
| RESEARCH ARTICLE

Impact of Immunotherapy on Survival Rates of Lung Cancer Patients in Suburban Bangladesh: A 24-Month Cohort Study

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| ABSTRACT

Lung cancer is one of the most prevalent and deadly malignancies worldwide, with a particularly high incidence in the suburban regions of Bangladesh, where healthcare infrastructure is often inadequate. Traditional treatment modalities such as chemotherapy have provided limited improvements in long-term survival rates and are associated with significant side effects. This 24-month cohort study aims to evaluate the impact of immunotherapy on the long-term survival rates of lung cancer patients in suburban Bangladesh. A total of 22 adult patients diagnosed with non-small cell lung cancer (NSCLC) were included, with 11 receiving immunotherapy and 11 undergoing conventional chemotherapy. Quantitative data were collected from medical records and analyzed using Kaplan-Meier survival analysis and Cox proportional hazards models to compare overall survival between the two groups and adjust for potential confounders such as age, gender, socioeconomic status, and cancer stage at diagnosis. The results demonstrated that the immunotherapy group had a median overall survival of 18 months compared to 12 months in the chemotherapy group, with a 24-month survival rate of 54.5% versus 18.2% ($p = 0.03$ and $p = 0.04$, respectively). The adjusted hazard ratio for death in the immunotherapy group was 0.55 (95% CI: 0.32–0.95, $p = 0.033$), indicating a 45% reduction in the risk of death compared to the control group. Additionally, patients diagnosed with Stage IV had a significantly higher risk of death (HR = 3.80, 95% CI: 1.15–12.50, $p = 0.029$). These findings suggest that immunotherapy significantly enhances survival outcomes for lung cancer patients in resource-limited suburban settings. However, financial constraints and limited geographical accessibility remain substantial barriers to the widespread adoption of immunotherapy. The study underscores the need for policy interventions and infrastructure improvements to enhance access to advanced cancer treatments, thereby improving survival rates and overall patient outcomes in similar contexts.

| KEYWORDS

Lung Cancer, Immunotherapy, Survival Rates, Non-Small Cell Lung Cancer, Suburban Healthcare, Kaplan-Meier Analysis, Cox Proportional Hazards Model.

| ARTICLE INFORMATION

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1. Introduction

Lung cancer remains one of the most prevalent and lethal malignancies globally, accounting for approximately 11.4% of all new cancer cases and 18.4% of all cancer-related deaths in 2020. This translates to over 2.2 million new

cases and nearly 1.8 million deaths worldwide (Li et al., 2023). In Bangladesh, lung cancer poses a significant health burden, particularly in suburban areas where healthcare infrastructure is often inadequate (Ansar et al., 2021). These regions face substantial challenges in diagnosing, treating, and managing lung cancer due to limited access to advanced medical facilities and specialized care. Traditional treatment modalities such as surgery, chemotherapy, and radiotherapy have been the mainstay for lung cancer management (Conron et al., 2006). However, these approaches often yield limited improvements in long-term survival rates and are associated with substantial side effects, especially in the advanced stages of the disease (Debela et al., 2021).

Recent advancements have introduced immunotherapy as a promising alternative, focusing on enhancing the body's immune response to identify and eliminate cancer cells (Kirkwood et al., 2012). Immunotherapy, remarkably immune checkpoint inhibitors targeting proteins like PD-1 and PD-L1 on T-lymphocytes, has shown significant efficacy in non-small cell lung cancer (NSCLC) by preventing the inhibition of T-cell activation (Christofi et al., 2019). Despite immunotherapy's potential benefits, its accessibility and effectiveness in developing countries like Bangladesh, especially in suburban areas, remain underexplored (Islam et al., 2021). The unique challenges posed by healthcare access limitations, economic constraints, and pharmaceutical imbalances necessitate an in-depth investigation. This study aims to evaluate the impact of immunotherapy on the long-term survival rates of lung cancer patients in the suburban areas of Bangladesh over 24 months. The specific objectives are to compare the long-term survival rates of lung cancer patients receiving immunotherapy with those undergoing conventional treatments, assess the accessibility and efficacy of immunotherapy in suburban settings, identify barriers preventing patients from accessing advanced immunotherapy treatments, and examine the influence of factors such as cancer stage at diagnosis, overall health, and socioeconomic status on treatment outcomes. Addressing these objectives, the study seeks to fill existing research gaps and provide valuable insights for healthcare practice and policy in resource-limited settings. The specific objectives are:

- To compare the long-term survival rates of lung cancer patients receiving immunotherapy with those undergoing conventional treatments.
- To explore the personal experiences, perceptions, and challenges faced by patients undergoing immunotherapy.
- To assess the accessibility and efficacy of immunotherapy in sub-urban settings.
- To identify barriers preventing patients from accessing advanced immunotherapy treatments.
- To examine the influence of factors such as cancer stage at diagnosis, overall health, and socioeconomic status on treatment outcomes.

2. Literature Review

Lung cancer, encompassing small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC), is a leading cause of cancer mortality worldwide, responsible for approximately 1.8 million deaths annually (Ricotti et al., 2021). NSCLC accounts for roughly 85% of all lung cancer cases and is frequently diagnosed at advanced stages, contributing to poor prognoses and high mortality rates (Deng et al., 2020). The high mortality rate underscores the urgent need for effective treatment strategies that can significantly improve survival outcomes for patients diagnosed with lung cancer.

In Bangladesh, the incidence of lung cancer is notably high, particularly in suburban regions where environmental and occupational risk factors are prevalent. Factors contributing to this elevated prevalence include high levels of air pollution, which is exacerbated by industrial emissions and vehicular exhaust (Hossain et al., 2020). Additionally, indoor smoke from biomass fuel used for cooking and heating in rural and suburban households exposes individuals to carcinogenic pollutants, increasing the risk of developing lung cancer (Sultana et al., 2016). Occupational exposures in industries such as cotton manufacturing also play a significant role, as workers are often exposed to hazardous substances that can contribute to the development of lung cancer (Hossain et al., 2020).

The lack of widespread awareness about lung cancer risk factors and the limited access to early detection services further exacerbate the burden of the disease in Bangladesh (Sultana et al., 2016). Many patients present with advanced-stage lung cancer due to delays in diagnosis, which significantly limits the effectiveness of traditional treatment modalities (Conron et al., 2006). Traditional treatments such as surgery, chemotherapy, and radiotherapy have been the cornerstone of lung cancer management; however, these approaches often result in limited improvements in long-term survival rates and are associated with substantial side effects, particularly in advanced stages of the disease (Debela et al., 2021).

Recent advancements in cancer treatment have introduced immunotherapy as a promising alternative to traditional modalities. Immunotherapy focuses on enhancing the body's immune response to identify and eliminate cancer cells, representing a paradigm shift from directly targeting tumor cells to modulating the immune system (Kirkwood et al., 2012). Immune checkpoint inhibitors, such as pembrolizumab and nivolumab, have demonstrated remarkable efficacy in improving overall survival and progression-free survival in patients with advanced NSCLC (Leprieur et al., 2017). These agents function by blocking inhibitory pathways that suppress immune responses, mainly targeting proteins like PD-1 and PD-L1 on T-cells, thereby enhancing the immune system's ability to detect and destroy cancer cells (Christofi et al., 2019).

Clinical trials have provided robust evidence supporting the efficacy of immunotherapy in NSCLC. For instance, the KEYNOTE-024 trial showed that pembrolizumab significantly improves overall survival compared to chemotherapy in patients with high PD-L1 expression (Li & Dong, 2021). Similarly, the CheckMate trials demonstrated the superiority of nivolumab over docetaxel in previously treated NSCLC patients, highlighting the potential of immunotherapy to extend survival in this patient population (Vokes et al., 2018). These findings have been corroborated by other studies, reinforcing the role of immune checkpoint inhibitors as a vital component of lung cancer treatment (Leprieur et al., 2017; Christofi et al., 2019).

Several factors influence the effectiveness of immunotherapy and long-term survival in lung cancer patients. Early-stage detection is crucial for better prognoses, as advanced stages are associated with lower survival rates (Lemjabbar-Alaoui et al., 2015). Additionally, patients' overall health status and the presence of comorbidities can significantly affect treatment tolerance and outcomes (Deshpande et al., 2020). The tumor's molecular characteristics, including specific genetic mutations and the tumor microenvironment, also play a critical role in determining responsiveness to immunotherapy (Deng et al., 2020). Socioeconomic status is another pivotal factor, as economic constraints can limit access to advanced treatments and supportive care, thereby impacting overall survival rates (Hussain & Sullivan, 2013).

In suburban areas of Bangladesh, the adoption of immunotherapy faces significant obstacles. Healthcare facilities in these regions often lack the necessary infrastructure and specialized personnel required for administering advanced treatments (Uddin et al., 2014). Financial barriers are particularly prominent, as the high cost of immunotherapy is prohibitive for many patients, especially those from low-income backgrounds (Ahmed et al., 2008). Furthermore, a lack of awareness about lung cancer and modern treatment options hinders early detection and treatment uptake (Sultana et al., 2016). Inadequate social and community support systems can further affect patients' ability to adhere to treatment regimens, exacerbating the challenges associated with managing lung cancer in these settings (Chambers et al., 2022).

Several strategies have been proposed to address these challenges. Implementing remote healthcare services, such as mobile health clinics and telemedicine, can enhance access to advanced treatments in remote and underserved areas (Tian et al., 2021). Community engagement initiatives, including awareness campaigns and education programs, can improve knowledge about lung cancer risk factors and the importance of early detection, thereby facilitating timely diagnosis and treatment (Joshi et al., 2021). Additionally, subsidizing treatment costs through financial assistance programs can alleviate the economic burden on patients, making immunotherapy more accessible and improving treatment adherence (Ahmed et al., 2008).

Despite the growing body of research on immunotherapy in lung cancer, there is a paucity of studies examining its impact in suburban settings of developing countries like Bangladesh. Specifically, there is a need to understand how socioeconomic and geographical factors affect treatment outcomes in these regions. Existing studies primarily focus on urban or high-resource settings, leaving a significant gap in the literature regarding the effectiveness and accessibility of immunotherapy in resource-limited environments (Islam et al., 2021).

3. Research Method

This study employed a cohort study design to evaluate the impact of immunotherapy on lung cancer patients in suburban Bangladesh over 24 months. The quantitative approach focused on comparing survival outcomes between patients receiving immunotherapy and those undergoing conventional chemotherapy.

3.1 Inclusion Criteria

The study included adult patients (aged ≥ 18 years) diagnosed with NSCLC, residing in suburban areas of Bangladesh, and receiving either immunotherapy or conventional chemotherapy. Additionally, patients had to be willing to provide informed consent to participate in the study. The study was conducted in suburban areas of Bangladesh, selected due to their high incidence of lung cancer and limited access to advanced healthcare facilities.

3.2 Exclusion Criteria

Patients were excluded if they were receiving both immunotherapy and chemotherapy simultaneously, had incomplete medical records, had other concurrent malignancies, or were unable to provide accurate medical histories due to cognitive impairments. A total of 22 patients were included in the study, with 11 in the immunotherapy group and 11 in the control group receiving conventional chemotherapy. The small sample size was a limitation, but efforts were made to recruit as many eligible patients as possible within the study period.

3.3 Data Collection

Clinical data were extracted from medical records, encompassing demographic information (age, gender, socioeconomic status), clinical characteristics (cancer stage at diagnosis, comorbidities), treatment details (type of therapy, duration), and survival outcomes (date of diagnosis, date of death, or last follow-up).

3.4 Data Analysis

Quantitative data were analyzed using statistical software, specifically SPSS version 17 and Stata. Descriptive statistics summarized demographic and clinical characteristics. Survival analysis was conducted using Kaplan-Meier survival curves to compare overall survival between the two groups, with the log-rank test assessing statistical significance. A Cox proportional hazards model was employed to calculate adjusted hazard ratios for potential confounders, including age, gender, socioeconomic status, and cancer stage. The statistical tests and their purposes are detailed in Table 1.

Table 1: Statistical Tests and Purpose

Statistical Test	Purpose
Kaplan-Meier Survival Analysis	Estimate survival functions and medians.
Log-rank Test	Compare survival distributions between groups.
Cox Proportional Hazards Model	Assess the effect of variables on survival time.
Chi-square and t-tests	Compare baseline characteristics between groups.

3.5 Ethical Considerations

The study adhered to ethical standards, obtaining informed consent from all participants after explaining the study's purpose, procedures, risks, and benefits. Participant confidentiality was maintained by assigning unique identifiers

and removing personal information from datasets. The study received ethical approval from the Cumilla Medical College Hospital's institutional review boards (IRBs), ensuring compliance with international ethical guidelines.

3.6 Limitations and Bias Mitigation

The study's small sample size limits the generalizability of the findings. To mitigate selection bias, participants were selected based on availability and consent, with strict application of inclusion criteria and matching of treatment groups on key characteristics. The Cox proportional hazards model adjusted for potential confounders, and variables such as smoking status and comorbidities were collected when possible to control for their effects. This research employs a robust cohort study design to evaluate the impact of immunotherapy on lung cancer patients in suburban Bangladesh. By focusing solely on quantitative data, the study aims to provide clear evidence of the effectiveness of immunotherapy in resource-limited settings over 24 months.

4. Findings and Discussion

The study included 22 patients, with 11 in the immunotherapy group and 11 in the control group receiving conventional chemotherapy. Table 2 details the participants' baseline characteristics, revealing that the two groups were comparable in terms of age, gender, socioeconomic status, and cancer stage at diagnosis, with no statistically significant differences observed ($p > 0.05$). This similarity enhances the validity of comparisons made between the groups regarding treatment outcomes.

Table 2: Baseline Characteristics of Participants

Characteristic	Immunotherapy Group (n = 11)	Control Group (n = 11)	p-value
Age (mean \pm SD)	60.1 \pm 3.7 years	59.8 \pm 4.1 years	0.85
Gender			0.68
- Male	6 (54.5%)	7 (63.6%)	
- Female	5 (45.5%)	4 (36.4%)	
Socioeconomic Status			1.00
- Low	8 (72.7%)	8 (72.7%)	
- Middle	3 (27.3%)	3 (27.3%)	
Stage of Lung Cancer			1.00
- Stage II	2 (18.2%)	2 (18.2%)	
- Stage III	5 (45.5%)	5 (45.5%)	
- Stage IV	4 (36.4%)	4 (36.4%)	

Note: p-values calculated using a t-test for age and a chi-square test for categorical variables.

4.1 Survival Outcomes

The primary outcome measured was overall survival (OS), defined as the time from the initiation of treatment to death or last follow-up. The median follow-up duration for all patients was 24 months. In the immunotherapy group, the median OS was 18 months (95% Confidence Interval [CI]: 14–22 months), compared to 12 months (95% CI: 9–15 months) in the control group. The difference in survival between the two groups was statistically significant (log-rank test, $p = 0.03$), indicating that patients receiving immunotherapy had a significantly longer median survival compared to those receiving conventional chemotherapy. Additionally, the 24-month survival rate was notably higher in the immunotherapy group (54.5%) compared to the control group (18.2%), with a p-value of 0.04, as shown in Table 3.

Table 3: Overall Survival Outcomes

Outcome	Immunotherapy Group (n = 11)	Control Group (n = 11)	p-value
Median OS (months)	18 (95% CI: 14–22)	12 (95% CI: 9–15)	0.03
24-Month Survival Rate	54.5% (6/11)	18.2% (2/11)	0.04

4.2 Cox Proportional Hazards Analysis

A Cox proportional hazards regression model was employed to account for potential confounding factors. The variables included in the model were age, gender, socioeconomic status, and cancer stage at diagnosis. The adjusted hazard ratio (HR) for death in the immunotherapy group was 0.55 (95% CI: 0.32–0.95, p = 0.033), indicating a 45% reduction in the risk of death compared to the control group after adjusting for potential confounders. Additionally, cancer stage at diagnosis was a significant predictor of survival, with patients diagnosed at Stage IV having a significantly higher risk of death compared to those at Stage II (HR = 3.80, 95% CI: 1.15–12.50, p = 0.029). These results are summarized in Table 4.

Table 4: Adjusted Hazard Ratios from Cox Proportional Hazards Model

Variable	Hazard Ratio (HR)	95% CI	p-value
Treatment Group			
- Immunotherapy	0.55	0.32–0.95	0.033
- Control (Reference)	1.00		
Age (per year increase)	1.02	0.95–1.10	0.58
Gender			
- Male	1.10	0.62–1.96	0.74
- Female (Reference)	1.00		
Socioeconomic Status			
- Low	1.25	0.65–2.40	0.50
- Middle (Reference)	1.00		
Cancer Stage			
- Stage II (Reference)	1.00		
- Stage III	2.10	0.65–6.75	0.21
- Stage IV	3.80	1.15–12.50	0.029

4.3 Survival Rates by Cancer Stage

The survival benefit of immunotherapy was further examined by stratifying patients based on their cancer stage at diagnosis. Table 5 presents the 24-month survival rates by cancer stage. In Stage II patients, all individuals receiving immunotherapy survived the 24 months, compared to a 50% survival rate in the control group. Among Stage III patients, the immunotherapy group had a higher survival rate (60%) compared to the control group (20%). For Stage IV patients, the immunotherapy group had a 50% survival rate, whereas none of the patients in the control group survived to 24 months. Although the small sample sizes in each stage category precluded achieving statistical

significance when comparing survival rates within individual stages, the observed trends suggest a potential benefit of immunotherapy across different stages of lung cancer.

Table 5: 24-Month Survival Rates by Cancer Stage

Cancer Stage	Immunotherapy Group (n)	Survival Rate (%)	Control Group (n)	Survival Rate (%)
Stage II	2	100% (2/2)	2	50% (1/2)
Stage III	5	60% (3/5)	5	20% (1/5)
Stage IV	4	50% (2/4)	4	0% (0/4)

5. Discussion

This study demonstrates that immunotherapy significantly improves long-term survival rates among lung cancer patients in suburban areas of Bangladesh over 24 months. The adjusted hazard ratio indicates a 45% reduction in the risk of death for patients receiving immunotherapy compared to those on conventional chemotherapy. The improved survival rates across different cancer stages suggest that immunotherapy can be beneficial even in advanced stages of lung cancer. However, early diagnosis and intervention remain critical for optimal outcomes. These findings align with international studies highlighting the efficacy of immunotherapy in NSCLC. For instance, studies by Li and Dong (2021) and Vokes et al. (2018) report improved survival outcomes with immune checkpoint inhibitors. However, this study adds to the literature by focusing on a resource-limited, suburban setting in a developing country, highlighting the unique challenges faced by patients in such settings, including access barriers and limited healthcare infrastructure, which are often underrepresented in global studies.

The significant survival benefits observed in this study necessitate efforts to enhance access to immunotherapy in suburban Bangladesh. This could involve subsidizing treatment costs, implementing health insurance schemes, and establishing treatment centers closer to suburban areas to reduce geographical barriers. Addressing financial barriers is crucial, as the high cost of immunotherapy remains prohibitive for many patients, particularly those from low-income backgrounds (Ahmed et al., 2008). Healthcare providers should be cognizant of patients' financial and logistical challenges and work to mitigate them through patient navigation services and social support programs.

Managing side effects is another critical aspect of ensuring the effectiveness of immunotherapy. Adequate side effect management is essential to maintaining patients' quality of life and adherence to treatment. Training healthcare professionals in side effect management and ensuring the availability of supportive medications are imperative. Strengthening support systems by encouraging family involvement and community support can enhance patients' coping mechanisms and adherence to treatment regimens.

Financial support policies should be a priority for governmental and non-governmental organizations to reduce the economic burden of immunotherapy on patients. Investment in healthcare infrastructure in suburban areas can improve access to advanced treatments and reduce geographical barriers. Public health initiatives focusing on raising awareness about lung cancer, its risk factors, and the importance of early detection are essential to improving early diagnosis rates. Additionally, capacity-building programs for healthcare professionals in suburban areas can enhance the quality of cancer care, including the administration of immunotherapy and the management of side effects.

5.1 Limitations

The study's small sample size limits the generalizability of the findings. More extensive studies with more participants are needed to confirm the observed trends and provide more robust evidence. Selection bias may have been introduced through a non-randomized selection of participants, as patients who opted for immunotherapy may differ systematically from those who received conventional therapy. Furthermore, unmeasured confounders such as smoking status, nutritional status, and genetic variations were not controlled for and may influence survival

outcomes. The reliance on medical records for data collection could also introduce information bias if records were incomplete or inaccurate.

5.2 Strengths of the Study

Despite its limitations, the study has several strengths. Its focus on suburban Bangladesh fills a gap in the literature regarding cancer treatment in resource-limited settings. The study's findings have direct implications for healthcare policy and clinical practice aimed at improving patient outcomes in similar contexts. By employing a cohort study design and using robust statistical methods, the study provides credible evidence of the effectiveness of immunotherapy in enhancing survival rates among lung cancer patients in suburban areas.

6. Conclusion

This study provides evidence that immunotherapy significantly enhances long-term survival rates among lung cancer patients in suburban areas of Bangladesh over 24 months. Patients receiving immunotherapy experienced a median overall survival of 18 months, compared to 12 months for those receiving conventional chemotherapy, with a 45% reduction in the risk of death after adjusting for confounders. However, significant barriers related to financial constraints and geographical accessibility hinder patients' ability to benefit fully from immunotherapy. Addressing these challenges requires concerted efforts from healthcare providers, policymakers, and community organizations. Improving access to immunotherapy through financial support, infrastructure development, and awareness campaigns, as well as strengthening support systems for patients, can maximize the therapeutic benefits and improve survival outcomes for lung cancer patients in resource-limited, suburban settings.

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