

**“COMPREHENSIVE INSIGHTS INTO MAJOR CANCER: FROM
PATHOGENESIS TO SURGICAL MANAGEMENT”**

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ABSTRACT

Unchecked cell proliferation, genetic alterations, and the capacity to spread to distant organs are the hallmarks of the complicated illness known as cancer. Among its more than 200 types are lung, breast, cervical, and oral cancers, all of which contribute to the high rates of disease and death in the world. The risk of cancer is greatly increased by lifestyle variables such as alcohol and tobacco use, illnesses, and exposure to the environment. Molecular biology advancements have shown the importance of deregulated signalling pathways, epigenetic modifications, and genetic abnormalities in the development and spread of cancer. Mouth cancer, particularly oral squamous cell carcinoma, which frequently manifests at a later stage, is significantly linked to tobacco and betel nut consumption. The high-risk human papillomavirus (HPV), which causes oncogenic transformation through E6 and E7 proteins, is the main cause of cervical cancer. Hormonal factors and genetic susceptibility combine to produce breast cancer, with BRCA mutations being a significant contributing factor. Smoking and environmental pollutants are intimately linked to non-small cell lung cancer, the most prevalent subtype of lung cancer and the primary cause of cancer-related mortality. Gene therapy, targeted therapy, chemotherapy, radiation, immunotherapy, and surgery are among the current treatments. For early-stage malignancies, surgery is the primary treatment; for more advanced cases, multimodal methods are needed. Artificial intelligence, liquid biopsy, and precision medicine are a few examples of cutting-edge technologies that are revolutionizing early detection and tailored treatment. Despite these developments, problems like drug resistance and delayed diagnosis still exist, underscoring the necessity of ongoing research and innovation to enhance patient outcomes and survival rates.

KEY WORDS: Cancer, Oral Cancer, Cervical Cancer, Breast Cancer, Lung Cancer

INTRODUCTION

The term "cancer" refers to about 277 different forms of the disease. Cancer, an aberrant cell disorder that causes aggressive malignancies and stunted growth, claims millions of lives each year ⁽¹⁾. Numerous gene changes are involved in the path physiology of cancer, as evidenced by the identification of multiple cancer stages ⁽²⁾. Epidemiological studies have shown that several cancer kinds, including breast, lung, oral, cervical, prostate, colorectal, stomach, liver, blood, head, and neck cancer, are clearly at risk. The rates of cancer-related morbidity and mortality are exceptionally high ⁽³⁾. Numerous screening tests are used to

detect cancer, and a variety of therapies are now accessible, such as gene therapy, chemotherapy, surgery, radiation therapy, immunotherapy, etc. There will probably be 22.2 million instances of cancer by 2030 ⁽⁴⁾. Cancer was uncommon a century ago, but it has significantly increased in frequency in recent decades. Our longer life spans, evolving lifestyles, and changing behaviours are probably to blame for this. One of the most dreaded illnesses of the 20th century; cancer is still spreading and becoming more common in the 21st. The fact that every fourth individual has a lifetime risk of developing cancer is extremely concerning. Therefore, cancer is a major issue that has an impact on everyone's health. Any organ or body structure can develop cancer, which is made up of microscopic cells that are unable to stop proliferating. Sometimes a regular lab test or radiological scan will "incidentally" reveal cancer, or it may be discovered for completely unrelated causes. Generally speaking, cancer cannot be identified until it has grown to one centimeter, or one million cells, in size. These days, it may be called a "mass," "growth," "tumor," "nodule," "lump," or "lesion." Prostate, lung and bronchus, colon and rectum, and bladder cancers are the most prevalent in men. Women are more likely to get breast, lung and bronchus, colon and rectum, uterine corpus, and thyroid cancers. Brain, lymph node, and blood malignancies account for most incidences of cancer in children ⁽⁵⁾. Every year, thousands of studies are carried out, expanding our knowledge of the illness and offering fresh perspectives and cures. Even Nevertheless, the illness continues to spread faster and is currently the main cause of death in many affluent nations.

ORAL CANCER

Oral cancer, namely oral squamous cell carcinoma (OSCC), is a major global public health concern, especially in areas where tobacco, alcohol, and betel nut chewing are prevalent. Approximately 90% of all oral cancers are OSCC, which affects the lips, tongue, cheeks, floor of the mouth, hard and soft palate, and gingiva, among other anatomical sites. With a 5-year survival rate of about 50% globally, oral cancer still carries a substantial risk of morbidity and mortality despite improvements in cancer treatment. The primary reasons for this low survival rate are rapid disease progression and delayed discovery, especially when the cancer is discovered later. This highlights the critical need for improved early detection techniques and creative treatment approaches.

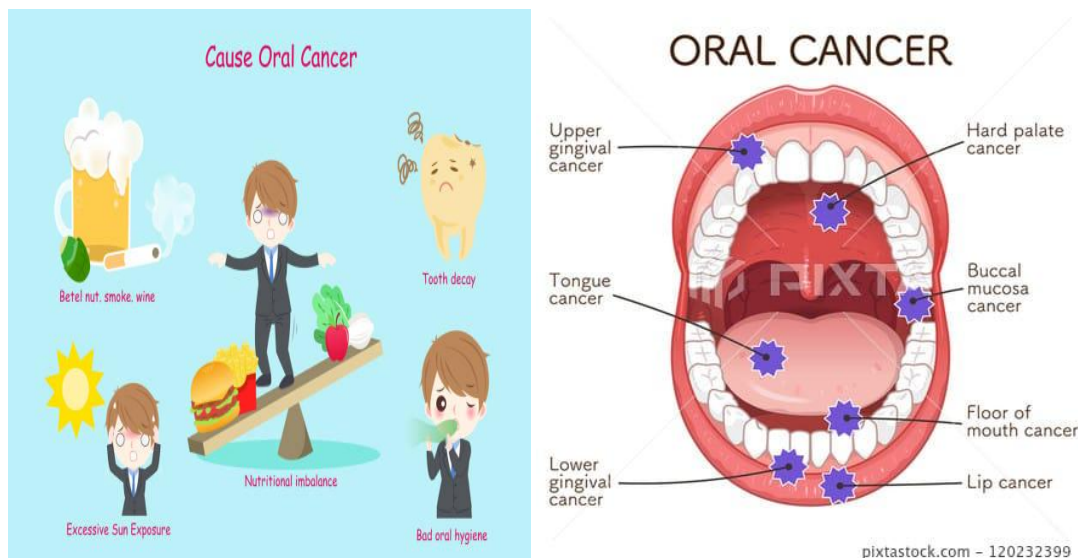


FIGURE NO:1 ORAL CANCER AND CAUSES OF ORAL CANCER

New biomarker-based screening technologies, like liquid biopsies and salivary diagnostics, have supplemented traditional biopsy-based methods by offering non-invasive and real-time tracking of disease progression. Additionally, improvements in imaging technology such as optical coherence tomography and fluorescence imaging have improved patient prognosis and treatment success by making it easier to detect early-stage lesions ⁽⁶⁾.

Squamous Cell Carcinoma (SCC)

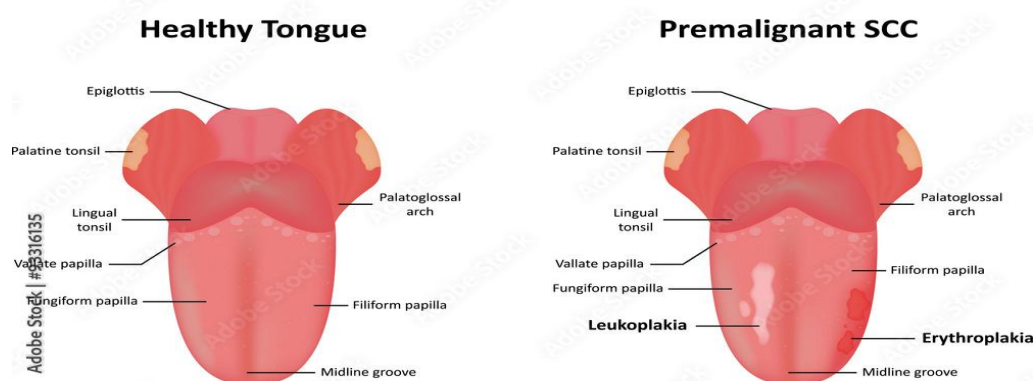


FIGURE NO: 2 HEALTHY TONGUE Vs PREMALIGNANT SCC

- MECHANISM OF ACTION⁽⁷⁾

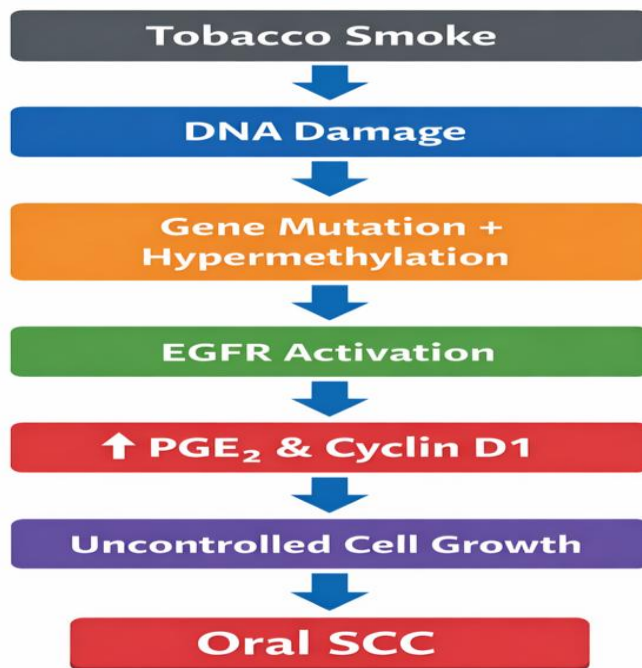


FIGURE NO: 3 MECHANISM OF ACTION OF ORAL SCC

- TREATMENT AND SURGERY

SURGICAL APPROACH	INDICATIONS (TUMOUR SITE/STAGE)	KEY FEATURES
PERORAL APPROACH	Early-stage (T1, T2) tumours of mobile tongue, floor of mouth, buccal mucosa, upper/lower gum	Direct access through oral cavity; suitable for resection and primary repair
LOWER CHEEK FLAP APPROACH	Larger tumours, especially posterolateral oral cavity with mandibular involvement	Lower lip splitting midline incision; cheek flap elevated to expose mandible
VISOR FLAP APPROACH	Large anterior oral cavity lesions (floor of mouth, lower gum)	Provides wide exposure for adequate resection
MANDIBULOTOMY APPROACH	Posterior oral cavity tumours (posterior tongue, base of tongue, pharynx, tonsil)	Mandible split for access; used when mandible is not involved
UPPER CHEEK FLAP APPROACH	Tumours of hard palate and upper gum	Enables partial maxillectomy for 3D tumour resection

TABLE NO: 1 TREATMENT AND SURGERY OF ORAL CANCER

- FDA APPROVED DRUGS

ORAL CANCER

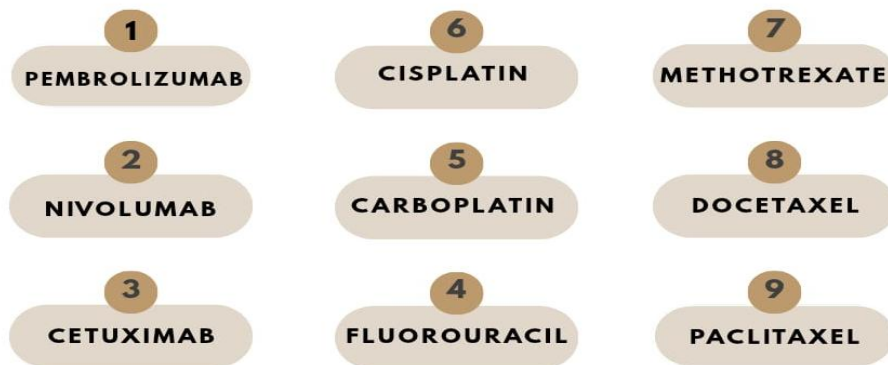


FIGURE NO: 4 FDA APPROVED DRUGS FOR ORAL CANCER

CERVICAL CANCER

Cervical cancer poses a significant risk to women's health because it is the second most frequent malignant tumor in the globe. Cervical cancer has been found to be primarily caused by a chronic, high-risk HPV infection (8). Cervical cancer develops in the cells of the cervix, which is the bottom portion of the uterus that joins the vagina.

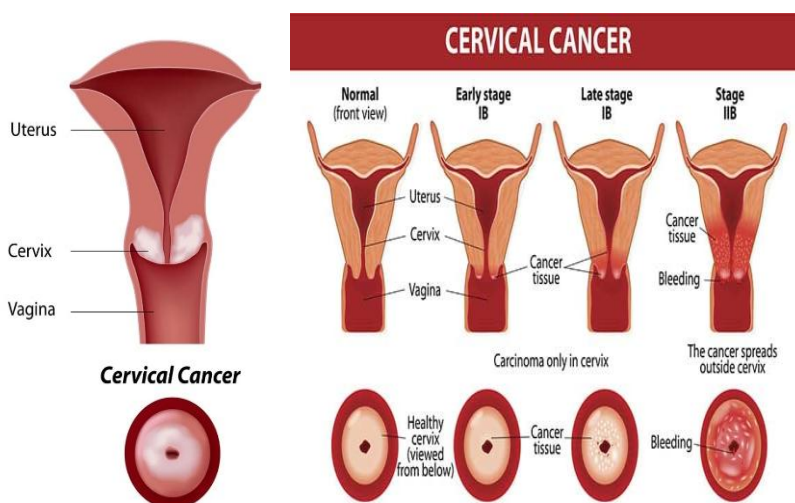


FIGURE NO: 5 CERVICAL CANCER

Over two million women over the age of fifteen are at risk of developing cervical cancer. There are 265672 fatalities and 527624 diagnoses annually. Cervical cancer is the second most frequent cancer in women between the ages of 15 and 44 and the fourth most prevalent cancer in women overall. The incidence was 284823 in just Asia. Due mainly to a decline in the early diagnosis of precancerous lesions, it was the second most common cause of death after breast cancer ⁽⁹⁾. Early onset of sexual activity, certain sexual behaviors such as having many partners, having sex at a young age, using condoms infrequently, having multiple pregnancies linked to chlamydia, and immune suppression with HIV, which is linked to an increased risk of HPV infection, are among the factors contributing to the disease's rise in developing nations. Multiple HPV infections, which are linked to an increased risk of precancerous cervical lesions, are more common in HIV-positive women than in non-HIV-positive women ⁽¹⁰⁾.

- MECHANISM OF ACTION

Persistent infection with high-risk oncogene subtypes of the human papillomavirus (HPV) was the cause of cervical cancer. The circular, double-stranded DNA virus known as HPV has 8000 bases and a diameter of 55 nm ⁽¹¹⁾.

Mechanism of HPV-Induced Cervical Carcinogenesis

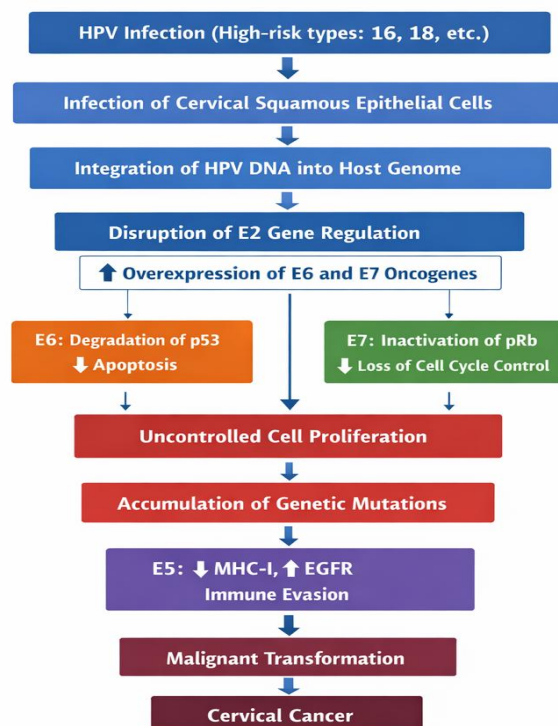


FIGURE NO: 6 FLOW CHART FOR MECHANISM OF ACTION OF CERVICAL CANCER

• FDA APPROVED DRUGS

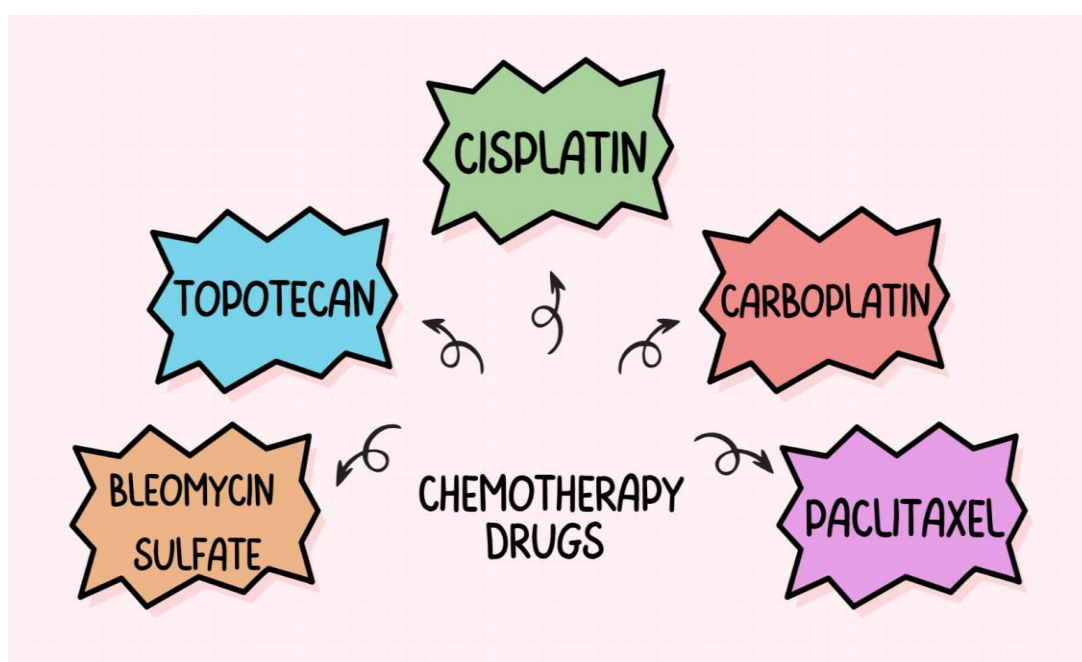
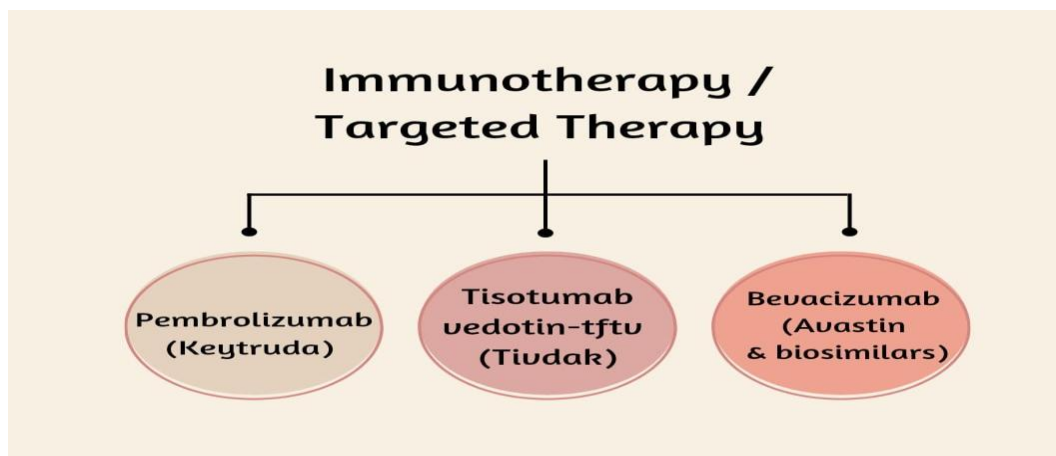


FIGURE NO: 7 FDA APPROVED DRUGS FOR CERVICAL CANCER

- TREATMENT AND SURGERY
- Surgical techniques' impact on cervical cancer ⁽¹²⁾

- ✓ MINIMUM SURGERY INVASIVITY
 - Frequently employed in the early phases of cervical cancer.
 - Benefits include reduced blood loss, fewer issues, and quicker healing.
 - Long-term survival results are currently being assessed.
- ✓ LYMPH SENTINEL NODE BIOPSY
 - Reduces morbidity while evaluating lymph node metastases.
 - An alternative to dissection of the pelvic lymph nodes (PLND).

- Finds uncommon lymph nodes involvement and micro-metastases.
- Advantageous when planning adjuvant therapy.
- ✓ **RADICAL HYSTERECTOMY THAT SPARES NERVES**
 - Shields the autonomic nerves in the pelvis.
 - Minimizes issues with bladder, sex, and intestines.
 - Rate of survival comparable to those of traditional surgery.
 - Calls for more validation and standards.
- ✓ **NEOADJUVANT TREATMENT**
 - Seeks to reduce micro-metastasis and increase operability.
 - Reduced survival without disease compared to chemotherapy.
 - Additional adjuvant therapy may be required.
 - As a standard for locally advanced cervical cancer, this is not advised.
- ✓ **STRONG TRACHELECTOMY**
 - Keeps young patients with early-stage cancer fertile.
 - Involves taking out the cervix without putting the uterus in danger.
 - Can be carried out abdominally, vaginally, or with minimal invasiveness.
- ✓ **NON-RADICAL AND LESS SURGERY**
 - Ideal for low-risk individuals (small tumour, no involvement of lymph nodes).
 - Includes a straightforward conization or hysterectomy.
 - Survival rates comparable to extreme surgery.
 - Dramatically reduced surgical morbidity.

BREAST CANCER

According to GLOBOCAN 2020 data, transitioned countries (Australia/New Zealand, Western Europe, Northern America, and Northern Europe) have lower rates of breast cancer death than Africa, Micronesia/Polynesia, and the Caribbean. The Breast Health Global Initiative (BHGI) is currently in charge of creating suitable recommendations and strategies to offer the best breast cancer control available globally ⁽¹³⁾ . One of the most prevalent diseases, breast cancer has the sixth-highest incidence rate in transitioning nations (Melanesia, Western cancer-related mortality with an estimated number of new cases worldwide). Implementing early treatment and lowering the incidence of breast cancer depend heavily on screening programs and general preventative measures. According to research, genetic abnormalities and family history account for 5% to 10% of cases of breast

cancer, whereas potentially modifiable factors account for 20% to 30% of cases. Breast cells give rise to breast cancer.



FIGURE NO: 8 CAUSES AND RISK FACTORS FOR BREAST CANCER

Malignant tumors are collections of cancer cells that have the capacity to expand into and damage adjacent tissue. It also has the ability to spread throughout the body. Occasionally, alterations can hinder the ability of breast cells to proliferate or function normally. Atypical hyperplasia and cysts are two non-cancerous breast disorders that may arise from these alterations. They may also lead to benign malignancies such as intraductal papillomas ⁽¹⁴⁾. Continued improvements in experimental methods and sequencing technologies have improved cancer detection and diagnosis. For instance, new methods for diagnosing cancer have been made possible by high-throughput sequencing technology and liquid biopsy. Clinical oncology is undergoing a revolution thanks to artificial intelligence (AI), which has the potential to significantly enhance risk assessment, early tumor diagnosis, and more precise, tailored treatment recommendations. Surgery, chemotherapy, radiation, endocrine therapy, targeted therapy, and other related methods are examples of conventional treatments for breast cancer. Thanks to precision medicine, which focuses on customized medicines that target the unique molecular features of certain malignancies, a new era in the treatment of breast cancer has just begun. Patients' survival time and quality of life are directly impacted by long-term cancer treatment, particularly for breast cancer. Keeping abreast of the most

recent scientific developments is essential to improving patient treatment results and increasing our understanding of breast cancer (15).

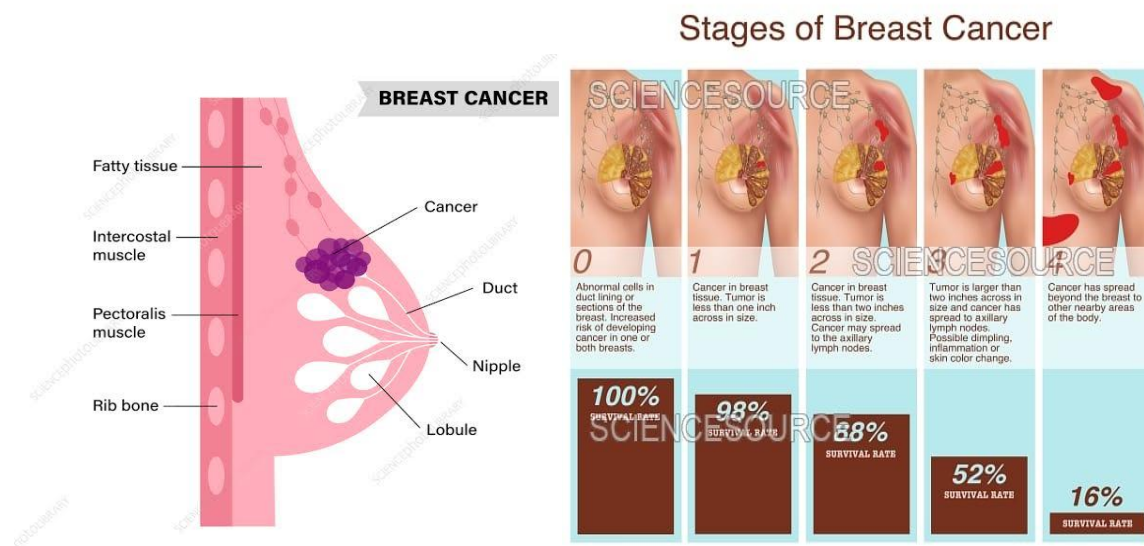


FIGURE NO: 9 DIFFERENT STAGES OF BREAST CANCER

• MECHANISM OF ACTION (16)

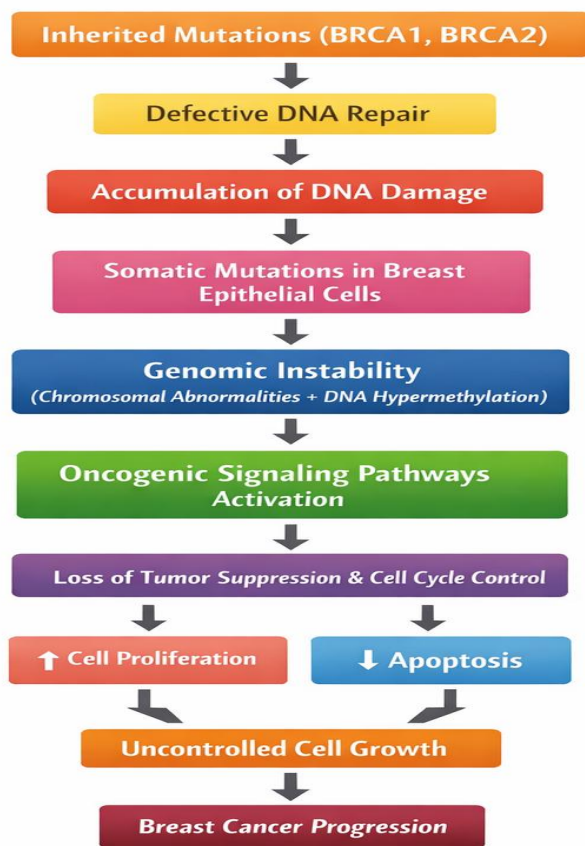


FIGURE NO: 10 MECHANISM OF ACTION OF BREAST CANCER

• FDA APPROVED DRUGS

The Department of Health and Human Services' federal agency, the United States Food and Drug Administration (United States FDA), is in charge of licensing medications for a range of uses in humans and animals as well as other goods. 39 of the 207 medications that the FDA has authorized for use in oncology are particularly designed to treat breast cancer, either as a stand-alone treatment or as an adjuvant (17).

▪ FDA APPROVED DRUGS BETWEEN 1953-2023

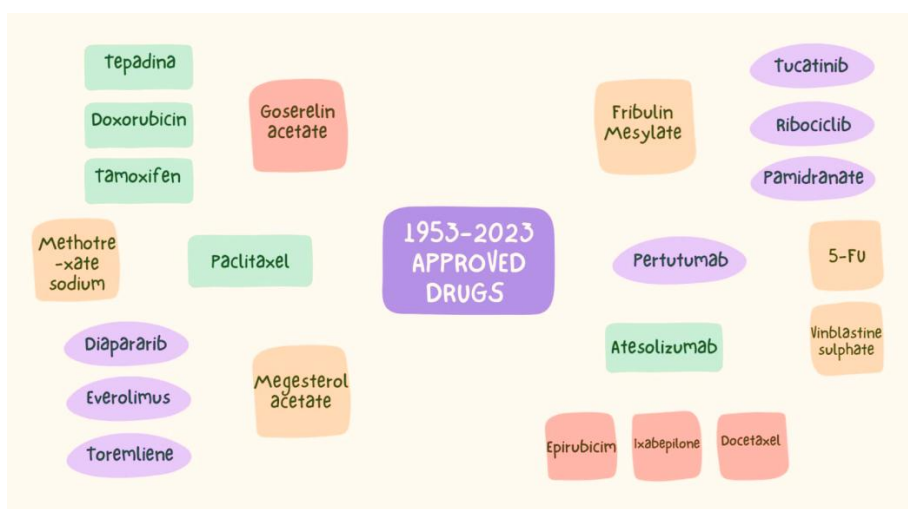


FIGURE NO: 11 FDA APPROVED DRUGS BETWEEN 1953 - 2023

▪ IN 2025, THE FDA APPROVED MEDICATIONS FOR TREATING BREAST CANCER.

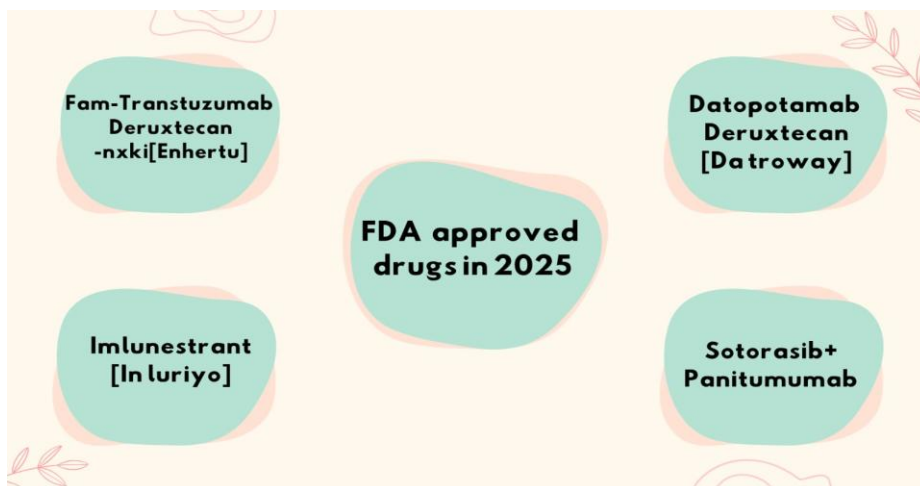


FIGURE NO: 12 FDA APPROVED DRUGS IN 2025

- **TREATMENT AND SURGERY**

Compared to other areas of cancer treatment, surgical innovation typically advances more slowly. However, innovation does happen, and to enhance patient outcomes, new surgical techniques for treating breast cancer must gain widespread acceptance. Breast cancer has traditionally been treated by surgery on the breast and axillary lymph nodes ⁽¹⁸⁾.

A LOOK AHEAD AT BREAST CANCER SURGERY ^(19, 20)

- **ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**
 - Utilized to analyze genetic and imaging data.
 - Enhances results and aids in predicting the response to treatment.
- **MANAGEMENT OF PRIMARY SURGERY IN THE EARLY STAGE**
 - Includes a mastectomy or breast-conserving surgery.
 - Keep cancer safety and cosmetic results in mind.
- **BCS, OR BREAST-CONSERVING SURGERY**
 - Total eradication of the tumour with negative boundaries.
 - Radiation therapy is subsequently used to treat any remaining disease.
 - Ensures favourable outcomes.
- **USES OF MASTECTOMY**
 - Large or multi centric tumours.
 - Inappropriate tumour size for preservation.
 - Trustworthy profits margins.
 - Radiation contraindications
 - BRCA mutation do occur.
 - The Patient's preference
- **TECHNIQUES OF ADVANCED MASTECTOMY**
 - Techniques for shielding the skin and nipples.
 - Best living conditions and visual results.
- **ADVANCES INBREAST RECONSTRUCTION**
 - Pre-pectoral implant placement (modern technique)
 - Aesthetically pleasing compared to conventional submuscular implantation.
 - Using cutting-edge prosthetic materials.
- **MINIMUM INVASIVE APPROACHES**
 - Both robotic and endoscopic methods.

- Improved cosmetic outcomes and less scarring.
- NEOADJUVANT TREATMENT
 - Used more often for breast cancer that is cured.
 - Aids in tumour reduction and enhances surgical results.

LUNG CANCER

Lung cancer was rare at the beginning of the century, but it is now the most frequent disease in the world, accounting for 12% of all new cancer diagnoses in both sexes combined and 18% in men. One hundred years ago, lung cancer was a disease that needed to be reported; today, it is the leading cause of cancer-related deaths globally ^(21, 22).

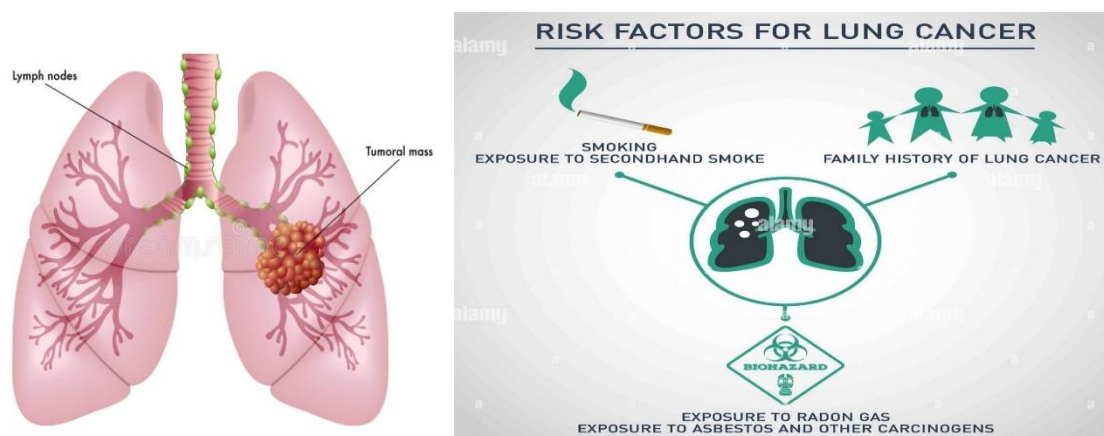


FIGURE NO: 13 RISK FACTORS FOR LUNG CANCER

Numerous other risk factors have been found to be tangentially linked to the development of lung cancer, even though tobacco smoking is the main risk factor accounting for 80% to 90% of all lung cancer diagnoses. Lung cancer is the eleventh most common type of cancer and the seventh leading cause of cancer-related death when considered as a separate reportable category. However, there aren't many risk factors that are directly linked to lung cancer. Although lung cancer survival has only marginally improved over the past few decades, the availability of screening and early detection by low-dose CT, along with advancements in targeted treatments and immunotherapy, will probably lower mortality rates and improve patient survival outcomes in the near future ⁽²³⁾.

Lung neoplasms are the primary cause of cancer incidence and death globally. Small-cell lung cancer (SCLC) and non-small-cell lung cancer (NSCLC), which is further classified, are the two types of lung cancer based on the cell of origin.

Adenocarcinoma (cancer of glandular cells), squamous cell carcinoma (SCC), and neuroendocrine malignancies including small cell carcinoma (SCLC), large cell neuroendocrine carcinoma (LCNEC), and carcinoid are the most frequent kinds of lung cancer, according to the 2015 WHO classification. While well-differentiated neuroendocrine cells (Kulchitsky cells) are the source of carcinoid tumors, poorly differentiated neuroendocrine cells can also produce SCLC, which has a poor prognosis, spreads quickly, and responds poorly to treatment. Particularly in men, squamous cell and small cell malignancies are more likely to be centrally situated and linked to a history of smoking. Peripherally growing adenocarcinomas, which are more common in women and people without a history of smoking, include targetable driver mutations such as BRAF, ROS1, anaplastic lymphomakinase (ALK), and epidermal growth factor receptor (EGFR). In recent years, immunotherapies, such as cytotoxic T-lymphocyte-associated protein 4 (CTLA-4) inhibitors and receptor tyrosine kinase small molecule inhibitors against certain mutations, have either replaced or augmented chemotherapy in eligible patients. In the West, smoking is the cause of over 80% of lung cancer cases, and efforts to quit have reduced both incidence and mortality. Smoking continues to be a significant contributing factor in poor countries along with other risk factors like air pollution, environmental exposure to arsenic, and occupational exposure to asbestos and combustion fumes ⁽²⁴⁾.

- THE LUNG CANCER STAGES

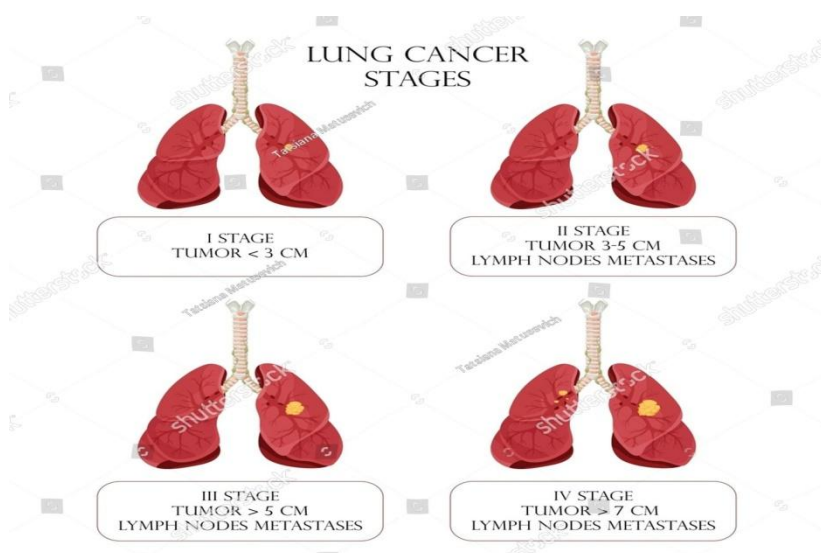


FIGURE NO: 14 DIFFERENT STAGES OF LUNG CANCER

- MECHANISM OF ACTION (25,26,27)

Mechanism of Lung Cancer Development

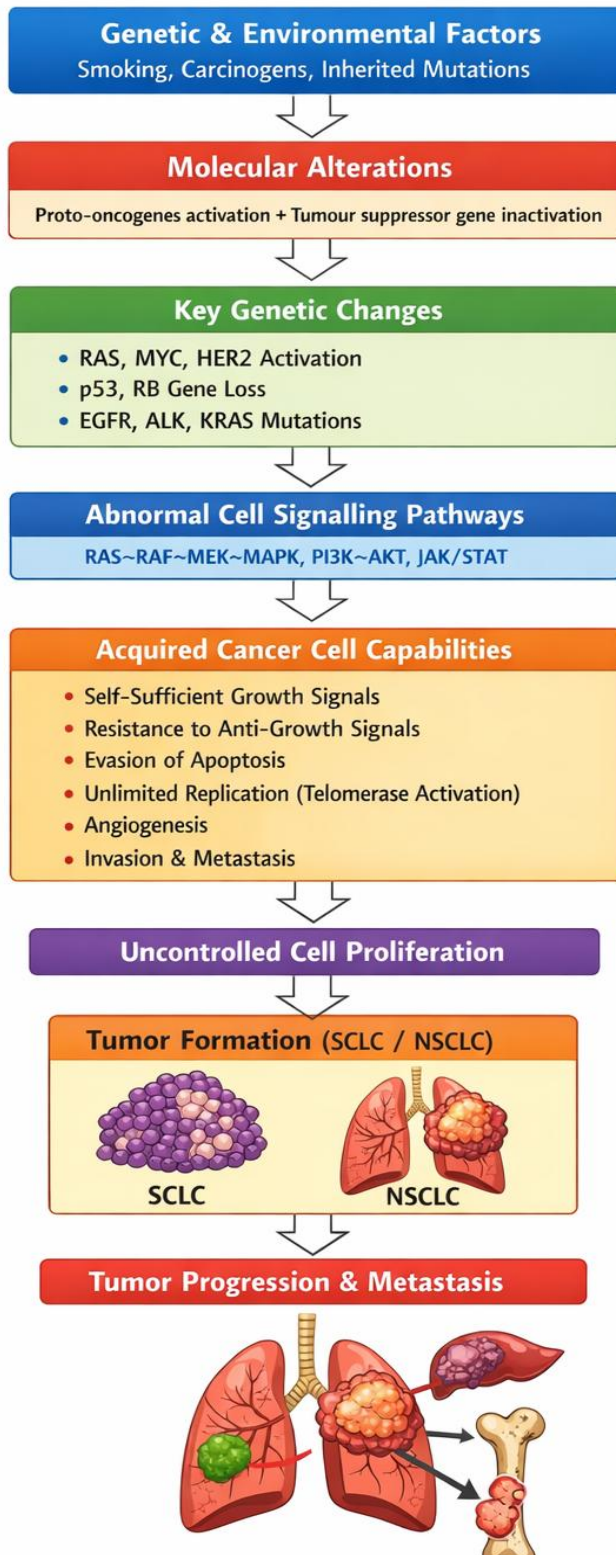


FIGURE NO: 15 MECHANISM OF ACTION OF LUNG CANCER

• FDA APPROVED MEDICATIONS

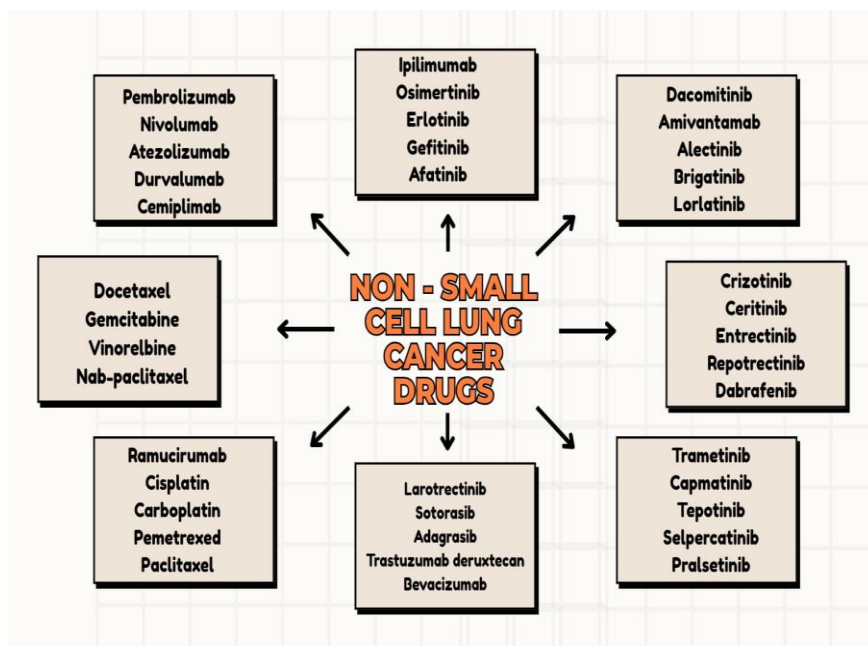


FIGURE NO: 16 FDA APPROVED DRUGS FOR LUNG CANCER

• SURGERY AND TREATMENT (28,29,30)

- ❖ Surgical excision is the main treatment for NSCLC in its initial stages (Stages I and II).
- ❖ Tumors are usually smaller than 7 cm and do not damage the mediastinal lymph nodes.
- ❖ The most common and successful surgical technique is lobectomy.
- ❖ The systematic removal of lymph nodes, or lymphadenectomy, is essential for prognosis and staging.
- ❖ Sublobar resections (in certain cases).
- ❖ A multimodal strategy (surgery + chemotherapy/radiation) is necessary for stage IIIA NSCLC.
- ❖ Preoperative evaluation is crucial for lowering surgical risks.
- ❖ Typical post-operative issues:
 - ❖ Pneumothorax, effusion, and atelectasis are examples of pulmonary problems.
 - ❖ Heart fibrillation.
 - ❖ After surgery, pain.

- ❖ Recovery and results are enhanced by supportive care and effective pain management.

SUMMARY AND CONCLUSION

Due to increased incidence and mortality rates in both developed and developing nations, cancer remains one of the major worldwide health concerns. The complicated aetiology of cancer, which includes genetic changes, environmental variables, lifestyle choices, and infectious organisms, explains its complexity. The four main types of cancer lung, breast, cervical, and oral are discussed in this synopsis. All of these cancers have the tendency for metastasis and unregulated cell development, despite differences in their genetic composition, risk factors, and aetiology

The identification of key oncogenes, tumor suppressor genes, and signaling pathways involved in carcinogenesis has greatly increased our understanding of the molecular and cellular origins of cancer. This has made it possible to tailor treatments according to the unique characteristics of each tumor, opening the door for targeted therapies and precision medicine. Furthermore, advancements in diagnostic technologies, including as liquid biopsies, biomarker identification, and imaging techniques, have made it feasible to boost early detection, which is essential for good treatment outcomes.

Many solid tumors, especially those in their early stages, nevertheless require surgery. To improve the quality of life for patients, minimally invasive and organ-preserving procedures are being developed. Additionally, many malignancies now have much higher survival rates thanks to the combination of chemotherapy, radiation, immunotherapy, and other targeted drugs. Optimal cancer therapy is still hampered by issues such drug resistance, recurrence, late-stage diagnosis, and restricted access to medical resources.

Reducing the incidence of cancer requires preventive measures like lifestyle changes, immunizations (such the HPV vaccine), and routine screening programs. To encourage early diagnosis and prompt intervention, public education and awareness must be prioritized equally. The application of AI and machine learning to enhance overall patient care, forecast treatment response, and increase diagnostic precision may be extremely beneficial for cancer in the future.

In conclusion, a multidisciplinary and integrated approach involving prevention, early detection, sophisticated treatment modalities, and ongoing research is necessary to successfully combat cancer and minimize its worldwide impact, despite notable breakthroughs in cancer research and therapy.

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