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Study of spectrum of pulmonary infections in patients with type 2 diabetes mellitus at tertiary care centre

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Abstract
Introduction: Diabetes Mellitus is independent risk factor for pulmonary infections manifesting with serious clinical features, frequent complications, increased morbidity & mortality.
Objectives: Determine whether the clinical, radiological findings & causative organisms of pulmonary infections are modified in Diabetes mellitus.
Methods: Prospective analytical case control study conducted from June 2016 - june2018 involving 150 Type 2 diabetes & 80 non-diabetic controls selected on basis of simple random sampling. RBS, Chest X-ray, sputum AFB, culture sensitivity were done.
Results: Patients in diabetic group had longer duration-of-hospital stay, symptoms like cough, sputum production, breathlessness & fever.
Patients in diabetic group had higher incidence of lower zone opacity, cavities & pleural effusion compared to non-diabetics, sputum showed higher positivity rate for gram-negative bacilli & fungal elements, higher incidence of pulmonary tuberculosis & culture showed higher rates of staph-aureus, candida species, klebsiella & pseudomonas which were sensitive to higher antibiotics like imipenem. Diabetic group had more complications like prolonged duration of hospital stay, pleural effusion, respiratory failure, anemia & mortality compared to non-diabetic group.
Conclusion: Diabetics had significantly longer duration of symptoms like cough, sputum production, breathlessness & fever compared to non-diabetics. Tachypnea, cyanosis were more in diabetics.
Diabetic patients had higher-involvement of lower zones, cavity & pleural effusion on chest x-ray. Gram stain & KOH showed higher incidence of gram negative bacilli and fungal elements.
Pulmonary tuberculosis presenting as pneumonia & cavitatory lesions were significantly higher among diabetics compared to non-diabetics, Diabetics had significantly higher incidence of pulmonary infections due to staph. Aureus, klebsiella and pseudomonas, candida species.
Diabetic patients had significantly prolonged duration of hospital stay, pleural effusion, sepsis, respiratory failure, anemia & mortality when compared to non-diabetics

Keywords: Diabetes mellitus, pulmonary infections, sputum culture

Introduction

Diabetes mellitus is the most common endocrine disorder worldwide. The worldwide prevalence of Diabetes Mellitus has risen dramatically over the past two decades. Although the prevalence of both type 1 and type 2 diabetes mellitus is increasing worldwide, the prevalence of type 2 diabetes mellitus is expected to rise more rapidly in the future because of increasing obesity and reduced physical activity.

Pulmonary infections in diabetes mellitus are characterized by alterations in host defenses in the entire body and in the lung locally as well as in the function of respiratory epithelium and ciliary motility.

Diabetes is often identified as an independent risk factor for developing pulmonary infections such as those caused by mycobacterium tuberculosis, mucor, staphylococcus aureus, gram-negative bacteria, pneumococci, legionella and influenza. These infections are characterized by serious clinical features, longer duration, more frequent complications and increased mortality.

The purpose of this study is to analyze the spectrum of pulmonary infections encountered in diabetic patients, focusing on the characteristic clinical features, discussing diagnostic approaches, therapeutic interventions and complications in this patient population.

Materials and Methods

Source of data

The study was carried out in BMCH Hospital, Chitradurga over a period of 2 years from June 2016 to June 2018. The study was designated as a case control study. 150 patients with type 2 diabetes mellitus meeting the inclusion criteria were included and were compared with 80 age and sex matched healthy controls, full filling the inclusion and exclusion criteria.

Inclusion criteria

All patients having fasting glucose more than 126mg/dl and presenting with one or more of the following respiratory symptoms like cough which may or may not be associated with sputum production, breathlessness, chest pain and fever as part of constitutional symptoms.

All patients who are previously known cases of diabetes mellitus2 and presenting with one or more of the above mentioned respiratory symptoms.

Exclusion criteria

Type 1 diabetes,
COPD,
Bronchial asthma,
Genetic diseases like cystic fibrosis.

Method of collection of data

A detailed proforma was filled up for each patient, which included age, sex, IP number, detailed history, past and personal history. A detailed clinical examination was done. Laboratory parameters including fasting and postprandial blood glucose, HbA1C, renal function tests, ECG and routine urine examination were done.

Patient is investigated for chest x-ray, sputum for gram stain, culture and sensitivity pattern, AFB, bactec culture for TB, fugal culture methods, BAL along with routine hematology and basic chemistry tests. Diagnosis of diabetes is done based on FBS/PPBS, oral glucose tolerance and HbA_1c criteria i.e. FBS>126 mg/dl, OGT>2oomg/dl. When needed tests like 24 hour urine protein excretion, ECG, ophthalmoscopy, echocardiography the proposed study is conducted over a sample size of 200-250 cases fulfilling the inclusion and exclusion criteria.

Statistical Methods Applied

Frequencies

The Frequencies procedure provides statistics and graphical displays that are useful for describing many types of variables. The Frequencies procedure is a good place to start looking at your data.

Chi-square

The Chi-Square Test procedure tabulates a variable into categories and computes a chi-square statistic. This goodness-of-fit test compares the observed and expected frequencies in each category to test either that all categories contain the same proportion of values or that each category contains a user-specified proportion of values.

Crosstabs procedure

The Crosstabs procedure forms two-way and multiway tables and provides a variety of tests and measures of association for two-way tables. The structure of the table and whether categories are ordered determine what test or measure to use.

Crosstabs' statistics and measures of association are computed for two-way tables only. If you specify a row, a column, and a layer factor (control variable), the Crosstabs procedure forms one panel of associated statistics and measures for each value of the layer factor (or a combination of values for two or more control variables).

All the statistical procedures were done through SPSS for windows (version 16.0) and Minitab (version 11.0) for windows.

Results

The study was carried out in BMCH Hospital, Chitradurga over a period of 2 years from June 2016 to June 2018. The study was a case control study in which 150 patients with type 2 diabetes mellitus meeting the inclusion criteria were included in test group and were compared with 80 controls age and sex matched, fulfilling the inclusion and exclusion criteria.

Table 1: Age distribution

		Group		Total
		Diabetic (test)	Nondiabetic (control)	
AGES	21-40	15	13	28
	41-60	78	43	121
	61-80	55	23	78
	>80	2	1	3
Total		150	80	230

Table 2: Sex distribution

		Group		Total
		Test	Ctrl	
SEX	M	87	38	125
	F	63	42	105
Total		150	800	230

Table 1 and 2 shows age and sex distribution among 230 patients. Out of 230 patients, 125 were males and 105 were females. There was male predominance among the test group.

Of these 230 patients, 121 patients(52.6%) were in the age group of 41- 60 years. This group constitutes the maximum number of cases.

Table 3: Mean and standard deviation of age in test and Controls

	N	Mean	Std. Deviation	Minimum	Maximum
Test	150	58.13	11.789	40	87
Ctrl	80	53.83	14.002	24	83
Total	230	56.63	12.738	24	87

This table 3 shows the mean age and the standard deviation from the mean age.

The mean age among the test group was 58.13 years with a S.D. of 11.789 years. The mean age among controls was 53.3 years with a S.D. of 14.002 years.

Table 4: Mean and S.D. of duration of stay among test and control group

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
Staydur	Test	150	10.16	4.301	.351
	Ctrl	80	6.79	2.103	.235

Table 4 shows the duration of stay in test and control groups.
Test group showed a mean duration of stay of 10.16 days (S.D. 4.301) and the control group showed a mean duration of stay of 6.79 days (S.D. 2.103).
Duration of stay was significantly higher among the test group compared to the control group, p value being .000(<.05).

Table 5: Mean and S.D. of duration of diabetes among test group

	N	Minimum	Maximum	Mean	Std. Deviation
DM Duration	120	1	30	6.38	5.573

Table 5 shows the mean duration of diabetes among the test group was 6.38 years with a S.D. of 5.573 years.

Table 6: Mean duration of symptoms among test and controls

	Group	N	Mean	Std. Deviation	Std. Error Mean
Cough	Test	150	8.45	8.570	.700
	Ctrl	80	5.53	3.725	.416
Sputum	Test	150	7.26	7.700	.629
	Ctrl	80	5.29	3.833	.428
Breathlessness	Test	149	2.22	4.740	.388
	Ctrl	79	1.01	2.193	.247
Fever	Test	150	5.38	6.423	.524
	Ctrl	80	3.74	3.109	.348

Table 7: t test for duration of symptoms among tests and controls

	t-test for Equality of Means			
	t	df	Sig. (2-tailed)	Mean Difference
Cough	2.904	228	.004	2.92
Sputum	2.152	228	.032	1.97
Brethles	2.146	226	.033	1.21
Fever	2.155	228	.032	1.64

Table 6 and 7 shows the mean duration of symptoms such as cough, sputum production, breathlessness and fever. Mean duration of cough was 8.45 days (S.D. 8.57 days) in the test group and 5.53 days (S.D. 3.725 days) in the control group. Mean duration of sputum production in the test group was 7.26 days (S.D 7.700 days), in the control group it was 5.29 days (S.D. 3.833 days). Mean duration of breathlessness in the test group was 2.22 days (S.D 4.740 days) and in the control group it was 1.01 days (S.D. 2.193 days). Mean duration of fever among the test group was 5.83 days (S.D. 6.423 days) and in the control group it was 3.74 days (S.D. 3.109 days). There was significant difference for duration of symptoms for test and control group with p values of 0.004, 0.032, 0.033, 0.032 for cough, sputum production, breathlessness, fever respectively.

Table 8: Percentage of patients who were tachypneic among test and controls

		Group		Total
		Test	Ctrl	
Tachypnea	Absent	108	71	179
	Present	42	9	51
Total		150	80	230

Table 8 shows the percentage of patients who were tachypneic. 42 patients (28.0%) in the test group and 9 (11.3%) patients in the control group were tachypneic. There was a significant difference among the test and control group with a p value of 0.004.

Table 9: Percentage of patients who showed cyanosis among test and controls

		Group		Total
		Test	Ctrl	
cyanosis	Absent	117	72	189
	Present	33	8	41
Total		150	80	230

Table 9 shows the percentage of patients showing cyanosis. In test group, 33 patients (22.0%) and in the control group 8 patients (10.0%) showed cyanosis. There was a significant difference in test and control group with a p value of 0.024.

Table 10: X ray findings

X ray findings	Trait	Diabetic	Non diabetic	Total	p value
Lower zone opacity	Absent	25	34	59	0.000
	Present	125	46	171	
Upper Zone opacity	Absent	111	62	173	0.558
	Present	39	18	57	
Bilateral lower zone opacity	Absent	92	60	152	0.037
	Present	58	20	78	
Bilateral upper zone opacity	Absent	145	79	224	0.345
	Present	5	1	6	
Mid zone opacity	Absent	129	75	204	0.077
	Present	21	5	26	
Cavity	Absent	129	77	206	0.015
	Present	21	3	24	

Table 10 shows the percentage of opacity in lower zone among test and control groups. 125 patients (83.3%) in test group and 46 patients (57.5%) in control showed opacity in lower zone in chest X –ray. Significant difference was observed among test and control group, p value being 0.000.
Opacity in upper zone among test and control groups. 39 patients (26.0%) in test group and 18 patients (22.5%) in control showed opacity in upper zone in chest X –ray. No significant difference was observed among test and control group, p value being 0.558. Opacity in the bilateral lower zone among test and control groups. 58 patients (38.7%) in test group and 20 patients (25.0%) in control showed opacity in bilateral lower zone in chest X –ray. Significant difference was observed among test and control group, p value being 0.037.
Opacity in bilateral upper zone among test and control groups. 5 patients (3.3%) in test group and 1 patients (1.3%) in control showed opacity in bilateral upper zone in chest X –ray. No significant difference was observed among test and control group, p value being 0.345. Opacity in mid-zone among test and control groups. 21 patients (14.0%) in test group and 5 patients (6.3%) in control showed opacity in mid-zone in chest X –ray. No significant difference was observed among test and control group, p value being 0.077. Cavity among test and control groups. 21 patients (14.0%) in test group and 3 patients (3.8%) in control showed cavity in chest X –ray. Significant difference was observed among test and control group, p value being 0.015.

Table 11: Percentage of sputum positivity for AFB among test and controls

		Group		Total
		Test	Ctrl	
Sputum AFB	Negative	121	74	195
	Positive	29	6	35
Total		150	80	230

Table 11 shows percentage of sputum positivity for AFB among test and control group. 29 patients (19.3%) in test group and 6 patients (7.5%) showed sputum positivity for AFB. Significant difference was observed among test and control group with a p value of 0.017.

Table 12: Sputum for Gram stain and KOH stain among test and control group

	Test	control	P-value
A (Gram positive cocci)	64.7	66.3	0.810
B (Gram negative bacilli)	40.0	23.8	0.013
C (KOH positive)	10.0	0.0	0.003

Table 13: Organisms isolated in sputum culture among test (Diabetic) and control (Non diabetic)

Organism	Culture	Diabetic	Non diabetic	Total	p value
Acinetobacter	Negative	145	78	223	0.726
	Positive	5	2	7	
Normal throat commensals	Negative	105	54	159	0.696
	Positive	45	26	71	
Staphylococci	Negative	120	74	194	0.013
	Positive	30	6	36	
Beta hemolytic streptococci	Negative	145	69	214	0.003
	Positive	5	11	16	
E coli	Negative	136	76	212	0.224
	Positive	14	4	18	
Candida	Negative	131	80	211	0.001
	Positive	19	0	19	
Pseudomonas	Negative	129	78	207	0.006
	Positive	21	2	23	
Pneumococci	Negative	149	77	226	0.088
	Positive	1	3	4	
Citrobacter	Negative	150	79	229	0.170
	Positive	0	1	1	
Klebsiella	Negative	133	77	210	0.050
	Positive	17	3	20	
No growth	No growth	25	12	37	*******

Table 13 shows the percentage of *Acinetobacter* species isolated in sputum culture among test and control groups. 5 patients (3.3%) in test group and 2 patients (2.5%) in control showed sputum culture positive, no significant difference was observed among test and control groups with p value of 0.726. Normal throat commensals (NTC) isolated in sputum culture among test and control groups. 45 patients (30.0%) in test group and 26 patients (32.5%) in control showed sputum culture positive no significant difference was observed among test and control groups with p value of 0.696

Coagulase positive staphylococci isolated in sputum culture among test and control groups. 30 patients (20.0%) in test group and 6 patients (7.5%) in control showed sputum culture positive for coagulase positive staphylococci. Significant difference was observed among test and control groups with p value of 0.013.

Beta-hemolytic streptococci isolated in sputum culture among test and control groups. 5 patients (3.3%) in test group and 11 patients (13.8%) in control showed sputum culture positive for beta-hemolytic streptococci. Significant difference was observed among test and control groups with p value of 0.003.

E-coli isolated in sputum culture among test and control groups. 14 patients (9.3%) in test group and 4 patients (5.0%) in control showed sputum culture positive for E-coli. No Significant difference was observed among test and control groups with p value of 0.224.

Candida species isolated in sputum culture among test and control groups. 19 patients (12.7%) in test group and 0 patients (0.0%) in control showed sputum culture positive for candida species. Significant difference was observed among test and control groups with p value of 0.001.

Pseudomonas species isolated in sputum culture among test and control groups. 21 patients (14.0%) in test group and 2 patients (2.5%) in control showed sputum culture positive for pseudomonas species. Significant difference was observed among test and control groups with p value of 0.006. Pneumococci species isolated in sputum culture among test and control groups. 1 patients (0.7%) in test group and 3 patients (3.8%) in control showed sputum culture positive for pneumococci species. No significant difference was observed among test and control groups with p value of 0.088.

Citrobacter species isolated in sputum culture among test and control groups. 0 patients (0.0%) in test group and 1 patient (1.3%) in control showed sputum culture positive for citrobacter species.

No significant difference was observed among test and control groups with p value of 0.170. Klebsiella species isolated in sputum culture among test and control groups. 17 patients (11.3%) in test group and 3 patients (4.0%) in control showed sputum culture positive for klebsiella species. Significant difference was observed among test and control groups with p value of 0.050.

25 patients (16.7%) in test group and 12 patients (15.0%) in control showed no growth in culture. No significant difference was observed among test and control groups with p value of 0.743.

Table 14: Antibiotic Sensitivity pattern of bacteria isolated in test and control groups

Antibiotic sensitivity pattern	Test	Control
A (*Acinetobacter*)	Imipenem, Ciprofloxacin,	ceftazidime ciprofloxacin
C (Staphylococcus)	Clindamycin, Amikacin	Amikacin, Gentamicin
D (Streptococcus)	Erythromycin cefotaxime	Erythromycin Cefotaxime
E (E.coli)	Amikacin, ciprofloxacin	Amikacin, imipenem
G (Pseudomonas)	Imipenem gentamicin	Ceftazidime gentamicin
H (Pneumococci)	Ampicillin gentamicin	Ampicillin Amoxicillin-clavulanic acid
I (Citrobacter)		Cefotaxime
J (Klebsiella)	Imipenem ceftazidime	Imipenem Gentamicin

Table 14 shows the antibiotic Sensitivity pattern of bacteria isolated in test and control groups Bacteria such as *Acinetobacter*, pseudomonas, klebsiella were sensitive to higher antibiotics like imipenem in diabetics compared to non-diabetics.

Table 15: Complications in Diabetic and Non diabetic groups

Complications	Trait	Diabetic group	Non diabetic group	Total	p value
Prolonged duration of stay	Absent	76	56	132	0.005
	Present	74	24	98	
Pleural effusion	Absent	128	76	204	0.027
	Present	22	4	26	
Lung abscess	Absent	146	80	226	0.141
	Present	4	0	4	
Sepsis	Absent	99	67	166	0.004
	Present	51	13	64	
Respiratory failure	Absent	114	73	187	0.005
	Present	36	7	43	
Necrotising pneumonia	Absent	146	80	226	0.141
	Present	4	0	4	
Anemia	Absent	125	77	202	0.004
	Present	25	3	28	
Death	Absent	137	79	216	0.025
	Present	13	1	14	

Table 15 shows the percentage of patients who had prolonged stay in hospital among test and control group. 74 patients (49.3%) in test group and 24 patients (30%) in control group had prolonged duration of stay in hospital. There was significant difference among test and control group with a p value of 0.005.

Lung abscess formation among test and control group. 4 patients (2.7%) in test group and 0 patients (0.0%) among controls had abscess formation as seen in chest x-ray. No significant difference was observed among test and control group with a p value of 0.141.

Pleural effusion among test and control groups. 22 patients (14.7%) among test group and 4 patients (5.0%) in control group had pleural effusion as seen in chest x- ray. significant difference was observed among test and control group with a p value of 0.027. Sepsis among test and control group. 51 patients (34.0%) in test group and 13 patients (16.3%) in control group showed features suggestive of sepsis. Significant difference was observed among test and control group with a p value of 0.004.

Respiratory failure, among test and control groups. 36 patients (24.0%) in test group and 7 patients (8.8%) in control group developed respiratory failure. Significant difference was observed among test and control group with a p value of 0.005.

Necrotising pneumonia among test and control group. 4 patients (2.7%) in test group and 0 patients (.0%) in control group showed necrotising pneumonia on chest x-ray. No significant difference was observed among test and control group with a p value of 0.141. Anemia among test and control group.25 patients (16.7%) in test group and 3 patients (3.8%) in control group developed anemia. Significant difference was observed among test and control group with a p value of 0.004. Expired patients among test and control group. 13 patients (8.7%) in test group and 1 patient (1.3%) in control group expired during the course of illness. Significant difference was observed among test and control group with a p value of 0.025.

Discussion

Mean and standard deviation of age of the patients (Table 3)

The mean age among test group was 58.13 years with a S.D. of 11.789 years. The mean age among controls was 53.3 years with a S.D. of 14.002 years.

D H Akbar *et al.* [1] study the mean age was 59.4 years with a S.D. of 14.0 years among diabetics and 53.7 years with a S.D. 20.6 years among non- diabetics.

Jette B. Kornum *et al.* [2] study the mean age was 75 years among diabetics and 73 years among non-diabetics.

Mean and S.D. of duration of hospital stay of the cases (Table 4)

In our study test group showed a mean duration of stay of 10.16 days (S.D. 4.301) and control group showed a mean duration of stay of 6.79 days (S.D. 2.103).

Duration of stay was significantly higher among test group compared to control group, p value being .000(<.05).

Miquel Falguera *et al.* [3] study the mean duration of hospital stay was 10.2 days in diabetics and 9.1 days in non-diabetics. Mean and S.D. of duration of diabetes among test group (Table 5). In our study the mean duration of diabetes among test group was 6.38 years with a S.D. of 5.573.

In Miquel Falguera *et al.* [3] study the mean duration of diabetes was 8 years.

Mean and S.D duration of symptoms among test and controls (Table 6 to 7)

In our study, Mean duration of cough was 8.45 days (S.D. 8.57 days) in test group and 5.53 days (S.D. 3.725 days) in control group. Mean duration of sputum production in test group was 7.26 days (S.D 7.700 days), in control group it was 5.29 days (S.D. 3.833 days).

Mean duration of breathlessness in test group was 2.22 days (S.D 4.740 days) and in control group it was 1.01 days (S.D. 2.193 days). Mean duration of fever among test group was 5.83 days (S.D. 6.423 days) and in control group it was 3.74 days (S.D. 3.109 days). Other less commonly occurring symptoms like hemoptysis was compared, test group had 9 patients (6.0%) and control group had 2 patients (2.5%) who had hemoptysis. However there was no significant difference among test and controls for hemoptysis.

There was significant difference for duration of symptoms for test and control group with p values of 0.004, 0.032, 0.033, 0.032 for cough, sputum production, breathlessness, fever respectively.

However there are no previous studies showing the mean duration of respiratory symptoms for diabetics and non-diabetics.

Clinical features among test and control group (Table 8 to 9)

In our study we compared clinical features like tachypnea, cyanosis, among test and control groups. There was significant difference among the test and control group for tachypnea, cyanosis, with p values of 0.004, 0.024, respectively. However there are no previous studies who have compared the clinical features of pulmonary infections among diabetics and non-diabetics.

Chest X-ray findings among test and control group (table 10)

Table 10 shows the percentage of chest x-ray findings among test and control groups. In our study we compared the occurrence of opacity in upper mid and lower zones, bilateral upper and lower zones. Our study showed a significant difference in the occurrence of opacity in lower zone, bilateral lower zone, cavity and pleural effusion with p value of 0.000, 0.037, 0.015, 0.027 respectively.

However there was no significant difference in the occurrence of opacity in the upper zone, mid-zone and bilateral upper zone. In patients with pleural effusion, few were positive for sputum AFB, in others it was part of synpneumonic effusion.All the patients who showed cavities on chest x-ray were positive for sputum AFB. In Miquel Falguera *et al.* [3] study there was significant difference in the rate of occurrence of pleural effusion among diabetics, compared to non-diabetics. (P _ 0.015). Perez-Guzman C *et al.* [4] study showed that diabetic patients with pulmonary TB had increased incidence of cavitatory lesions on X ray.

Diabetic patients are more prone for aspiration[5], increased upper airway colonization by gram-negative organisms[6], the straight course of the right main bronchus in comparison to left bronchus might predispose diabetics for lower lobe pneumonias.

In our study we compared the sputum for Gram stain, KOH stain (table 12) findings among test and control groups. There was significant difference among test and control group for gram negative bacilli and KOH positive fungal elements with p values of 0.013 and 0.003 respectively. There was no significant difference in gram positive cocci among test and control groups.

Percentage of sputum positivity for AFB among test and controls (Table 11)

In our study 29 patients (19.3%) in test group and 6 patients (7.5%) showed sputum positivity for AFB. Significant difference was observed among test and control group with a p value of 0.017

Veracruz, Ponce de Leon A *et al.* [7], observed that 29.6% of patients with TB were suffering from DM and the attributable risk was 25%.

Jeon CY *et al.* [8], who did a meta-analysis of 13 observational studies, showed that DM was associated with an increased risk of TB (relative risk = 3.11, 95% CI 2.27-4.26)

In our study following organisms were isolated in sputum culture, *Acinetobacter*, normal throat commensals, staphylococcus, streptococcus, E.coli, candida species, pseudomonas, pneumococci, citrobacter species, klebsiella.

There was a significant higher incidence of staphylococcus (p=0.013), candida species (p=0.001), pseudomonas (p=0.006) and klebsiella (p=0.050) in the test group compared to the control group. Streptococcus species showed a significant higher incidence among control group compared to the test group.

In our study 16.7% of patients in test group and 15% of patients in control did not isolate any organisms on sputum culture. The most common bacteria isolated in test group was staphylococci and in control group it was streptococci. Bacteria such as *Acinetobacter*, pseudomonas, klebsiella were sensitive to higher antibiotics like imipenem in diabetics compared to non-diabetics.

In study done by D H Akbar *et al.* [1], H.influenza was the commonest pathogen isolated in community-acquired pneumonia both among diabetics and non-diabetics, but there was a predominance of staphylococcus aureus in diabetics compared to non-diabetics. Gram-negative bacilli (pseudomonas) were commonest pathogens in hospital acquired pneumonia both in diabetics and non-diabetics. These findings are consistent with our study.

In a study done by Miquel Falguera *et al.* [3], microbiological results obtained from patients with diabetes, in comparison with the nondiabetic population, did not show significant differences. For both groups, S. pneumoniae, which was identified in 225 patients (34%), was the agent most commonly isolated. They also included cases of COPD in the study group.

In our study following complications observed among test and control group were; prolonged duration of hospital stay which was defined as length of stay more than 7 days, abscess formation in chest x- ray, pleural effusion on chest x-ray, features of sepsis as evidenced by leukocytosis / leukopenia (>12,000/<4000) as per 1992 ACCP guidelines, respiratory failure as evidenced by less than 90% spo_2 on pulse-oximeter and with clinical features like tachypnea and cyanosis, necrotising pneumonia on chest x-ray, anemia and those who expired during the course of illness.

Our study showed a significant difference for complications such as prolonged duration of stay (p=0.005), pleural effusion (p=0.027), sepsis (p=0.004), respiratory failure (p=0.005), anemia (p=0.004) and those who expired (p=0.025) in the course of their of illness with rates being higher in the test group compared to the control group. There was no significant difference in the rates of occurrence of abscess formation, necrotising pneumonia among test and control groups.

Majority of the patients who had a prolonged stay in the hospital were associated with other complications like sepsis, anemia, and their sputum culture isolated organisms which were sensitive to higher antibiotics like linezolid, imipenem, clindamycin.

Few patients who developed pleural effusion were positive for sputum AFB. In others synpneumonic effusion was seen.

In our study patients who had abscess formation isolated fungal elements such as candida species and gram-negative organisms like E-coli. Majority of the patients who developed pleural effusion were positive for sputum AFB.

Patients who had sepsis as evidenced by leukocytosis / leukopenia, had increased rates of other complications like respiratory failure, prolonged hospital stay. Majority of the patients with sepsis isolated staphylococcus, fungal elements, pseudomonas in their sputum culture. These patients also had increased rates of admission to ICU, requiring ventilatory support.

In our study patients who had respiratory failure were associated with other complications like sepsis, increased mortality, increased need for admission to ICU. Majority of these patients isolated gram-negative organisms like klebsiella, E.coli, pseudomonas in their sputum. There was no significant difference in the occurrence of necrotising pneumonia; E.coli was isolated in their sputum culture.

In this study, significant number of people who had anemia, were positive for sputum AFB. There was a significant difference in mortality among test and control group. Patients who expired also had other complications like sepsis, respiratory failure. Those who expired were in the age group of 45-60 years, few patients had other comorbidities like diabetic nephropathy and hypertension. Majority of these patients were treated in ICU requiring ventilatory support.

In study done by Miquel Falguera *et al.* [3], in the multivariate analysis, diabetes remained significantly (p=0.027) associated with mortality. Age > 65years, the presence of other concomitant comorbid conditions, bacteremia, empyema, and multilobar infiltrates were also found to be independent factors related to mortality.

Diabetes was also an independent factor associated with the development of pleural effusion.

In a study done by Jette B Kornum *et al*. [2] mortality among diabetic patients was greater than that among other patients: 19.9 vs. 15.1% after 30 days and 27.0 vs. 21.6% after 90 days, respectively. Presence of type 2 diabetes did not predict pulmonary complications or bacteremia.

In this study we have shown a significant difference in the spectrum of pulmonary infections among diabetics and non-diabetics.

It has been clearly studied that diabetes predisposes to various infections because of alterations in the immune system locally as well as systematically. Neutrophil functions like adherence, migration, phagocytosis and oxidative burst are depressed in diabetic patients which favors easy spread of infections. Innate immunity and cell-mediated immunity are also affected, however humoral immunity appears to be preserved.

Infections with increased frequency may be due to Staphylococcus Aureus, gram-Negative bacteria like Klebsiella, *E. Coli*, Enterobacter, Pseudomonas and Actinobacteria. Staphylococcus is the major pathogen causing nosocomial and community acquired pneumonia. Infections with possibly increased morbidity and mortality may be due to Streptococcus, Pneumococcus, Legionella and Viral Infections. Pulmonary tuberculosis in diabetics include a severe form and more aggressive course of the disease, increased destruction, cavitations, more resistance to anti-tubercular drugs, atypical x-ray findings and more effusions. Primary pneumonia in diabetics may be caused by mucormycosis, aspergillus species, *coccidioides* immitis, *cryptococcus neoformans*.

In our study diabetic patients had a significantly higher incidence of pulmonary infections due to staphylococcus, candida species, gram-negative bacteria like klebsiella and pseudomonas. There was significantly higher incidence of pulmonary tuberculosis among diabetics with increased rates of cavitation compared to non-diabetics. These findings are consistent with the previous studies [1, 2, 3].

Conclusion

In our study diabetic patients presenting with pulmonary infections had significantly longer duration of symptoms like cough, sputum production, breathlessness and fever compared to non-diabetics. Features like tachypnea, cyanosis were more in diabetics. Diabetic patients had higher involvement of lower zones on chest X ray, higher incidence of cavity and pleural effusion. In our study gram stain and KOH staining showed higher incidence of gram negative bacilli and fungal elements among diabetics. Pulmonary tuberculosis presenting as pneumonia were significantly higher among diabetics with increased rates of cavitations compared to non-diabetics. In our study diabetic patients had a significantly higher incidence of pulmonary infections due to staphylococcus, gram-negative bacteria like klebsiella and pseudomonas, candida species.

There was significantly higher incidence of complications like prolonged duration of hospital stay, pleural effusion, sepsis, respiratory failure, anemia and mortality among diabetics compared to non-diabetics.

This suggests that the clinical, radiological findings and causative microorganisms of pulmonary infections are modified by the presence of diabetes mellitus as an underlying condition.

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