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A REVIEW ON: CURRENT ADVANCEMENTS IN CANCER THERAPIES

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ABSTRACT

The medical community has struggled to better understand and treat the complexity of cancer, which is the second leading cause of death worldwide, responsible for one in every six deaths (world health organization). It discusses the use of AI in medical oncology, such as how AI is used in treatment decision-making for adult and pediatric cancer care, and how applications like advanced imaging, drug discovery, and clinical decision support systems enhance precision, personalization, and efficiency. Despite the challenges, AI-driven personalized medicine has improved diagnostics, risk stratification, and targeted therapies, leading to better patient outcomes and reduced costs in pediatric oncology. Important ethical issues, including data privacy, algorithmic bias, and explain ability, continue to be key to responsible integration of AI. Explainable AI and other future advancements are to be expected.

KEYWORDS: Cancer, WHO, Oncology, Artificial Intelligence, Advanced imaging, Drug discovery.

INTRODUCTION

Cancer is a broad term for a group of diseases characterized by the uncontrolled growth and spread of abnormal cells in the body. Normally, human cells grow, divide, and die in a highly regulated way. In cancer, this regulation breaks down, leading to excessive cell division and the formation of masses called tumors.

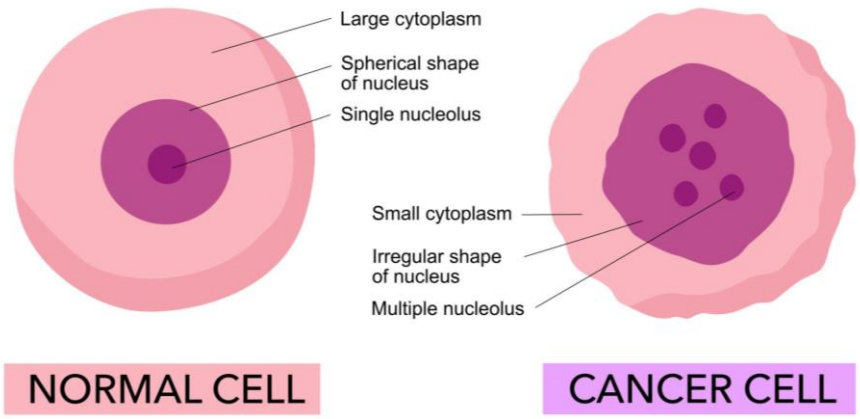

Fig No 1: Normal cell and Cancer cell.

What is Cancer?

Cancer develops when genetic changes (mutations) disrupt the normal cell cycle. These mutations can cause cells to:

- Grow uncontrollably
- Avoid programmed cell death (apoptosis)
- Invade nearby tissues
- Spread to other parts of the body (a process called metastasis)

Types of Cancer

Cancer is classified based on the type of cell or tissue where it originates. Major categories include

- **Carcinomas** – arise from epithelial cells (e.g., skin, lung, breast)
- **Sarcomas** – develop in connective tissues (bone, muscle)
- **Leukemias** – cancers of blood-forming tissues
- **Lymphomas** – cancers of the lymphatic system
- **Central nervous system cancers** – affect the brain and spinal cord

Causes and Risk Factors

Cancer can result from a combination of genetic and environmental factors. Common causes include

- **Genetic mutations** (inherited or acquired)
- **Tobacco use** (a leading cause of lung cancer)
- **Radiation exposure** (UV rays, X-rays)
- **Infections** (e.g., HPV, hepatitis viruses)

- **Unhealthy lifestyle** (poor diet, lack of exercise)
- **Environmental pollutants** (chemicals, toxins)

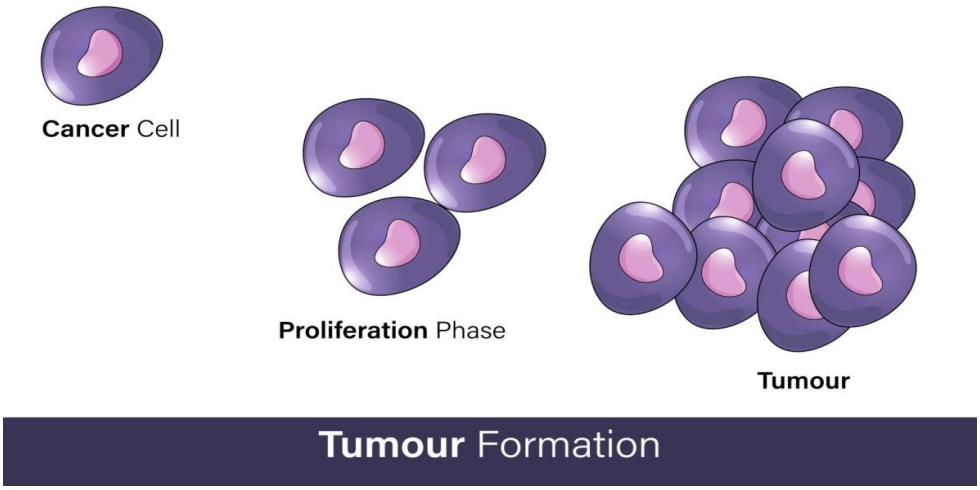

Fig. No. 2: Tumour formation.

Signs and Symptoms

Symptoms vary depending on the type and stage of cancer but may include:

- Unexplained weight loss
- Persistent fatigue
- Pain or lumps in the body
- Changes in skin or moles
- Persistent cough or difficulty breathing

Diagnosis and Treatment

Cancer is diagnosed through methods such as:

- Imaging (X-rays, CT scans, MRI)
- Biopsy (examining tissue samples)
- Blood tests

Treatment depends on the type and stage of cancer and may include:

- **Surgery** – removal of tumors
- **Chemotherapy** – drugs that kill cancer cells
- **Radiation therapy** – high-energy rays to destroy cells
- **Immunotherapy** – boosts the body's immune system to fight cancer

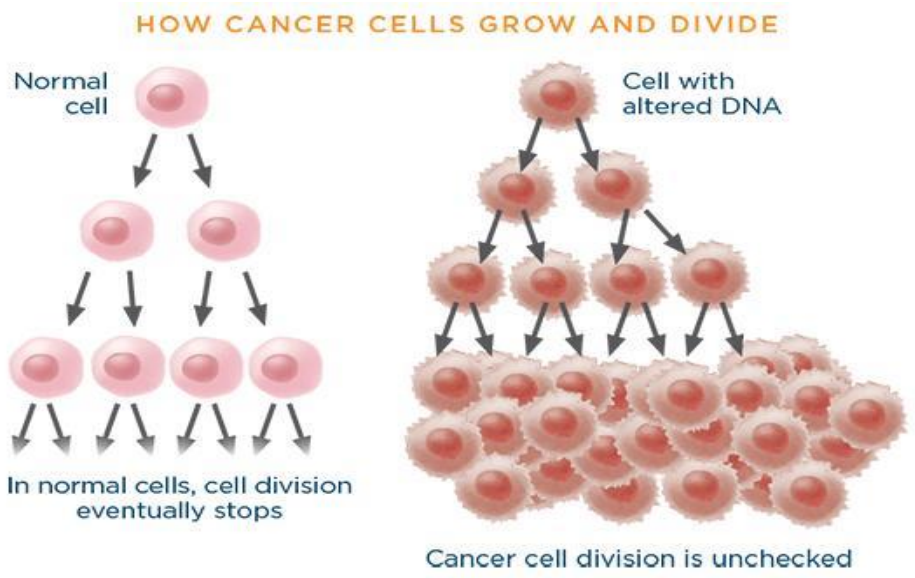

Fig No 3: Cancer cell growth.

Prevention and Early Detection

While not all cancers can be prevented, risk can be reduced by.

- Avoiding tobacco
- Maintaining a healthy diet and weight
- Getting regular exercise
- Protecting against UV radiation
- Participating in screening programs (e.g., mammograms, colonoscopy)

UNDERSTANDING HOW CANCER CAN BE FOUND EASILY

Early detection of cancer means identifying cancer before it spreads or becomes advanced. Detecting cancer at an early stage often improves the chances of successful treatment and survival.

Why early detection matters

When cancer is found early

- Treatment is usually more effective
- Smaller tumors are easier to remove or control
- The risk of spreading (metastasis) is lower
- Survival rates are generally higher

WAYS CANCER CAN BE FOUND EASILY

1. Recognizing Warning Signs and Symptoms

Some cancers produce early symptoms that should not be ignored. Common warning signs include

- Unexplained weight loss
- Persistent fatigue
- A lump or swelling
- Changes in bowel or bladder habits
- Persistent cough or hoarseness
- Unusual bleeding or discharge
- Changes in a mole or skin appearance

These symptoms do not always mean cancer, but medical evaluation is important.

2. Cancer Screening Tests

Screening means testing healthy people to detect cancer before symptoms appear.

Common screening methods include

Cancer Type	Screening Method
Breast cancer	Mammography
Cervical cancer	Pap test and HPV test
Colorectal cancer	Colonoscopy or stool tests
Prostate cancer	PSA blood test
Lung cancer	Low-dose CT scan (for high-risk smokers)

Screening helps detect

- Early-stage cancers
- Precancerous changes that can be treated before cancer develops

3. Regular Medical Checkups

Routine health examinations help doctors identify abnormal signs early. During checkups, doctors may

- Perform physical examinations
- Review family history
- Recommend age-appropriate screening tests

4. Genetic Testing and Family History

Some cancers run in families because of inherited gene mutations. People with strong family histories may benefit from

- Genetic counseling

- Genetic testing
- Earlier or more frequent screening

Examples include inherited mutations linked to breast and ovarian cancers.

Diagnostic Methods Used After Suspicion

If cancer is suspected, doctors may use

Imaging Tests

- X-rays
- CT scans
- MRI scans
- Ultrasound
- PET scans

Biopsy

A small tissue sample is removed and examined under a microscope. This is often the most reliable way to confirm cancer.

Laboratory Tests

Blood tests and tumor marker tests may help in diagnosis and monitoring.

Importance of Awareness

Public awareness and education help people

- Recognize symptoms early
- Participate in screening programs
- Seek medical care promptly

Healthy lifestyle habits and regular screening greatly improve early detection outcomes.

What is Cancer?

Cancer is a condition characterised by the abnormal behaviour of certain cells within the body. In a healthy person, cells follow a specific pattern of growth, division, and eventually, natural death, which is essential to maintain proper bodily function. However, in the case of cancer, these cells deviate from this normal behaviour, undergoing uncontrollable and abnormal growth.

Risk factors of cancer

Cancer risk factors are conditions, habits, or exposures that increase the likelihood of developing cancer. Having one or more risk factors does not mean a person will definitely develop cancer, but it raises the probability.

Major Risk Factors of Cancer

Tobacco use

Alcohol consumption

Unhealthy diet

Physical inactivity and Obesity

Radiation exposure

Infections

Environmental and occupational exposure

Genetics and Family History Factors

Age

Week Immune System

DIFFERRENT TYPES OF CANCER

Cancer is not a single disease. It is a group of diseases that can begin in almost any organ or tissue of the body. Different cancers are classified according to the type of cell or tissue in which they originate.

MAINLY THE TYPE OF CANCERS ARE

Carcinoma

Carcinomas are the most common type of cancer. They begin in epithelial cells, which cover the skin and line internal organs.

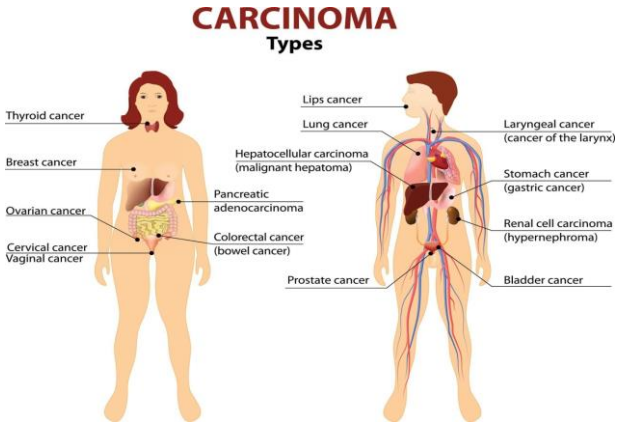

Fig No 4: Carcinoma.

Characteristics

- Often forms solid tumors
- Can spread to nearby tissues and organs

Sarcoma

Sarcoma develop in connective and supportive tissue

Affected tissues

- Bone
- Muscle
- Fat
- Cartilage
- Blood vessels

Leukemia

Leukemia is a cancer of blood-forming tissues, mainly the bone marrow.

Types

- Acute leukemia
- Chronic leukemia

Lymphoma

Lymphoma begins in the lymphatic system, which is part of the immune system.

Main types

- Hodgkin lymphoma
- Non-Hodgkin lymphoma

Multiple Myeloma

Multiple myeloma affects plasma cells, a type of white blood cell found in bone marrow.

Effects

- Weakens bones
- Affects immune defense
- May cause kidney problems

Melanoma

Melanoma is a serious form of skin cancer that develops in melanocytes, the cells producing skin pigment.

Major cause

- Excessive exposure to ultraviolet (UV) radiation

Brain and Spinal Cord Tumors

These cancers originate in the central nervous system.

Examples

- Glioma
- Meningioma

Symptoms depend on the tumor's location and size.

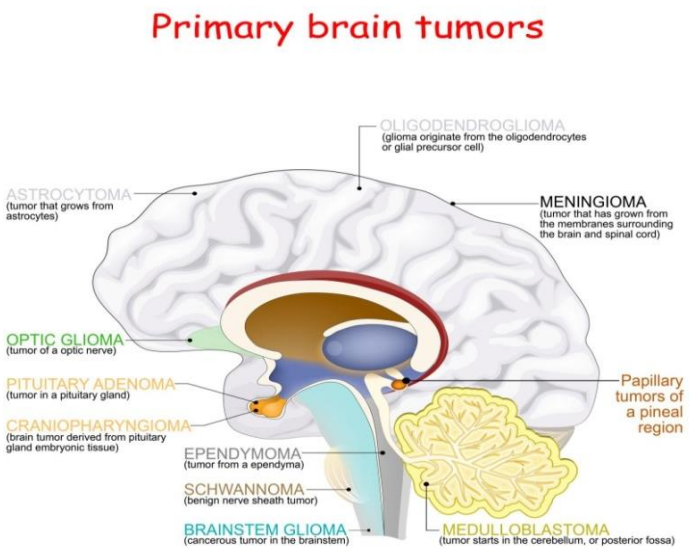

Fig. No. 5: Primary brain tumors.

Classification Based on Spread

Benign Tumors

- Non-cancerous
- Do not spread to other parts of the body
- Usually less dangerous

Malignant Tumors

- Cancerous
- Invade nearby tissues
- Can spread through blood or lymphatic system

Common Cancers in Humans

Cancer Type	Common Site
Breast cancer	Breast
Lung cancer	Lungs
Colorectal cancer	Colon/rectum
Prostate cancer	Prostate gland
Cervical cancer	Cervix
Liver cancer	Liver

What the future of cancer research holds?

The future of cancer research is moving toward **more precise, personalized, and less toxic treatments**, with the aim of improving survival and quality of life.

1. Precision / Personalized Medicine

Treatments will be tailored to a patient's **genetic profile and tumor mutations**.

Use of biomarkers and genomic sequencing to select the best therapy.

Fewer side effects compared with conventional chemotherapy.

2. Advanced Immunotherapy

- Expansion of **CAR-T cell therapy** beyond blood cancers to solid tumors.
- Development of cancer vaccines and immune checkpoint inhibitors.
- Improved immune system targeting of cancer cells.

3. Gene Editing and Gene Therapy

- Technologies like **CRISPR** may help correct cancer-causing mutations.
- Potential for prevention and targeted treatment at the genetic level.

4. Artificial Intelligence (AI) in Oncology

AI may assist in

Early cancer detection

Drug discovery

Predicting treatment response

Personalized treatment planning

5. Nanotechnology

- Nanoparticles for targeted drug delivery.
- Benefits
  - Reduced toxicity
  - Controlled drug release

6. Liquid Biopsy

- Detection of cancer using blood samples instead of invasive tissue biopsy.
- May help in
  - Early diagnosis
  - Monitoring recurrence
  - Tracking treatment response

7. Cancer Vaccines

- Development of preventive and therapeutic vaccines.
- Research is ongoing for vaccines against multiple cancer types.

8. Combination Therapies

Future treatment may combine

Immunotherapy + Targeted therapy + Gene therapy + Nanomedicine

9. Prevention and Early Detection

Focus will increase on

- Screening programs
- Genetic risk assessment
- Lifestyle interventions
- Early diagnosis technologies

AI- IN CANCER THERAPIES:

Artificial Intelligence (AI) is transforming cancer therapy by improving early diagnosis, treatment planning, drug discovery, and personalized medicine**.**

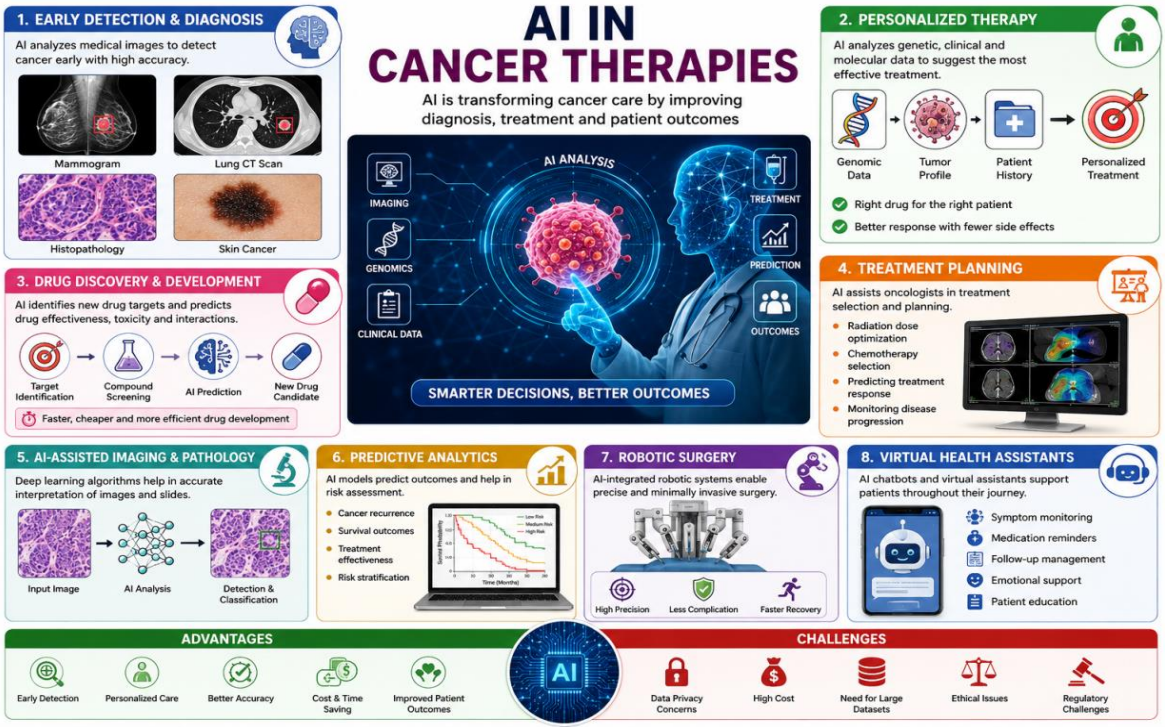

Fig. No. 6: AI In Cancer Therapies.

Types of AI based on capabilities

Artificial Intelligence can be classified into **three types based on capabilities.**

1. Narrow AI (Weak AI)

- Designed to perform **specific tasks only**.
- Works within a limited domain.
- Most AI systems available today belong to this category.

Examples

- Virtual assistants
- Recommendation systems
- Image recognition
- Chatbots

Examples of applications

- ChatGPT
- Siri
- Google Assistant

2. General AI (Strong AI)

- Hypothetical AI capable of performing **human-level intellectual tasks**.
- Can learn, reason, solve problems, and adapt like humans.
- Not yet fully achieved.

Characteristics

✔ Self-learning

✔ Decision making

✔ Human-like reasoning

3. Super AI (Artificial Super Intelligence)

- AI that exceeds human intelligence and capabilities.
- Expected to outperform humans in creativity, decision-making, and problem solving.
- Currently theoretical/future concept.

Potential abilities

- Advanced reasoning
- Independent decision making
- Scientific innovation

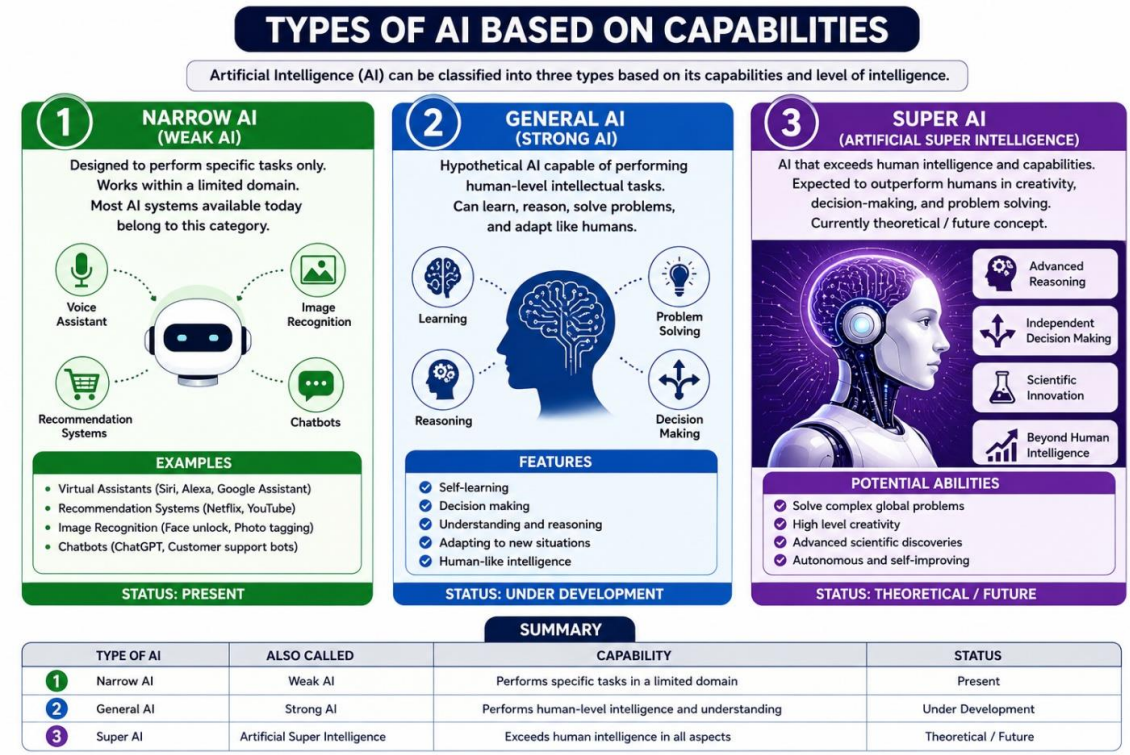

Fig No 7: Types of AI based on Capabilities.

Current applications of AI in Cancer therapies

AI is currently being used in several areas of cancer care, from **diagnosis to treatment and follow-up management**.

1. Early Cancer Detection and Diagnosis

AI analyzes medical images and pathology slides to detect cancer earlier and more accurately.

Applications

- Mammogram analysis for breast cancer
- CT scan analysis for lung cancer
- Histopathology image interpretation
- Skin cancer detection

Techniques used: Machine learning, deep learning, computer vision

2. Medical Imaging and Radiology

AI helps radiologists by

- Tumor detection
- Tumor segmentation
- Measuring tumor size
- Detecting metastasis
- Monitoring disease progression

Imaging methods

- CT
- MRI
- PET scans

3. Personalized / Precision Medicine

AI analyzes

- Genomic data
- Biomarkers
- Tumor mutations
- Patient history

4. Drug Discovery and Development

AI accelerates anticancer drug research by

- Identifying drug targets
- Screening compounds
- Predicting toxicity
- Optimizing molecules

Benefits: Reduced cost and faster development.

5. Radiation Therapy Planning

AI supports

- Radiation dose optimization
- Treatment planning
- Organ protection
- Automatic contouring of tumors

Result: Better precision and reduced damage to healthy tissue.

6. Robotic-Assisted Surgery

AI-guided robotic systems improve surgical precision.

Example: Da Vinci Surgical System

Advantages

- Minimally invasive procedures
- Faster recovery
- Reduced complications

7. Predictive Analytics

AI predicts

- Cancer recurrence
- Survival outcomes
- Risk assessment
- Treatment effectiveness

8. Virtual Assistants and Patient Monitoring

AI-based tools assist in

- Medication reminders

- Symptom tracking
- Follow-up scheduling
- Patient support and education

9. Clinical Decision Support Systems (CDSS)

AI assists oncologists by providing:

- Treatment recommendations
- Evidence analysis
- Clinical data interpretation

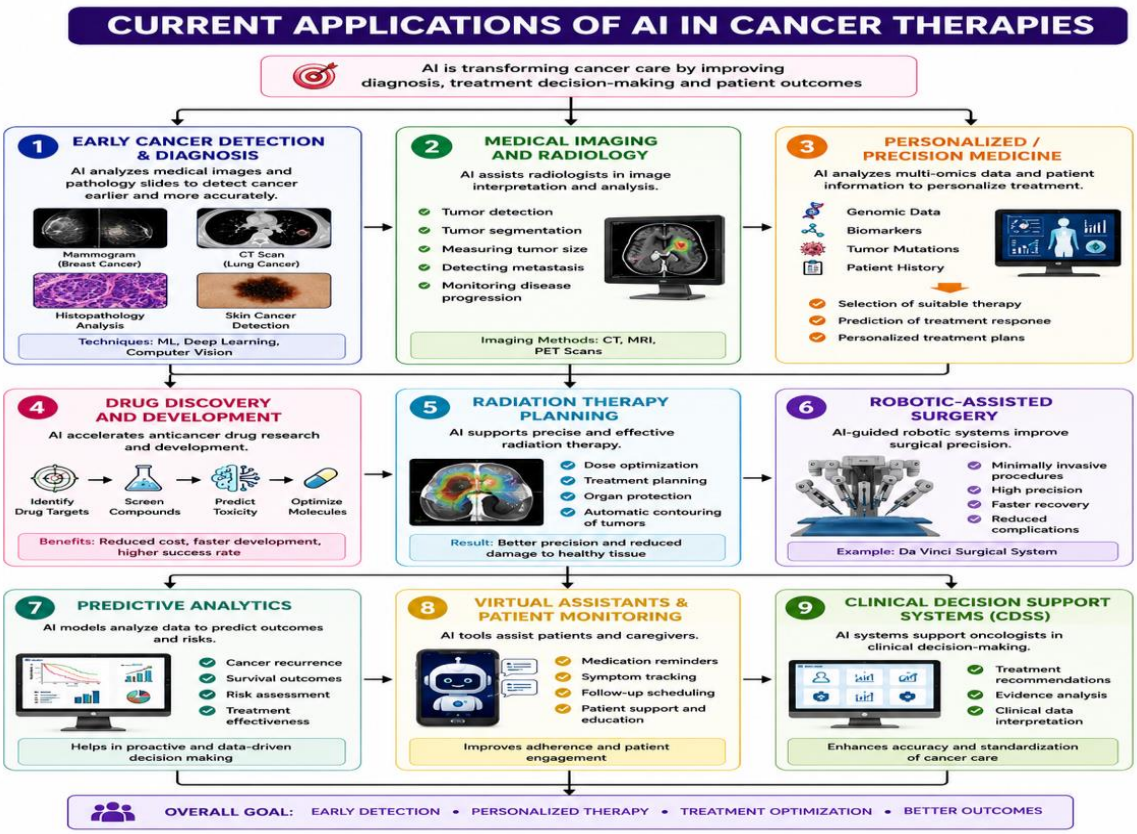

Fig No 8: Current applications of AI in Cancer therapies.

CONCLUSION

In recent years, traditional cancer treatment methods, such as chemotherapy and radiation, were once considered broadly destructive, more recent advances have led to highly targeted, personalized, and immune-based treatments that minimize collateral damage to healthy tissues and improve survival rates. However, the recent developments in artificial intelligence have changed cancer therapy by enhancing accuracy, efficiency, and personalization of treatment. AI helps detect cancer early using advanced imaging analysis and predictive

diagnostics, enabling timely intervention and better survival rates. During treatment planning, AI can analyze huge amounts of clinical data to suggest individualized treatments, including targeted treatments and immunotherapy, and can also accelerate drug discovery by identifying potential compounds and predicting their effectiveness, while reducing time and cost and supporting real-time monitoring of patient responses.

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