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A Review: Lung Cancer

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Abstract: ***Lung cancer continues to be one of the most common and deadly types of cancer in the world, accounting for a sizable amount of cancer-related deaths. It is often divided into two types: small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC), with the former originating mostly in the respiratory tract's epithelial lining. About 85% of cases are NSCLC, while SCLC is more aggressive and spreads more quickly. Lung cancer has a complex aetiology, with tobacco use being the main risk factor, followed by exposures at work, genetic predispositions, and environmental contaminants. The asymptomatic aspect of the early stages frequently prevents early detection, which results in a poor prognosis and delayed treatment. Early detection rates have increased thanks to sophisticated diagnostic tools like biomarkers, imaging techniques, and biopsy-based approaches. Lung cancer continues to be one of the most common and deadly types of cancer in the world, accounting for a sizable amount of cancer-related deaths. It is often divided into two types: small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC), with the former originating mostly in the respiratory tract's epithelial lining. About 85% of cases are NSCLC, while SCLC is more aggressive and spreads more quickly. Lung cancer has a complex aetiology, with tobacco use being the main risk factor, followed by exposures at work, genetic predispositions, and environmental contaminants. The asymptomatic aspect of the early stages frequently prevents early detection, which results in a poor prognosis and delayed treatment. Early detection rates have increased thanks to sophisticated diagnostic tools like biomarkers, imaging techniques, and biopsy-based approaches.***
Keywords: Lung cancer, Non-small cell lung cancer (NSCLC), Small cell lung cancer (SCLC), Pathogenesis, Diagnosis, Chemotherapy, Herbal medicine, Immunotherapy, Smoking, Targeted therapy.

I. INTRODUCTION

The most deadly cancer in the world is lung cancer, a malignant neoplasm that starts in the pulmonary tissues. Late-stage diagnosis and poor therapeutic efficacy in advanced stages are the reasons for its high fatality rate. NSCLC, which makes up around 85% of cases, and SCLC, which makes up the remaining 15%, are the two histological types in which the illness most commonly manifests. Risk factors are complex and include genetic predispositions, lifestyle decisions, and environmental exposures. Its prevalence has dramatically increased with the onset of industrialization and rising tobacco use. Even with advances in medical research, problems with early detection and efficient treatment still exist. The epidemiology, risk factors, and importance of early intervention for lung cancer are thoroughly examined in this section[1-3].

A. Summary and Significance

Nearly 1.8 million people die from lung cancer each year, making it one of the top causes of cancer-related mortality globally. The prognosis for lung cancer is still dismal, particularly in low- and middle-income nations, despite advancements in detection technology and treatment approaches. The goal of this study is to present a thorough understanding of lung cancer by examining its aetiology, pathophysiology, methods of diagnosis, and contemporary therapeutic strategies[4].

B. Trends in Epidemiology and Incidence

Males are more likely than females to develop lung cancer, which is the second most frequent cancer worldwide. While incidence rates are still rising in developing countries, they have started to fall in those with successful tobacco control measures. Smoking habits and environmental exposures including air pollution and work-related risks are both factors in the worldwide burden[5].

C. Trends in Epidemiology and Incidence

Males are more likely than females to develop lung cancer, which is the second most frequent cancer worldwide. While incidence rates are still rising in developing countries, they have started to fall in those with successful tobacco control measures. Smoking habits and environmental exposures including air pollution and work-related risks are both factors in the worldwide burden of lung cancer[6].

D. The Value of Early Identification

When lung cancer is discovered early, the prognosis greatly improves. However, the majority of cases are diagnosed at a late stage because the disease is frequently asymptomatic in its early stages. Worldwide, initiatives are being made to enhance early detection via biomarkers and screening programs[7].

E. Clinical Presentation and Symptoms

Prolonged coughing, chest pain, haemoptysis, dyspnea, and inexplicable weight loss are typical symptoms. Treatment may become more difficult in advanced stages if metastasis-related symptoms such liver failure, neurological impairments, and bone discomfort are present[8].

F. Effect on Life Quality

Due to physical symptoms, psychological distress, and the high cost of long-term care and treatments, lung cancer not only reduces lifespan but also negatively affects quality of life.

The Burden of the Economy and Society

Lung cancer not only poses a serious threat to public health but also has a significant financial impact. Diagnostics, extended treatment plans, hospital stays, palliative care, and lost productivity—particularly in more advanced cases—all come at a cost[9].

G. Worldwide Control Strategies

WHO is among the many international organizations that have started air quality improvement projects, smoke cessation programs, and awareness campaigns. Reducing the rising incidence of lung cancer requires policies that priorities prevention and control.

H. Imaging and Biopsy's Role

CT, PET, and MRI scans are examples of advanced imaging technologies that are essential for diagnosis and staging. To collect tissue samples for histological confirmation, invasive procedures like bronchoscopy and needle biopsies are used.

Multimodal Methods of Therapy

Some patients have showed better survival when surgery, chemotherapy, radiation, and new drugs are combined. To maximize results, multimodal techniques are customized based on patient-specific characteristics and the stage of the disease.

I. Resistance Strategies and Difficulties

One major obstacle to treating lung cancer is drug resistance. Research into combination medicines and second-line treatments must continue due to mechanisms such secondary mutations and the activation of alternate signalling pathways[10-11]

J. Management Focused on the Patient

Psychosocial support, dietary care, and rehabilitation programs are all part of effective management, in addition to medical therapies. In order to provide comprehensive patient care, multidisciplinary teams are essential.

K. Lung Cancer and Immunology

Attention has been drawn to the immune system's role in the development and suppression of cancer. Immunotherapy, especially immune checkpoint inhibitors, has shown significant promise in improving patient survival and is increasingly being used as a key component of lung cancer treatment.

L. Specific Treatments

Remarkable results have been obtained from targeted therapies based on particular genetic changes. This strategy is best illustrated by tyrosine kinase inhibitors (TKIs), such as gefitinib and osimertinib for EGFR mutations. When compared to conventional chemotherapy, these treatments frequently have less adverse effects.

M. Traditional Methods

Chemotherapy and radiotherapy continue to be fundamental treatments despite advancements in targeted therapy and immunotherapy, especially in situations where more sophisticated alternatives are unavailable. Their use is dictated by tumor stage, patient condition, and cancer subtype[12-15].

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II. ETIOLOGY[16-20]

The unchecked growth of epithelial cells in the lung tissues is the cause of lung cancer. Prevention and early intervention both depend on an understanding of the aetiology. Lung cancer has multiple etiologies, including hereditary and environmental influences. These elements work together in intricate ways to start and encourage lung cancer.

A. Smoking Tobacco

About 85 to 90 percent of all occurrences of lung cancer are caused by cigarette smoking, making it the most common etiological factor. Among the more than 7,000 compounds included in tobacco smoke are at least 70 recognized carcinogens, including polycyclic aromatic hydrocarbons, nitrosamines, and benzo[a]pyrene. These chemicals harm bronchial epithelial cells' DNA, which results in mutations in tumor suppressor genes (like TP53) and oncogenes (like KRAS).

B. Cigarette Smoke

Secondhand smoke exposure, sometimes referred to as passive smoking, is a serious health factor, especially for nonsmokers who live with smokers. Secondhand smoke is categorized as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC). Long-term indoor exposure raises the risk of lung cancer in nonsmokers by 20–30%, particularly in women and children.

C. Pollution of the Environment

Lung cancer incidence is significantly influenced by air pollution, especially in urban and industrialized areas. The main pollutants involved are Sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter (PM2.5 and PM10). The IARC has designated diesel exhaust as carcinogenic to humans, making it an especially dangerous component. Genetic alterations, oxidative stress, and chronic inflammation are brought on by prolonged exposure to these contaminants.

D. Exposure to Radon Gas

A naturally occurring radioactive gas, radon is created when uranium decays in rocks and soil. It can enter buildings through crevices and gather inside, especially in basements with little ventilation. Among non-smokers, radon exposure is the most common cause of lung cancer and the second most common cause after smoking. Smoking and radon have a compounding effect that increases the risk.

E. Risks at Work

Lung cancer risk is greatly increased by occupational exposure to carcinogenic substances. Particularly at risk are those employed in shipbuilding, asbestos manufacture, mining, and construction. It is well recognized that certain substances, including as arsenic, asbestos, silica, chromium, and nickel compounds, can change DNA and induce lung damage. Chronic lung inflammation and cellular change are the outcomes of long-term inhalation of these substances.

The aetiology of lung cancer is a complex field that includes both internal biological vulnerabilities and external carcinogenic exposures. Although smoking is still the leading cause, other risk factors that can be changed, like indoor smoke, occupational risks, and air pollution, can have a big impact. The etiological landscape is further complicated by factors associated to lifestyle and genetics. Effective preventative tactics, risk assessment, and the creation of specialized therapy approaches all depend on an understanding of these underlying factors.

F. Pathogenesis21-25:

The development of lung cancer is a multi-step process that includes chronic inflammation, epigenetic changes, and genetic mutations:

Origin: Carcinogens, such as radon and tobacco smoke, damage the DNA of bronchial epithelial cells.

Promotion: Normal cell cycle control is disrupted by mutations in tumor suppressor genes (TP53, RB1) and oncogenes (KRAS, EGFR).

Progression: Unchecked cell division, apoptosis evasion, angiogenesis, and tumor growth are caused by accumulated mutations.

Metastasis: Cancer cells spread to distant organs (usually the liver, brain, and bones) by invading surrounding tissue and entering the blood and lymphatic systems.

III. DIAGNOSIS[26-27]

Lung cancer is diagnosed using a combination of clinical, imaging, histopathological, and molecular methods:

- Clinical Signs: Persistent cough, hemoptysis (coughing up blood), chest pain, weight loss, shortness of breath.
- Imaging:
  - Chest X-ray – Initial screening tool.
  - CT scan – Detects small lesions, lymph node involvement.
  - PET-CT – Assesses metabolic activity and metastasis.
- Tissue Biopsy:
  - Bronchoscopy with biopsy.
  - CT-guided needle biopsy.
- Cytology: Sputum cytology and pleural fluid analysis.
- Molecular Testing: EGFR, ALK, KRAS mutations – guides targeted therapy.

IV. TREATMENT[28-29]

The kind, stage, molecular profile, and health of the patient all influence the course of treatment:
Surgery: Pneumonectomy or lobectomy are the best options for non-small cell lung cancer (NSCLC) in its early stages.
Radiotherapy: Used after surgery or for tumors that cannot be removed.
Chemotherapy: Platinum-based treatment plans for advanced illness, such as cisplatin with paclitaxel.
Targeted Therapy: For cancers that have mutations in ROS1, ALK, or EGFR (e.g., erlotinib, crizotinib).
Immunotherapy: PD-1/PD-L1 inhibitors, such as pembrolizumab and nivolumab, aid the immune system's assault on cancerous cells.
Palliative care: Enhances quality of life and manages symptoms in later phases.

V. HERBAL VS ALLOPATHIC DRUGS[30-35]

Table.1: Herbal drugs used for Lung Cancer

Type	Drug/Extract Name	Source/Compound	Mechanism / Site of Action
Herbal	Curcumin	Turmeric (Curcuma longa)	Inhibits NF-κB, STAT3, and COX-2 pathways; suppresses proliferation and induces apoptosis.
Herbal	Resveratrol	Grapes, Red wine	Inhibits PI3K/Akt and MAPK pathways; induces apoptosis and autophagy.
Herbal	Withaferin A	Ashwagandha (Withania somnifera)	Suppresses STAT3, NF-κB pathways; induces G2/M arrest in lung cancer cells.
Herbal	Berberine	Berberis vulgaris	Modulates AMPK and p53 pathways; inhibits cell proliferation and metastasis.
Herbal	Honokiol	Magnolia officinalis	Blocks EGFR and mTOR signaling; promotes cell cycle arrest and apoptosis.
Herbal	EGCG (Epigallocatechin gallate)	Green tea	Inhibits VEGF, MMPs, and EGFR; blocks angiogenesis and metastasis.
Herbal	Lycopene	Tomatoes	Antioxidant; inhibits IGF-1 signaling and suppresses cell proliferation.
Herbal	Thymoquinone	Nigella sativa (Black seed)	Inhibits PI3K/Akt pathway and induces oxidative stress-mediated apoptosis.

Table.2: Allopathic Drugs used for Lung Cancer

Type	Drug Name	Class	Mechanism / Site of Action
Allopathic	Cisplatin	Chemotherapy (Platinum compound)	Cross-links DNA, preventing replication; causes apoptosis in rapidly dividing cells.
Allopathic	Paclitaxel	Chemotherapy (Taxane)	Stabilizes microtubules, arresting mitosis in cancer cells.
Allopathic	Erlotinib	EGFR Tyrosine Kinase Inhibitor	Inhibits EGFR signaling; blocks cell proliferation in EGFR-mutated NSCLC.
Allopathic	Crizotinib	ALK Inhibitor	Blocks ALK fusion protein signaling in ALK-positive NSCLC.
Allopathic	Nivolumab	Immune Checkpoint Inhibitor (PD-1 inhibitor)	Enhances T-cell activity against tumor cells by blocking PD-1 pathway.
Allopathic	Bevacizumab	Monoclonal Antibody (Anti-VEGF)	Inhibits angiogenesis by binding VEGF-A, cutting tumor blood supply.
Allopathic	Pembrolizumab	Immune Checkpoint Inhibitor (PD-1 inhibitor)	Stimulates immune response against tumor cells by blocking PD-1 receptor.
Allopathic	Carboplatin	Chemotherapy (Platinum compound)	Causes DNA damage via alkylation, triggering cell death in tumor tissues.

Table.3: Herbal vs Allopathic drugs

Aspect	Herbal Medicine	Allopathic Medicine
Source	Natural plant extracts	Synthetic chemicals
Mechanism of Action	Modulates multiple pathways; induces apoptosis	Targets specific molecular pathways
Side Effects	Generally fewer and milder	Potentially severe and numerous
Standardization	Variable; lacks uniform dosing	Highly standardized and regulated
Clinical Evidence	Limited large-scale trials	Extensive clinical trials and data
Accessibility	Widely available; often over-the-counter	Requires prescription; may be costly
Site of Action	Broad systemic effects	Specific cellular targets
Regulatory Approval	Varies by region; less stringent	Strict regulatory processes (e.g., FDA approval)

VI. FUTURE SCOPE OF STUDY[36-40]

The different but occasionally complementary strategies employed to treat this potentially fatal illness are highlighted by the comparison of herbal and allopathic medications for lung cancer. Herbal remedies, which come from natural sources like plants, have less negative effects and show promise in their anticancer properties. By modifying important signalling pathways including NF-κB, STAT3, and PI3K/Akt, which are essential for cancer cell survival, proliferation, and resistance to apoptosis, compounds like resveratrol from grapes and curcumin from turmeric demonstrate potent anti-inflammatory and antioxidant qualities. Similarly, berberine (from Berberis vulgaris) and withaferin A (from ashwagandha) cause cell cycle arrest and apoptosis via the p53 and AMPK pathways, which results in lethal effects on lung cancer cells.

Allopathic treatments, on the other hand, use proven pharmaceuticals such as paclitaxel, carboplatin, and cisplatin, which directly disrupt DNA replication or cell division in order to kill cancer cells. Treatment precision is provided by targeted medicines like crizotinib (an ALK inhibitor) and erlotinib (an EGFR inhibitor), which are made to specifically target genetic alterations present in subsets of non-small cell lung cancer (NSCLC). Lung cancer treatment has been transformed by immune checkpoint inhibitors like pembrolizumab and nivolumab, which boost the body's immune response to cancer cells via the PD-1/PD-L1 axis. Furthermore, the anti-VEGF monoclonal antibody bevacizumab prevents tumor angiogenesis, depriving cancer cells of oxygen and vital nutrients.

Allopathic treatments frequently have serious side effects, such as nephrotoxicity, neuropathy, and immune-related adverse events, even if they are backed by strong clinical trials and established protocols. Herbal medications, on the other hand, need additional pharmacological testing and regulatory clearance even though they might be safer and easier to obtain. Integrative cancer treatments may be possible in the future if the advantages of both approaches are combined, for example, by employing herbal components as adjuvants to lessen toxicity or resistance.

VII. CONCLUSION

One of the most common and fatal cancers in the world, lung cancer presents a serious problem for international health systems. Despite advancements in diagnostic imaging, surgical techniques, chemotherapy, targeted therapy, and immunotherapy, the prognosis for many lung cancer patients remains poor, particularly in advanced stages. Despite their effectiveness, allopathic treatments are frequently linked to serious side effects, exorbitant expenses, and resistance over time. These drawbacks highlight the necessity of complementing or alternative approaches that are less harmful and equally successful.

Herbal remedies have demonstrated significant promise in the prevention and treatment of lung cancer. These remedies are taken from traditional medical systems including Ayurveda, Traditional Chinese Medicine, and Unani. Phytochemicals that modulate important molecular pathways like NF-κB, STAT3, PI3K/Akt, and p53, such as curcumin, resveratrol, withaferin A, and berberine, show intriguing anticancer activities. These natural substances frequently have apoptotic, anti-inflammatory, anti-metastatic, and antioxidant properties, which enhance their potential as chemo preventive and therapeutic agents. However, obstacles like inadequate bioavailability, limited clinical validation, and a lack of standardisation make it difficult to include them into regular treatment plans.

A more comprehensive and patient-centered approach to lung cancer treatment may be provided by a well-rounded and integrative method that combines the advantages of both allopathic and herbal approaches. To confirm the effectiveness and safety of herbal medications, future research should concentrate on clinical trials, pharmacokinetic investigations, and regulatory frameworks. In conclusion, herbal medicines are the key to long-term, sustainable solutions in the battle against lung cancer, even while modern medicine offers quick and focused intervention.

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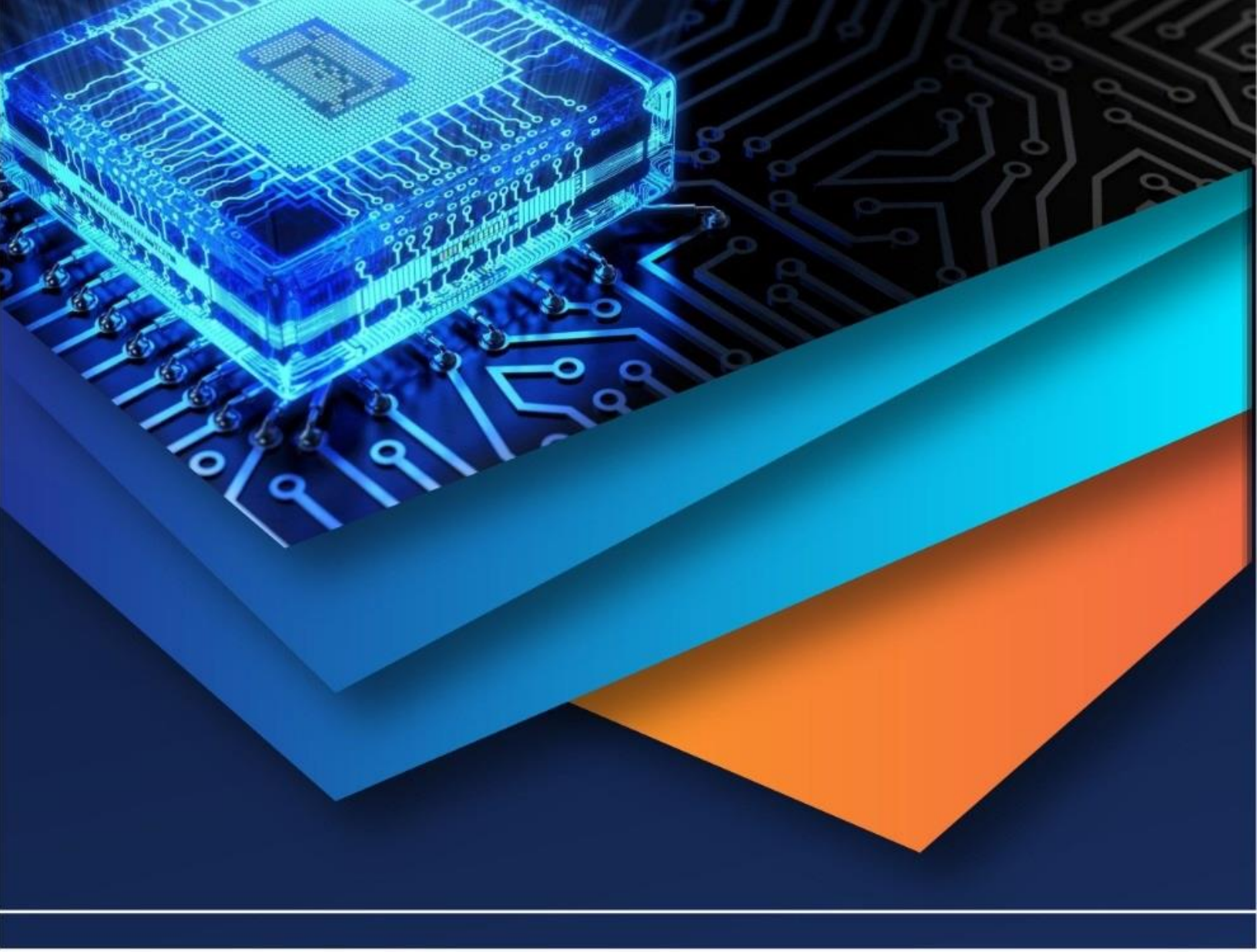

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