

*“This chapter provides great information on bone and marrow stem cell basics.”*

— BMT Survivor

## CHAPTER 4



### **Blood and Marrow Stem Cell Transplant Basics**

Normal Blood Cells

Peripheral Blood Stem Cells

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# Chapter 4

## Blood and Marrow

### Stem Cell Transplant Basics

#### Normal Blood Cells

##### Red Blood Cells

Red blood cells (RBCs, erythrocytes) contain hemoglobin which picks up oxygen in the lungs and carries it to the cells. Hemoglobin also picks up carbon dioxide from the cells and brings it back to the lungs to be exhaled when you breathe. **Anemia** is a condition in which there are too few RBCs or hemoglobin in the blood. If you are anemic you may feel weak, dizzy, short of breath and/or tired.

##### White Blood Cells

White blood cells (WBCs, leukocytes) are part of the body's immune system and are responsible for fighting infections. There are five different types of WBCs. When your body gets an infection, an increased number of WBCs are produced in response to the illness. When there are fewer numbers of WBCs in the body individuals are more susceptible to infection. **Neutropenia** is a condition in which there are a lower-than-normal number of neutrophils, the most common type of WBCs.

##### Platelets

Platelets (thrombocytes) are cells that help prevent bleeding by assisting with clotting. When you cut yourself, it is the platelets that help form blood clots to stop the bleeding at the site of injury. **Thrombocytopenia** is a condition in which there are a lower-than-normal number of platelets in the blood. It may result in easy bruising and excessive bleeding from wounds or bleeding in mucous membranes and other tissues.

#### Peripheral Blood Stem Cells

Mature blood cells develop from "mother" cells called stem cells. When doctors harvest bone marrow for use in transplantation, it is the stem cells they are seeking. Peripheral stem cells are the stem cells that circulate in the blood vessels rather than the bone marrow. In some transplants, peripheral stem cells are used instead of bone marrow.

## Bone Marrow

Bone marrow is the soft, spongy material found in the center of long bones in your body. The principal function of the bone marrow is the formation of blood cells, mainly **red blood cells**, **white blood cells** and **platelets**. When bone marrow is withdrawn from the bone it looks very similar to blood.

## Reasons for Transplant

### Why Stem Cells are Transplanted

Traditionally, blood and marrow transplants are given to patients with malignant and nonmalignant blood diseases. When someone has a blood disorder, the bone marrow is diseased and, as a result, is unable to produce the appropriate number of normal functioning blood cells.

The goal of blood and marrow stem cell transplant is to destroy the malfunctioning bone marrow with high doses of chemotherapy and/or radiation therapy to make room for new “healthy” stem cells (from the bone marrow). Stem cell transplantation replaces diseased or damaged bone marrow with new functioning bone marrow.

### Diseases Treated with Blood and Marrow Transplants:

- Acute Leukemia
- Chronic Leukemia
- Lymphoma
- Myelodysplasia
- Multiple Myeloma
- Aplastic Anemia
- *Solid Tumors (ovarian, testicular cancer)*

### Pediatric Conditions:

- Sickle Cell Anemia
- Thalassemia
- Fanconi Anemia
- Dyskeratosis Congenita
- Diamond Blackfan
- Hemophagocytic Lymphohistiocytosis
- Langerhans Cell Histiocytosis

## Factors that are Evaluated when Selecting Patients for Transplantation:

- **Age** — There is usually an age limit depending on the type of transplant planned for the patient.
- **Disease Status** — Is the patient in remission or relapse?
- **Donor Availability** — It is necessary to determine who will be the donor: a brother or sister, an unrelated donor or the patient him/herself.
- **Type of Transplant Required** — Autologous, syngeneic or allogeneic transplant (*see next section*)
- **Psychosocial Status** — Transplantation involves a major commitment from the patient and family. A great deal of time is spent in the hospital away from family and friends. The patient loses some independence during this period. This may cause some emotional stress for all involved.
- **Overall Health** — The patient must be free of any significant kidney, heart, lung or other health problems that may jeopardize treatment.

## Types of Stem Cell Transplants

High doses of chemotherapy and radiation are given to destroy the cancer. In the process, the stem cells in the bone marrow are destroyed. Stem cell transplantation is a procedure that restores stem cells that have been destroyed by high doses of chemotherapy and/or radiation therapy.

There are four basic types of transplants:

- In an **autologous transplant**, your own stem cells are taken before treatment, then given back to you after chemotherapy and radiation.
- In an **allogeneic transplant**, you receive stem cells from another person such as a sibling or parent. Stem cells from a person who is not related to you also may be used and is called a matched unrelated donor or “URD” transplant. This may include umbilical cord blood as well.
- A **syngeneic transplant** is a special type of transplant and can only happen if you have an identical twin who is the donor.
- A **haplo identical donor (relative)** is half matched to the recipient.

## Sources for Transplant

There are three possible sources for stem cells:

- **Bone marrow:** This is the spongy tissue found in the center of bones that produces blood cells.
- **Peripheral blood:** There are normally some stem cells found in peripheral blood circulating in the body. In order to get enough stem cells for the transplant, the donor is given “growth factors” to help with stem cell growth. This causes the stem cells to grow faster and move from the marrow into the peripheral blood.
- **Umbilical cord blood:** This is blood taken from the placenta and umbilical cord after birth. This blood is usually thrown out, but can be taken and stored for later use in a stem cell transplant.

# Stem Cell Collection

## Peripheral Stem Cell Collection

Peripheral blood stem cells are collected by drawing blood out of an arm vein (or from a catheter placed in a vein) and sending it through a machine that separates the stem cells from the other blood cells. The stem cells are collected and the rest of the blood is given back to the donor. The stem cells are stored or frozen for use later. This process is called apheresis (AY-fer-EE-sis). It usually takes five to six hours and is done as an outpatient procedure.

In order to collect enough stem cells, the donor will be given a medication for four to five days before the scheduled collection to increase the number of stem cells in the blood. Sometimes the apheresis procedure needs to be repeated until enough stem cells are collected.

Before stem cells are collected, the donor must have a medical examination and some lab tests done. This is to ensure that the donor is healthy enough to donate stem cells. The donor will be given more detailed instructions about stem cell collection and the nurse coordinator will make arrangements for the donor.

Allogeneic and autologous stem cell donation is similar, except that in autologous transplants the patient is the stem cell donor for him or herself.

## Bone Marrow Harvest

The procedure for collecting bone marrow is referred to as the **bone marrow harvest**. The procedure is done in the operating room under general anesthesia. Special needles are used to remove 500 to 1,000 milliliters (one to two pints) of marrow from the rear hip bones.

Only 3 to 5 percent of the donor's total bone marrow is removed. Since this is a small amount, the donor is still able to produce blood cells and the donated marrow is replaced within two to three weeks. If the donor's red blood cell count gets too low, a blood transfusion might be necessary, but this rarely happens.

Once harvested, the marrow is filtered to remove fat and small pieces of bone and is then transferred to a blood transfusion bag. In an allogeneic transplant, the bone marrow of the donor is given to the patient following the harvest procedure.

After the procedure, the donor is taken to the recovery room until awake and is then transferred to an outpatient area for further observation and is usually released the same day. Complications are few but may include infection, bleeding at the collection site and local pain. Pain medication will be ordered for any discomfort felt. The soreness may last a few days. Recovery to normal activity varies with each person and may take anywhere from a few days to a week.

Donor insurance coverage is not impacted by the process of donating stem cells for a transplant. The insurance coverage of the recipient will cover all of the costs associated with the donation.