PN, or your doctor may discontinue the treatment that caused PN.

- Velcade can be given in incrementally lower doses, reduced from the standard 1.3 mg per square meter of body mass (1.3 mg/m<sup>2</sup>) to 1.0 mg/m<sup>2</sup> or to 0.7 mg/m<sup>2</sup>. Velcade can also be given once weekly rather than twice weekly in combination therapies without sacrificing efficacy. In addition to dose and schedule, the route of administration can be important. Velcade is usually given as a subcutaneous injection rather than as an intravenous infusion (IV) because rates of PN are

significantly lower with subcutaneous injection (38%) versus IV (53%). If you are taking Velcade twice weekly and have symptoms of PN, discuss a once-weekly schedule with your doctor.

- Ninlaro dosing can be withheld or lowered until PN symptoms improve. Ninlaro's standard dose is one 4-mg capsule per week for 3 consecutive weeks of a 28-day cycle. Ninlaro also comes in 3 mg and 2.3 mg capsules if dose reductions are needed.
- Thalomid (standard dose 200 mg/day), Revlimid (standard dose 25 mg daily for 21 days of each 28-day cycle), and Pomalyst (standard dose 4 mg daily for 21 days of each 28-day cycle) are also oral medications (capsules) that come in several dosages to accommodate the need for dose reductions. Patients who are using Revlimid as long-term maintenance therapy usually take 10 mg daily, but your doctor can change the schedule of your Revlimid to provide you with a week or two off each cycle, or can prescribe as little as 5 mg of Revlimid daily if appropriate.

## Medications for painful neuropathy

The pain associated with PN can vary in intensity and is often described as "sharp," "burning," or "jabbing."

- Mild pain from PN can be controlled with a simple over-the-counter (non-prescription) pain-reliever such as acetaminophen (Tylenol®).
- In general, myeloma patients should not use non-steroidal anti-inflammatory drugs (NSAIDs) such as naproxen or ibuprofen because NSAIDs can cause kidney damage.
- Common medications prescribed to treat neuropathic pain are anti-seizure medications gabapentin (Neurontin®) and pregabalin (Lyrica®).
- Duloxetine (Cymbalta®) and some of the tricyclic antidepressant drugs, like amitriptyline (Elavil®) and nortriptyline (Pamelor®), can also be effective for nerve pain.
- A neurologist may be able to give you a prescription that combines topical versions of several drugs for nerve pain mixed into a neutral gel or ointment that can be made at a compounding pharmacy.
- A lidocaine patch or lidocaine ointment can offer local relief to a particular area of pain, as can capsaicin cream, which is a very inexpensive numbing agent made from the active ingredient in chili peppers. Other patients have reported success in reducing PN pain with a menthol cream. Gently massaging cocoa butter into an affected area can be soothing.

## Supplements that are neuroprotective

Before taking any of these supplements, discuss their use with your doctor.

- Vitamin B6, not to exceed 100 mg per day. (More than that can be toxic to the nerves.) If you're already taking a multi-vitamin or a B vitamin complex that includes B1, B6, B12, and folic acid, make sure that the total daily dose of B6 is not more than 100 mg.
- Vitamin B12, at least 400 micrograms daily (can be part of the B complex vitamin)
- L-glutamine, 500 mg per day
- L-carnitine, 500 mg per day
- Alpha lipoic acid (ALA), 400–600 mg per day. ALA comes in 200-mg capsules; take one capsule with a meal. If no improvement is seen with 400 mg, you can take a third capsule with food. ALA is especially effective for leg cramping associated with peripheral neuropathy. A caveat: ALA can prevent Velcade from working. To be absolutely safe, patients who are being treated with Velcade should NOT TAKE ALA the day before, the day of, and the day after a Velcade treatment. [NOTE: high-dose vitamin C and green tea can also interfere with the action of Velcade, reducing its anti-myeloma effect.]

## Dealing with cramps and muscle twitching

Nocturnal leg cramps can be caused by peripheral neuropathy.

- To lessen the likelihood of leg cramps, stretch and lengthen the calf and leg muscles a bit before bed.
- Loosen the sheet and blanket from the corners and bottom of the bed to relieve pressure on the feet and legs. A pillow at the end of the bed can lift the sheets off the legs.
- Drink plenty of fluids to stay well hydrated.
- A warm towel, heating pad, or warm bath can soothe tight muscles.
- There is scientific evidence to support the claim that drinking pickle juice helps alleviate leg cramps. The acid in pickle juice triggers a reflex in the back of the throat that decreases activity in the alpha motor neurons, which causes muscle relaxation. You don't even have to swallow the pickle juice to trigger the reflex, which can relieve cramps in 3–4 minutes.

## Other strategies for dealing with peripheral neuropathy

- Studies show that aerobic exercise can stabilize or partially reverse neuropathy. Swimming is an excellent way for myeloma patients to get aerobic exercise, because it safely offers resistance to the muscles

without the potential harm of impact. Even putting on a floatation belt and treading water can raise the heart rate and strengthen muscles in the arms and legs.

- Acupuncture is thought to stimulate the nervous system by causing the release of endorphins, the body's natural painkillers. Acupuncture can complement the use of pain-relieving drugs. A list of doctors who practice acupuncture is available from the American Academy of Medical Acupuncture.
- Transcutaneous electrical nerve stimulation (TENS) machines can sometimes help reduce pain by delivering tiny electrical impulses to specific nerve pathways at or near the site of pain through small electrodes placed on the skin. These electrical impulses prevent pain signals from reaching the brain.
- CBD (cannabidiol), the non-psychoactive compound in marijuana, and THC (tetrahydrocannabinol), the principal psychoactive compound, may be helpful in managing neuropathic pain. Animal tests have shown that both THC and CBD are neuroprotective antioxidants. CBD has particularly strong anti-inflammatory and anti-seizure properties; as we saw above, anti-seizure medications are also effective for the treatment of neuropathy. If you live in a state where you can obtain medical marijuana legally, you may want to discuss this option with your doctor.
- Reduce alcohol intake. Alcohol consumption can increase nerve damage.

## Strategies to help manage autonomic symptoms

### Feeling dizzy or light-headed after standing up (orthostatic hypotension)

- Compression stockings that go above the knees can help prevent pooling of blood in the legs. Your doctor may prescribe these for you.
- Have your doctor monitor your blood pressure regularly.
- Fluid intake of 2–3 liters daily can help.
- Unless you have a heart condition that limits your salt intake, get a normal amount of salt in your diet to help keep water in your blood vessels.
- Sit up or stand up slowly and move the feet and legs to allow the blood pressure to adjust.
- In cases of severe hypotension, your doctor may prescribe a medication.

## Gastrointestinal problems: constipation and/or diarrhea

- Eat small, more frequent meals that *don't* contain insoluble fiber (beans, whole wheat or bran products, green beans, potatoes, cauliflowers, and nuts).
- Liquids are easier to digest than solids, so supplement with protein shakes.
- Avoid carbonated beverages and alcohol and stay well hydrated.
- Your doctor may need to recommend a medication that you can take before eating to get your gut moving.

## Urinary frequency caused by neuropathy

Your doctor may recommend a medication to help with urinary frequency, although caution must be taken because some of these medications also cause lightheadedness. There are drugs for this problem that do not make hypotension worse.

## Sexual dysfunction

- Men who have a change in their ability to get or sustain an erection should report the problem their doctor, who can prescribe a medication (like Viagra® or Cialis®) or a medical procedure.
- Some women may notice vaginal dryness. The doctor can recommend a lubricant or cream.

## Maintaining good general health

- A well-balanced diet with freshly prepared ingredients and ample sources of vitamins B6, B12, and folate, vitamins D and E, and healthy fats helps protect the nervous system. Eat lots of fresh fruits and vegetables, whole grains, and fish rich in omega 3 fatty acids.
- Drink plenty of water and other non-alcoholic drinks.
- Limit sugar intake. High blood sugar increases damage to peripheral circulation and peripheral nerves.
- Make regular, daily exercise for 20–30 minutes a part of your life. If swimming is not convenient or possible, a brisk walk outdoors or on a treadmill or a ride on a stationary exercise bike are other good options.
- Maintain healthy skin in areas of sensory neuropathy. Reduced sensation can result in injuries that leave sores or blisters. Moisturize the hands and feet daily and keep toenails carefully trimmed and filed smooth.
- Reduce accident risk by turning the lights on before entering a dark room, removing small rugs and loose floor mats, wiping up spills immediately, removing clutter near walkways, and using skid-free shower and bath mats.

## Self-assessment tool

The IMF Nurse Leadership Board has developed a tool to help you keep track of your PN symptoms. It was designed to help you review these symptoms with members of your healthcare team so that they can make appropriate adjustments to your medications, suggest other interventions, and help you prevent painful neuropathy. Remember that good communication is the key element in prevention and early treatment of peripheral neuropathy. If you have other symptoms, please add them to your list and report them to your nurse and/or doctor.

### Instructions for Patients

By circling one number per line, please indicate how true each statement has been for you during the past seven days using the following scale:

0 = not at all					
1 = a little bit					
2 = somewhat					
3 = quite a bit					
4 = very much					
0	1	2	3	4	I have numbness or tingling in my hands.
0	1	2	3	4	I have numbness or tingling in my feet.
0	1	2	3	4	I feel discomfort in my hands.
0	1	2	3	4	I feel discomfort in my feet.
0	1	2	3	4	I have joint pain or muscle cramps.
0	1	2	3	4	I feel weak all over.
0	1	2	3	4	I have trouble hearing.
0	1	2	3	4	I get a ringing or buzzing in my ears.
0	1	2	3	4	I have trouble buttoning buttons.
0	1	2	3	4	I have trouble feeling the shape of small objects when they are in my hand.
0	1	2	3	4	I have trouble walking.

## In closing

While a diagnosis of cancer is something you cannot control, gaining knowledge that will improve your interaction with your doctors and nurses is something you can control, and it will have a significant impact on how well you do throughout the disease course.

This booklet is not meant to replace the advice of your doctors and nurses who are best able to answer questions about your specific healthcare management plan. The IMF intends only to provide you with information that will guide you in discussions with your healthcare team. To help ensure effective treatment with good quality of life, you must play an active role in your own medical care.

We encourage you to visit [myeloma.org](http://myeloma.org) for more information about myeloma and to contact the IMF InfoLine with your myeloma-related questions and concerns. The IMF InfoLine consistently provides callers with the most up-to-date and accurate information about myeloma in a caring and compassionate manner. IMF InfoLine specialists can be reached at [InfoLine@myeloma.org](mailto:InfoLine@myeloma.org) or 818.487.7455 or 800.452.CURE.

## Terms and definitions

**Amyloid light-chain amyloidosis (AL amyloidosis):** AL amyloidosis is a condition in which myeloma light chains crosslink with each other in a beta-pleated fashion and then are deposited in tissues and organs throughout the body, such as the heart, nerves, and kidneys, rather than being excreted by the kidneys. This condition is also known as primary amyloidosis.

**Atherosclerosis:** The deposits of fats, cholesterol, and other substances inside the artery walls.

**Autonomic nervous system:** The part of the nervous system that regulates functions of organs over which we have no conscious control. The autonomic nerves connect the spinal cord to the internal organs, including the blood vessels, stomach, intestines, lungs, liver, kidneys, bladder, and heart.

**Cancer:** A term for diseases in which malignant cells divide without control. Cancer cells can invade nearby tissues and spread through the bloodstream and lymphatic system to other parts of the body.

**Central nervous system (CNS):** The part of the nervous system consisting of the brain and spinal cord, and made up of nerve cells and groups of nerves that transmit messages between the brain and the rest of the body.

**Cytokine:** Cytokines are proteins secreted by cells which can stimulate or inhibit growth/activity in other cells. Cytokines are produced locally (for myeloma, in the bone marrow) and circulate in the bloodstream. Cytokines are normally released in response to infection.

**Immunomodulatory drug:** An agent that affects, enhances, or suppresses the immune system. Sometimes called an IMiD® compound.

**Monoclonal:** A clone or duplicate of a single cell. Myeloma cells are derived from a “monoclonal,” a single malignant plasma cell in the bone marrow. The type of myeloma protein produced is also monoclonal, a single form rather than many forms (polyclonal). The important practical aspect of a monoclonal protein is that it shows up as a sharp spike (M-spike) on the protein electrophoresis test.

**Monoclonal gammopathy of undetermined significance (MGUS):** A category of plasma cell disorder characterized by comparatively low levels of monoclonal protein in the blood and/or urine. Bone marrow plasma cell levels are low (< 10%). Myeloma-related symptoms (i.e., anemia, renal failure, hypercalcemia, and lytic lesions) are absent.

**Monoclonal protein (myeloma protein, M-protein, M-spike):** An abnormal protein produced by myeloma cells that accumulates in and damages bone and bone marrow. Antibodies or parts of antibodies found in unusually large amounts in the blood or urine of myeloma patients. A monoclonal spike (M-spike), the sharp pattern that occurs on protein electrophoresis, is the telltale indicator of M-protein in the blood, a marker for the activity of myeloma cells. See “**Monoclonal.**”

**Multiple myeloma:** A cancer of the bone marrow plasma cells, white blood cells that make antibodies. The cancerous plasma cells are called myeloma cells.

**Myelin sheath:** A protective membrane that forms around nerve fibers, then speeds the transmission of electrical impulses efficiently along the nerve cells.

**Natural killer (NK) cell:** A lymphocyte (type of white blood cell) that is a component of the innate immune system. NK cells are responsible for tumor surveillance and are able to induce strong responses against tumors through the release of cytokines.

**Orthostatic hypotension:** Feeling dizzy or light-headed when blood pressure drops after suddenly standing up from a lying or sitting position. Can lead to fainting.

**Proteasome inhibitor:** Any drug that interferes with the normal function of the proteasome, an enzyme complex responsible for breaking down and recycling unwanted proteins in both normal cells and cancer cells.

**T cells (T lymphocytes):** A type of white blood cell that plays a central role in the immune system. T cells can be distinguished from other lymphocytes, such as B cells and natural killer (NK) cells, by the presence of a T-cell receptor (TCR) on the cell surface. They are called T cells because they mature in the thymus (although some also mature in the tonsils).



## You are not alone. The IMF is here to help.

Myeloma is a cancer that is not known to most patients at the time of diagnosis. To be empowered to play an active role in your own medical care and to make good decisions about your care with your doctor, it is vital for you to learn as much as possible about myeloma and its treatments.

The IMF produces and maintains a library of publications to help arm you with one of the most important weapons in the fight against myeloma: INFORMATION. The following is a partial list of publications available in English, and selected titles are also available in other languages.

- *Patient Handbook*
- *Concise Review of the Disease and Treatment Options*
- *Understanding Clinical Trials*
- *Understanding Dexamethasone and Other Steroids*
- *Understanding DARZALEX® (daratumumab)*
- *Understanding EMPLICITI® (elotuzumab)*
- *Understanding Fatigue*
- *Understanding High-Dose Therapy with Stem Cell Rescue*
- *Understanding the Immune System in Myeloma*
- *Understanding KYPROLIS® (carfilzomib)*
- *Understanding MGUS and Smoldering Multiple Myeloma*
- *Understanding NINLARO® (ixazomib) capsules*
- *Understanding POMALYST® (pomalidomide)*
- *Understanding REVLIMID® (lenalidomide)*
- *Understanding Treatment of Myeloma Bone Disease*
- *Understanding Treatment of Myeloma-Induced Vertebral Compression Fractures*
- *Understanding VELCADE® (bortezomib)*
- *Understanding Your Test Results*

All IMF publications and periodicals are always free of charge. Visit [publications.myeloma.org](http://publications.myeloma.org) to read, download, or order printed copies. Subscribe to IMF periodicals at [subscribe.myeloma.org](http://subscribe.myeloma.org) or by contacting the IMF.

As always, the IMF urges you to discuss all medical issues with your doctor, and to contact the IMF's InfoLine specialists with your myeloma questions and concerns.