JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

"Cancer Etiology and Therapeutic Advances: A Comprehensive Review of Causes and Treatments"

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ABSTRACT

Now a day's Cancer is the most prevalent life-threatening disease which is spreading because of the lifestyle we are living, Cancer is due to uncontrolled growth of cell which can be cured if diagnosed in early stage of life. The impact of cancer is increasing significantly day by day. Tobacco is 22% responsible for causing cancer, 15% cancer is caused due some infections like HIV, hepatitis B, EpsteinBarr etc, and 10% is due to poor diet, obesity, excessive consumption of alcohol, exposure to ionizing radiation, etc. Treatment of Cancer depends on the various internal and external factors causing Cancer is screened by different screening test and number of treatments are now available these such as Gene Therapy, Chemo Therapy, Surgery, Radiation Therapy, Immune Therapy etc.

INTRODUCTION

Cancer means crab. Just as a crab once it catches an objects, completely destroyed it and leaves it simiorly, Cancer is completely destroys the human body, in fact it will not be wrong to say that it destroys it. A more Appropriate word can be called Bandagul. Just as a bandgul once sticks to a mango tree and completely eats the tree, similarly, Cancer completely eats the human body.

Cancer is a disorder that results from genetic or epigenetic alterations in the somatic cells and has abnormal cell growth which may be spread to other body parts. They form a subset of neoplasm. The unregulated growth of cells in a group called neoplasm or tumour and they form a lump or mass and may be distributed diffusely. An estimated 9.7 million people died from cancer worldwide in 2022. In future up 2030 around 22.2 million cases are expected to be diagnosed for Cancer.

Causes of Cancer

Why Cancer is occurs in human body?

Naturally:

A small amount of cancer cells is constantly being produced in our human body. Many of these cells are destroyed automatically, but some remain.

Exposure to certain chemicals e.g. some chemicals are use in paints, some chemicals made from asphalt, soot, made of paper, gaseous produced after the combustion and petroleum, nicotine in cigarettes or beedi. It mainly causes by tobacco and certain unwanted pollution and UV rays.

Radioactive Substances:

Radioactive substance are energetic rays produced after nuclear fission, these definitely changes the cell's nucleus. It has been observed that people and workers involved in nuclear reactors and nuclear fission process.

There are many causes which may cause cancer in different body parts like mainly 22% deaths are due to tobacco consumption, 10% of deaths are due to poor diet, obesity, lack of physical activity, excessive drinking of alcohol or other facts include certain exposure to ionizing radiation, environmental pollutants, and infection.

About 15% of cancer in the world is due to some infections like hepatitis b, hepatitis c, human papilloma virus infection, helicobacter pylori, and immunodeficiency virus (HIV), Epstein - Barr virus. These factors are at least partly responsible for changing the genes.

Inherited genetic defects from patient's parents are also responsible for 5-10% of cancer.

Top 10 causes of Cancer-related deaths

Cancer Type	Deaths in 2017
Lung cancer	8,216
Bowel cancer	5,325
Blood and lymph cancer	4,499
Prostate cancer	3,275
Pancreatic cancer	2,996
Skin cancer	2,011
Liver cancer	1,914
Brain cancer	1,415
Oesophageal cancer	1,265
Breast cancer	2,928

The main types of Cancer

Our bodies are made up of billions of cells. The cells are so small that we can only see them under a microscope. Cells group together to make up the tissue and organs of our bodies. They are very similar but vary in some ways because body organs do very different things. For example, nerves and muscles do different things, so the cells have different structures.

There are more than 200 types of cancer and we can classify cancers according to where they start in the body, such as breast cancer or lung cancer.

We can also group cancers according to the type of cell they start in. There are 5 main groups, these are:

I. **Carcinoma**: This cancer begins in the skin or in tissues that line or cover internal organs. There are different sub-types, including adenocarcinoma, basal cell carcinoma, squamous cell carcinoma, and transitional cell carcinoma.

II. **Sarcoma**: This cancer begins in the connective or supportive tissues such as bone, cartilage, fat, muscle, or blood vessels.

III. **Leukemia**: This is cancer of the white blood cells. It starts in the tissues that make blood cells such as the bone marrow.

IV. **Lymphoma and Myeloma**: These cancers begin in the cells of the immune system.

V. **Brain and Spinal Cord Cancers**: These are known as central nervous system cancers.

VI. **Multiple Myeloma:** Multiple myelomas is cancer that begins in plasma cells, another type of immune cell. The myeloma cells which are plasma cells, are build up in bone marrow and make tumors in bones. It is called plasma cell myeloma and Kahler disease.

VII. **Melanoma:** It starts in cells that become melanocytes. These cells are specialized cells that make melanin, i.e., the pigment that gives the color to the skin. Mainly melanomas develop on the skin, but it can also develop in other pigmented tissue like an eye.

VIII. **Other Types of Tumors:**
Germ Cell Tumors: It is the type of tumor that starts in the cells which give rise to eggs or sperms. This can be occurring anywhere in the body and either malignant or benign. Neuroendocrine Tumors: Neuroendocrine tumors form from cells that release hormones into the blood in response to a signal from the nervous system. It forms from those cells which release hormones in blood in response to signal from the nervous system. These tumors, which can create higher-than-normal amounts of hormones, will cause many various symptoms. It may be either benign or malignant.

Location and System:

- **Breast cancers**: Cancer that forms in the breast tissue.
- **Lung cancers**: Cancer that develops in the lungs.
- **Colorectal cancers**: Cancer that affects the colon or rectum.
- **Prostate cancer**: Cancer that occurs in the prostate gland.
- **Bladder cancers**: Cancer that forms in the bladder.
- **Liver cancers**: Cancer that starts in the liver.
- **Kidney cancers**: Cancer that develops in the kidney.
- **Pancreatic cancers**: Cancer that originates in the pancreas.

- **Brain and spinal cord cancers**: These cancers can start in the cells of the brain or spinal cord.

Cancer – Cell Changes, Growth & Symptoms

1. Cell Changes and Cancer

Our body is made up of **~100 trillion cells**. All cancers start in **cells** due to changes. Normally, cells produce signals to keep the right balance. If signals go missing → cells multiply unnecessarily → form a **lump (tumor)**. Some cancers (like **leukemia**) begin in blood cells and don't form solid tumors.

2. Genes and Cell Division

Different cells have different jobs but all have a **nucleus**. Nucleus contains **chromosomes**, which are made of **DNA (Deoxyribonucleic Acid)**. DNA is a long string carrying **genes** (instructions for cells). Genes tell cells **when to grow, divide, or die**. Cell division process:

1 cell → divides into 2 identical cells → then 4 → 8 → and so on.

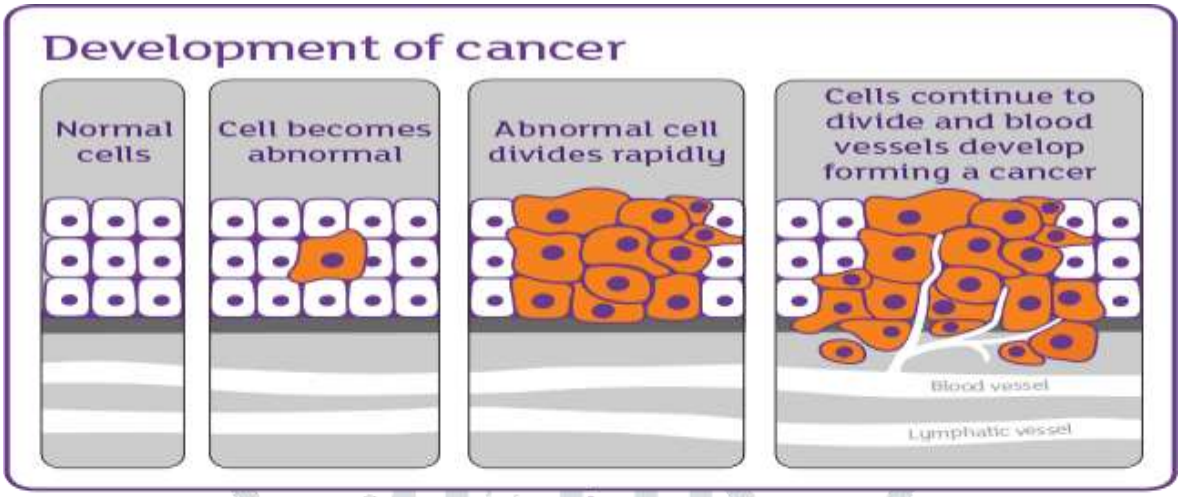
3. Gene Changes within Cells (Mutations)

Mutations = changes in genes during cell division or due to chemicals (like tobacco smoke). Mutation = gene copied twice, lost, or damaged.

Results of mutations: Cells **don't follow instructions**. Cells **divide uncontrollably**, forming tumors. Tumor = made up of **millions of cancer cells**. Some mutations: Stop cells from producing division-control proteins. Cause overproduction of proteins → rapid growth.

4. How Cancer Grows

Cancer cells behave differently than normal cells: Remain **immature** (don't become specialized). **Avoid immune system** detection. **Ignore stop signals** for division. Don't stick together well → spread through blood/lymphatic system. Grow into and damage tissues/organs. Need **nutrients + oxygen** from blood vessels → tumor grows quickly once supplied.



5. Symptoms of Cancer (Warning Signs)

Early diagnosis = higher chance of successful treatment.
Doctors should look for: Sudden weight loss, Sudden anaemia or weakness, Loss of appetite or unusual food cravings, Lump or ulcer anywhere in body that does not heal. Lump or ulcer in breast Change in voice/hoarseness, Persistent cough with blood or Blood-Tinged Saliva, Breast Lump or Breast discharge, Lumps in the Testicles, Unexplained Anemia, Difficulty swallowing or "stuck throat" feeling, Persistent heaviness or indigestion in stomach, Non-healing painless sore or ulcer in mouth → sign of oral cancer, Sudden bleeding without cause (urine, stool) → bladder or rectal cancer.
Other signs or symptoms may also alert you. These include the following:
Unexplained loss of weight or loss of appetite, Nausea, Vomiting, Fatigue, Unexplained low-grade fevers may be either persistent or not. Recurring Infections, Pain in the bones and other body parts.

6. Types of Tumors

(a) Benign Tumor: Non-cancerous. Can be easily removed, does not spread to other organs. generally, not life-threatening**.**

(b) Malignant Tumor Cancerous. Spreads to nearby and distant organs. Dangerous and lifethreatening.

Diagnosis:

Diagnosis of cancer is carried by doctors by taking screening tests of patients. For example, colonoscopy, mammography, and a pap test. Other tests are also performed before screening tests to check the abnormalities in

the body. For example, CT scan, MRI scan, X-rays and ultrasound. In that area which is not clearly visualized like some lymph nodes or inside bones, radionuclide test is performed for this purpose.

Person with cancer who have no symptom then they diagnosed during tests of other condition or issues, and if any person has symptoms of cancer doctor will perform various tests.

- Lab Test
- Imaging Tests
- Ct Scan
- MRI
- Nuclear Scan
- Bone Scan
- Pet Scan
- Ultrasound
- X-rays
- Biopsy: i. With Needle ii. With Endoscopy iii. With Surgery

After tests and reports if anyone having cancer then the doctor will figure out the stage of cancer for the best treatment.

Treatment

There are various types of cancer treatments, which depend upon the cancer type and how to advance it is. Some patients have only one cancer treatment but mainly have a combination of treatments like surgery with radiation therapy. The various types of treatments are:

Surgery: To prevent or reduce the disease's spread and remove cancer from the body, surgeon may remove lymph nodes

i. **Cryosurgery / Cryotherapy:** This therapy is used to treat precancerous growth on the cervix and skin by argon gas and nitrogen gas to destroy abnormal cells from extreme cold.

ii. **Lasers:** This treatment is used for more precise surgeries because it has an accurate focus on small areas and it is also used to shrink or destroy a tumor. This powerful beam of light is used for treatment on the skin or inside the lining of internal organs. For example, vaginal, cervical, basal cell carcinoma.

iii. **Hyperthermia:** In this therapy, the small body part is exposed to a high temperature so this heat kills cancer cells and makes sense to radiation or chemotherapy drugs. High energy radio waves are used to provide heat.

iv. **Photodynamic Therapy:** In this therapy, photodynamic drugs are used to treat cancer cells. These drugs are reacting with a particular light, and then tumors are exposed to that particular light, and this drug becomes active and kills cancer cells that are nearby it. Non-small cell lung cancer and skin cancer are treating by this therapy.

Radiation Therapy: In this therapy high doses of radiation are used to treat cancer by shrinking tumors, killing cancer cells and slow the growth of cancer cells by damaging their DNA because the damaged DNA does not repair and the cell die which is removed by the body. The treatment takes weeks or months and prevents from returning.

Chemotherapy: In this therapy, chemicals are used to treat cancer by stopping or slowing the growth of cancer cells or by killing cancer cells or also by shrink tumors that causing pain and other problems but have severe side effects. Chemotherapy is given only and also given with other cancer treatments that depend upon the cancer type

Example:

• Neo-adjuvant chemotherapy, in this tumor, is made smaller before surgery or radiation therapy. • Adjuvant chemotherapy, in this the cancer cells are destroyed, which remains after the treatment.
• Help other treatments to work better.
• It also kills those cancer cells which are spread to other body parts.

Immunotherapy: In this therapy, the immune system is boost by medication or other treatments. Example, adoptive cell and checkpoint inhibitors treatment, etc. The immune system is made up of WBC and tissues of lymph nodes help to provide the strength to the body to fight against the disease and infection. It is also called biological therapy, which means the substances used in the treatment made from living organisms to treat cancer. It is not yet widely used, but many immunotherapies are studied in clinical trials.
Some immunotherapies boost the body's immune system to work better or others make easier for the immune system to identify the cancer cells and then destroy it by marking on these cells.
Checkpoint Inhibitors
Adoptive Cell Transfer
Monoclonal Antibodies

Targeted Therapy: In this therapy, changes in a cancer cell that help them divide, spread and grow by targeting and immune system also boost. Example, monoclonal antibodies and small-molecule drugs.
• Monoclonal Antibody: These antibodies are get attached to specific targets found on cancer cells and mark cancer cells and help the immune system to find and destroy it. Some antibodies also stop the growth of cancer cells and made self-destructed. These antibodies are proteins that are made in a laboratory.
• Small Molecule Drugs: By their small size these drugs can easily enter inside the cell and used for targets.

Hormone Therapy: In this therapy, hormones are used to treat cancer, such as prostate and breast by stop and slow growth of those hormone.
If this therapy is taken for prostate cancer then regular PSA tests performed for checking the progress of the therapy. If the PSA level will stay the same or go down then the therapy is working, but if the PSA level goes up then are results that the therapy is not working.
If this therapy is taken for breast cancer then regular checkup of neck, chest, underarm and breast areas is performed.

Stem Cell Transplants: In this therapy, the stem cells restore in cancer patients, which are destroyed by very high doses of radiation or chemotherapy.
A transplant can be:
• Allogeneic: In this, the stem cells come from someone else like blood relations or other people. • Autologous: In this, the stem cells come from the patient itself.
• Syngeneic: The stem cells come from identical twins if the patient has one.

Precision/Personalized Medicine: It is the newer approach, in which the best treatment for a patient is determined by genetic testing. Nowadays, cancer treatments are is same for patients who have same cancer and the same stage of cancer, but the responses are different in some patients. After a lot of research, scientists understand those tumors have genetic changes that cause cancer cells to grow and spread. The genetic changes in different cancer may be the same. Scientists see the future in precision medicine because it helps in receiving the best treatment for cancer. The research is going on, to test the treating patients with treatments that target the cancer-causing genetic changes in the tumor, many drugs are used as treatment known as target therapies.
Precision medicine helps the doctors to decide the best treatment because it has all the information regarding the genetic changes in the tumor, size, type, and if spread. Nowadays, the patients receive a combination of treatment

for cancers include chemo, radiation, immunotherapy, and surgery if the doctor has information, then the treatment is going to be easy.

Side Effects of Cancer Treatments:

The treatment of cancer can affect also to the normal cells, tissue, and organs. Side effects are the effects of treatment which are shown with therapeutic effect. Common side effects are shown below

- Anemia
- Hair loss (Alopecia)
- Appetite loss
- Bruising and bleeding (thrombocytopenia)
- Constipation
- Delirium
- Diarrhea
- Edema
- Fatigue
- Fertility issue in boys and men
- Fertility issue in girl and women
- Flu-like symptoms
- Infection and Neutropenia
- Lymphedema
- Memory or concentration problems
- Mouth and throat problems
- Nausea and vomiting
- Nerve problems (Peripheral Neuropathy)
- Organ related inflammation and immunotherapy
- Pain
- Sexual health issue in both men and women
- Skin and nail changes
- Sleep problems
- Urinary and bladder problems.

Conclusion:

In this review paper, cancer and its treatments were illustrated in detail, including signs and symptoms, diagnostic tests, and causes of cancer along with its spread.

Cancer treatments include **surgery, immunotherapy, chemotherapy, targeted therapy, hormone therapy, radiation therapy, stem cell transplant, and precision medicine**.

These therapies involve various drugs, such as antibiotics (commonly used in chemotherapies), and different targeted systems like **nanotechnology and microspheres** to directly treat cancer. Radiation therapy uses different radiations to directly attack cancer cells. In hormone therapy, different hormones are used to treat cancers such as breast and prostate cancer, which are hormone-related. In immunotherapy, the immune system is strengthened using drugs to fight against cancer cells.

Out of these, therapies are often used in **combination** (e.g., radiation with surgery, hormone therapy with surgery, chemotherapy with immunotherapy). However, these treatments have limitations and side effects because cancer arises from genetic changes, and these changes differ across patients and cancer types.

After extensive research, scientists prefer **precision medicine** for improved treatment, as it allows doctors to study the genetic information of cancer cells. This makes treatment more effective and reduces side effects.
Among advanced approaches, **stem cell transplant** is considered one of the best therapies for restoring patient health. **Autologous and syngeneic transplants** are associated with fewer side effects, while **allogeneic transplants** have more side effects because stem cells are taken from another person or a blood relation.

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