ORIGINAL RESEARCH

Comparison of treatment outcomes in diabetic vs. non-diabetic patients with tuberculosis

Naresh Dude

Assistant Professor, Department of TB &Chest Medicine, Tagore Medical College &Hospital, Chennai, Tamil Nadu, India

Corresponding Author
Naresh Dude
Assistant Professor, Department of TB &Chest Medicine, Tagore Medical College &Hospital, Chennai, Tamil Nadu, India
Email: naresh2k3@gmail.com

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ABSTRACT

Objective: To evaluate the impact of diabetes on tuberculosis treatment efficacy by identifying factors influencing differing outcomes between diabetic and non-diabetic patients and offering insights for optimizing treatment protocols for diabetic individuals. **Methodology:** A prospective observational study was conducted and total of 286 hospitalized adult patients aged 18 years and older, newly diagnosed with pulmonary tuberculosis (PTB) and/or diabetes mellitus (DM), were included in the study. TB diagnosis was confirmed through sputum smear microscopy, culture, and cartridge-based nucleic acid testing, while DM was diagnosed based on fasting plasma glucose (FBS) levels ≥126 mg/dl or HbA1c levels ≥6.5%. Patients were classified based on their TB diagnosis (PTB or extrapulmonary TB [EPTB]) and their diabetic status. The treatment outcomes were categorized as "cured," "treatment completed," "defaulter," "treatment failure," or "lost to follow-up." Data were analysed using descriptive statistics, chi-square tests, and Mann-Whitney U-tests, with fasting glucose and HbA1c levels monitored at baseline, three months, and six months post-treatment. **Results:** The study revealed significant differences in treatment outcomes between diabetic and non-diabetic TB patients. The cure rate was considerably higher in non-diabetic patients (72.8%) compared to those with diabetes (55.5%). Diabetic patients exhibited higher rates of treatment failure (8.1%), defaulters (5.7%), and those lost to follow-up (10.4%) compared to their non-diabetic counterparts. Overall, non-diabetic patients had more favourable outcomes (88.4%) than diabetic patients (75.8%). Furthermore, patients with pulmonary TB (PTB) had significantly higher fasting blood sugar and HbA1c levels at baseline compared to those with extrapulmonary TB (EPTB), but both groups experienced marked improvements in glucose control following TB treatment, with more pronounced changes in the PTB group. **Conclusion:** The study underscores the negative impact of diabetes on tuberculosis treatment outcomes. Diabetic TB patients exhibited slower recovery rates, higher treatment failure rates, and a greater likelihood of discontinuing treatment or being lost to follow-up. These findings highlight the need for integrated TB and diabetes management strategies to improve treatment success. Close monitoring of glycaemic control and personalized treatment approaches are critical for optimizing outcomes in diabetic TB patients, ultimately contributing to better health and reducing the global burden of both diseases.

Keywords: Tuberculosis (TB) Diabetes Mellitus (DM) Treatment Outcomes Glycemic Control Pulmonary Tuberculosis (PTB)

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BACKGROUND

Worldwide, an astounding 550 million additional cases of diabetic mellitus (DM) are projected to be recorded by 2030. A large percentage of the population has diabetes mellitus (DM). Some 88 million people in Southeast Asia have diabetes, according to a recent poll that estimated 463 million people with the disease globally(1). About 77 million people have diabetes, and 1/3 of the world's tuberculosis (TB) infections are in India. It is well recognized that a variety of infectious disorders, including TB, are considerably and dramatically increased in people with diabetes mellitus because of the effects of the disease on the immune system(2).

Furthermore, diseases like tuberculosis (TB) might amplify diabetics' worries about maintaining a healthy blood sugar level. In addition, uncontrolled diabetes may worsen the symptoms of other health issues. Patients with TB have an increased risk of developing

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diabetes and other metabolic complications due to their impaired glucose control(3).

Tuberculosis (TB) infects over 25% of the global population. On a global scale, it ranks as the top killer. There are twenty nations with the highest rates of tuberculosis and HIV prevalence inside their boundaries, and Brazil is one of them. Diabetes mellitus (DM) is associated with an increased risk of active tuberculosis (TB) and poor outcomes following anti-TB treatment, including TB recurrence(4). Among the 10 million tuberculosis cases reported in 2019, 8.2% were in persons living with HIV. Worldwide, 215,000 people lost their lives in 2020 due to tuberculosis and HIV. The prognosis for tuberculosis (TB) patients with HIV or diabetes is worse when additional socioeconomic or epidemiological factors are present compared to those without these co-morbidities. In addition to a higher likelihood of heavy alcohol and tobacco use, TB-HIV patients with DM had a higher probability of abnormal x-rays and positive smears(5).

The infectious illness known as tuberculosis (TB) is responsible for the death of more people than any other disease in the world. Approximately forty-four percent of all tuberculosis cases and thirty-eight percent of the total burden are concentrated in the South Asian region, which is comprised of eight countries with incomes ranging from low to medium. South Asia is experiencing an increase in the prevalence of risk factors such as acquired immunodeficiency syndrome, renal disease, malnutrition, and diabetes, which is making the already problematic burden of tuberculosis (TB) even more difficult to manage. Several variables are contributing to the rising incidence of cardiometabolic diseases, more specifically diabetes(5).

The incidence of cardiometabolic diseases, such as insulin resistance, is significantly higher among South Asians compared to the prevalence of these diseases among people of other ethnic groups(5). Patients who have diabetes have a threefold increased risk of contracting TB, a higher risk of treatment failure or relapse, a higher risk of failure in culture conversion at 6, and a higher risk of death from tuberculosis, particularly in instances affecting the lungs (6).

Between 2015 and 2025, the World Health Organization (WHO) established the ambitious goal of reducing the mortality rate from tuberculosis (TB) by 75% and the incidence of TB by 25% simultaneously. To accomplish this goal, it is essential to address the growing impact of risk factors such as diabetes appropriately when it comes to the situation(7).There is still a lack of understanding regarding the specific mechanism by which diabetes comorbidity influences health outcomes in tuberculosis patients. On the other hand, there is evidence to suggest that the presence of diabetes may harm the outcomes of treatment for tuberculosis. This includes alterations in the immune response, increased insulin resistance due to anti-tuberculosis medications, and decreased immunity due to diabetes(8).

Patients with diabetes mellitus (DM) may be more likely to experience treatment outcomes that are ineffective for tuberculosis (TB). In this study, the profiles of tuberculosis patients with and without diabetes were compared, and the prevalence of diabetes within the tuberculosis population was investigated. The purpose of this research was to evaluate the influence that diabetes has on unsuccessful treatment outcomes among tuberculosis patients.

AIM OF THE STUDY

To compare the treatment outcomes of diabetic and non-diabetic patients diagnosed with tuberculosis, assessing differences in recovery rates, complications, and overall prognosis.

Objective

To evaluate the impact of diabetes on tuberculosis treatment efficacy by identifying factors influencing differing outcomes between diabetic and non-diabetic patients and offering insights for optimizing treatment protocols for diabetic individuals.

Methodology

A prospective observational study was conducted and total of 286 adult patients aged 18 years and above, newly diagnosed with either pulmonary tuberculosis or diabetes mellitus.

Inclusion Criteria

The study inclusion criteria were 286 participants aged 18+ and were hospitalized due to a recent diagnosis of pulmonary tuberculosis (PTB) or diabetes Miletus. Sputum smear microscopy, culture, and cartridge-based nucleic acid testing were the approaches that were used to confirm the diagnosis of TB and DM. This diagnosis was confirmed, and radiological and pathological evaluations further confirmed this diagnosis. Diabetes treatment, as well as those who had just been diagnosed with diabetes, were both included in the inquiry. The presence of diabetes was defined as having fasting plasma glucose (FBS) levels that were more than 126 mg/dl or an HbA1c amount that was greater than 6.5% when tuberculosis was identified.

Exclusion Criteria

The following criteria were used to exclude patients from the study:

- Patients who had been on anti-tubercular therapy (ATT) for more than 15 days prior to the study.
- Patients with incomplete clinical data or those unable to provide informed consent.
- Patients with prior tuberculosis treatment or those already undergoing TB treatment at the time of enrolment.

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- Patients who failed to meet the diagnostic criteria for PTB or EPTB.
- Patients with other significant comorbidities that could interfere with study outcomes, such as advanced immunosuppressive conditions unrelated to diabetes.

Data Collection

Each patient's tuberculosis diagnostic tests and their height, weight, comorbidities, and body mass index (BMI) were diligently documented. During the baseline examinations carried out at the time of diagnosis, the fasting plasma glucose (FBS) and haemoglobin A1c levels were assessed accordingly. Fasting blood sugar (FBS) levels that were more than 126 mg/dl or haemoglobin A1c values greater than 6.5% were used to diagnose diabetes in individuals. The categorization of the results of anti-tuberculosis (ATT) therapeutic responses was the objective of the data collection that was carried out after that. The results were classified as "cured," "treatment completed," "defaulter," "treatment failure," or "lost to follow-up." Each outcome was categorized in one of these ways. Furthermore, the fasting blood sugar (FBS) and haemoglobin A1c levels were evaluated in persons with diabetes at three and six-month intervals during the experiment.

Data Analysis

Analyses were conducted using Excel and IBM SPSS Statistics for Windows, version 25, produced by IBM Corporation in Armonk, New York, USA. To report data, we used the mean plus or minus the standard deviation for variables described as having a normal distribution. In addition, Fisher's exact and chi-square tests were used to compare the baseline characteristics of the population. After doing a post hoc analysis, the HbA1c values of the PTB and EPTB groups were compared. In addition, a Mann-Whitney U-test was used to investigate the disparities between the two groups.

RESULTS

Table 1: Baseline Characteristics and TB Diagnosis Methods in Diabetic vs. Non-Diabetic Patients

Characteristic	Diabetics	Non-Diabetics
PTB	Predominantly seen	Less common
Age group (45-65 years)	More prevalent	Less prevalent
Mean Age (years)	47.6 ± 1.2	-
Gender (Male)	Higher incidence	Lower incidence
BMI (No significant difference)	No difference	No difference
History of smoking	Frequently seen	Less common
History of alcohol consumption	Frequently seen	Less common
History of ischemic heart disease	More prevalent	Less prevalent

The features and processes used to diagnose tuberculosis in diabetic and non-diabetic individuals are shown in Table 1. Patients with diabetes were the ones who were diagnosed with pulmonary tuberculosis (PTB) the most often. Most TB cases were found in men between 45 and 65, with a mean age of 47.6 years. When compared to those who did not have diabetes, diabetics had a higher risk of smoking, drinking alcohol, and having ischemic heart disease. Although this was the case, the groups' body mass indices (BMIs) did not vary substantially.

Table 2: Treatment Outcomes in TB Patients with and without Diabetes

Outcome	Diabetics (%)	Non-Diabetics (%)
Cured	55.5%	72.8%
Treatment completed	20.3%	15.6%
Defaulter	5.7%	3.9%
Treatment failure	8.1%	3.1%
Lost to follow-up	10.4%	4.6%
Favourable outcome	75.8%	88.4%
Unfavourable outcome	24.2%	11.6%

Table 2 shows the patients who did not have diabetes had a greater cure rate (72.8%) than those who did have diabetes (55.5%), according to the findings of researchers who treated tuberculosis patients. When it came to diabetic patients, the incidence of treatment failure was 8.1%, and the percentage of patients who abandoned their follow-up was 10.4%. According to the findings, 88.4% of those who did not have diabetes got favourable results, whereas 24.2% of those who did have diabetes had negative outcomes.

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Table 3: Mean FBS and HbA1c in PTB and EPTB Patients

Parameter	PTB Patients	EPTB Patients
FBS at baseline	182.5 ± 85.4	150.7 ± 56.2
HbA1c at baseline	8.7 ± 2.1	7.6 ± 1.8
Mean change in FBS (PTB)	Significant	N/A
Mean change in FBS (EPTB)	N/A	Significant
Mean change in HbA1c (PTB)	Significant	N/A
Mean change in HbA1c (EPTB)	N/A	Significant

Table 3 shows the comparison to individuals diagnosed with EPTB at the beginning of the study; those diagnosed with PTB had significantly higher levels of HbA1c and fasting blood sugar (FBS). Individuals who were diagnosed with diabetes saw considerable decreases in their fasting blood sugar (FBS) and haemoglobin A1c levels after therapy; individuals who were diagnosed with post-diabetes exhibited even more dramatic improvements. On top of that, those who suffered from EPTB also had considerable improvements, although to a lesser extent than those who suffered from PTB.

DISCUSSION

Diabetes mellitus (DM) is a condition that is affecting an increasing number of people all over the world; it is anticipated that an extra 550 million cases will be reported by the year 2030. A total of 88 million individuals in Southeast Asia are coping with diabetes, which accounts for about half of the 463 million cases of diabetes that have been reported worldwide. It is estimated that 77 million people in India are living with diabetes, and India is home to one-third of the world's tuberculosis (TB) infections. Diabetes makes patients more susceptible to diseases such as tuberculosis in several ways, one of which is that it weakens the immune system. People who have diabetes already have extra obstacles when attempting to maintain stable blood sugar levels while suffering from tuberculosis, and diabetes that is not under control may make other health concerns much more severe. An increased risk of developing diabetes and other metabolic problems is associated with those who have tuberculosis and have difficulty controlling their glucose levels.

Tuberculosis (TB), which continues to be the greatest infectious agent killer, affects over 25 percent of the world's population. When it comes to nations that have a high prevalence of both tuberculosis and HIV/AIDS, Brazil stands out. The co-occurrence of diabetes and tuberculosis is a cause for concern because diabetes raises the probability of getting active tuberculosis and has a detrimental effect on treatment results, including the likelihood of infection returning. When compared to those who do not have these conditions, those who have comorbidities, such as diabetes and tuberculosis, often have less favourable outcomes. These individuals often demonstrate high rates of alcohol and tobacco use, abnormal chest X-rays, and positive smear findings, all of which contribute to the already difficult nature of their prognosis.

There is evidence to show that people with tuberculosis who also have diabetes are at a greater risk of experiencing unsatisfactory treatment results. TB patients with diabetes and those without diabetes were shown to respond to therapy in very different ways, according to research that compared the two groups. In individuals with tuberculosis who also had diabetes, the percentage of cure was 55.5%, which was lower than the rate for persons who did not have diabetes (72.8%). People who had diabetes had a greater rate of treatment failure (8.1% against 10.4%), whereas people who did not have diabetes had a higher rate of lost follow-ups (3.1% versus 4.6%). Diabetes patients had a greater risk of treatment failure than the general population. The percentage of those who did not have diabetes who had positive outcomes was much higher (88.4% compared to 75.8%) than patients who had diabetes.

Both the fasting blood sugar (FBS) and haemoglobin A1c levels of diabetic patients with pulmonary tuberculosis (PTB) and extrapulmonary tuberculosis (EPTB) were substantially different from one another at the beginning of the study. It was shown that diabetic patients who were treated with insulin saw considerable decreases in their levels of fasting blood sugar (FBS) and haemoglobin A1c. Patients with postprandial hyperglycaemia (PTB) showed even more dramatic reductions. This underscores the influence that diabetes has on the course and prognosis of tuberculosis, particularly in pulmonary cases where the disease load is often more severe.

The effective treatment of tuberculosis (TB) is considerably hindered by the fact that patients with diabetes often have a more rapid progression of the illness and a delayed response to therapy. There is a significant cause for worry that delayed culture conversion is associated with the immunosuppressive effects of diabetes. These effects limit the body's capacity to resist tuberculosis germs properly. Because patients who are delayed in treatment stay infected for longer periods and are more prone to develop serious tuberculosis complications, there is a correlation between delays in treatment and higher death rates in the community(9).

Patients with diabetes who also have tuberculosis often have greater bacterial loads, which makes treatment more difficult, extends the amount of time it takes to recover and increases the probability that therapy will not be successful. Because their immune

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cells, which are typically responsible for fighting diseases like tuberculosis, are compromised, people with chronic hyperglycaemia have a lower capacity to manage and reduce the concentration of germs in their bodies(10). This increased bacterial load may make both the severity of the symptoms of the illness and the effectiveness of therapy within the standard treatment periods more difficult to achieve. On top of that, it can make the process of dispensing medicine a little bit more difficult(11).

Two of the most significant issues that are heightened by the return of tuberculosis are the further deterioration of patient's health and the emergence of drug-resistant strains of tuberculosis. Diabetic tuberculosis patients may have metabolic and physiological changes that influence the efficacy of anti-TB drugs(12). As a result, drug concentrations may not be optimal, and treatment efficiency may be reduced. Anti-tuberculosis medications, such as rifampicin, have the potential to aggravate insulin resistance, which in turn makes it more difficult to regulate diabetes and slows down the progression of therapeutic developments(13).

To improve treatment results for tuberculosis and diabetes, it is necessary to provide integrated care for both illnesses. According to this strategy, individuals with tuberculosis and diabetes are subjected to intensive monitoring of their blood sugar levels. Because both conditions are treated together, the likelihood of issues relating to either disease occurring is reduced. When it comes to treating tuberculosis, tailored treatment options may include altering anti-tuberculosis drug regimens. This is done to consider the patient's slowed metabolism or the usage of extra drugs to manage blood sugar levels(14). Diabetes screening at an early stage in tuberculosis patients, especially in regions where the disease is prevalent, has the potential to detect individuals who are at risk of experiencing unfavourable outcomes. Other essential elements of an integrated treatment plan include providing comprehensive patient education, monitoring dietary habits, and regularly scheduling follow-up sessions(15).

CONCLUSION

In conclusion, comparing treatment outcomes between patients with tuberculosis who do not have diabetes and those who have diabetes demonstrates the significant influence that diabetes has on the effectiveness of medical therapy for tuberculosis. Some of the outcomes associated with diabetes include a decreased risk of being cured, an increased likelihood of treatment failure, and a higher likelihood of experiencing adverse consequences. These results emphasize the need to combine therapy for diabetes and tuberculosis to enhance outcomes for the group that is most vulnerable to both conditions.

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