Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 8
Open Access

Applications Of Stemcells In Modern Medical Treatments

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Cite this paper as: Polasani Veena, Padidela Swapna, Bandari Jyothsna, Boddireddy Sridevi, (2024) Applications Of Stemcells In Modern Medical Treatments. *Frontiers in Health Informatics*, *13(8) 707-714*

ABSTRACT
Stem cells are important for living organisms for many reasons. In the 3- to 5-day-old embryo, called a blastocyst, the inner cells give rise to the entire body of the organism, including all of the many specialized cell types and organs such as the heart, lung, skin, sperm, eggs and other tissues. In some adult tissues, such as bone marrow, muscle, and brain, discrete populations of adult stem cells generate replacements for cells that are lost through normal wear and tear, injury, or disease. Given their unique regenerative abilities, stem cells offer new potentials for treating diseases such as diabetes, and heart disease. However, much work remains to be done in the laboratory and the clinic to understand how to use these cells for cell-based therapies to treat disease, which is also referred to as regenerative or reparative medicine.Laboratory studies of stem cells enable scientists to learn about the cells' essential properties and what makes them different from specialized cell types. Scientists are already using stem cells in the laboratory to screen new drugs and to develop model systems to study normal growth and identify the causes of birth defects. The various stem cells are based upon their origin and ability to differentiate. Stem cells are revolutionizing medicine because of their potential to regenerate damaged tissue that is otherwise unable to be repaired. Bone marrow transplantation is one of the most widespread uses of stem cells today, and it helps with the treatment of some cancers. Ongoing research can help popularize stem cells for the treatment of other chronic illnesses. With stem cell therapy, the progression of autoimmune diseases can be slowed down and regressed, and even stopped completely. The success rate of the treatment is proportional to the patient's age, the duration of the disease and the patient's condition. Stem cell transplants are most often used to help people with leukemia and lymphoma. They may also be used for neuroblastoma and multiple myeloma. In recent years, stem cell therapy has shown promising results in HIV management, and it can have a major impact on the future of HIV treatment and prevention. The idea behind anti-HIV hematopoietic stem/progenitor cell (HSPC)-directed gene therapy is to genetically engineer patient-derived (autologous) HSPC to acquire an inherent resistance to HIV infection. COVID-19 is harmful and increases the risk of secondary infection, and effective treatment remains challenging owing to fibrosis and severe inflammation and infection. Sometimes our immune system can severely damage ourselves in disease. In the past, many researchers have conducted various studies on the immunomodulatory properties of stem cells.
Keywords: Stem cells, Neuroblastoma, Leukemia, lymphoma

Introduction

Stem cells are specialized human cells that can develop into many different types of cells in the body. In biology, a stem cell is an undeveloped cell of an organism capable of giving rise to indefinitely more cells of the same type. Stem cells can also become certain other kinds of cells through a process called differentiation. Stem cells serve as a body repair system and can generate healthy cells to replace those affected by the disease.

There are two main types of stem cells: embryonic stem cells, which come from embryos, and adult stem cells, which come from fully developed tissues such as the brain, skin, umbilical cord tissue and bone marrow. A third type of human engineered stem cell (Induced pluripotent stem cells) are adult stem cells that have been changed in a lab to be more like embryonic stem cells. There are several different types of stem cells, including:***Types of stem cells***

Researchers categorize stem cells, according to their potential to differentiate into other types of cells. Embryonic stem cells are the most potent, as their job is to become every type of cell in the body. The classification includes

Totipotent: These stem cells can differentiate into all possible cell types. The first few cells that appear as the zygote

starts to divide are totipotent.
Pluripotent: These cells can turn into almost any cell. Cells from the early embryo are pluripotent.
Multipotent: These cells can differentiate into a closely related family of cells. Adult hematopoietic stem cells, for example, can become red and white blood cells or platelets.
Oligopotent: These can differentiate into a few different cell types. Adult lymphoid or myeloid stem cells can do this.
Unipotent: These can only produce cells of one kind, which is their own type. However, they are still stem cells because they can renew themselves. Examples include adult muscle stem cells.Embryonic stem cells are considered pluripotent instead of totipotent because they cannot become part of the extra-embryonic membranes or the placenta.

How can stem cells be used?

MSCs are widely used in various stem cell treatments due to their self-renewable, differentiation, anti-inflammatory, and immunomodulatory properties. In-vitro (performed in a laboratory setting) and in-vivo (taking place in a living organism) studies have supported the understanding mechanisms, safety, and efficacy of MSC therapy in clinical applications.

Stem cell therapeutics

Stem cell therapeutics refers to the use of stem cells for the treatment or prevention of diseases or disorders. Stem cells are a type of cell that have the ability to differentiate into many different types of cells, and they have the ability to self-renew, meaning they can divide and produce more stem cells.

Tissue regeneration

Tissue regeneration is probably the most important use of stem cells.Until now, a person who needed a new kidney, for example, had to wait for a donor and then undergoatransplant.There is a shortage of donor organs but, by instructing stem cells to differentiate in a certain way, scientists could use them to grow a specific tissue type or organ.

Stem cell cancer treatment

It is also known as peripheral blood cell transplant. In stem cell cancer treatment, the doctor uses transplanted 'stem cells' to treat certain types of cancers. Cancers like myeloma, leukemia, and lymphoma can be treated through this process. Stem cell transplants do not usually work against cancer directly. Instead, they help you recover your body's ability to produce stem cells after treatment with very high doses of radiation therapy, chemotherapy, or both. However, in multiple myeloma and some types of leukemia, the stem cell transplant may work against cancer directly. This happens because of an effect called graft-versus-tumor that can occur after allogeneic transplants. Graft-versus-tumor occurs when white blood cells from your donor (the graft) attack any cancer cells that remain in your body (the tumor) after high-dose treatments. This effect improves the success of the treatments.

Cardiovascular disease treatment

Researchers are using stem cells in two important ways to improve cardiac health. First, they are turning stem cells into "heart muscle in a dish." If patients have genetic causes of heart disease, their stem cell-derived heart muscle also will have this disease and this heart muscle can be used to discover new drugs. Second, stem cells offer ways to replace damaged heart tissue. Using cellular therapy, researchers hope to repair or replace heart tissue damaged by congestive heart failure and heart attacks. Unlike the treatments listed above, cellular therapy could provide a durable treatment for heart deficiencies, rather than symptom-focused treatment.

Brain disease treatment

Doctors may one day be able to use replacement cells and tissues to treat brain diseases, such as Parkinson's and Alzheimer's. In Parkinson's, for example, damage to brain cells leads to uncontrolled muscle movements. Scientists could use stem cells to replenish the damaged brain tissue. This could bring back the specialized brain cells that stop the uncontrolled muscle movements. Researchers have already tried differentiating embryonic stem cells into these types of cells, so treatments are promising.

Cell deficiency therapy

Scientists hope one day to be able to develop healthy heart cells in a laboratory that they can transplant into people with heart disease. These new cells could repair heart damage by repopulating the heart with healthy tissue. Similarly, people with type I diabetes could receive pancreatic cells to replace the insulin-producing cells that their own immune systems have lost or destroyed. The only current therapy is a pancreatic transplant, and very few pancreases are available for transplant.

Blood disease treatments

Doctors now routinely use adult hematopoietic stem cells to treat diseases, such as leukemia, sickle cell anaemia, and other immunodeficiency problems.

Hematopoietic stem cells occur in blood and bone marrow and can produce all blood cell types, including red blood cells that carry oxygen and white blood cells that fight disease. Mesenchymal stem cells (MSCs) are a type of adult stem cell in many body tissues, including bone marrow, fat tissue, and muscle. MSCs can differentiate into bone, cartilage, and fat cells.

MSCs have shown promise as a regenerative therapy for various diseases and conditions. In preclinical and clinical studies, MSCs have been shown to have anti-inflammatory and immune-modulatory effects invoking a positive immune response. They have been used to treat human diseases, including autoimmune diseases, degenerative neurological conditions, spinal cord injuries, joint pain, and other diseases affecting the human condition.

One of the key benefits of using MSCs for stem cell therapy is that they can be easily obtained from various sources and expanded in the laboratory. MSCs also have a low risk of immune rejection, as they are less immunogenic than other stem cells.

Overall, using MSCs for stem cell therapy holds great promise for treating various diseases and conditions. While more research is needed to fully understand these cells' potential and develop safe and effective treatments using MSCs, early results are encouraging. MSCs have the potential to be a valuable tool in the field of regenerative medicine.

Umbilical cord blood

The blood of newborn babies normally has large numbers of stem cells. After birth, the blood that's left behind in the placenta and umbilical cord (known as **cord blood**) can be taken and stored for later use in a stem cell transplant. Cord blood can be frozen until needed. A cord blood transplant uses blood that normally is thrown out after a baby is born. After the baby is born, specially trained members of the health care team make sure the cord blood is carefully collected. The baby is not harmed in any way.

Even though the blood of newborns has large numbers of stem cells, cord blood is only a small part of that number. So, a possible drawback of cord blood is the smaller number of stem cells in it. But this is partly balanced by the fact that each cord blood stem cell can form more blood cells than a stem cell from adult bone marrow. Still, cord blood transplants can take longer to take hold and start working. Cord blood is given into the patient's blood just like a blood transfusion.

List Of Diseases That Can Be Treated With Stem Cells

Scientists have recognised the potential of stem cells and with advancements in regenerative medicine, scientists have been making attempts to its usage to individuals of all ages. Over 40,000 transplantations around the world have been performed to save thousands of lives. Stem cells obtained from cord blood are known to treat 80+ diseases and you'll find an FDA-approved list of diseases treated by stem cells further in this article. Numerous life-threatening diseases such as sickle-cell anaemia and malignancies have been approved for stem cell treatment. Let us know more!

List of Diseases can be Cured with Stem Cells

The full list of FDA-approved cord blood treatments is as follows:

Category of Diseases	**Name of the Diseases**
Leukemias	Acute Lymphoblastic Leukemia Acute Myelogenous Leukemia Acute Biphenotypic Leukemia Acute Lymphoblastic Leukemia Acute Undifferentiated Leukemia Acute Myelogenous Leukemia (AML) Chronic Lymphocytic Leukemia Juvenile Chronic Myelogenous Leukemia Refractory Anemia Refractory Anemia with Excess Blasts Juvenile Myelomonocytic Leukemia Chronic Myelomonocytic Leukemia
Lymphomas/Malignancies	Hodgkin's Lymphoma

Solid Tumors/Malignancies	Neuroblastoma Retinoblastoma Medulloblastoma
Anaemias	Congenital Dyserythropoietic Anaemia Aplastic Anaemia Fanconi Anemia Paroxysmal Nocturnal Hemoglobinuria
Blood Disorders or Inherited Red Cell Abnormalities	Blackfan-DiamondAnaemia Beta Thalassemia Major (Cooley's Anaemia) Pure Red Cell Aplasia Sickle Cell Disease
Inherited Platelet Abnormalities	Glanzmann Thrombasthenia Congenital Thrombocytopenia
Inherited Immune Disorders or Immunodeficiencies	SCID (X-linked) SCID (ADA-SCID) SCID with absence of normal B cells and T cells Omenn Syndrome Kostmann Syndrome Bare Lymphocyte Syndrome Ataxia-Telangiectasia DiGeorge Syndrome Common Variable Immunodeficiency Lymphoproliferative Disorders Leukocyte Adhesion Deficiency Wiskott-Aldrich Syndrome Acute Myelofibrosis Myeloproliferative disorders Polycythemia Vera Agnogenic Myeloid Metaplasia Essential Thrombocythemia
Phagocyte Disorders	Neutrophil Actin Deficiency Chronic Granulomatous Disease Chediak-Higashi Syndrome Reticular Dysgenesis
Inherited Immune and Other System Disorders	Cartilage-Hair Hypoplasia Pearson's Syndrome Gunther's Disease Hermansky-Pudlak Syndrome Systemic Mastocytosis Shwachman-Diamond Syndrome

Bone Marrow Cancers or Malignancies	Plasma Cell Leukemia Multiple Myeloma Waldenstrom's Macroglobulinemia
Inherited Metabolic Disorders	Hurler's Syndrome Mucopolysaccharidoses Scheie Syndrome Sanfilippo Syndrome Hunter's Syndrome Morquio Syndrome Maroteaux-Lamy Syndrome Sly Syndrome Mucolipidosis II Adrenoleukodystrophy Metachromatic Leukodystrophy Krabbe Disease Metachromatic Leukodystrophy Gaucher Disease Pelizaeus-Merzbacher Disease Sandhoff Disease Niemann-Pick Disease Tay-Sachs Disease Lesch-Nyhan Syndrome Wolman Disease Osteopetrosis

How Life Cell Comes to Rescue?

We bring in good tidings from the medical field that more than 40 diseases including autism, spinal cord injury, diabetes type I and knee cartilage repair are under clinical trials for cord blood umbilical stem cell treatment. Let us have a glance at medical conditions that are under clinical trials for cord blood stem cell treatment. It highlights the greater possibilities of diseases treated by stem cell therapy.

Before referring to the chart below, we want to highlight autologous and allogeneic. Autologous eligibility means therapy or transplantations done with the stem cells of the donor itself and allogeneic eligibility means therapy or transplants done with the matching stem cells from other family members including siblings.

Diseases or Rare Conditions	**Autologous**	**Allogeneic**
Cerebral Palsy	✅	✅
Crohn's Disease	✅	✅
Congenital Heart Defects	✅	✅
Autism	✅	✅
Acquired Hearing Loss	✅	✅

Eczema	✅	✅
Diabetes	✅	✅
Parkinson's	✅	✅
Stroke	✅	✅
Brain Injury	✅	✅
Alzheimer's	✅	✅
Cartilage Injury	✅	✅
Heart Disease	✅	✅
Lupus	✅	✅
Cleft Palate Repair	✅	✅
Multiple Sclerosis	✅	✅
Rheumatoid Arthritis	✅	✅
Spinal Cord Injury	✅	✅
Wound Healing	✅	✅
Amyotrophic Lateral Sclerosis (ALS)	✅	✅

Current uses of stem cells to treat diseases and injuries which are under clinical trials:
It's a lifetime comfort that you can attain access to your baby's preserved umbilical stem cells at any time. A broad range of rare conditions such as Autism Spectrum Disorder (ASD), related to brain development, makes parents worrisome. With LifeCell's stem cell banking program, you can benefit from a secure and healthy family future. Preserving stem cells of a newborn is not only helpful for the child, moreover, it benefits the other members of your family as well as the community. Opt for the private or community stem cell banking program and keep your near and dear ones well protected from the misfortune of rare diseases.

TREATMENT OFAUTOIMMUNE DISEASES

With stem cell therapy, the progression of autoimmune diseases can be slowed down and regressed, and even stopped completely. The success rate of the treatment is proportional to the patient's age, the duration of the disease and the patient's condition. Most common autoimmune diseases

Rheumatoid arthritis

Rheumatoid arthritis (RA) is an autoimmune disease caused by the immune system attacking the joints. This attack leads to inflammation in the joints with pain, redness, swelling and increased temperature. Rheumatoid arthritis is a chronic disease and tends to begin in 30s.

Systemic Lupus Erythematosus (SLE)

Lupus is caused by the immune system's perception of many tissues and organs of the body as foreign. It affects a great

deal of organs, including the skin, joints, kidneys, brain and heart. Joint pain, weakness and skin rashes are the most common symptoms.

Diabetes

The pancreas produces insulin, a hormone that helps regulate blood sugar levels. In Type 1 diabetes, the immune system attacks and destroys insulin-producing cells in the pancreas. As a result, insulin cannot be produced in the body, which leads to high blood sugar levels. High blood sugar damages various organs and tissues such as blood vessels, heart, kidneys, eyes and nerves.

Hashimoto

In Hashimato's disease, the thyroid gland is affected and thyroid hormone production is reduced. Its symptoms include weight gain, intolerance to heat and cold, fatigue, hair loss, and goiter (enlargement of the thyroid gland).

Psoriasis

Skin cells normally grow and shed when they are no longer needed. Psoriasis causes skin cells to multiply very quickly. Excess skin cells produced create plaque or patchy red rashes on the skin covered with white scales.

Sjogren Syndrome

In Sjögren syndrome, the immune system attacks joints and lachrymal and salivary glands. The most important symptoms of Sjogren syndrome are joint pain, dry eye and mouth.

Familial Mediterranean Fever (FMF)

Familial Mediterranean fever is a genetic autoimmune disease that causes recurrent fever and painful inflammation of the abdomen, lungs and joints. Joint pain, swelling, skin rashes and muscle pain are among other important symptoms. Familial Mediterranean fever is caused by a gene mutation that transmits from parents to children.

Ankylosing Spondylitis

Ankylosing spondylitis is an autoimmune disease affecting the spine. Spine bones (vertebrae) adhere to each other, creating movement limitation in the spine. These changes may be mild or severe and result in a hunched posture.

Behcet's Disease

Behçet's disease is an autoimmune rheumatic disease characterized by sores in the mouth or genital region, redness and swelling of the eyes, inflammation of the joints, skin and digestive system problems.

Multiple Sclerosis (MS)

Multiple sclerosis is a disease that occurs when the immune system attacks the protective myelin sheath surrounding nerve cells. Damage to the myelin sheath affects the transmission of messages between the brain and the body. This damage leads to symptoms such as drowsiness, weakness, balance problems and difficulty in walking.

Celiac Disease

Hypersensitivity to gluten, which is a protein that exists in cereal products such as barley, wheat, and rye, is seen in celiac patients. The immune system, which attacks gluten, also damages the wall of the small intestine and causes inflammation. Diarrhea, abdominal pain, nausea, vomiting are among the symptoms of this disease.

covid-19 Long-term steroid therapy for chronic inflammation following COVID-19 is harmful and increases the risk of secondary infection, and effective treatment remains challenging owing to fibrosis and severe inflammation and infection. Sometimes our immune system can severely damage ourselves in disease. In the past, many researchers have conducted various studies on the immunomodulatory properties of stem cells.

By priming the immune system and providing cytokines, chemokines, and growth factors, stem cells can be employed to build a long-term regenerative and protective response. This review addresses the latest trends and rapid progress in stem cell treatment for Acute Respiratory Distress Syndrome (ARDS) following COVID-19.

Human immunodeficiency virus (HIV) infection is a major global public health issue. Despite this, the only treatment available in mainstay is antiretroviral therapy. This treatment is not curative, it needs to be used lifelong, and there are many issues with compliance and side effects. In recent years, stem cell therapy has shown promising results in HIV management, and it can have a major impact on the future of HIV treatment and prevention. The idea behind anti-HIV hematopoietic stem/progenitor cell (HSPC)-directed gene therapy is to genetically engineer patient-derived (autologous) HSPC to acquire an inherent resistance to HIV infection. Multiple stem-cell-based gene therapy strategies have been suggested that may infer HIV resistance including anti-HIV gene reagents and gene combinatorial strategies giving rise to anti-HIV gene-modified HSPCs. Such stem cells can hamper HIV progression in the body by interrupting key stages of HIV proliferation: viral entry, viral integration, HIV gene expression, etc. Hematopoietic stem cells (HSCs) may also protect leukocytes from being infected. Additionally, genetically engineered HSCs have the ability to continuously

produce protected immune cells by prolonged self-renewal that can attack the HIV virus. Therefore, a successful treatment strategy has the potential to control the infection at a steady state and eradicate HIV from patients. This will allow for a potential future benefit with stem cell therapy in HIV treatment.

CONCLUSION

We conclude that ongoing research on stem cell therapies gives hope to patients who would normally not receive treatment to cure their disease. Stem cells have a bright future for the therapeutic world by promising stem cell therapy. We hope to see new horizon of therapeutics in the form of bone marrow transplant, skin replacement, organ development, and replacement of lost tissue such as hairs, tooth, retina and cochlear cells.

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