# Allogeneic Stem Cell Transplantation

## Educational Guide for Patients and Families

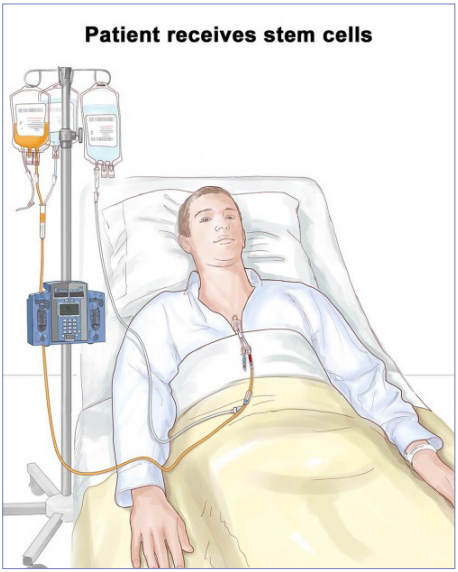


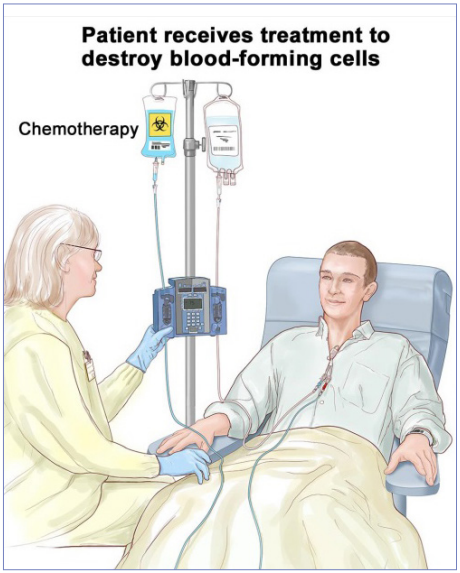
المركز الوطني لعلاج وأبحاث السرطان
National Center for Cancer Care & Research

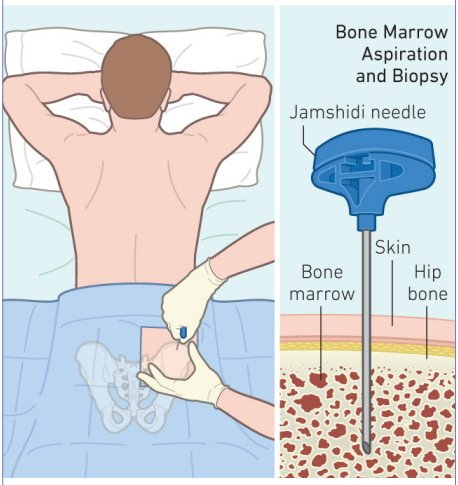
عضو في مؤسسة حمد الطبية
A Member of Hamad Medical Corporation

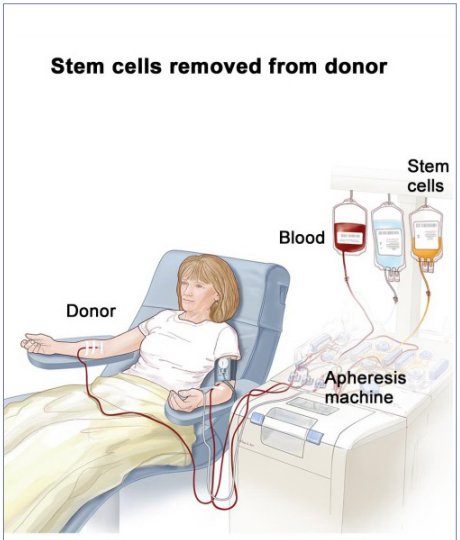
# Allogeneic Stem Cell Transplantation





## Stem Cell Transplant

An allogeneic stem cell transplant is also known as a bone marrow transplant. It involves replacing damaged or destroyed bone marrow cells with healthy bone marrow cells (from a healthy donor). In an allogeneic stem cell transplant, stem cells (specialized cells that can develop into different types of blood cells in the body, such as white blood cells, red blood cells, and platelets) are first collected from the donor. The donated healthy cells are then infused into the patient (the recipient) so they can grow and produce normal blood cells and immune cells that help fight disease.

## Purpose

An allogeneic stem cell transplant is being offered to you as a treatment option because you have a type of blood disease that has a low chance of being cured with chemotherapy, blood transfusions, or other non-transplant treatments. Your doctor has recommended that you have an allogeneic stem cell transplant as a possible cure for your disease.

## Donor Selection

Donors for allogeneic stem cell transplants are chosen based on results from a blood test or a mouth swab test for human leukocyte antigens (HLA). HLA plays an important role in immune system function. There are many variations in HLA between different people. In choosing a donor for an allogeneic stem cell transplant, the closer the match between a patient's HLA markers and the donor's, the less likely it is that the patient (recipient) will experience transplant-related complications, such as graft rejection or graft-vs-host disease.

If you choose to have an allogeneic stem cell transplant, you will need stem cells from one of the following stem cell sources:

1. An adult donor who is related to you
2. An adult donor who is not related to you
3. Infant umbilical cord blood that is donated after an infant has been delivered

For an adult donor transplant, matching between the donor and the recipient requires:

1. The willingness of the individual to be a donor
2. Test results indicating that the donor's overall health is not likely to cause any significant transplant-related problems for him/her or for you
3. An acceptable HLA (human leukocyte antigen) matching

For adult donors, stem cells may be collected from blood circulating in the donor's body (peripheral blood), or the donor may have their bone marrow harvested in an operating room.

## The following categories of donors are generally considered:

**Matched Related and Matched Unrelated Donor Transplants (MRD/MUD):**
With an MRD transplant, the donor is a relative (usually a brother or sister), and with a MUD transplant, the donor is an unrelated individual found through a registry of donors. With MRD and MUD transplants, the donor shares at least eight (8) main HLA-antigens with the patient (i.e. 8/8 match or 10/10 match if 10 HLA genes are tested).

**Haploidentical transplant (Haplo):**
This type of transplant may be used when there is not a fully matched family member. A haplo is a half-matched rather than a full match. This type of transplant has the same requirements as MRD and MUD transplants except that the number of HLA antigens that are shared between the donor and the recipient is less with these types of transplants.

**Umbilical Cord blood (UCB):**
The stem cells used for this type of transplant come from the umbilical cord blood of healthy newborn babies. This is considered a partial match transplant. If you do not have a full-blooded relative or an unrelated donor match, a UCB transplant may be the option for you.

## Transplant Plan

Transplant physicians will discuss the methods of stem cell collection with you. Stem cells for allogeneic transplant will be collected from:
1. Peripheral blood circulating in the donor's body (PBSC)
2. Bone marrow harvested in an operating room

Your transplant physician will discuss the different types of allogeneic transplants, and will determine the best option for you at this time:
1. Matched Related Donor (MRD)
2. Matched Unrelated Donor (MUD)
3. Haploidentical (Haplo)
4. Umbilical Cord Blood (UCB)

## What is Involved in an Allogeneic Stem Cell Transplant?

Before, during, and after your stem cell transplant, you will receive supportive care instructions and interventions, which will be explained in detail. These measures will help to prepare your body for the transplant, reduce the potential for infections and other complications, support you with transfusions (if needed), and help your bone marrow recover after your transplant.

There are four phases to an allogeneic stem cell transplant:
1. Screening
2. Conditioning
3. Transplantation
4. Post-Transplant

## Screening

During the screening phase, you will be asked questions about your health, your quality of life, your ability to go about your daily tasks, your medical history, and your current and previous medications. You will also have the following tests/procedures performed:

1. A physical examination.
2. Vital signs, including measurements of your body temperature, blood pressure, heart rate, respiration (breathing) rate, weight, and height.
3. Blood will be drawn for an HIV test as well as other infectious diseases.
4. Women who may be able to have children will have a pregnancy test. If you are pregnant, you cannot have an allogeneic stem cell transplant.
5. You may need to provide a urine sample. This is to check protein levels and kidney function.
6. You will have blood tests to assess your liver and kidney function.
7. You will have a chest x-ray to look at your lungs and heart.
8. A pulmonary function test will be performed to check your lung function by measuring how much air is in your lungs and how forcefully this air can be exhaled.
9. An electrocardiogram (EKG), a painless test that looks at the electrical activity of your heart.
10. A multiple gated acquisition scan (MUGA), or echocardiogram (ECHO), will be performed. A MUGA is a non-invasive test of your heart pumping capability, and an ECHO is a painless procedure that uses ultrasound directed over the chest wall to get a record of your heart's position, the motion of the walls, or internal parts, such as the valves. It also measures how well your heart muscle is functioning.
11. A dental exam and/or an eye exam. Certain dental and eye problems will need to be treated before your conditioning treatment starts.

The status of your disease before the transplant will be assessed. This may include:

1. A bone marrow aspiration and biopsy - a procedure in which a sample of bone marrow fluid and a small sample of solid bone marrow will be taken. Samples are usually removed from a bone in your hip area. Your skin and bone will be numbed, and a needle will be inserted to remove both samples.
2. Other procedures that will be done during screening will depend on your disease, and on which procedures your transplant physician feels are necessary.

You may be asked to have:

1. A computed tomography scan or CT scan (a specialized type of x-ray) of the stomach, pelvis, chest areas, and/or sinuses.
2. A PET scan – positron emission tomography scan – this uses a tracer chemical to show potential active/cancerous areas in your body.
3. A skeletal survey, which is an x-ray of your bones.



You will sign separate consent forms for many of the procedures above that are required. Risks and additional details will be discussed when you review the procedure-specific consent forms.

The results of your screening tests and procedures will be reviewed with you. Test results may require consultation from a specialist. If other health problems are found during screening, they may require treatment before you are cleared for your transplant.

Certain health problems could mean it is not safe for you to have a transplant. If tests show that stem cell transplantation is not safe for you, alternative treatments will be discussed. Alternative treatments may include chemotherapy, supportive measures, or no treatment.

## Conditioning



Several days before your transplant, you will receive high-dose chemotherapy and/or total body irradiation (TBI). This is called the preparative or conditioning regimen. A conditioning regimen may include chemotherapy, monoclonal antibody therapy, and radiation to the entire body. It helps make room in the patient's bone marrow for new blood stem cells to grow, helps prevent the patient's body from rejecting the transplanted cells, and helps kill any cancer cells that are in the body.

Indwelling Tunneled Central Venous Access Catheter: Before you start chemotherapy, you will need to have a central venous catheter placed for drawing blood and giving intra-venous (by vein) treatments. During the procedure, you will have a plastic tube placed through your skin and the wall of your chest. Once you no longer need regular blood draws and IV treatments, the catheter will be removed. This procedure will be done under local or general anesthesia.

To prepare your body for an allogeneic stem cell transplant, you will need to have chemotherapy and/or radiation therapy and/or medications to:

1. Treat your disease
2. Prepare your body for the transplant graft
3. Lower your immune system to prevent rejection of the stem cell graft

Members of your multi-disciplinary stem cell transplant team will review the characteristics of your disease as well as the history of your treatments with you and will recommend the type of conditioning regimen appropriate for you.

If your treatment requires radiation therapy, a radiation oncologist will discuss the procedure with you and will ask you to sign a separate informed consent document. Your conditioning regimen will be done in the Inpatient BMT Unit at the NCCCR. You may need to be transported to the Radiation Oncology Department for your radiation treatment (if you require radiation).

Chemotherapy and radiation will cause your white blood cell counts to decrease. This means that you will be more likely to get infections. To lower your chances of contact with infectious agents, you will remain isolated from other patients in a private room with a private bathroom. Additional precautions will be necessary to prevent infections. For example, friends and family members with colds or other infectious diseases will be asked not to visit you.

The inpatient unit is equipped with high efficiency particulate air (HEPA) filters and the rooms have positive pressure to the hallway. If for any reason you need to leave your room, you will be required to wear a mask. The best way to reduce the chances of getting an infection is through hand washing.

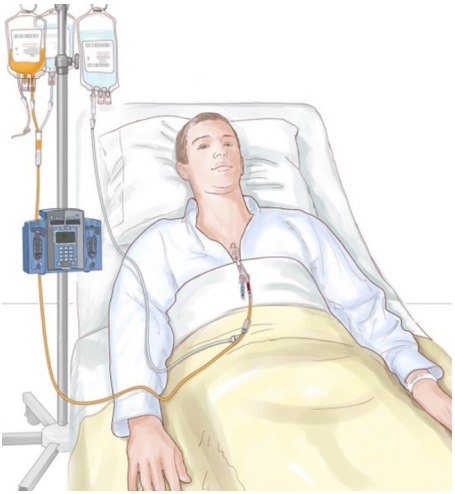
## Transplantation of Donor Stem Cells

The matched stem cells from your donor will be infused into you after you complete your conditioning regimen. When there is a major ABO incompatibility (donor blood group A, AB, or B and patient blood group O), red blood cells will be removed from the donor marrow using a special machine. This procedure will be done in the Stem Cell Lab at the NCCCR.

## The Day of Your Transplant is Referred to as Day 0

On day 0, the following will happen:

1. You will be placed on a heart monitor prior to the infusion of the donor cells. You will be closely monitored for at least eight (8) hours after the infusion of fresh cells and for at least 24 hours after the infusion of cells that were previously frozen.
2. You will be given intravenous fluids before, during, and after the infusion of the donor cells.
3. You may or may not experience a different taste in your mouth. This will depend on how the donor stem cells were preserved.



4. You will receive the donor stem cells through your central venous catheter. An infusion typically takes between one and six hours. A transplant physician or designee will be available during the infusion and until one hour after the procedure is complete.
5. During the infusion, you will be asked questions about your health. You will have a physical examination and your vital signs will be taken (temperature, blood pressure, heart rate, breathing rate, and weight).

While it is rare to experience adverse effects at the time of donor cell infusion, the following effects can occur and are usually related directly to the cells or the preservative used to stabilize the stem cells:

1. Alteration of taste during the infusion or nausea. There can also be a change in the smell of your breath for approximately 24 hours if a preservative is used.
2. Changes in heart rate or high blood pressure, which may need to be treated with a blood pressure-lowering medication.
3. Occasional chest tightness. This is typically related to the infusion and generally relieved by slowing or stopping the infusion for a few minutes.
4. Difficulty breathing, which may necessitate oxygen use for a few hours.
5. There are sometimes extra red blood cells in the donor cells collected from peripheral blood (PBSC), so you may have a slight amount of red blood cells in your urine after the infusion. If this occurs, it will pose minimal risk to you and your urine will be monitored until the red blood cells are no longer present.
6. When a major ABO incompatibility exists, despite the removal of some amount of red blood cells from collected donor bone marrow, one may experience more rapid destruction of red blood cells, which may result in symptoms of chills, fever, pain in back and abdomen, and reddish-brown urine color. In this event, you will be treated with aggressive hydration, blood transfusions as needed, and close monitoring of your blood counts.
7. Despite rigorous testing, there is a small chance of infection transmission during an infusion. All cell products are carefully screened for infection. If an infection is suspected, you will be treated with appropriate antibiotics according to transplant protocols.

## Post-Transplant Course

Post-transplant days are referred to Day "+" – for example, Day +1, Day +2, Day +3, etc.

After you have your transplant, you will receive supportive care instructions. You must follow all instructions and keep up with treatments until your bone marrow recovers and your new immune system can protect you against infections. After your transplant, you will remain hospitalized and monitored until you meet the discharge criteria. Discharge criteria will be discussed in detail with you and your caregiver. It is important to understand that you may need to be re-admitted to the NCCCR one or more times for complications following your stem cell transplant. This is not uncommon.

It is important to monitor the levels of medications that suppress your immune system after transplant. These levels will be drawn at least twice to three times a week for the first few months after transplant. Your medications will be adjusted periodically based on these results, complications that arise, and the clinical judgment of your doctor. Tapering off your immune-suppressing medications will typically begin about three months after you have your transplant unless you have complications, or your disease comes back.

Once you are discharged from the inpatient unit, you will have frequent visits to the outpatient clinic and Day Care Unit at the NCCCR. Sometimes these visits will only take a couple of hours, but other visits will take anywhere from half a day to an entire day, depending on the tests and procedures that you need. During this time, you can expect:

- Frequent blood work to see how your body is reacting to the transplant
- Levels of your immune-suppressing medications to be checked regularly
- Regular checks to look for infections
- Continued support of your red blood cells and platelets with transfusions if needed
- Infusion of intravenous fluids and medications to replace electrolytes in your body
- Radiologic imaging procedures to check for infections or assess your disease

You may also need:

1. Bone marrow biopsies at Days +30, +100, +180, and +365 to see how many donor cells are in your body compared to your own cells and to ensure that there is no detectable disease. You may need bone marrow biopsies beyond these time points, depending on clinical status.
2. Various tests to watch for side effects of all the treatments you have received. You may have lung function tests, heart studies (MUGA and/or ECHO), blood tests to check your thyroid function, blood tests to check your immune system recovery, and

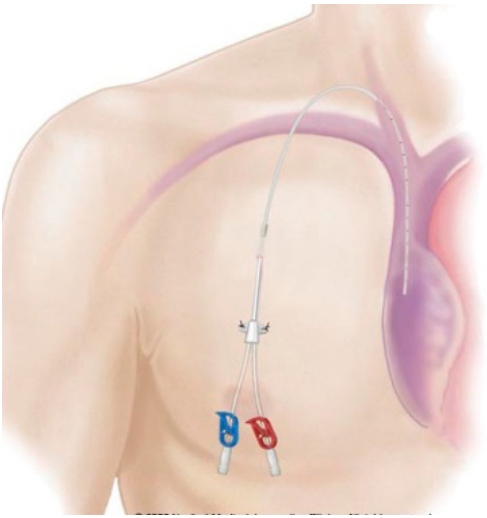
possibly other tests ordered as needed.
3. If you have Non-Hodgkin's Lymphoma or Hodgkin's Disease, you will also need a PET/CT scan of your whole body to see how the stem cell transplant has affected your cancer.
4. Other procedures and medications that your transplant doctor may order.

Until transplant Day +100, you will have to stay in Doha so that you will have immediate access to your transplant team and qualified medical care. As your recovery progresses, your transplant physician may allow you to return home for short periods. In these instances, your transplant physician will communicate with your local medical oncologist, and arrangements will be made before you go home. This will ensure a safe transition home. As you get better and require less observation, visits home can be more frequent and can last for longer periods.

## Medications, Complications, and Possible Side Effects

### Risks and Complications of a Central Venous Catheter:

Discomfort and/or pain are common for a few days at the site where the catheter has been placed. Potential risks related to insertion of the catheter line, and risks of anesthesia and/or local analgesia during placement of the catheter, will be discussed with you by the team performing the procedure. Bruising or bleeding around the catheter can occur. Rarely, further procedures may be needed to stop the bleeding. Infections can occur, requiring antibiotics or catheter removal. A clot in a vein can occur, which may require treatment with medication or removal of the catheter.



## Infections During Transplant and Transmission of Infectious Diseases:

All products derived from human blood carry a small risk of transmission of blood-borne infectious diseases, including hepatitis and HIV. Before donor cells are given to you for your transplant, screening tests will be done to look for infectious diseases. The risk of infections being transmitted to you is estimated to be around 1 in 200,000 for Hepatitis B, and 1 in 2 million for Hepatitis C and HIV.

Because of bone marrow suppression as well as medications that further suppresses your immune system, you will have a significant risk of serious infection as you recover from your stem cell transplant. Infections can be caused by bacteria, viruses or fungal organisms. You will be monitored closely in hospital and after discharge for potential infections, which will then be treated according to protocol and often with the assistance of an infectious disease specialists. Some infections can be fatal or result in significant discomfort.

## Common Viral Infections

CMV - Before you have your transplant, your blood will be tested to see if you have previously been exposed to cytomegalovirus (CMV). CMV is a common virus that infects most people at some time during their lives but rarely causes obvious illness. However, people with a compromised immune system may experience more serious illness from an active CMV infection involving fever, pneumonia, inflammation of your bowel, and other symptoms.

EBV - Epstein-Barr virus (EBV) is best known as the cause of infectious mononucleosis. It infects cells in a person's immune system called B cells. Once a person's body is infected with EBV it stays in a person's B cells for the rest of the individual's life. Sometimes transplant patients who were previously exposed to EBV will develop an EBV associated lymphoproliferative disorder, which is a viral condition that causes the production of higher than normal numbers of white blood cells and enlarged lymph nodes. EBV associated lymphoproliferative disorder usually occurs within a year after transplantation. It is often treated with a drug called Rituximab, an antibody to the immune cells that harbor the virus.

## Bone Marrow Suppression

This is a condition resulting from chemotherapy and/or radiation in which the production of blood cells in the bone marrow activity is decreased. This results in fewer red blood cells, white blood cells, and platelets.

- Decreased red blood cells cause anemia (a lower than normal number of red blood cells), resulting in fatigue or shortness of breath.
- Decreased white blood cells may result in infections.
- Decreased platelets may result in bleeding and bruising.

These side effects occur before there is engraftment and recovery of white blood cell and platelet counts. This will require frequent monitoring of blood counts. Platelet and packed red cell transfusion may be required. Antibiotics will be used if an infection is suspected or found.

## Graft Versus Host Disease (GVHD)

Graft Versus Host Disease is a complication of a transplant where the donor stem cells attack the recipient's normal cells, organs, and tissues. Medications will be given after you have your transplant to try to prevent and minimize GVHD, but it may still occur.

There are two forms of GVHD: acute and chronic. Acute GVHD occurs up to transplant Day +100, and chronic GVHD occurs after transplant Day +100. In the acute form, skin rashes, diarrhea, gastrointestinal disturbances, liver abnormalities, and lowered blood counts can occur. Chronic GVHD most commonly results in skin changes; however, it can affect any organ in your body, leading to decreased function of that organ and potential disability. Treatment for GVHD is associated with a higher risk of infection. Although both forms can be treated, GVHD can be a life-threatening complication.

To prevent or minimize GVHD, you will be given immunosuppressant medications before your transplant. These medications will continue to be given for at least three months after your transplant and will then be tapered off. If you develop chronic GVHD, medications will continue until the GVHD resolves. Medications will be given intravenously initially but will be given orally as soon as it is feasible.

### Disease Recurrence (Relapse)

It is not possible to predict if you will be cured of your disease following an allogeneic stem cell transplant. While some patients relapse shortly after their transplant, others have prolonged or lifelong remissions. If your disease comes back after your allogeneic stem cell transplant, your doctor will discuss your options with you. Treatment may include a second transplant, chemotherapy, immunotherapy, comfort care, or other types of treatments.

### Graft Failure or Rejection

The bone marrow stem cells (the 'graft') may fail to grow inside your body. If graft failure occurs, this may result in low blood counts for a long period of time. If your counts do not recover, you may need to receive a second transplant.

### Thrombotic Thrombocytopenic Purpura (Thrombotic Microangiopathy)

In this post-transplant complication, chemotherapy and/or radiation produce damage to the lining of the blood vessels causing generalized clotting in the bloodstream. These clots can choke the blood supply to some of the body organs and this can lead to brain and kidney damage, a drop in the platelet count, as well as high blood pressure.

### Risks of Having Radiation

You may have radiation therapy during your conditioning regimen. You may have CT scans, bone scans, x-rays, and/or other scans that utilize radioactivity to evaluate your disease. In the long term, there is a low risk that you could develop new cancer from radiation exposure from these tests. A radiation oncologist will go over the procedures and risks of radiation if radiation therapy is part of your treatment plan.

## Other Reactions/Complications that Occur After an Allogeneic Transplant Include:

**Mucositis:**
A side effect resulting from radiation and chemotherapy agents on the gastrointestinal tract, resulting in mouth ulcerations, mouth pain, inability to eat food, abdominal pain, and diarrhea. Supportive measures and pain medications are available to treat this condition until resolution, which normally occurs over one to two weeks.

**Veno-Occlusive Disease:**
A rare but serious complication that occurs from high doses of chemotherapy. Patients develop jaundice (yellow skin and eyes), liver function abnormalities, abdominal swelling, and abdominal or shoulder pain, usually in the first month after their transplant. Although many patients recover completely, some patients cannot recover from this complication.

**Interstitial Pneumonia:**
This occurs when patients suffer from severe lung problems as a reaction to chemotherapy. Although treatments are available, this form of pneumonia can be life-threatening.

**Metabolic Disorders:**
It is possible that you may develop hyperglycemia (high blood sugar), typically related to the use of steroids. You could also develop thyroid dysfunction, which may need repletion therapy with oral thyroid hormones.

**Secondary Cancer**
A long-term complication following an allogeneic stem cell transplant is the risk of developing a second malignancy. Possible secondary malignancies include skin cancer and oral cavity cancer.

**Other complications:**
- Cardiac and vascular
- Renal
- Endocrine
- Adrenal insufficiency
- Skeletal: Osteoporosis/Osteopenia

## Risks of Becoming Pregnant or Fathering a Child



Many of the drugs given to you prior to, during, and after your allogeneic transplant can harm an unborn baby or a nursing baby.

If you are a female, you cannot have an allogeneic transplant if you are pregnant or nursing a baby. Please discuss any plans of becoming pregnant with your transplant doctor. If you become pregnant or think you may be pregnant, you must tell your doctor right away. Your doctor will discuss your treatment and the effect on pregnancy.

If you are a male, you should not attempt to father a child as the treatment could affect your sperm and could potentially cause harm to an unborn baby.

If you are sexually active, you and your partner must use an approved form of birth control in order to be considered for stem cell transplantation. Examples of birth control you may use are: norplant, birth control pills, IUD (intrauterine device), birth control patch, depo-provera, and sterilization.

The birth control methods listed below are less effective. They may be used if combined with other birth control methods (condoms, diaphragm, jellies or foam, rhythm, withdrawal, cervical cap, sponge). No matter what type of birth control you and your partner are using, a condom must be worn to protect your partner against medications or by-products of medications that may be in your semen.

## Infertility Risks and Fertility Preservation Options

Some cancer treatments can cause infertility, or decrease your fertility. Infertility is the inability to have a child. Radiation and chemotherapy may damage the cells required for childbirth. The damage may be short-term or life-long. Your cancer type, age, sex, and treatment plan determine your individual risk. Your fertility status before cancer may also play a role in your individual risk.

The effects of cancer treatment may be temporary or permanent. Some of the effects for women include vaginal dryness, early menopause, and sterility. Since every patient is different, your doctor may not be able to predict whether cancer treatment will make you infertile. You should consider your fertility risks and discuss this with your doctor even if you are not sure if you want to have a child.



There are many available fertility preservation options. For women, the most established options are embryo and egg freezing. For men, the most common and successful option is sperm banking. Other experimental options exist for both men and women if the established methods are not viable options for you. If you would like to learn more, a referral can be made for you to an appropriate reproductive specialist. A timely referral is important. Fertility preservation treatments need to be scheduled before you begin cancer treatment. Fertility preservation methods can take as little as 24 hours for men, and methods for women may take two to four weeks.

## Medications

All cancer drugs and treatments can have side effects, which can range from mild and reversible to severe, long-lasting, and possibly life-threatening. There is a great deal of variability among side effects of different drugs and between individuals.

The most frequently used medications and complications associated with allogeneic stem cell transplantation are listed below. Common, rare, and serious side effects are provided, but the list is not all-inclusive.

### Busulfan

Busulfan is a type of chemotherapy drug used in combination with other drugs during the conditioning phase prior to transplantation. Side effects include mouth sores, high blood sugar, low magnesium and phosphate levels, shortness of breath, cough, nausea/vomiting/diarrhea, infection, anxiety, dizziness, depression, skin rashes, temporary darkening of the skin, hair loss, bleeding from the bladder, liver damage, and possible infertility. Very rarely seizures can occur for which preventative medicine will be given.

**Cyclophosphamide**
Cyclophosphamide is a chemotherapy drug used in combination with other drugs during the conditioning phase prior to transplantation. It is also used to suppress the immune system and may be used after the transplant to prevent GVHD.

Side effects include suppression of the blood-forming units of bone marrow, irritation and bleeding of the bladder (hemorrhagic cystitis), poor appetite, nausea and vomiting, mouth sores, diarrhea, hair loss, fluid retention, low sodium, and sterility. Very high doses over a short period of time may be associated with heart damage, blurred vision, and irregular heart rate.

**Etoposide**
Etoposide is a chemotherapy drug used with other drugs or radiation treatment during the conditioning phase prior to transplantation. Side effects include bone marrow suppression resulting in low red cell, white cell, and platelet counts. Other potential effects include mouth sores, difficulty swallowing, poor appetite, nausea/vomiting, diarrhea, liver inflammation, loss of hair, low blood pressure during drug infusion, allergic reactions, numbness in the hands or feet, and lung inflammation.

**Fludarabine**
Fludarabine is a chemotherapy drug used in combination with other drugs during the conditioning phase before the transplant. Side effects include very low lymphocyte count (a type of white blood cell with an important function in the immune system), which significantly increases your risk of developing infections, lowering of other blood counts, nausea, vomiting, fatigue, weakness, a general feeling of discomfort, and chills.

**Melphalan**
Melphalan is a chemotherapy drug used in combination with other drugs during the conditioning phase before the transplant. Side effects include mouth sores, bowel irritation, nausea, vomiting, diarrhea, loss of appetite and taste, hair loss, bladder irritation, and fatigue. It causes bone marrow suppression with a decrease in red cell, white cell, and platelet counts. It can also cause liver inflammation and damage, and lung inflammation.

**Antithymocyte Gobulin (ATG)**
This is a serum (type of a blood product), commonly derived from an animal, that attacks human immune cells and is used for immunosuppression. Side effects include fever/chills, skin rash/itching, kidney problems which are usually mild and reversible, serum sickness (a flu-like condition) with severe skin rashes, mouth and vaginal sores, joint pain and swelling, low blood pressure, wheezing (difficulty breathing), anaphylaxis (a life-threatening allergic reaction that can cause low blood pressure), rash hives, wheezing, low blood counts with risks of serious bleeding and infections, and the need for transfusions and antibiotics.

**Thiotepa**
This is an antineoplastic and alkylating agent. The most common adverse reactions include fertility effects, myelosuppression, secondary malignancies, potentially carcinogenic, use with caution in participants with hepatic and renal impairment. It can cause significant skin toxicity due to lipid solubility, thus bathing three times daily during its administration through 24 hours after the last dose is strongly recommended.

**Methotrexate (MTX)**
Methotrexate is a chemotherapy drug commonly used in transplant to suppress immune system function and prevent graft vs. host disease. Side effects include low blood cell counts, which can increase your chances of getting an infection or can make you bleed more easily, liver dysfunction, lung injury, kidney injury, and mouth ulceration/ discomfort.

**Tacrolimus**
This is a drug that suppresses a person's immune system after an allogeneic stem cell transplant. This reduces the activity of the immune system to lower the risk of rejection or graft-vs-host disease (GVHD). Side effects include a decrease in the body's ability to fight infections, high blood pressure, blurred vision, liver and kidney problems, neuropathy (damage to the peripheral nerves, which can cause abnormal sensations in the arms, legs, and/or feet), seizures, tremors, electrolyte imbalances, low red cell and platelet counts, high blood sugar levels, itching, loss of appetite, confusion, weakness, depression, cramps, posterior reversible leukoencephalopathy syndrome (RPLS) (a syndrome characterized by headache, nausea, vomiting, confusion, seizures, and visual loss; symptoms tend to resolve after some time). Tacrolimus levels typically need close monitoring.

**Cyclosporine**
This is a drug that suppresses a person's immune system after an allogeneic stem cell transplant. This reduces the activity of the immune system to lower the risk of rejection or graft-vs-host disease (GVHD). Side effects include a decrease in the body's ability to fight infections, cardiac damage, high blood pressure, blurred vision, liver and kidney problems, neuropathy (damage to the peripheral nerves, which can cause abnormal sensations in the arms, legs, and/or feet), seizures, tremors, electrolyte imbalances, low red cell and platelet counts, swollen red painful gums, excessive hair growth, vomiting, diarrhea, loss of appetite, confusion, and increased cholesterol levels. Cyclosporine levels typically need close monitoring.

**Sirolimus**
This is a drug that suppresses a person's immune system after an allogeneic stem cell transplant. This reduces the activity of the immune system to lower the risk of rejection or graft-vs-host disease (GVHD). Side effects include high blood pressure, headache, kidney dysfunction, abdominal pain, nausea, diarrhea or constipation, lung inflammation, increased blood cholesterol, elevated blood sugar level, and low red cell and platelet counts. Sirolimus levels typically need close monitoring.

**Mycophenolate Mofetil (MMF)**
This is a drug that suppresses a person's immune system after an allogeneic stem cell transplant. This reduces the activity of the immune system to lower the risk of rejection or graft-vs- host disease (GVHD). Side effects include diarrhea, nausea, abdominal pain, leukopenia (abnormal decrease in the number of white blood cells in the blood), liver or kidney dysfunction, changes in blood pressure, headache, difficulty sleeping, high blood sugar, high cholesterol, low magnesium level, low potassium level, low calcium level, and fever.

**Steroids (Methylprednisolone or Prednisone)**
These are steroid medications, often given to treat graft-vs-host disease, an allergic reaction, or other inflammatory conditions, such as chemotherapy-related pneumonitis. Steroids can be administered intravenously or as a pill. Frequent side effects associated with steroids include fluid retention, weight gain, muscle weakness, puffy face appearance with prolonged use, stomach ulcer with possible complications, increased blood pressure, permanent changes in the bones (weakening of the bone secondary to the loss of calcium, also called osteoporosis), increase in infection risk, high blood sugar levels and possible development of diabetes-like syndrome, eye problems (cataracts) with prolonged use, and changes in mood/agitation. Fluid and electrolyte problems can also occur. Rarely, loss of production of cortisol from the adrenal glands (adrenal insufficiency) can occur after prolonged use.

**Intravenous Immune Globulin (IVIG)**
This is a blood product collected from multiple healthy donors and used to treat immune deficiencies, autoimmune diseases, and acute infections. During your hospitalization and after you are discharged from the hospital, you may receive IVIG for protection against infection or bleeding related to low platelet count. Side effects of IVIG therapy include headache, infection, irregular heartbeat, flushing, chills, back pain, muscle aches, nausea/vomiting, dizziness, and fever. Less commonly, people may experience chest tightness, shortness of breath, low blood pressure. Other rare but serious complications that can occur include serious allergic reaction, lung injury, and an aseptic meningitis syndrome (a condition marked by severe headache, drowsiness, fever, light sensitivity, painful eye movements, nausea, and vomiting).

**Filgrastim (G-CSF)**
Filgrastim is a drug that is used to boost low neutrophil counts (a type of white blood cell). Treatments used to prepare you for your stem cell transplant will cause you to have low neutrophil counts. Side effects include injection site irritation and muscle or bone pain. Rarely reported side effects include lung toxicity, enlargement or rupture of the spleen, or severe allergic reactions. Mild hair loss has also occurred. Spontaneously reversible mild to moderate elevations in liver tests may occur.

**References:**

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