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Original Research Article

STUDY OF IMPACT OF DIABETES MELLITUS ON SPUTUM CONVERSION IN TREATMENT OUTCOME

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ABSTRACT

Background: Diabetes mellitus (DM) is increasingly recognised as a significant comorbidity in patients with pulmonary tuberculosis (TB), potentially influencing disease presentation and treatment response. Early sputum conversion is a critical predictor of treatment success and transmission control. **Aim:** To evaluate the impact of diabetes mellitus on sputum conversion and treatment outcomes in pulmonary tuberculosis.

Materials and Methods: This prospective observational case control study included 120 patients with newly diagnosed smear-positive pulmonary TB, of whom 60 had DM (diabetic group) and 60 did not (non-diabetic group). Baseline demographic, clinical, and laboratory data were recorded. Sputum smear microscopy was performed at diagnosis, 2 months, and 6 months to assess conversion rates. Glycemic status was assessed using random blood sugar and HbA1c levels. Statistical analysis included t-tests, chi-square tests, and calculation of 95% confidence intervals; $p < 0.05$ was considered significant.

Results: Diabetic patients were older (49.8 ± 10.2 vs 46.5 ± 9.8 years) and had higher BMI (25.4 ± 3.2 vs 24.6 ± 3.0 kg/m²), though differences were not statistically significant. The diabetic group had a longer mean cough duration (5.8 ± 2.1 vs 4.9 ± 1.9 weeks, p=0.021) and higher rates of high-grade sputum positivity (70.0% vs 58.3%). HbA1c and random blood sugar levels were significantly higher in the diabetic group (p<0.001). Sputum conversion at 2 months was significantly lower in diabetics (73.3% vs 88.3%, p=0.040), and mean time to conversion was longer (8.6 ± 1.9 vs 7.9 ± 1.5 weeks, p=0.031). At 6 months, conversion rates were high in both groups (95.0% vs 98.3%, p=0.408).

Conclusion: Diabetes mellitus adversely affects early sputum conversion in pulmonary TB, likely due to delayed bacillary clearance associated with poor glycemic control and higher baseline bacillary load. Enhanced screening, glycemic optimisation, and integrated care are essential for improving early treatment outcomes in this high-risk population.

Keywords: Tuberculosis, Diabetes Mellitus, Sputum Conversion

INTRODUCTION

Tuberculosis (TB) remains a major public health challenge worldwide, ranking among the leading causes of morbidity and mortality from infectious diseases. Despite advances in diagnostic techniques and treatment strategies, TB continues to affect millions of people annually, particularly in developing countries like India, where the burden of disease is disproportionately high. According to WHO estimates, India accounts for nearly one-quarter of the world's TB cases, with an incidence rate of 160–180 cases per 100,000 population. This persistent high burden is influenced by various

socio-economic, environmental, and health-related risk factors.[1,2]

Among these risk factors, Diabetes Mellitus (DM) has emerged as a significant contributor to the global TB epidemic. The prevalence of diabetes has been rising steadily due to rapid urbanization, sedentary lifestyles, and dietary changes, creating a dual public health problem in TB-endemic countries. The interaction between TB and diabetes is bi-directional: diabetes triples the risk of developing active TB, while TB can worsen glycemic control, complicating diabetes management. The coexistence of these two conditions leads to increased disease severity, delayed sputum conversion, higher relapse rates, and greater mortality.[3,4]

The pathophysiological basis for this association lies in the immunosuppressive effects of chronic hyperglycemia. Diabetes impairs cell-mediated immunity by affecting macrophage and lymphocyte function, leading to reduced containment of *Mycobacterium tuberculosis*. Consequently, diabetic patients often present with higher bacterial loads, atypical radiographic patterns (such as lower lung field involvement), and delayed clinical response to therapy. Furthermore, poor glycemic control during TB treatment can be exacerbated by drug interactions, particularly with rifampicin, which accelerates the metabolism of oral hypoglycemic agents and insulin.[5,6]

From a clinical standpoint, sputum smear conversion—defined as the change from positive to negative acid-fast bacilli (AFB) status during treatment—is a critical indicator of treatment success. Delayed sputum conversion is associated with ongoing infectivity, prolonged treatment, higher treatment failure rates, and an increased risk of drug resistance. Evidence suggests that diabetic TB patients are more likely to have delayed sputum conversion compared to non-diabetic patients, potentially due to higher baseline bacterial loads and pharmacokinetic alterations in anti-TB drugs.[7]

Aim

To assess the impact of Diabetes Mellitus on sputum conversion in treatment outcomes of sputum-positive pulmonary tuberculosis patients.

Objectives

1. To compare sputum conversion rates at 2 and 6 months between diabetic and non-diabetic sputum-positive pulmonary TB patients.
2. To evaluate the association between glycemic control and sputum conversion rates.
3. To compare overall treatment outcomes between diabetic and non-diabetic TB patients.

MATERIALS AND METHODS

Source of Data

Data were collected from patients admitted to the medicine ward, pulmonology ward, and tuberculosis ward at the Directly Observed Treatment, Short-course (DOTS) Center of the study hospital.

Study Design

Prospective observational case-control study.

Study Location

The study was conducted at a tertiary care hospital with an established DOTS center.

Study Duration

The study was carried out over a defined period covering patient recruitment, treatment, and follow-up until completion of the treatment regimen.

Sample Size

Total of 120 newly diagnosed sputum-positive pulmonary TB patients:

- Diabetic group: 60 patients with Type 2 Diabetes Mellitus (T2DM).
- Non-diabetic group: 60 patients without diabetes.

Inclusion Criteria

- Adults aged ≥18 years.
- Newly diagnosed sputum-positive pulmonary TB cases.
- Diabetic patients already diagnosed with T2DM and on oral hypoglycemic agents or insulin.
- Non-diabetic patients matched for age and sex.

Exclusion Criteria

- Patients on corticosteroids or thiazide diuretics.
- HIV-positive patients.
- Sputum smear-negative or extrapulmonary TB cases.
- Pregnant women and women within six weeks postpartum.
- Multi-drug resistant TB patients.
- Patients with prior treatment failure or relapse.
- Patients with peripheral neuropathy at baseline.
- Patients with history of alcohol use disorder.

Procedure and Methodology

Eligible patients were enrolled after obtaining informed consent. Detailed clinical history, including TB-related symptoms (fever, cough, weight loss, hemoptysis, chest pain, dyspnea) and diabetes history, was recorded. Physical examination and relevant investigations were conducted, including:

- Sputum AFB smear microscopy (baseline, at 2 months, and at 6 months).
- Chest X-ray for disease extent and cavity detection.
- Random Blood Sugar (RBS) and/or HbA1c for glycemic control assessment.

Patients received standard first-line anti-tubercular therapy as per RNTCP/DOTS guidelines:

- **Intensive Phase**: 2 months of HRZE (Isoniazid, Rifampicin, Pyrazinamide, Ethambutol).
- **Continuation Phase**: 4 months of HRE (Isoniazid, Rifampicin, Ethambutol).

Diabetic patients were co-managed for glycemic control with necessary adjustments in hypoglycemic therapy.

Sputum conversion was defined as two consecutive negative smears at the end of the second month and at the end of treatment. Treatment outcomes were categorized as completed, failure, or defaulter per WHO definitions.

Sample Processing

- Three sputum samples collected (spot-morning-spot) for AFB smear.
- Ziehl-Nielsen staining performed for microscopic detection.
- Samples processed as per standard biosafety protocols.

Statistical Methods

Data were entered into IBM SPSS v26. Continuous variables were expressed as mean ± SD; categorical variables as frequencies (%). Chi-square test was applied for categorical variables, and independent t-test for continuous variables. $p < 0.05$ was considered statistically significant.

Data Collection

Data were recorded in a structured proforma, including demographic details, risk factors, clinical presentation, laboratory and radiological findings, and treatment follow-up results. Regular follow-up ensured timely sputum testing and outcome assessment.

RESULTS

Table 1: Baseline Demographic Profile of Study Participants

Parameter	Diabetic Group (n=60)	Non-Diabetic Group (n=60)	Test of Significance	95% CI (Difference)	p-value
Age (years), Mean ± SD	49.8 ± 10.2	46.5 ± 9.8	t(118)=1.77	-0.6 to 7.1	0.079
Male, n (%)	38 (63.3)	35 (58.3)	$\chi^2(1)=0.32$	—	0.571
Female, n (%)	22 (36.7)	25 (41.7)	—	—	—
BMI (kg/m²), Mean ± SD	25.4 ± 3.2	24.6 ± 3.0	t(118)=1.38	-0.6 to 2.2	0.171

Table 1 shows that the mean age of participants was slightly higher in the diabetic group (49.8 ± 10.2 years) compared to the non-diabetic group (46.5 ± 9.8 years), but this difference was not statistically significant ($p = 0.079$, 95% CI: –0.6 to 7.1). The proportion of males was marginally higher among diabetics (63.3%) than non-diabetics (58.3%), with no significant association ($p = 0.571$). Female distribution followed the opposite trend (36.7% vs. 41.7%). The mean BMI was also slightly higher in the diabetic group (25.4 ± 3.2 kg/m²) compared to non-diabetics (24.6 ± 3.0 kg/m²), though the difference was not significant ($p = 0.171$).

Table 2: Clinical Presentation at Diagnosis

Parameter	Diabetic Group (n=60)	Non-Diabetic Group (n=60)	Test of Significance	95% CI (Difference)	p-value
Duration of cough (weeks), Mean ± SD	5.8 ± 2.1	4.9 ± 1.9	t(118)=2.34	0.16 to 1.64	0.021*
Fever present, n (%)	51 (85.0)	49 (81.7)	$\chi^2(1)=0.24$	—	0.624
Weight loss present, n (%)	43 (71.7)	39 (65.0)	$\chi^2(1)=0.63$	—	0.427
Hemoptysis present, n (%)	9 (15.0)	7 (11.7)	$\chi^2(1)=0.27$	—	0.604

Table 2 describes the clinical presentation at diagnosis. The mean duration of cough was significantly longer in the diabetic group (5.8 ± 2.1 weeks) compared to non-diabetics (4.9 ± 1.9 weeks) ($p = 0.021$, 95% CI: 0.16 to 1.64). Fever was present in a high proportion of patients in both groups (85.0% vs. 81.7%), with no significant difference ($p = 0.624$). Similarly, weight loss (71.7% vs. 65.0%) and hemoptysis (15.0% vs. 11.7%) were slightly more common among diabetics, but these differences were not statistically significant ($p > 0.05$ for both).

Table 3: Baseline Laboratory Findings

Parameter	Diabetic Group (n=60)	Non-Diabetic Group (n=60)	Test of Significance	95% CI (Difference)	p-value
Sputum AFB grading ≥2+, n (%)	42 (70.0)	35 (58.3)	$\chi^2(1)=1.76$	—	0.185
HbA1c (%) (Mean ± SD)	8.2 ± 1.4	5.4 ± 0.5	t(118)=13.2	2.37 to 3.23	<0.001*
ESR (mm/hr), Mean ± SD	52.6 ± 16.3	48.7 ± 15.1	t(118)=1.34	-1.3 to 9.1	0.184
Random Blood Sugar (mg/dL), Mean ± SD	198.4 ± 40.6	108.6 ± 18.2	t(118)=15.3	77.2 to 102.4	<0.001*

Table 3 summarizes baseline laboratory findings. A higher proportion of diabetics had sputum AFB grading ≥2+ (70.0% vs. 58.3%), although the difference was not significant ($p = 0.185$). HbA1c levels were significantly elevated in the diabetic group (8.2 ± 1.4%) compared to non-diabetics (5.4

± 0.5%), with a mean difference of 2.37–3.23% ($p < 0.001$). ESR values were slightly higher among diabetics (52.6 ± 16.3 mm/hr) than non-diabetics (48.7 ± 15.1 mm/hr), though not statistically significant ($p = 0.184$). Random blood sugar was markedly higher in diabetics (198.4 ± 40.6 mg/dL) compared to non-diabetics (108.6 ± 18.2 mg/dL), with a large and statistically significant difference ($p < 0.001$, 95% CI: 77.2 to 102.4 mg/dL).

Table 4: Sputum Conversion Rates

Parameter	Diabetic Group (n=60)	Non-Diabetic Group (n=60)	Test of Significance	95% CI (Difference)	p-value
Sputum conversion at 2 months, n (%)	44 (73.3)	53 (88.3)	$\chi^2(1)=4.20$	—	0.040*
Sputum conversion at 6 months, n (%)	57 (95.0)	59 (98.3)	$\chi^2(1)=0.68$	—	0.408
Mean time to sputum conversion (weeks)	8.6 ± 1.9	7.9 ± 1.5	t(118)=2.18	0.06 to 1.34	0.031*

Significant at $p < 0.05$

Table 4 presents sputum conversion rates. At 2 months, sputum conversion was significantly lower in diabetics (73.3%) than in non-diabetics (88.3%) ($p = 0.040$). By 6 months, conversion rates were high in both groups (95.0% vs. 98.3%) with no significant difference ($p = 0.408$). The mean time to sputum conversion was significantly longer in diabetics (8.6 ± 1.9 weeks) compared to non-diabetics (7.9 ± 1.5 weeks) ($p = 0.031$, 95% CI: 0.06 to 1.34 weeks).

DISCUSSION

Table 1 (Baseline demographics). Cohort shows diabetics were modestly older (49.8 ± 10.2 vs 46.5 ± 9.8 years) with slightly higher BMI (25.4 ± 3.2 vs 24.6 ± 3.0 kg/m²), though differences were nonsignificant. Similar age/BMI patterns—TB–DM patients skewing older with comparable sex distribution—have been reported in multi-setting cohorts, suggesting DM clusters in middle-to-late adulthood among TB cases without large sex imbalances. These observations align with clinic-based series in Qatar and reviews synthesizing TB–DM epidemiology. Nakamura A *et al.*(2014).[8]

Table 2 (Clinical presentation). Diabetics had a longer cough duration at diagnosis (mean difference ~0.9 weeks, p=0.021), while fever, weight loss and hemoptysis frequencies were similar. Prior comparative studies consistently note more respiratory symptom burden among TB–DM patients—particularly cough and hemoptysis—and more extensive pulmonary disease at presentation. Prasad P *et al.*(2014),[9] found higher odds of cough/hemoptysis and cavitation in DM, supporting signal of greater symptom chronicity even when binary symptom prevalence look comparable.

Table 3 (Baseline laboratory profile). A greater share of diabetics had higher smear grades (AFB ≥ 2+ in 70.0% vs 58.3%), echoing evidence that DM is associated with heavier bacillary burden and cavitary disease at baseline. Markedly higher RBS and HbA1c among diabetics is expected; importantly, multiple analyses link poor glycemic control to worse TB trajectories—lower conversion rates and slower lesion resolution implying elevated HbA1c (8.2%) group is biologically poised for delayed response. Meta- and umbrella reviews Kornfeld H *et al.*(2020),[10] converge that suboptimal control adversely affects conversion and outcomes.

Table 4 (Sputum conversion). Findings lower 2-month conversion in diabetics (73.3% vs 88.3%, p=0.040) and longer mean time to conversion (8.6 vs 7.9 weeks, p=0.031) with convergence by 6 months mirror several programmatic and hospital cohorts. Leung CC *et al.*(2017),[11] reported higher 2-month smear/culture positivity in DM, while an ERS abstract similarly showed lower initial-phase conversion (86.9% vs 97.7%). Time-to-conversion prolongation in DM is also shown in culture-based studies (including MDR-TB), reinforcing a biologically plausible delay attributable to hyperglycemia and higher initial bacillary load; good glycemic control appears to mitigate this penalty.

CONCLUSION

The present study demonstrates that patients with pulmonary tuberculosis and coexisting diabetes mellitus tend to have a longer duration of symptoms at presentation, higher baseline bacillary load, and poorer glycemic control compared to non-diabetic counterparts. These factors contribute to a significantly lower sputum conversion rate at two months and a longer mean time to sputum conversion, although final sputum conversion at six months remains high in both groups. The findings underscore the detrimental influence of diabetes, particularly poor glycemic control, on early treatment response in tuberculosis, highlighting the need for integrated TB–DM management strategies to improve early microbiological outcomes.

Limitations

1. The study was conducted at a single tertiary care centre, limiting generalisability to other settings.
2. Glycemic control during treatment was not serially monitored to assess its dynamic impact on conversion rates.

3. Culture-based methods were not employed, which could have provided more sensitive and specific bacteriological outcomes.
4. Potential confounders such as nutritional status, HIV co-infection, and socioeconomic variables were not adjusted for in the analysis.
5. The relatively small sample size may have limited the statistical power to detect differences in some secondary parameters.

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