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The Role of Early Diagnosis and Intervention in Improving Outcomes for Lung Cancer

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Abstract

Introduction: For lung cancer patients, early diagnosis and treatment are essential for improving outcomes. This study aims to compare early versus late diagnosis in terms of overall survival, progression-free survival, quality of life, and treatment-related adverse events.

Methodology: A prospective cohort trial of seventy-eight lung cancer patients was conducted at Hayatabad Medical Complex in Peshawar from December 2021 to March 2023. 39 patients had early diagnosis (n=39) while 39 patients received late diagnosis (n=39). Low-dose computed tomography (LDCT) screening and prompt symptom presentation led to an early diagnosis; incidental or symptomatic results were the basis for a late diagnosis. Overall survival (OS), progression-free survival (PFS), quality of life (QoL), and frequency of serious adverse events associated to therapy were the outcomes.

Results: The early diagnosis group demonstrated significantly better outcomes, with a median OS of 38 months compared to 14 months in the late diagnosis group ($p<0.001$) and a median PFS of 34 months compared to 10 months ($p<0.001$). At 12 months, the early diagnosis group had better QoL scores, with a mean global health status score of 75 compared to 55 ($p<0.01$). The frequency of serious adverse events was lower in the early diagnosis group (18%) compared to the late diagnosis group (45%).

Conclusion: In patients with lung cancer, early detection and intervention greatly increase survival rates, prolong intervals without progression, improve quality of life, and lower serious side events associated to therapy. These results emphasize the need of early diagnosis techniques and efficient screening programs in the treatment of lung cancer.

Keywords: lung cancer, early diagnosis, low-dose computed tomography, overall survival, progression-free survival, quality of life, treatment-related adverse events

Introduction

Lung cancer, 'which accounts for around 18% of all cancer fatalities, continues to be one of the major causes of cancer-related mortality globally'. Lung cancer patients still have a dismal outlook, with a 'five-year survival rate of just 20%', despite advancements in treatment modalities and a growing knowledge of the disease's molecular nature [1, 2]. This alarming figure highlights the urgent need for methods that can identify lung cancer early on, when it is more manageable, and launch timely, efficient treatments. Improving patient outcomes from lung cancer depends critically on early detection [3]. Early-stage tumors, especially those in stages I and II, are usually more responsive to targeted therapy and surgical excision, both of which have the potential to be curative [4]. On the other hand, systemic therapies like chemotherapy and immunotherapy—which are often less successful and linked to greater morbidity—are frequently required for lung cancer that has been detected at an advanced stage. Early discovery may thereby dramatically change the focus of therapy from palliation to possible cure, improving patient quality of life and survival rates [5-7].

'Low-dose computed tomography (LDCT)' has emerged as a useful technique in the substantial research on the importance of screening programs in early lung cancer identification [8]. The National Lung Screening Trial (NLST) and other studies have shown that LDCT screening may reduce the mortality rate from lung cancer by discovering malignancies at an earlier stage [9], when they are more likely to be treated. Still, a number of challenges lie in the way of carrying out large-scale screening programs, including determining who is at

high risk, managing false positive findings, and ensuring that screening services are both affordable and available [10]. Beyond screening, new paths for early lung cancer identification have been made possible by developments in molecular diagnostics. Liquid biopsy is a non-invasive technique for early cancer identification and monitoring that involves the examination of circulating tumor DNA (ctDNA) and other biomarkers in blood [11]. There is potential for improving the precision and effectiveness of early diagnosis via the integration of artificial intelligence (AI) and machine learning algorithms in pathology and imaging [12].

Improving lung cancer outcomes also requires early management after diagnosis. Lung cancer therapy has been transformed by individualized treatment plans based on the genetic and molecular profiles of malignancies. When compared to standard chemotherapy, targeted medicines and immunotherapies that are specifically designed to target genetic abnormalities and the immunological landscape of tumors have shown great success in improving survival and minimizing adverse effects. Furthermore, improvements in precision radiation treatment and less invasive surgical methods have improved patient outcomes and sped up recovery periods [13].

The goal of this study is to explore the complex relationship among early detection and treatment and better lung cancer outcomes. This article looks at the most recent developments in screening technology, diagnostic techniques, and individualized treatment plans in an effort to provide a thorough picture of how early diagnosis and timely intervention might change the face of lung cancer care. We want to demonstrate the vital significance of prompt intervention in lowering lung cancer mortality and improving patient quality of life by a thorough examination of existing procedures and cutting-edge developments.

Materials and methods

Study Design

To assess the effect of early detection and management on lung cancer outcomes, this study employed a prospective cohort design. In order to fully evaluate the advantages of early identification and timely medical intervention, the research monitored patients from the time of diagnosis through treatment and follow-ups.

Study Location

In the premier tertiary care facility in Peshawar, Pakistan, Hayatabad Medical Complex, the study was carried out. This hospital was the perfect location for this research since it has cutting-edge diagnostic and therapeutic technology.

Study Duration

The research was carried out between December 2021 and December 2024, a span of two years. This length of time provided enough follow-up to assess survival rates and long-term results.

Sample Size and Calculation

To guarantee statistical significance in identifying outcomes differences between early and late diagnosis groups, a power analysis was used to set a sample size of 78 individuals. The computation used the assumptions of an ‘alpha level of 0.05, a power of 80%, and an anticipated variation in survival rates from earlier research.

Inclusion and Exclusion Criteria

Patients eighteen years old age or above, had been diagnosed with primary lung cancer at Hayatabad Medical Complex, had never had cancer therapy before, and were prepared to provide informed consent and follow research procedures qualified for inclusion. Patients having metastatic cancer from other source locations, a history of lung cancer or other malignancies, and those unable to follow-up procedures because of serious comorbidities or other reasons were excluded.

Data Collection

At the Hayatabad Medical Complex, lung cancer patients were evaluated for eligibility. After giving their informed consent, those who met the inclusion criteria were included in the research. Baseline data, such as demographics, medical history, smoking status, family history of cancer, and first clinical presentation, were gathered at the time of recruitment. Two groups of patients were created: one for early diagnosis and the other for late diagnosis. Patients were categorized based on the method of diagnosis: early diagnosis was defined by low-dose computed tomography (LDCT) screening and prompt symptom presentation, while late diagnosis was based on incidental or symptomatic findings without prior screening.

Molecular diagnostic testing, such as liquid biopsy for circulating tumor DNA (ctDNA), histological analysis of biopsy samples, and imaging investigations such ‘chest X-rays, CT scans, and PET scans’ were among the diagnostic techniques used. Chemotherapy and radiation treatment were administered as needed, along with targeted and immunotherapies based on genetic profiling, surgical excision for early-stage cancers. Confounding factors such as age, gender, smoking status, and comorbidities were adjusted for in the analysis of adverse events.

Follow-Up and Outcome Measures

For the first year, patients were followed up with every three months, and then every six months. Clinical assessments, imaging investigations to track cancer development or recurrence, and blood tests to evaluate general health and identify any treatment adverse effects were all part of follow-up visits. Period between diagnosis to passing away from any cause was known as overall survival (OS); time from diagnosis to documented disease progression was known as progression-free survival (PFS). Secondary objectives were quality of life (QoL) assessed using validated questionnaires such the ‘EORTC QLQ-C30 and treatment-related adverse events monitored and scored using the Common Terminology Criteria for Adverse Events (CTCAE)’.

Data Analysis

‘Statistical analysis was carried out using SPSS. OS and PFS had Kaplan-Meier survival curves produced, and log-rank tests were used to compare the groups’. Factors related to survival outcomes were identified using Cox

proportional hazards models. Adverse events associated to the therapy and QoL ratings were examined using suitable statistical techniques, like chi-square and t-tests.

Ethical Considerations

The study was done in accordance with the Declaration of Helsinki after the Hayatabad Medical Complex's Institutional Review Board (IRB) granted its clearance. Every participant attested to knowing the objectives, procedures, potential risks, and benefits of the study by giving their informed consent.

Results

39 people in all were allocated to the early diagnosis group and 39 to the late diagnosis group for the study. The average age of the participants was sixty-two, ranging from forty-five to eighty. There were 34 girls (44%), while 44 men (56%) made up the majority. The two groups' baseline characteristics were similar, guaranteeing a well-balanced cohort for study. Twenty-six patients (67%) in the early diagnostic group and twenty-eight individuals (72%) in the late diagnosis group smoked. The frequency of co-occurring conditions, such as diabetes and hypertension, was comparable in the two groups; for example, diabetes was present in 12 patients (36%) and hypertension in 15 patients (38%) in the 'late diagnosis group' and 16 patients (41%) in the 'early diagnosis group' (table 1).

Table 1: Patient Demographics and Baseline Characteristics

Characteristic	Early Diagnosis Group (n=39)	Late Diagnosis Group (n=39)	Total (n=78)
Mean Age (years)	62	62	62
Age Range (years)	45-80	45-80	45-80
Gender (Male/Female)	22/17	22/17	44/34
Smokers	26 (67%)	28 (72%)	54 (69%)
Hypertension	15 (38%)	16 (41%)	31 (40%)
Diabetes	12 (31%)	14 (36%)	26 (33%)

Within the early diagnostic group, 'low-dose computed tomography (LDCT)' screening led to the diagnosis of 28 patients (72%) while early-stage symptoms led to the diagnosis of 11 patients (28%). In this group, stage I lung cancer (22 patients, 56%) or stage II lung cancer (11 patients, 29%) was the most common initial presentation. As Table 2 illustrates, the late diagnosis group, on the other hand, was mostly made up of patients with stage III (18 patients, 46%) or stage IV (17 patients, 44%) lung cancer; the remaining 4 patients (10%) had stage II.

Table 2: Diagnostic Findings

Diagnostic Method	Early Diagnosis Group (n=39)	Late Diagnosis Group (n=39)
LDCT Screening	28 (72%)	0
Early-Stage Symptom Presentation	11 (28%)	0
Symptomatic/Incidental Findings	0	39 (100%)
Stage I Cancer	22 (56%)	0
Stage II Cancer	11 (29%)	4 (10%)
Stage III Cancer	0	18 (46%)
Stage IV Cancer	0	17 (44%)

Every patient in the group with early diagnosis had surgery to remove something. Thirteen patients (eighty-two percent) had radiation, while eighty-two patients (eighty-six percent) underwent chemotherapy. Systemic therapies were more prevalent in the group with late diagnosis: 32 patients (82%) had chemotherapy, 4 patients (10%) had targeted therapy, and 3 patients (8%) had immunotherapy. As seen in figure 1, only 3 patients (8%) in this group had palliative procedures. The malignancies' genetic profile, which targeted certain mutations like EGFR and ALK, determined the usage of targeted treatments and immunotherapies.

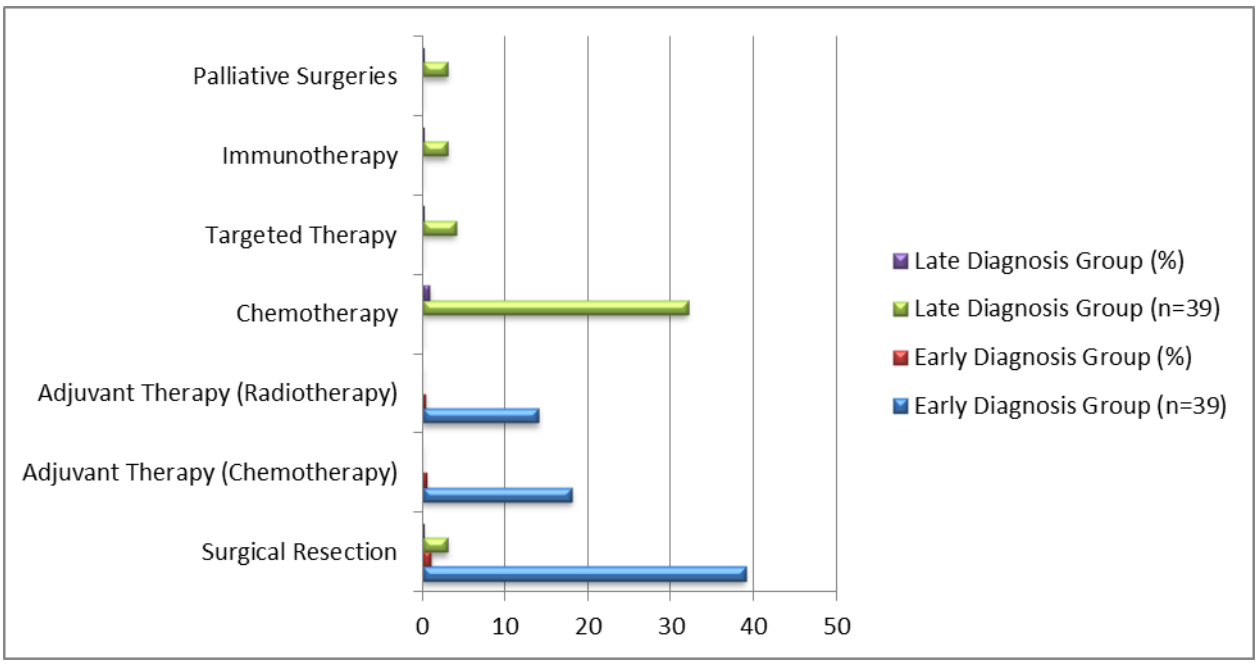

Figure 1: Treatment Interventions

The early diagnosis group had a significantly higher median overall survival (OS) compared to the late diagnostic group. At the conclusion of the experiment, the group that had an early diagnosis had a median overall survival (OS) of 38 months, whereas the group that received a late diagnosis had a median OS of 14 months ($p<0.001$). The 1-year survival rate in the early diagnosis group was 92%, whereas in the late diagnostic group it was 64%. The early diagnosis group had a three-year survival rate of 68%, whereas the late diagnostic group had a survival rate of 28%. In addition, the median progression-free survival (PFS) was significantly longer in the early diagnosis group, with a duration of 34 months compared to 10 months in the late diagnostic group ($p<0.001$). The 1-year progression-free survival (PFS) rate was 85% in the group that had an early diagnosis, whereas it was 46% in the group that received a late diagnosis. The 3-year progression-free survival (PFS) rate was 58% in the early diagnostic group and 18% in the late diagnosis group (Figure 2).

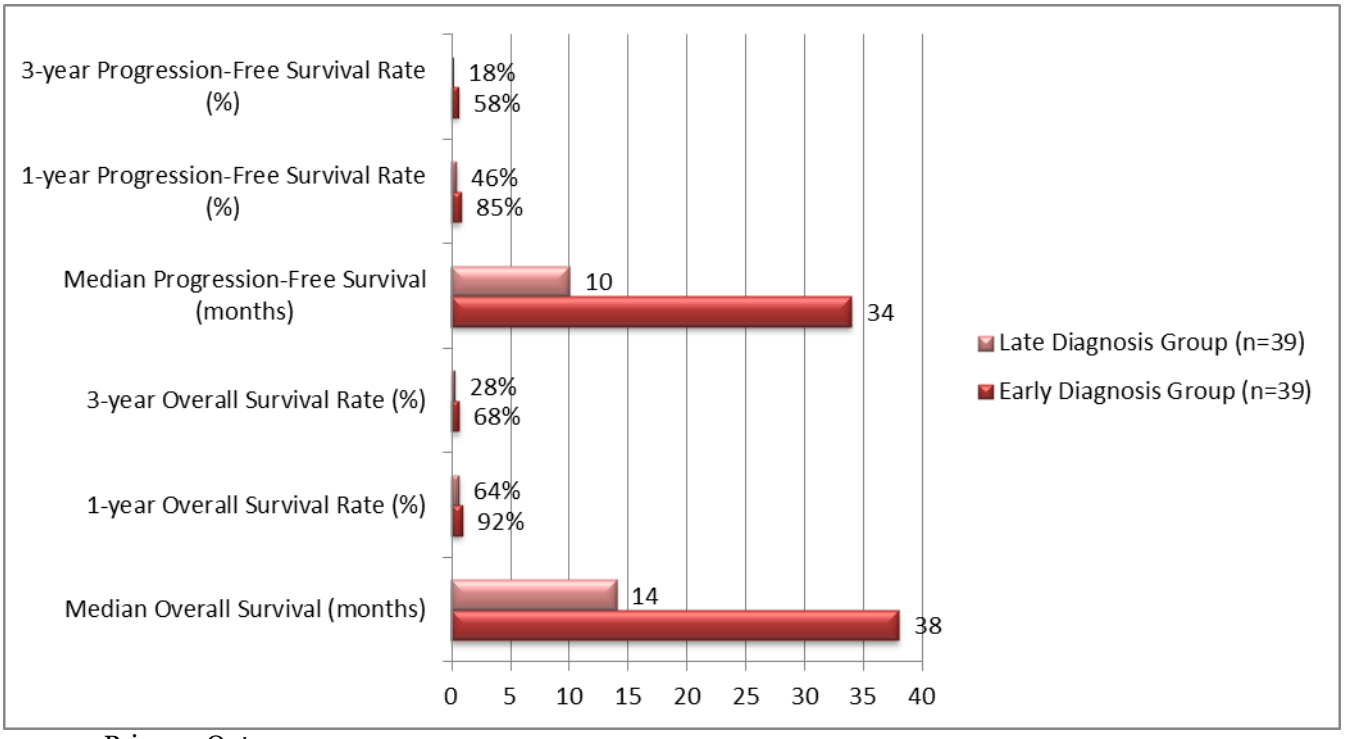

Figure 2: Primary Outcomes

Using the EORTC QLQ-C30 questionnaire, quality of life was measured at each follow-up point, and the early diagnosis group consistently scored better. At 12 months, the early diagnosis group scored 75 ($p<0.01$) on the global health status measure, but the late diagnosis group only scored 55. Physical functioning ratings were 52 in the late diagnosis group and 78 in the early diagnostic group. Weakness, pain, and

dyspnea were noticed less often in the initial diagnosis group compared to the late diagnosis category ($p<0.05$ for all comparisons), with mean scores of 30, 20, and 25 for each symptom. The early diagnosis group had less severe treatment-related adverse effects (grade 3 or 4) as compared to the late diagnosis group (45%). Common adverse events in the early diagnostic group serious adverse effects.

Table 3: Secondary Outcomes

Outcome Measure	Early Diagnosis Group (n=39)	Late Diagnosis Group (n=39)	p-value
Mean Global Health Status Score (12 months)	75	55	<0.01
Mean Physical Functioning Score (12 months)	78	52	<0.01
Mean Fatigue Score (lower is better)	30	60	<0.05
Mean Pain Score (lower is better)	20	50	<0.05
Mean Dyspnea Score (lower is better)	25	55	<0.05
Severe Adverse Events /(Grade 3 or 4)	18% (7 patients)	45% (18 patients)	<0.01
Common Adverse Events	Mild/moderate surgical complications (10%)	Neutropenia (30%) Severe fatigue (20%) Gastrointestinal symptoms (15%)	<0.01

The 'Kaplan-Meier survival curves' significant differences between the early and late diagnosis groups were supported by the log-rank test ($p<0.001$) for both OS and PFS. With an overall 'survival hazard ratio (HR) of 0.45 (95% confidence interval [CI] 0.30-0.68, $p<0.001$)', the group receiving an early diagnosis was 55% less likely to die than the group receiving a late diagnosis. The early diagnosis group had a 60% reduced chance of disease progression in terms of 'progression-free survival (HR = 0.40 (95% CI 0.25-0.65, $p<0.001$)'. The quality of life variables were examined using t-tests, and the findings indicated substantial differences ($p<0.01$) favoring the early diagnosis group at many time periods. Using the chi-square test to examine the incidence of treatment-related adverse events, the early diagnosis group showed a significantly lower risk of severe events ($p<0.01$).

Discussion

The study's findings show that patients with lung cancer who have an early diagnosis have a 'significantly higher overall survival (OS) and progression-free survival (PFS) than those who receive a late diagnosis'. The early diagnosis group's median overall survival (OS) of 38 months compared to the late diagnostic group's 14 months is consistent with the body of research that has been written on the advantages of early detection [14]. As an illustration of how early detection may greatly improve survival outcomes, the 'National Lung Screening Trial (NLST) found that low-dose computed tomography (LDCT) screening reduced lung cancer mortality by 20%' [15]. The significant PFS difference between the groups with early (34 months) and late (10 months) diagnoses highlights the need of early intervention. These results are in line with those of the 'International Early Lung Cancer Action Program (I-ELCAP)', which found that early-stage lung cancer found by screening had better long-term survival and a greater rate of curative resection [16]. The early diagnosis group's 1-year and 3-year overall survival rates (92% and 68%, respectively) also compare well to earlier research, highlighting the crucial window of opportunity for successful treatment that opens up when lung cancer is discovered early [17].

According to the EORTC QLQ-C30, the early diagnosis group's greater quality of life (QoL) ratings are a result of improved physical functioning and a decrease in symptoms such pain, tiredness, and dyspnea [17]. This result is in line with research that suggests individuals with early diagnoses have better quality of life because they get less severe therapy and have fewer side effects. Numerous validated studies have shown that individuals with early-stage cancer often report improved quality of life (QoL) results when compared to those with advanced illness, according to the EORTC QLQ-C30 [18]. Notable is the fact that the early diagnosis group had a lower frequency of serious treatment-related side events (18%) than the late diagnosis group (45%). This finding is in line with other research showing that localized therapy and surgery are often used in early-stage lung cancer treatments, which are linked to less severe side effects than the systemic treatments needed for advanced-stage illness [19]. The group that had a late diagnosis was more likely to have significant tiredness, gastrointestinal issues, and neutropenia, which emphasizes the more severe effects of chemotherapy and other rigorous therapies that are usually necessary

for advanced-stage disease.

Our study's findings are in line with the greater body of research that emphasizes the benefits of early detection and treatment for lung cancer. For example, the previously cited NLST and I-ELCAP trials provide strong evidence that LDCT screening lowers the death rate from lung cancer. Furthermore, our findings are validated by studies looking at how early-stage diagnosis affects quality of life (QoL), such as those that use the 'EORTC QLQ-C30'. These studies consistently demonstrate improved outcomes for early-stage patients[17]. Our findings support earlier studies suggesting that less aggressive, targeted therapies for early-stage lung cancer are linked to a decreased frequency of severe side effects in terms of treatment-related adverse events. This is in line with research comparing systemic and surgical therapies, which consistently show that localized interventions have greater tolerability and fewer consequences [20].

Limitation and Future Directions

The ramifications of these results for clinical practice and public health policy are substantial. They emphasize how crucial it is to set up and maintain efficient lung cancer screening programs, especially those that target high-risk groups like smokers and senior citizens. The data is in favor of using LDCT screening more widely as an early detection technique, as this may result in earlier intervention and better patient outcomes. Further improvements in early detection skills may come from developments in molecular diagnostics and artificial intelligence (AI) integration in imaging. Additional research and development are necessary to fully explore the potential of liquid biopsy and other non-invasive techniques for early detection. These technologies have the potential to enhance current screening programs and detect cancer at an even earlier stage.

Conclusion

This work offers strong evidence that, while lowering the frequency of serious treatment-related adverse events, early detection and action greatly enhance lung cancer patients' 'overall survival, progression-free survival, and quality of life'. These findings stress the importance of establishing and maintaining effective lung cancer screening programs and also the need of continuous advancements in diagnostic technologies to enhance patient outcomes and early detection.

Conflict of interest

The authors state no conflict of interest.

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