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Research Paper

Evaluating the Impact of Immunotherapy on Long-term Survival Rates in Lung Cancer Patients in Sub-urban Areas in Bangladesh

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Abstract

Lung cancer is a leading cause of cancer mortality worldwide, with an exceptionallyhigh incidence and poor outcomes in the suburban areas of Bangladesh due to limited healthcare infrastructure. Immunotherapy is a promising treatment modality for non-small-cell lung cancer (NSCLC), but its impact on resource-limited settings underexplored. This study evaluated the effect of immunotherapy on long-term survival rates among patients with lung cancer in the sub-urban districts of Cumilla and Feni, Bangladesh. A mixed-methods approach was used, involving 22 patients with NSCLC who were divided equally into the immunotherapy group and control group receiving conventional chemotherapy. Quantitative data on survival outcomes were analyzed using Kaplan–Meier estimates and Cox proportional hazard models to adjust for confounders. Qualitative data were collected through semi-structured interviews with patients in the immunotherapy group, focusing on access barriers, perceptions, side effects, and support systems. The immunotherapy group had a median overall survival of 18 months compared with 12 months in the control group ($p = 0.03$), with an adjusted hazard ratio of 0.55 (95% CI: 0.32–0.95, $p = 0.033$), indicating a 45% reduction in the risk of death. Qualitative findings revealed significant financial and geographical barriers to receiving immunotherapy. Patients reported a mix of hope and anxiety regarding treatment efficacy and side effects, with support systems playing a crucial role in treatment adherence and coping mechanisms. Immunotherapy significantly improves long-term survival rates among patients with lung cancer in sub-urban Bangladesh. Addressing financial constraints, enhancing healthcare infrastructure, and strengthening support systems are essential to maximize the therapeutic potential of immunotherapy in resource-limited settings.

Keywords: *Lung cancer, Immunotherapy, Sub-urban healthcare, Long-term survival, Bangladesh, Patient experiences, Access barriers*

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, translating 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 like Cumilla and Feni, where healthcare infrastructure is often inadequate (Ansar et al., 2021). These regions face challenges in diagnosing, treating, and managing lung cancer because of 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. However, these approaches often yield limited improvements in long-term survival rates and are associated with substantial side effects,

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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, particularly 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. The unique challenges posed by healthcare access limitations, economic constraints, and pharmaceutical imbalances necessitate an in-depth investigation.

This study aimed to evaluate the impact of immunotherapy on the long-term survival rates of patients with lung cancer in the sub-urban areas of Cumilla and Feni, Bangladesh. The specific objectives are as follows:

- To compare the long-term survival rates of patients with lung cancer receiving immunotherapy and those undergoing conventional treatment.
- 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 cancer stage at diagnosis, overall health, and socioeconomic status on treatment outcomes.

To address these objectives, this study seeks to fill existing research gaps and provide valuable insights for healthcare practice and policy in resource-limited settings.

LITERATURE REVIEW

Global Burden of Lung Cancer

Lung cancer, which includes small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC), is a leading cause of cancer mortality worldwide (Ricotti et al., 2021). NSCLC accounts for approximately 85% of all lung cancer cases and is often diagnosed at advanced stages, contributing to poor prognoses (Deng et al., 2020). The high mortality rate underscores the need for effective treatment strategies that improve survival outcomes.

Lung Cancer in Bangladesh

In Bangladesh, lung cancer incidence is notably high, particularly in sub-urban regions such as Cumilla and Feni. Factors contributing to this prevalence include high levels of air pollution, indoor smoke from biomass fuels, and occupational exposure in industries such as cotton manufacturing (Hossain et al., 2020). The lack of widespread awareness regarding lung cancer risk factors and limited access to early detection further exacerbate the situation (Sultana et al., 2016).

Evolution of Immunotherapy

Immunotherapy has emerged as a revolutionary approach in cancer treatment, shifting the paradigm from directly targeting tumor cells to modulating the immune system to recognize and combat cancer cells (Leprieur et al., 2017). 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, particularly by targeting proteins like PD-1 and PD-L1 on T-cells, thus enhancing the immune system's ability to detect and destroy cancer cells (Christofi et al., 2019). Clinical trials, such as

KEYNOTE-024, have shown that pembrolizumab significantly improves overall survival compared with 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 (Vokes et al., 2018).

Factors Affecting Long-term Survival

Several factors influence the effectiveness of immunotherapy and long-term survival in lung cancer patients:

- Stage at Diagnosis: Early-stage detection is crucial for better prognosis because advanced stages are associated with lower survival rates (Lemjabbar-Alaoui et al., 2015).
- Overall Health and Comorbidities: Patients' general health status can affect treatment tolerance and outcomes (Deshpande et al., 2020).
- Genetic Mutations and Tumor Microenvironment: The molecular characteristics of tumors can influence their responsiveness to immunotherapy (Deng et al., 2020).
- Socioeconomic Status: Economic constraints can limit access to advanced treatments and supportive care (Hussain & Sullivan, 2013).

Challenges in Suburban Healthcare Settings

In the suburban areas of Bangladesh, the adoption of immunotherapy faces significant obstacles:

- Limited Access to Advanced Treatments: Healthcare facilities in these regions often lack the necessary infrastructure and personnel (Uddin et al., 2014).
- Financial Barriers: The high cost of immunotherapy is prohibitive for many patients, particularly those from low-income backgrounds (Ahmed et al., 2008).
- Awareness and Education: A lack of knowledge about lung cancer and modern treatment options hinders early detection and treatment uptake (Sultana et al., 2016).
- Support Systems: Inadequate social and community support can affect patients' ability to adhere to treatment regimens (Chambers et al., 2022).

Patient Experiences and Perceptions

Studies on patient experiences with immunotherapy reveal diverse perspectives:

- Physical and Psychological Impact: The treatment process can be physically taxing and emotionally challenging for patients and their families (Galvin & Hourihane, 2018).
- Social Support: Strong support networks are crucial for managing disease and treatment side effects (Chambers et al., 2022).
- Access to Healthcare Services: Difficulties in navigating healthcare systems and accessing services can increase patient burden (Ansar et al., 2023).

Strategies to Overcome Barriers

To address these challenges, several strategies have been proposed:

- Mobile healthcare clinics and telemedicine Implementing remote healthcare services can enhance access to remote areas (Tian et al., 2021).
- Community Engagement: Involving local communities in awareness campaigns can improve knowledge and support (Joshi et al., 2021).
- Financial Assistance Programs: Subsidizing treatment costs can alleviate financial burdens and improve treatment adherence (Ahmed et al., 2008).

Despite the growing body of research on immunotherapy for lung cancer, a paucity of studies

has examined its impact on sub-urban settings of developing countries like Bangladesh. Specifically, there is a need to understand how socioeconomic and geographical factors affect treatment outcomes and patient experiences in these regions.

RESEARCH METHOD

A mixed-methods approach was used, combining quantitative and qualitative data to comprehensively evaluate the impact of immunotherapy on lung cancer patients in sub-urban Bangladesh. A cohort study design was used to compare survival outcomes between patients receiving immunotherapy and those undergoing conventional chemotherapy.

The study was conducted in the sub-urban districts of Cumilla and Feni, Bangladesh. These areas were selected because of their high incidence of lung cancer and limited access to advanced healthcare facilities.

Participant Selection

Inclusion Criteria:

- Adult patients (aged ≥18 years) diagnosed with NSCLC.
- Residents of Cumilla or Feni districts.
- Patients receiving either immunotherapy or conventional chemotherapy.
- Willingness to provide informed consent and participate in interviews.

Exclusion Criteria:

- Patients receiving simultaneous immunotherapy and chemotherapy simultaneously.
- Incomplete medical records.
- Presence of other concurrent malignancies.
- Inability to participate in interviews due to cognitive or language barriers.

A total of 22 patients were included, including 11 in the immunotherapy group and 11 in the control group, who received conventional chemotherapy.

Data Collection

Quantitative Data

Clinical data were extracted from medical records, and the following data were included:

- Demographic information (age, gender, socioeconomic status).
- Clinical characteristics (cancer stage at diagnosis, comorbidities).
- Treatment details (type of therapy, duration).
- Survival outcomes (date of diagnosis, date of death or last follow-up).

Qualitative Data

In-depth semi-structured interviews were conducted with patients in the immunotherapy group to explore their experiences. An interview guide was developed to cover key themes, such as the following:

- Access to treatment.
- Perceptions and attitudes toward immunotherapy.
- Side effects and their management.
- Support systems.

Interviews were conducted privately to ensure confidentiality, recorded with consent, and transcribed verbatim.

Data Analysis

Quantitative Analysis

- **Survival Analysis:** Kaplan–Meier survival curves were generated to compare overall survival between the groups. The log-rank test was used to assess statistical significance.
- **Cox Proportional Hazards Model:** Adjusted hazard ratios were calculated for potential confounders such as age, gender, socioeconomic status, and cancer stage.
- **Statistical Software:** Data were analyzed using SPSS version 25 and Stata software.

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 effects of variables on survival time.
Chi-square and t-tests	Comparison of baseline characteristics between groups.

Qualitative Analysis

- **Thematic Analysis:** NVivo software was used to code and identify themes from interview transcripts.
- **Coding Process:** Initial codes were generated, reviewed, and organized into overarching themes and subthemes.
- **Validation:** Themes were cross-checked by multiple researchers to ensure reliability.

Ethical Considerations

- **Informed Consent:** After explaining the study's purpose, procedures, risks, and benefits, all participants provided written informed consent.
- **Confidentiality:** Participant anonymity was maintained by assigning unique identifiers and removing personal information from transcripts.
- **Ethical Approval:** The study, which adhered to international ethical guidelines, received approval from the Cumilla Medical College Hospital's institutional review boards (IRBs).

Limitations and Bias Mitigation

- **Sample Size:** The relatively small sample size may affect the generalizability of findings. Efforts were made to recruit as many eligible patients as possible within the study period.
- **Selection Bias:** Participants were selected on the bases of availability and consent. The inclusion criteria were strictly applied to minimize bias, and both treatment groups were matched according to key characteristics.
- **Recall Bias:** To reduce recall bias during interviews, participants were encouraged to focus on recent experiences, and probing questions were used for clarification.
- **Confounding Variables:** The Cox proportional hazards model was adjusted for potential confounders, and variables such as smoking status and comorbidities were collected when possible.

This study employed a robust mixed-methods approach to evaluate the impact of immunotherapy on lung cancer patients in sub-urban Bangladesh. By integrating quantitative survival analysis with qualitative insights into patient experiences, this study provides comprehensive evidence on the effectiveness and challenges of immunotherapy in resource-limited settings.

FINDINGS AND DISCUSSION

Quantitative Findings

Participant Characteristics

The study included 22 patients (11 in the immunotherapy group and 11 in the control group) who received conventional chemotherapy. Table 2 details the participants' baseline characteristics.

Table 2. Baseline Characteristics of Participants

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

Note: p-values were calculated using Student's t-test for age and the chi-square test for categorical variables.

The demographic and clinical characteristics of the two groups were comparable, with no significant differences observed ($p > 0.05$). This similarity enhances the validity of comparisons made between the groups regarding treatment outcomes.

Survival Outcomes

The primary outcome measured was overall survival (OS), which was defined as the time from treatment initiation to death or last follow-up. The median follow-up duration was 24 months.

- **Immunotherapy Group**: The median OS was 18 months (95% Confidence Interval [CI]: 14–22 months).
- **Control Group**: The median OS was 12 months (95% CI: 9–15 months).

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 with those receiving conventional chemotherapy.

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

The 24-month survival rate was notably higher in the immunotherapy group than in the control group (54.5% vs. 18.2%, **$p = 0.04$**).

Cox Proportional Hazards Analysis

A Cox proportional hazards regression model was used to account for potential confounding factors. The variables included in the model were age, sex, socioeconomic status, and cancer stage

at diagnosis.

Table 4. Adjusted hazard ratios from the 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

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 with the control group after adjusting for potential confounders. Cancer stage at diagnosis was a significant predictor of survival, with patients diagnosed at Stage IV having a significantly higher risk of death compared with those diagnosed at stage II (HR = 3.80, 95% CI: 1.15–12.50, p = 0.029).

Survival Rates according to Cancer Stage

The survival benefit of immunotherapy was further examined by stratifying patients according to their cancer stage at diagnosis.

Table 5. 24-month survival rates according to 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)

In Stage II patients, all individuals receiving immunotherapy survived for 24 months, compared with a survival rate of 50% in the control group. Among patients with Stage III lesions, the immunotherapy group had a higher survival rate (60%) than the control group (20%). For Stage IV patients, the immunotherapy group had a survival rate of 50%, whereas none of the patients in the control group survived to 24 months. Due to the small sample size for each stage category, statistical significance was not achieved when comparing survival rates within individual stages. However, the observed trends suggest the potential benefit of immunotherapy across different stages of lung cancer.

Qualitative Findings

Semi-structured interviews with 11 patients in the immunotherapy group provided insights

into their experiences. Thematic analysis revealed four major themes: Access to Immunotherapy, Patient Perceptions and Attitudes, Side Effects and Management, and Support Systems.

Theme 1: Access to Immunotherapy

Prevalence**:** All 11 participants discussed access-related issues.

Patients reported significant challenges in accessing immunotherapy due to financial constraints and geographical barriers.

- Financial Constraints:
  - *Participant 3:* 'I had to sell part of my land and borrow money to afford the treatment.'
  - *Participant 7:* 'It is overwhelming. Sometimes I consider stopping the treatment because I cannot afford it.
- Geographical Barriers:
  - *Participant 5:* 'Traveling to the hospital takes an entire day and costs a lot in transport fees.'
  - *Participant 9:* 'There are no treatment facilities nearby. Missing appointments is common because it is difficult to arrange transportation.

Theme 2: Patient Perceptions and Attitudes

Prevalence: 9 of 11 participants expressed their perceptions and attitudes toward immunotherapy.

Patients' attitudes ranged from hopeful about the potential benefits to anxiety about the uncertainties and side effects.

- Hopefulness:
  - *Participant 2:* 'Immunotherapy gives me hope for more time with my family.'
  - *Participant 6:* 'I believe this treatment is my best chance to fight the cancer.'
- Anxiety and Uncertainty:
  - *Participant 8:* 'I'm worried about the side effects and whether the treatment will actually help.'
  - *Participant 10:* 'It's a new treatment, and that makes me nervous about possible risks.'

Theme 3: Side Effects and Management

Prevalence: 10 of 11 participants reported experiencing side effects.

Commonly reported side effects include fatigue, skin reactions, and joint pain, which affect patients' daily lives.

- Impact on Daily Life:
  - *Participant 4:* 'I feel too tired to work or even help around the house.'
  - *Participant 11:* 'The rash is painful and makes it difficult to sleep.'
- Challenges in Management:
  - *Participant 1:* 'Medications to manage side effects are expensive, and I cannot always afford them.'
  - *Participant 9:* 'I don't have access to proper care to manage these side effects effectively.'

Theme 4: Support Systems

Prevalence**:** 8 of 11 participants highlighted the importance of family and community support.

- Family Support:
  - *Participant 5:* 'My family supports me emotionally and helps with expenses.'
  - *Participant 7:* 'Without my family's help, I wouldn't be able to continue treatment.'
- Community Support:
  - *Participant 8:* 'Neighbors help with chores and sometimes contribute financially.'
  - *Participant 2:* 'Community members have been generous in providing assistance.'

Integrating Quantitative and Qualitative Findings

The integration of quantitative and qualitative findings provides a holistic understanding of the impact of immunotherapy on lung cancer patients in sub-urban Bangladesh.

- Efficacy of Immunotherapy: Quantitative data confirmed that compared with conventional chemotherapy, immunotherapy improves survival outcomes.
- Barriers to Access: Qualitative data revealed that financial and geographical barriers limit patients' ability to access and adhere to immunotherapy treatment, potentially affecting its efficacy.
- Importance of Support Systems: Strong family and community support enhances patients' ability to cope with treatment challenges and maintain adherence, thereby contributing to better outcomes.
- Management of Side Effects: Effective management of side effects is crucial for maintaining quality of life and ensuring continued treatment adherence.

Discussion

Interpretation of Findings

This study demonstrated that immunotherapy significantly improved long-term survival rates among patients with lung cancer in sub-urban areas of Bangladesh. The adjusted hazard ratio indicates a 45% reduction in the risk of death for patients receiving immunotherapy compared with conventional chemotherapy.

The improved survival rates across different cancer stages suggest that immunotherapy may be beneficial even in advanced lung cancer stages. However, early diagnosis and intervention are critical for optimal outcomes.

Comparison with Existing Literature

These findings are consistent with international studies highlighting the efficacy of immunotherapy against NSCLC. For example, Li and Dong (2021) and Vokes et al. (2018) reported improved survival outcomes in patients treated with immune checkpoint inhibitors.

However, this study adds to the literature by focusing on a resource-limited, sub-urban setting in a developing country. The study highlights the unique challenges faced by patients in such settings, including access barriers and limited health care infrastructure, which are often underrepresented in global studies.

Implications for Clinical Practice

- Enhancing Access: The observed significant survival benefit requires efforts to improve access to immunotherapy. This could involve subsidizing treatment costs, implementing health insurance schemes, and establishing treatment centers closer to suburban areas.
- Addressing Barriers: Healthcare providers should be aware of patients' financial and logistical challenges and work toward mitigating them through patient navigation services and social support programmes.
- Managing Side Effects: Adequate side effect management is essential for maintaining patients' quality of life and treatment adherence. Training healthcare professionals on side effects management and ensuring the availability of supportive medications are critical.
- Strengthening Support Systems: Encouraging family involvement and community support can enhance patients' coping mechanisms and treatment adherence.

Policy Recommendations

- Financial Support Policies: Governmental and non-governmental organizations should consider providing financial assistance to patients to reduce the economic burden of immunotherapy.
- Healthcare Infrastructure Development: Investment in healthcare facilities in sub-urban areas can improve access to advanced treatments and reduce geographical barriers.
- Awareness Campaigns: Public health initiatives should focus on raising awareness of lung cancer, its risk factors, and the importance of early detection.
- Training Programs Capacity-building programs for healthcare professionals in sub-urban areas can enhance the quality of cancer care, including immunotherapy administration and side effects.

Limitations

- Sample Size: The small sample size limits the generalizability of the findings. Larger studies are needed to confirm the observed trends.
- Selection bias: Nonrandomised selection of participants may introduce bias. Patients who opt for immunotherapy may differ systematically from those who receive conventional therapy.
- Unmeasured Confounders: Factors such as smoking status, nutritional status, and genetic variations were not controlled for and may influence survival outcomes.
- Reliance on Self-reported Data: The qualitative findings are based on self-reported experiences that may be subject to recall or social desirability bias.

Study strengths

- Mixed-Methods Approach: The combination of quantitative and qualitative data provides a comprehensive understanding of the impact of immunotherapy.
- Contextual Relevance: The focus on sub-urban Bangladesh fills a gap in the literature regarding cancer treatment in resource-limited settings.

The findings directly affect healthcare policy and clinical practice, which improve patient outcomes in similar contexts.

CONCLUSION

This study provides evidence that immunotherapy significantly enhances long-term survival rates among patients with lung cancer in sub-urban areas of Bangladesh. Patients receiving immunotherapy experienced a median overall survival of 18 months, compared with 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 from fully utilizing immunotherapy. The importance of support systems in facilitating treatment adherence and coping with side effects was also highlighted.

Addressing these challenges requires concerted efforts from healthcare providers, policymakers, and community organizations. Improving access to immunotherapy and supporting patients throughout their treatment journey can maximize the therapeutic benefits and improve survival outcomes for lung cancer patients in resource-limited, suburban settings.

LIMITATION & FURTHER RESEARCH

Limitations

Despite providing valuable insights, this study has several limitations:

- Small Sample Size: The limited number of participants reduces the statistical power and may not accurately represent the broader population of lung cancer patients in sub-urban Bangladesh.
- Nonrandomised Design: The observational nature and nonrandom allocation to treatment groups may introduce selection bias and affect the internal validity of the findings.
- Potential Confounders: Unmeasured variables such as smoking history, environmental exposure, nutritional status, and genetic factors may confound the relationship between treatment and survival outcomes.
- Generalization The findings are specific to the sub-urban districts of Cumilla and Feni and may not be generalizable to other regions or countries with different health care systems and socio-economic contexts.
- Data Collection Methods: Reliance on self-reported data in qualitative interviews may introduce recall bias and affect the accuracy of findings.

Further Research

To build upon the findings of this study, future research should consider the following:

- Larger, Multicentre Studies: Conducting studies with larger sample sizes across multiple regions can enhance the generalizability of the findings and provide more robust statistical analyses.
- Randomised Controlled Trials (RCTs): Implementing RCTs would minimize selection bias and allow determination of the causal relationship between immunotherapy and survival outcomes.
- Longitudinal Studies: Long-term follow-up studies are needed to assess the sustained impact of immunotherapy on survival and quality of life, as well as potential late-onset side effects.
- Inclusion of Additional Variables: Future studies should collect data on potential confounders, such as smoking status, environmental exposure, nutritional status, and genetic markers, to control for their effects.
- Economic Evaluations: Cost-effectiveness analyses can inform policymakers about the economic feasibility of implementing immunotherapy programs in resource-limited settings.
- Interventional Studies on Access Barriers: Research focusing on interventions to reduce financial and geographical barriers, such as subsidized treatment programmes and mobile health clinics, can provide evidence for effective strategies to improve access.
- Qualitative Studies with Healthcare Providers: Exploring healthcare professionals' perspectives can offer insights into systemic challenges and potential solutions for implementing immunotherapy in sub-urban areas.
- Patient Education and Support Interventions: Evaluating the effectiveness of patient education programs and support interventions can enhance the understanding of how to improve patient adherence and outcomes.

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