



Understanding Fatigue



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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.**

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.

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 doctor. The more information you have about resources that are available to you, the better and more fruitful those discussions will be.

What is fatigue?

Cancer or cancer treatment fatigue is a distressing, persistent, subjective sense of tiredness or exhaustion that is not proportional to recent activity and interferes with usual functioning.

In healthy people, fatigue is understood as exhaustion or tiredness that interferes to some extent with normal everyday activities. It usually occurs after strenuous or prolonged exertion of some kind and is temporary. Rest and refraining from strenuous activity can help restore energy and make a healthy person feel better.

Fatigue that is related to cancer and its treatments, however, is different and more severe than normal fatigue and tends to last longer. Simply resting does not alleviate this type of fatigue, which has been defined by the National Comprehensive Cancer Network (NCCN) as "a distressing, persistent, subjective sense of tiredness or exhaustion related to cancer or cancer treatment that is not proportional to recent activity and interferes with usual functioning."

Asthenia (the medical term for weakness or the loss of physical strength) often accompanies or is a component of fatigue. Cancer-related fatigue (CRF) may also be associated with difficulty concentrating, dizziness, or a disinterest in what is going on around you.

In patients with myeloma, fatigue and asthenia can be the result of many individual or collective causes. You should report persistent fatigue and/or weakness to your healthcare providers. Do not simply assume that you are experiencing an unavoidable consequence of your diagnosis and treatment.

What causes fatigue in patients with myeloma?

There are many causes of fatigue in myeloma patients:

- The myeloma itself.
- Treatments for myeloma.
- Other medical problems (known as "comorbidities") and medications for other medical problems.

It can be difficult to diagnose fatigue associated with myeloma for a number of reasons. If your fatigue is the result of a source other than **anemia**, there are no laboratory tests that can be used to diagnose it. You must report it, or it will go undetected. Your healthcare team will need to evaluate your situation and try to identify the source or sources of your fatigue in order to find ways to manage it as effectively as possible. Patients need to openly discuss their feelings of fatigue and weakness with members of their healthcare team. Do not think that feeling tired and weak is not important enough to discuss at your appointments.

Grading system for fatigue

Make notes for yourself when you feel fatigued or when anything in particular makes you feel better or worse. Keep track of how limiting your fatigue is by noting to what extent it interferes with your daily activities. Any input you can provide about your fatigue and weakness will be very helpful to your healthcare team. They need your feedback so they can determine the severity of these problems and develop strategies to help you manage them.

Based on your feedback, your healthcare team will rate your fatigue on a scale of 0 to 10 (with 0 = no fatigue and 10 = worst fatigue imaginable) and then classify your fatigue as one of the following:

- Mild (0 to 3).
- Moderate (4 to 6).
- Severe (7 to 10).

Important descriptors of fatigue

Examples of things that you should be looking at and want to report to your healthcare team include (but are not limited to) the following:

- Time when fatigue is most noticeable.
- Medications that you are taking.
- Emotional stress, anxiety, or depression.

- Presence and location of physical pain.
- Existence of other conditions or illnesses.
- Sleep disturbances.
- Dietary changes.
- Changes in weight.
- Changes in activity or daily routine.
- Changes in health.

Myeloma-related fatigue

There are three common causes of fatigue in myeloma patients:

- Myeloma-induced anemia.
- High levels of **cytokines**.
- Persistent pain.

Each of these causes can result in weight loss, decreased appetite, weakness, and fatigue. When all three myeloma-related issues are present at the same time, fatigue can be severe.

Anemia

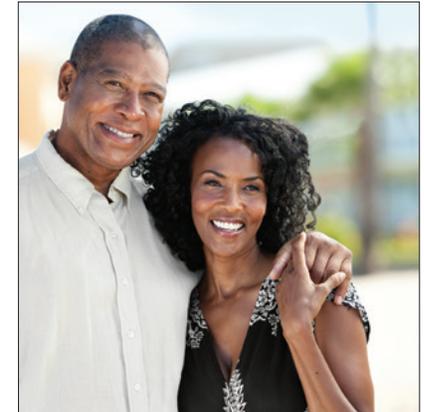
Myeloma **cells** interfere with the blood-producing activities of **bone marrow**, often leading to anemia, or a shortage of **red blood cells (RBC, erythrocytes)**. RBCs transport oxygen from the lungs to the organs and tissues in the body. If the body does not receive enough oxygen, the result is exhaustion, shortness of breath, and the inability to carry out the activities of daily living. Anemia is often the first symptom of myeloma.

Anemia is very common in myeloma patients. At least 60%–70% of patients have anemia at the time they are diagnosed with myeloma. Most patients with myeloma experience anemia at some point during their disease course.

If your doctor suspects you have anemia, a physical examination will be performed and your blood will be drawn for lab tests. It is wise to bring a family member or caregiver with you to your appointment. He or she may be able to add to the information you provide. Remember to report any of the following symptoms:

- Shortness of breath.
- Lack of energy and motivation.
- Rapid heartbeat.

- Swelling in the legs, especially in the ankles.
- Dizziness.
- Headache.
- Chills.
- Change in appetite.
- Decreased libido.



A simple blood test is used to determine your **hemoglobin** level, which measures the number of RBCs in the body. Low hemoglobin levels indicate anemia. Hemoglobin is measured in units designated as grams of RBCs per deciliter of blood (g/dL). Normal hemoglobin levels range from 14 to 18 g/dL for men and 12 to 16 g/dL for women. If your hemoglobin level is 2 grams or more below the level that was normal for you before your myeloma diagnosis, you are considered anemic.

For newly diagnosed patients who are anemic, the first and most important thing to do is treat the myeloma. Often, when a treatment successfully attacks and destroys myeloma cells in the bone marrow, the marrow will once again be able to make a normal number of RBCs, and the hemoglobin level will rise.

When a patient is being treated for myeloma and is responding well to therapy, the blood counts should ideally return to normal. However, it is often the case that blood cell counts drop as a **side effect** of treatment. Some of the therapies that successfully kill myeloma cells suppress the bone marrow's ability to make needed blood cells. (See "Treatment-related fatigue" section.)

Blood transfusions can replace and replenish the RBCs that you have lost. Transfusions are recommended when immediate correction of the anemia is desired. Although transfusions have an immediate beneficial effect for patients, the increase in hemoglobin levels may not be very large and may last only up to a few weeks, so repeated transfusions may be necessary. Unfortunately, after a prolonged period of receiving transfused blood, a patient may become resistant to transfusions of blood from other people.

High levels of cytokines

Some myeloma patients have high levels of cytokines, which are known to be a source of cancer-related fatigue. Cytokines – such as **interleukins**,

interferon, and **tumor necrosis factor alpha (TNFα)** – are molecules that send signals within the immune system. While cytokines are released by **T cells (T lymphocytes)** in response to infection or **inflammation** to help guard the body, they can also stimulate cancer cells' growth, hinder cancer cells' naturally programmed death (**apoptosis**), and aid cancer cells in spreading to other areas of the body.

In high amounts, cytokines can be toxic. The effect of cytokine release is similar to the fatigue you feel when fighting a viral illness such as the flu, but it lasts much longer. Effective anti-myeloma treatment lowers the level of cytokines in the bone marrow environment where myeloma grows.

Pain

Many myeloma patients suffer from painful bone disease or from pain related to **peripheral neuropathy (PN)**, a condition affecting the nerves in the hands and feet. PN can be caused by myeloma's effect on nerve tissue and/or by the side effects of certain treatments. Chronic, severe pain, whether from bone disease or from neuropathy, causes fatigue, and some of the most effective pain relievers can also cause drowsiness, loss of appetite, nausea, weight loss, and headache, all adding to fatigue.

Treatment-related fatigue

Fatigue is the most common side effect of cancer treatment.

According to the National Cancer Institute (NCI), fatigue is the most common side effect of cancer treatment. As long as there have been drugs to treat myeloma, fatigue has been a common side effect of treatment. Chemotherapy, radiation therapy, surgery, high-dose therapy with stem cell rescue, and the newer therapies – **immunomodulatory drugs**, **proteasome inhibitors**, and **monoclonal antibodies** – can all cause fatigue.

Chemotherapy

You may experience fatigue because therapy can kill healthy cells along with cancer cells, so the body expends extra energy to repair the healthy cells. If too many **white blood cells (WBCs)** are killed during therapy, you may get an infection, contributing further to fatigue. If too many red cells are killed, anemia results. Side effects such as nausea and vomiting, insomnia, muscle wasting, and changes in mood may also cause fatigue and weakness. These side effects are common when patients undergo high-dose chemotherapy (usually melphalan) with stem cell rescue.

Newer therapies

For reasons both known and unknown, fatigue is among the most commonly reported side effects of Darzalex®(daratumumab), Emlipicti®

(elotuzumab), Farydak® (panobinostat), Kyprolis® (carfilzomib), Pomalyst® (pomalidomide), Revlimid® (lenalidomide), Thalomid® (thalidomide), and Velcade® (bortezomib).

These drugs can all impair the production of new blood cells, leading to anemia and infection, but there are other factors, such as increased cytokine levels, that can cause fatigue. With most of these drugs, fatigue may improve over time with duration of treatment. In general, asthenia and fatigue often improve as the myeloma disease burden decreases, usually after the first two cycles of therapy. However, fatigue associated with Kyprolis may actually increase over time.

Thalidomide not only causes PN and drowsiness but can also suppress the function of the thyroid gland, causing hypothyroidism (low levels of secretion of thyroid hormone), which slows down the metabolism so that the body does not burn calories from food fast enough to provide adequate energy.

Steroids

Steroids (dexamethasone, prednisone, and methylprednisolone) are part of almost every treatment regimen for myeloma. Steroids can cause insomnia, mood changes, suppressed immune response, and muscle wasting, all of which result in fatigue and weakness. Patients taking doses of steroids sufficient to treat cancer experience an initial burst of energy and sleeplessness followed by a "crash" into fatigue and weakness that may last for days. Steroids can cause a number of other serious side effects as well, and patients taking them should be monitored closely. You may need the full prescribed dose of dexamethasone initially to get the myeloma under control. However, if you are receiving therapy with steroids and are experiencing side effects that threaten your health and/or quality of life, you must report them to your doctor, who can adjust your dose or schedule, change the steroid you're taking, or give you a "steroid vacation."

Radiation therapy

Radiation therapy is known to cause fatigue regardless of the site being treated, and it seems to become worse over time. Fatigue from **radiation therapy** usually lasts 3–4 weeks after the treatment ends, but may last up to 3 months. Up to 80% of patients report fatigue during treatment, and up to 30% report it at follow-up visits. Radiation therapy damages both healthy cells and cancer cells, requiring extra energy to repair cellular damage. In addition, if you are having radiation therapy in the upper chest or neck area, the thyroid gland may be affected, causing hypothyroidism. As noted above, hypothyroidism slows down the body's

metabolism so that it does not break down food fast enough to provide adequate energy.

Managing treatment-related fatigue

Anemia

Treatments for myeloma can reduce all the blood cell counts, including RBCs, and thus can cause anemia. If your treatment is the cause of the anemia, and the myeloma is improving while the treatment is taking a toll on your RBC count, your doctor may order a blood transfusion and/or an **erythropoiesis** stimulating agent (ESA). These agents – epoetin alfa or pegfilgrastim – can be used to stimulate the production of RBCs only when there is a concomitant chemotherapy agent in use. ESAs carry their own side effects and risks. They should be used with caution in light of their association with increased tumor growth and reduced survival in some patients with cancer.

Neutropenia

If your treatment is causing lowered white cell counts (**neutropenia**) and you develop an infection, treatment with antibiotics and antivirals and the support of a drug that stimulates white cell production (a “colony stimulating factor” such as filgrastim) can help to treat the problem underlying the infection and fatigue and will help prevent it from occurring again.

Other options for managing treatment-related fatigue

Your doctor can assess your level of fatigue and the extent to which it impairs your quality of life and either reduce your dose of medication, suggest a better time of day to take it, or stop it until your fatigue improves.

- If your fatigue is severe enough to prevent you from performing the normal activities of daily living, your doctor can prescribe drugs that are taken at low doses early in the morning to ensure that you are able to be more active during the day:
 - Provigil® (armodafinil).
 - Ritalin® (methylphenidate).
 - Adderall® (amphetamine and dextroamphetamine).
- An article published in the *Journal of the National Cancer Institute* (NCI) in 2013 presents clinical trial data that supports the benefit of American ginseng, 2000 mg daily, to treat cancer-related fatigue over an 8-week period. There were no discernable toxicities associated with

the treatment. The researchers discovered that patients who were receiving anti-cancer treatment at the time they took the ginseng responded better than those who were not currently being treated. In the absence of other “low-impact” therapies, it is encouraging to know that a widely available and inexpensive herbal agent with minimal side effects may be helpful for cancer-related fatigue.

- Clinical trials are being conducted with various approaches to helping cancer patients better manage their cancer-related fatigue. The NCI clinical trials database clinicaltrials.gov provides information about the trials and their locations. Among the open trials for the treatment of cancer-related fatigue in 2018 are those using:
 - Systemic light exposure.
 - Tailored exercise interventions.
 - Exercise programs.
 - Dietary supplements.
 - Yoga.
 - Ritalin® (methylphenidate).
 - Acupuncture or acupressure.
 - Prescription drugs.
 - Self-hypnosis.
 - Qigong.

Other possible causes of fatigue

Medications for other medical conditions

Another factor to consider in treatment-related fatigue is other drugs you may be taking for other medical conditions while being treated for myeloma. The drugs themselves, or the combination of drugs, may be causing fatigue. If you are taking a number of drugs at once, it is best to consult with your pharmacist and provide him or her with a complete list of the medications (with correct dosages) you’re taking. Your pharmacist can help you by checking for drug side effects and interactions. There may be other versions of drugs you can take that do not cause the same side effects or other schedules you can follow for your drug regimens.

Drugs for the following conditions that are common among myeloma patients may cause fatigue:

- **High blood pressure medications** may slow down the pumping action of the heart as well as depress the central nervous system.
- **Statins** used to treat high cholesterol stop the production of muscle growth: Some researchers think that they also interfere with the production of energy at the cellular level.
- **Proton pump inhibitors** used to treat gastroesophageal reflux disease (GERD) and related disorders frequently lead to low levels of

magnesium in the blood, which can cause loss of appetite, fatigue, and weakness.

- **Tranquilizers (benzodiazepines)** are used to treat a variety of anxiety disorders, agitation and muscle spasms, neuropathic pain, and seizures. They can cause sedation and fatigue by suppressing activity in parts of the central nervous system.
- **Antidepressants** are used not only to treat depression but are also prescribed for neuropathic pain, anxiety disorders, obsessive compulsive disorder, and some hormone-related disorders. Researchers believe that they cause fatigue through their effect on hormones and neurotransmitters in the brain. They can also lower levels of potassium, causing muscle weakness.
- **Antibiotics** can affect some people with feelings of tiredness and extreme fatigue, although researchers have not discovered why. Certainly the changes in bowel habits and food and nutrient absorption that can occur with antibiotics can cause fatigue and listlessness. The package inserts of many antibiotics (e.g., Bactrim DS®, Keflex®, Zithromax®) list fatigue or somnolence (sleepiness) as a potential side effect.
- **Diuretics** are prescribed to control high blood pressure, glaucoma, edema (fluid retention that causes swelling), and other conditions. Diuretics can interfere with the balance of **electrolytes** in the body. In addition to many other serious problems, electrolyte imbalances can cause extreme fatigue, muscle weakness, and pain in joints, bones, and muscles.
- **Sleep aids** interact with the same neurotransmitters in the brain as tranquilizers and can also cause fatigue. Patients fighting the insomnia caused by dexamethasone may add to their post-dex fatigue by using certain sleeping medications.
- **Anti-emetics** are prescribed to control nausea and vomiting, but can also cause fatigue and asthenia through their effects on neurotransmitters.
- **Antihistamines** such as Benadryl® (diphenhydramine) are



used to inhibit allergic responses and are frequently given to prevent drug reactions. They are also given to people to help them sleep, and thus can add to the general feeling of listlessness and fatigue.

Anxiety and depression

Anxiety, stress, and depression frequently accompany a cancer diagnosis. It is almost abnormal NOT to feel anxious and depressed when faced with a life-threatening illness. Patients are anxious and depressed about having cancer and the unknown course ahead, about the financial impact, and about meeting expectations at work and in the family. Stress, depression, and fatigue go hand in hand. Insomnia often accompanies these feelings, aggravating the cycle of stress, depression, and fatigue.

It's often difficult to know whether depression causes fatigue or vice versa, but it's important to try to identify the primary problem. Talk to your doctor about your feelings and seek a support system to help you better manage your mental health. For some patients, the need for good emotional support can be met within the community of family and friends; others find meditation and relaxation techniques helpful; others seek membership in a support group with fellow myeloma patients; many seek professional help from a licensed family therapist, social worker, psychologist, or psychiatrist. There is no stigma attached to seeking help or to taking a medication for depression or anxiety that will help you feel and function better.

Poor nutrition

Fatigue can be the result of not eating or not absorbing enough calories, vitamins, minerals, and other nutrients. There are many reasons myeloma patients and cancer patients in general do not receive enough nutrition. Even when patients eat the same amount they did before diagnosis, they may lose weight because the body may not be able to absorb and use all available nutrients. Additionally, a growing tumor, an infection, a fever, and shortness of breath can all cause an increase in the amount of energy the body needs each day. Often, patients are dealing with treatments that cause nausea, diarrhea, constipation, or anorexia (appetite loss), and with emotional stress that dampens appetite.

Maintaining good nutrition is vital to fighting fatigue. On average, you need 15 calories for every pound of your weight each day to keep your weight stable. If you have lost weight, you need an extra 500 calories each day. If you are undergoing treatment, it's important to eat **protein**, because protein repairs and rebuilds damaged cells. The best sources of protein are from the dairy and meat groups. (If you are not a committed

vegan or vegetarian prior to diagnosis, it's not the best time to adopt those diets when you're being treated for cancer.) The NCI publication *Eating Hints*, available on the cancer.gov website, is free and can help you address your special dietary needs during treatment.

Dehydration can also drain your energy. Make sure that you are drinking enough liquids to restore what may be lost with vomiting or diarrhea. All myeloma patients, but especially those with kidney dysfunction, must drink plenty of water to flush out their kidneys and reduce the side effects of medications.

Reduced activity

Contrary to widely held opinion, resting and napping is not the best remedy for CRF. Inactivity deepens fatigue. Experts now recommend frequent light exercise to reduce fatigue and stress, build and maintain bone and muscle, and improve endurance. Walking just a short distance and trying to go a little further each day can help you gain strength. If bone pain makes it difficult to walk or do other exercise, swimming or treading water can be a non-stressful and very effective substitute. The resistance of the water helps to build muscle strength.

Sometimes simply forcing yourself to keep up with your normal schedule and not give in to fatigue – using “mind over matter” – can get you through a bad day. At other times, doing something you enjoy can distract and restore you and help overcome fatigue. To conserve energy, try alternating sedentary and more physically demanding activities and schedule activities at your times of peak energy. Discuss all exercise plans with the doctor treating your myeloma and get clearance for anything you plan to do. Exercise should be tailored to your bone health and overall fitness.

Going forward

Effective communication with your healthcare team is essential. If any changes have occurred that you think could be adding to your fatigue, discuss these with your doctors. Some factors that may not be obvious could be making your fatigue worse, and many are treatable. Your healthcare team can work with you and your caregiver(s) to develop a plan for you.



Depending on their findings, they may do the following:

- Adjust your medications.
- Change or modify your dietary intake.
- Improve your fluid and electrolyte intake.
- Treat the underlying cause(s) as is appropriate.
- Prescribe drugs that can help you be more wakeful during the day.
- Create strategies for coping with and managing your fatigue.
- Suggest a clinical trial, if appropriate, for treating fatigue.

Along with transfusions, medications, and dose and schedule adjustments that the doctor can help with, there are also a number of other things you can do to manage and cope with your fatigue, including the following:

- Exercise (walking, swimming, gentle yoga).
- Coping strategies (doing things you enjoy, seeing people you enjoy).
- Modification of activities (re-establishment of priorities, use of labor-saving devices, getting a good night's sleep).
- Counseling.

Involve your family and caregivers; they can be great support. Do not be ashamed or afraid to talk about your fatigue and the impact it has on your life. Good communication with your healthcare team is essential while you are a myeloma patient.

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 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 or 818.487.7455 or 800.452.CURE.

Terms and definitions

Anemia: A decrease in hemoglobin, a protein which is contained in red blood cells and carries oxygen to the body's tissues and organs. Anemia is usually defined as hemoglobin below 10 g/dL, and/or as a decrease of ≥ 2 g/dL from the normal level for an individual. Over 13–14 g/dL is considered normal.

Antibody: A protein produced by white blood cells called plasma cells in response to an antigen that enters the body. The medical term for antibody is "immunoglobulin."

Apoptosis: A normal cellular process leading to the death of a cell.

Asthenia: A condition in which the body lacks or has lost strength either as a whole or in any of its parts.

Bone marrow: The soft, spongy tissue in the center of bones that produces white blood cells, red blood cells, and platelets. This is the tissue within which abnormal plasma cells build up when myeloma is growing.

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.

Cell: The basic unit of any living organism. Millions of microscopic cells comprise each organ and tissue in 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.

Electrolytes: Minerals in your blood and other body fluids that carry an electrical charge and are essential for life. Electrolytes include sodium, potassium, calcium, magnesium, chloride, phosphate, and bicarbonate. They affect the amount of water in the body, the acidity of the blood (pH), nerve and muscle function (including the heart), and other important processes.

Erythropoiesis: The formation of new red blood cells.

Hemoglobin: A protein in red blood cells that carries oxygen.

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

Inflammatory: Relating to inflammation, a protective response of the body against injury or disease.

Interferon: A naturally produced hormone (cytokine) released by the body in response to infection or disease that stimulates the growth of certain disease-fighting blood cells in the immune system. Interferon can be artificially produced by genetic engineering techniques and used as a form of immunotherapy.

Interleukin: A naturally produced chemical released by the body, or a substance used in biological therapy. Interleukins stimulate the growth and activities of certain kinds of white blood cells. Interleukin-2 (IL-2) is a type of biological response modifier that stimulates the growth of certain blood cells in the immune system that can fight some types of cancer. Interleukin-6 (IL-6) is a cytokine that is a potent stimulus to osteoclast and plasma cell growth.

Monoclonal antibody: An antibody manufactured in a lab rather than produced in the human body. Monoclonal antibodies are specifically designed to find and bind to cancer cells and/or immune system cells for diagnostic or treatment purposes. Monoclonal antibodies can be used alone, or they can be used to deliver drugs, toxins, or radioactive material directly to tumor cells.

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

Neutropenia: A reduced level of neutrophils, a type of white blood cell necessary to combat bacterial infection.

Neutrophil: A type of white blood cell necessary to combat bacterial infection.

Peripheral neuropathy (PN): A feeling of numbness, tingling, burning, and/or pain in the hands, feet, lower legs, and/or arms.

Plasma cells: Special white blood cells that produce antibodies (immunoglobulins). Myeloma is a cancer of the plasma cells. Malignant plasma cells are called myeloma cells. In myeloma, malignant plasma cells produce abnormal antibodies that lack the ability to fight infection. These abnormal antibodies are the monoclonal protein, or M-protein, that functions as a tumor marker for myeloma. The presence of malignant plasma cells in the bone marrow can lead to organ and tissue damage (anemia, kidney damage, bone disease, and nerve damage).

Proteasome: A joined group (or complex) of enzymes that destroy damaged or unwanted proteins and undamaged proteins that require degradation in the cell. This turnover or "recycling" of proteins is important to maintain balance within the cell and helps to regulate several functions including cell growth.

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.

Proteins: Substances composed of amino acids. Proteins are an essential part of all living organisms, especially as structural components of body tissues such as muscle, hair, collagen, etc., as well as enzymes and antibodies.

Radiation therapy: Treatment with X-rays, gamma rays, or electrons to damage or kill malignant cells. The radiation may come from outside the body (external radiation) or from radioactive materials placed directly in the tumor (implant radiation).

Red blood cells (RBC, erythrocytes): Cells in the blood that contain hemoglobin, deliver oxygen to all parts of the body, and take away carbon dioxide. Red cell production is stimulated by a hormone (erythropoietin) produced by the kidneys. Myeloma patients with damaged kidneys don't produce enough erythropoietin and can become anemic. Myeloma patients can also become anemic because of myeloma cells' effect on the ability of bone marrow to make new red blood cells.

Side effect: Unwanted effect caused by a drug. Also known as adverse reaction or adverse event (AE).

Steroid: A type of hormone. Synthetic steroids are often given to myeloma patients along with one or more anticancer drugs and typically enhance the anti-myeloma treatment benefit.

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).

Tumor: An abnormal mass of tissue that results from excessive cell division. In myeloma, a tumor is referred to as a plasmacytoma.

Tumor necrosis factor (TNF): A cell signaling protein (cytokine) involved in systemic inflammation and bone resorption. TNF alpha is elevated in myeloma patients.

White blood cells (WBC): General term for a variety of cells responsible for fighting invading germs, infection, and allergy-causing agents. These cells begin their development in bone marrow and then travel to other parts of the body. Specific white blood cells include neutrophils, basophils, eosinophils, lymphocytes, and monocytes.



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 to read, download, or order printed copies. Subscribe to IMF periodicals at 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.