Non-cystic fibrosis bronchiectasis: a retrospective review of clinical, radiological, microbiological and lung function profile at a tertiary care center of a low-middle-income country

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Abstract

Non-cystic fibrosis (non-CF) bronchiectasis has emerged as a significant respiratory disease in developing countries. Given the variation in causes and clinical characteristics across different regions, it is necessary to conduct studies in regions with limited data, such as low-middle-income countries (LMIC). The aim of the study was to investigate the underlying causes, clinical presentation, etiology, lung function, and imaging in patients with bronchiectasis who sought treatment at a tertiary care hospital in an LMIC. We conducted a retrospective observational study at the Aga Khan University, Pakistan. Adult patients diagnosed with non-CF bronchiectasis on high-resolution computed tomography (HRCT) scan between 2000 and 2020 were included. We evaluated the etiology, clinical characteristics, microbiology, radiology, and spirometric patterns of these patients. A total of 340 patients were included, with 56.5% being female and 44.7% aged over 60 years. Among them, 157 (46.2%) had experienced symptoms for 1-5 years. The most common spirometric pattern observed was obstructive impairment (58.1%). Previous tuberculosis (TB) (52.94%) was the most common etiology, followed by allergic bronchopulmonary aspergillosis (7.64%). Bilateral lung involvement on HRCT scan was found in 63.2% of patients. *Pseudomonas aeruginosa* was the most frequently identified organism (38.75%) among 240 patients with available specimens. Patients with *P. aeruginosa* infections had a significantly higher number of exacerbations (p=0.016). There was a significant difference (p<0.001) in *P. aeruginosa* growth among different etiologies. In conclusion, post-TB bronchiectasis was the most common cause of non-CF bronchiectasis in our study population. *P. aeruginosa* was the predominant organism, and 63.2% of the patients exhibited bilateral lung involvement. Since *P. aeruginosa* growth and extensive lung involvement have been associated with poor prognosis and increased mortality risk, we recommend close follow-ups of these patients to improve quality of life and survival in developing countries like Pakistan.

Introduction

Bronchiectasis is a progressive disease of the respiratory tract that leads to permanent dilation of the bronchi due to chronic inflammation [1]. It is characterized by overproduction of mucus with decreased clearance [1]. Following clinical suspicion, the diagnosis of bronchiectasis is usually confirmed using a high-resolution computed tomography (HRCT) scan, which is considered the gold standard [2,3]. Pathogenesis of bronchiectasis follows Cole's vicious circle model, which begins with an inflammatory response to a pulmonary infection [4]. The pro-inflammatory state results in mucus stasis, which then favors chronic inflammation [4]. Over a long period of time, retained mucus may lead to mucus plugs and airway obstruction, which can lead to more advanced bronchiectasis [4].

Bronchiectasis causes substantial morbidity and mortality in adults [5]. It may be caused by various clinical conditions, which include cystic fibrosis (CF), allergic bronchopulmonary aspergillosis (ABPA), post-infectious [*e.g.*, post-tuberculosis (TB)] connective tissue diseases (CTD), asthma, chronic obstructive pulmonary disease (COPD), and other causes, which include some rare etiologies and idiopathic cases [6,7]. Post-TB bronchiectasis is considered to be the leading etiology in developing countries like Pakistan, but very few studies have been conducted in this region [8,9].

Gram-negative bacteria, including *Pseudomonas aeruginosa and Haemophilus influenzae*, are the most frequently isolated organisms from the sputum of non-CF bronchiectasis patients, followed by others that include *Staphylococcus aureus* and *Streptococcus pneumoniae* [2,7,10-16]. In addition, a cohort study conducted in a tertiary care hospital in Karachi, Pakistan, mentioned *P. aeruginosa*, *M. catarrhalis* and *H. influenza* to be the most frequently isolated organisms, showing similar results to a study conducted in India [8,9].

Sputum cultures positive for *P. aeruginosa*, male sex, low body mass index (BMI), advanced age, and COPD have been identified as risk factors for mortality [5]. The radiologic extent of the disease can give us useful information regarding the prognosis of the disease as the higher number of lobes affected has been significantly associated with higher mortality [17]. In another study by Loebinger *et al*., there were strong associations between the extent of bronchiectasis, bronchiectasis severity (using modified Chrispin or Birmingham method), and wall thickness on computed tomography (CT) assessment with mortality [18]. A study in Turkey also demonstrated a significant association [19]. Like most advances in modern medicine, much of the literature and development stem from developed countries. However, bronchiectasis is more prevalent among developing countries as compared to their developed counterparts [20]. In such countries, it is imperative to outline the etiological demographics to identify the high-risk groups since early diagnosis and treatment increase the survival and quality of life of the patients [21]. Differences in etiology, epidemiology, and microbiology have been observed across countries, and these are likely to influence treatment and outcomes [11]. According to Chandrasekaran *et al*., considering the geographic variation in etiology and other clinical features, studies targeting regions where a paucity of data exists, including Africa, Asia, and South America, are now necessary [6]. Little has been published regarding different aspects of non-CF bronchiectasis in low and middle-income countries (LMIC); hence, this study was conducted to identify the underlying causes, signs and symptoms at presentation, radiological extent of disease, causative microorganisms, and lung function seen in patients presenting with bronchiectasis to a tertiary care hospital in an LMIC.

Materials and Methods

A retrospective observational study was conducted at Aga Khan University Hospital (AKUH), Karachi, Pakistan (tertiary care hospital), which included adult patients (>18 years) diagnosed with non-CF bronchiectasis on HRCT scan. Patients with a diagnosis of CF, and patients whose HRCT scans were not available were excluded. Records of all patients with non-CF bronchiectasis from 2000-2020 were retrieved using the International Classification of Diseases-9 (ICD-9) system.

The selection criteria included the following cases: adult patients (≥18 years of age) with non-CF bronchiectasis diagnosed by HRCT. The exclusion criteria included any patient with any other lung pathology other than non-CF bronchiectasis, along with any patient who was not diagnosed via an HRCT. Initially, 880 patient records with a diagnosis of bronchiectasis were reviewed, and 540 of these were excluded due to non-availability of HRCT scans or age below 18 years (Figure 1).

A preformed questionnaire was then filled out for each case. The questionnaire looked at the following factors: age, gender, smoking status, BMI, comorbid diseases, cause of bronchiectasis exacerbation, CT findings, clinical features, duration of symptoms, spirometry data, complications, microbiology, treatment options, long-term non-invasive ventilation, chest physiotherapy, number of exacerbations in a year, number of hospital admissions, and vaccination status. Age was divided into four groups (18-30, 31-45, 46-60, >60). Causes were divided into post-TB, post-pneumonia, ABPA (diagnosed using ISHAM criteria), hypogammaglobinemia, immotile cilia, foreign body aspiration, CTD, and idiopathic.

Consent was waived because this is a retrospective study with no human or animal experimentation. The study was approved by the ethical review committee at AKUH.

The data was entered on IBM SPSS (Statistical Package for Social Sciences) version 26.0 (IBM Corp., Armonk, NY, USA) for analysis. Baseline characteristics, etiology, microbiological, spirometric, and radiological characteristics, and various other parameters were assessed, and their frequencies and percentages were calculated. Furthermore, the entire sample was divided into two subgroups namely *Pseudomonas* and non-*Pseudomonas* groups, based on sputum culture findings, and the clinical characteristics (*e.g.*, complications, number of exacerbations, *etc*.) were compared. A chi-squared test was done to determine if there was any statistically sig-

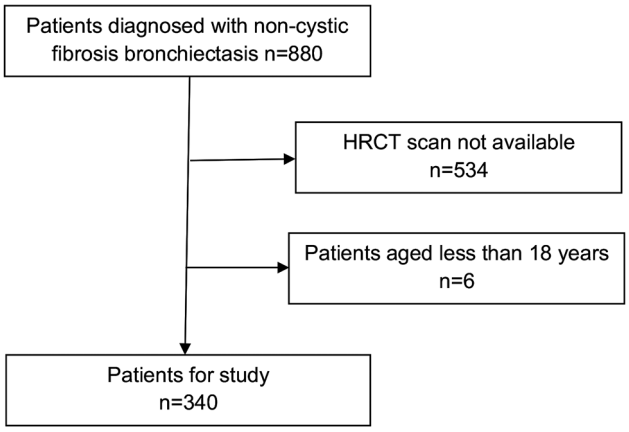

Figure 1. Flow diagram illustrating patient selection. HRCT, high resolution computed tomography.

nificant difference among various groups, and a p-value of less than 0.05 was considered significant.

Results

A total of 340 patients who fulfilled the inclusion criteria were studied. Table 1 shows the demographic and clinical characteristics of the patients. Women (56.5%) and the age group ">60" (44.7%) predominated. The majority of the patients (46.2%; n=157) had a duration of symptoms between 1-5 years. Spirometry was available for 93 (27.4%) patients. It was normal in only 3.2% (n=3) cases. Obstructive impairment was observed in 58.1% (n=54) of the patients, and 38.7% (n=36) had restrictive impairment. The most common clinical feature was cough (n=311; 91.5%) followed by increased sputum production (n=255; 75%). On the HRCT scan, 215 (63.2%) patients had bilateral involvement, 124 (36.5%) had unilateral involvement, and one scan (0.3%) did not specify lateralization. Of these 340 patients, 27.9% (n=95) had one exacerbation in the last year, and 11.5% had two exacerbations, while 1.2% (n=4) and 1.8% (n=5) of the patients had four and five exacerbations in the past year, respectively. More than half (51.2%, n=174) of the patients had been stable for the past year. There were 34.1% (n=116) patients who had to be hospitalized due to bronchiectasis, whereas 8.5% (n=29) had major hemoptysis requiring hospital admission. The majority of the patients (77.3%, n=263) did not require hospital admission for respiratory infections in the past year, while 14.7% (n=50) and 5.3% (n=18) had to be admitted once and twice in the past year, respectively, for respiratory infections. Of the 340 cases in this study, the number of cases where the etiology was identified was 72.1% (n=245) and was unidentified/idiopathic in 27.9% (n=95 cases). Figure 2 shows the distribution of etiologies, indicating that the most common cause of non-CF bronchiectasis was post-TB bronchiectasis (52.9%; n=180), followed by ABPA (7.6%; n=26). Some uncommon etiologies in our study included CTD and bronchiectasis secondary to fungal etiology. Figure 3 shows microbes isolated from the sputum culture of 240 patients over the course of the disease.

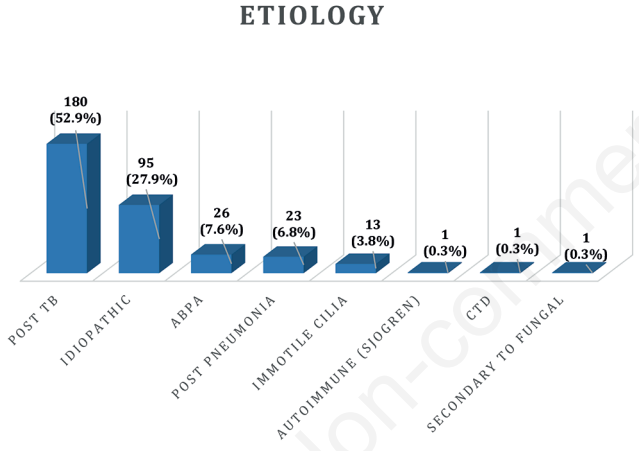

Figure 2. Etiology of bronchiectasis in patients. CTD, connective tissue disease; ABPA, allergic bronchopulmonary aspergillosis; TB, tuberculosis.

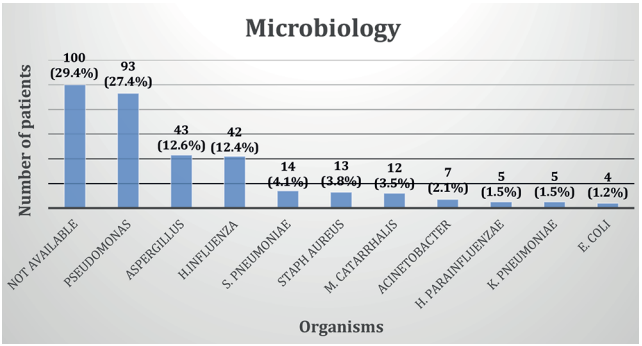

Figure 3. Organisms isolated from patients with non-cystic fibrosis bronchiectasis.

Table 1. Demographics and clinical characteristics of patients.

Characteristics	Frequencies, n (%)
Age	
18-30	53 (15.6)
31-45	61 (17.9)
46-60	74 (21.8)
>60	152 (44.7)
Sex	
Female	192 (56.5)
Male	148 (43.5)
Duration of symptoms	
<1 year	56 (16.5)
1-5 years	157 (46.2)
6-10 years	68 (20)
>10 years	52 (15.3)
Unknown	7 (2.1)
Spirometry* (n=93)	
Non-specific/restricted	36 (38.7)
Obstructive	54 (58.1)
Normal	3 (3.2)
Clinical features	
Cough	311 (91.5)
Sputum production	255 (75)
Hemoptysis	113 (33.2)
Fever	167 (49.1)
Dyspnea	224 (65.9)
Wheeze	139 (40.9)
Clubbing	11 (3.2)
Computed tomography scan lateralization	
Bilateral	215 (63.2)
Unilateral	124 (36.5)
Number of exacerbations in last year	
0	174 (51.2)
1	95 (27.9)
2	39 (11.5)
3	21 (6.2)
4	4 (1.2)
5	6 (1.8)
Hospitalization for bronchiectasis in last year	
Yes	116 (34.1)
No	224 (65.9)
Major hemoptysis requiring hospital admission in last year	
Yes	29 (8.5)
No	311 (91.5)
Hospital admissions for respiratory infections in last year	
0	263 (77.3)
1	50 (14.7)
2	18 (5.3)
3	7 (2.1)
5	1 (0.3)

*Out of those available.

Many patients cultured multiple organisms. Sputum cultures of 100 patients were not available either due to non-compliance or tests done from an outside laboratory. The most commonly identified organism was *P. aeruginosa,* seen in 93 (38.8%) patients, followed by *Aspergillus species* (17.9%; n=43) and *H. influenzae* (17.5%; n=42). A few uncommon isolates were also observed with *Nocardia sp.* and *S. maltophilia* seen in two (0.8%) patients each; meanwhile, *Aeromonas, Enterobacter, Serratia sp.,* and *Drechslera sp. were* seen in one (0.4%) patient each. We have investigated variations in age, gender, and different clinical characteristics (signs and symptoms, radiological and microbiological findings, and complications) of patients according to different etiologies. Table 2 shows a comparison of the different characteristics of different etiologies. Table 3 summarizes the comparison between *Pseudomonas* (n=93) and non-

Table 2. Comparison of characteristics of different etiologies.

	ABPA n=26	Idiopathic n=95	Immotile cilia n=13	Post-pneumonia n=23	Post-TB n=180
Age (y), n (%)					
18-30	6 (23.1)	14 (14.7)	9 (69.2)	2 (8.7)	21 (11.7)
31-45	3 (11.5)	11 (11.6)	3 (23.1)	3 (13)	41 (22.8)
46-60	5 (19.2)	25 (26.3)	1 (7.7)	5 (21.7)	37 (20.6)
>60	12 (46.2)	45 (47.4)	0 (0)	13 (56.5)	81 (45)
Gender, n (%)					
Male	9 (34.6)	38 (40)	8 (61.5)	14 (60.9)	78 (43.3)
Female	17 (65.4)	57 (60)	5 (38.5%)	9 (39.1)	102 (56.7)
CT findings, n (%)					
Bilateral	16 (61.5)	62 (65.3)	12 (92.3)	11 (47.8)	112 (62.2)
Unilateral	10 (38.5)	33 (34.7)	0 (0)	12 (52.2)	68 (37.8)
Not available	0 (0)	0 (0)	1 (7.7)	0 (0)	0 (0)
If localized, n (%)					
Upper lobe	13 (50)	33 (34.7)	3 (23.1)	8 (34.8)	100 (55.6)
Middle Lobe/lingula	12 (46.2)	37 (38.9)	8 (61.5)	10 (43.5)	54 (30)
Lower lobe	15 (57.7)	59 (62.1)	5 (38.5)	11 (47.8)	75 (41.7)
Not available	2 (7.7)	9 (9.5)	2 (15.4)	2 (8.7)	17 (9.4)
If diffuse, n (%)					
Cylindrical	4 (15.4)	1 (1.1)	1 (7.7)	1 (4.3)	2 (1.1)
Cystic	7 (26.9)	11 (11.6)	2 (15.4)	5 (21.7)	24 (13.3)
Varicose	0 (0)	0 (0)	0 (0)	0 (0)	2 (1.1)
Not available	15 (57.7)	83 (87.4)	10 (76.9)	17 (73.9)	152 (84.4)
Microbiology, n (%)					
Aspergillus	9 (34.6)	4 (4.2)	2 (15.4)	4 (17.4)	24 (13.3)
Acinetobacter	2 (7.7)	1 (1.1)	1 (7.7)	0 (0)	3 (1.7)
E. coli	0 (0)	1 (1.1)	0 (0)	0 (0)	3 (1.7)
H. influenzae	2 (7.7)	11 (11.6)	5 (38.5)	7 (30.4)	16 (8.9)
H. parainfluenzae	0 (0)	0 (0)	0 (0)	2 (8.7)	3 (1.7)
K. pneumoniae	0 (0)	0 (0)	1 (7.7)	1 (4.3)	4 (2.2)
M. catarrhalis	2 (7.7)	3 (3.2)	1 (7.7)	1 (4.3)	5 (2.8)
P. aeruginosa	15 (57.7)	17 (17.9)	8 (61.5)	11 (47.8)	41 (22.8)
S. aureus	0 (0)	2 (2.1)	1 (7.7)	2 (8.7)	8 (4.4)
S. pneumoniae	2 (7.7)	2 (2.1)	3 (23.1)	2 (8.7)	4 (2.2)
Has the patient ever grown *Pseudomonas*?, n (%)					
Yes	15 (57.5)	17 (17.9)	8 (61.5)	11 (47.8)	41 (22.8)
No	6 (23.1)	43 (45.3)	3 (23.1)	9 (39.1)	83 (46.1)
Not available	5 (19.2)	35 (36.8)	2 (15.4)	3 (13)	56 (31.1)
Clinical features, n (%)					
Cough	26 (100)	85 (89.5)	11 (84.6)	21 (91.3)	165 (91.7)
Sputum Production	25 (96.2)	66 (69.5)	12 (92.3)	20 (87)	130 (72.2)
Hemoptysis	6 (23.1)	24 (25.3)	3 (23.1)	8 (34.8)	71 (39.4)
Fever	15 (57.7)	41 (43.2)	8 (61.5)	9 (39.1)	93 (51.7)
Dyspnea	20 (76.9)	63 (66.3)	9 (69.2)	11 (47.8)	120 (66.7)
Clubbing	3 (11.5)	0 (0)	1 (7.7)	0 (0)	7 (3.9)
Wheezing	15 (57.7)	37 (38.9)	6 (46.2)	7 (30.4)	72 (40)
Not available	0 (0)	1 (1.1)	0 (0)	0 (0)	2 (1.1)
Complications, n (%)					
Pneumonia	5 (19.2)	20 (21.1)	1 (7.7)	6 (26.1)	33 (18.3)
Empyema	0 (0)	1 (1.1)	1 (7.7)	0 (0)	3 (1.7)
Lung abscess	1 (3.8)	0 (0)	0 (0)	0 (0)	3 (1.7)
Respiratory Failure	3 (11.5)	7 (7.4)	2 (15.4)	2 (8.7)	27 (15)
Cor pulmonale	0 (0)	2 (2.1)	0 (0)	0 (0)	7 (3.9)
Pneumothorax	0 (0)	1 (1.1)	0 (0)	0 (0)	6 (3.3)
Hemoptysis	6 (23.1)	15 (15.8)	3 (23.1)	6 (26.1)	44 (24.4)

Pseudomonas (n=247) groups. Compared to the non-*Pseudomonas* group, the group with *Pseudomonas* has a significantly higher number of exacerbations (p=0.015). There is also a difference in certain clinical characteristics between patients with post-TB bronchiectasis and patients with non-TB bronchiectasis, and we have been published earlier in our research letter [22]. Significantly more (p<0.05) upper lobe involvement and residual fibrosis and lesser *P. aeruginosa* and *H. influenzae* growth were seen in post-TB patients. Hemoptysis and hospitalization for bronchiectasis (at least once) were also observed significantly more frequently in post-TB patients. Furthermore, forced expiratory volume in 1 second and forced vital capacity were significantly reduced in patients with post-TB bronchiectasis; however, no significant difference was noted between the two groups when comparing obstructive and restrictive impairment on spirometry [22].

Discussion

Limited data is available regarding non-CF bronchiectasis in developing countries, therefore, collecting various data on this disease in these regions is necessary as it is likely to affect treatment and outcomes [6]. Our study, consistent with the previous studies, represented that the majority of patients were females (n=192; 56.5%) and were over the age of 60 (n=152; 44.7%) [2,8,23]. However, it varies from the findings of a similar study conducted in Pakistan by Sharif *et al*., where a major fraction of the patients were males and below 60 years of age [8]. The reason for this difference is the conservative nature of culture in Pakistan. The study by Sharif et al. was conducted in a government hospital, while our study was conducted in AKUH, which is a private hospital. Although government hospitals are more affordable, women are more comfortable visiting private hospitals, while men prefer more affordable care, which can be seen in our study [8]. Similarly, private hospitals, according to general opinion, are thought of as more reliable and of a higher standard; hence, the majority of people prefer consulting these for the elderly population to take no chances. Clinical features present in the patients showed that cough was the most frequently present symptom in 311 (91.5%) patients. Daily sputum production was noted in 255 (75%) patients, and the frequency of both these features was similar to studies done previously in the region [8,9]. In terms of the spirometry pattern, data was not available in 244 (71.8%) of our patients due to the retrospective nature of our study. Among the patients in whom spirometry was performed, 54 (58.1%) patients had an obstructive pattern. This pattern is also reflected in studies of Dimakou *et al*. (Greece), Dhar *et al.* (India), and Pasteur *et al.* (UK) [2,7,9].This was followed by restrictive impairment, which was present in 36 (38.7%) of the patients. In our study, TB was the most common cause of bronchiectasis, responsible for 52.94% (n=180) of the total cases. Given that Pakistan has been ranked the 5th highest TB burden country in the world according to the World Health Organization TB Report of 2021, it is not surprising to find TB as the most common cause in our study [24].

Other studies done within the region also show TB as the most common cause of bronchiectasis [8,9]. However, the proportion of post-TB bronchiectasis in our study was even higher than the data published from India and another study from Pakistan [8,9]. This calls for investigating potential delays in TB diagnosis and non-com-

Table 3. Comparison between Pseudomonas and non-Pseudomonas groups.

Variable	*Pseudomonas* n=93 (%)	Non-*Pseudomonas* n=147 (%)	p
Respiratory failure	14 (15.1)	27 (10.9)	0.350
Empyema	2 (2.2)	3 (1.2)	0.617
Lung abscess	2 (2.2)	3 (1.2)	0.617
Cor pulmonale	3 (3.2)	6 (2.4)	0.709
Pneumothorax	1 (1.1)	6 (2.4)	0.679
Hemoptysis	26 (28)	49 (19.8)	0.108
Pneumonia	21 (22.6)	44 (17.8)	0.319
Major hemoptysis requiring hospital admission	13 (14)	16 (6.5)	0.069
Number of hospital admissions for respiratory infections last year	0.438		
0	63 (67.7)	101 (68.7)	
1	18 (19.4)	33 (22.5)	
2	10 (10.8)	8 (5.4)	
3	2 (2.1)	5 (3.4)	
Number of exacerbations last year	0.015*		
0	35 (37.6)	83 (56.5)	
1	26 (28.0)	38 (25.8)	
2	18 (19.3)	17 (11.6)	
3	9 (9.7)	6 (4.1)	
4	3 (3.2)	0 (0.0)	
5	2 (2.2)	3 (2.0)	
Duration of symptoms	0.061		
<1 year	5 (5.4)	24 (16.3)	
1-5 years	47 (50.5)	71 (48.3)	
6-10 years	24 (25.8)	23 (15.7)	
>10 years	17 (18.3)	29 (19.7)	

*Chi-squared test was done to determine if there was any statistically significant difference among groups, and a p-value of less than 0.05 was considered significant.

pliance of TB therapy in patients as a reason for the increased incidence of bronchiectasis and rectifying any shortcomings.

ABPA was the 3rd most common cause, responsible for 7.64% (n=26). Similar to the patients with post-TB bronchiectasis, most of the patients were more than 60 years old. This percentage is similar to previous studies where it is responsible for 3.3 to 5.6% of the bronchiectasis. Similarly, 27.94% of the cases were idiopathic, falling within the range of 18-55% as seen in prior data [8,9,25]. Our results also demonstrate that irrespective of etiology, the number of patients with bronchiectasis increases with increasing age, a pattern that is consistent with other studies [11,26,27].

Clinical features, disease severity, and effect on lung function vary with different bacteria. *P. aeruginosa* was the most commonly isolated organism in our study. This is extremely concerning as *P. aeruginosa* infections have been associated with worse pulmonary function, greater disease spread (involvement of the lung), and poor quality of life [28,29]. This might be prevented with better measures for infection control along with improved empirical and definitive treatment regimens [18]. There was a significant difference (p=0.016) between the number of exacerbations in a year in patients with *Pseudomonas versus* those without *Pseudomonas*, with patients with *Pseudomonas* having more frequent exacerbations (n=54; 58.1%) compared to non-*Pseudomona*s patients (n=112; 45.3%). It has also been noted previously that the growth of *P. aeruginosa* in patients presenting with an acute exacerbation of bronchiectasis is significantly associated with a higher number of hospital admissions in a year [30]. This can be one of the reasons why culturing *P. aeruginosa* is associated with an increased risk of mortality [5,18]. Incorporating findings of previous studies linking *P. aeruginosa* to a higher risk of mortality, we can deduce that different etiologies of bronchiectasis carry a different risk of mortality [5]. In light of the findings in our study, we would like to suggest that in a developing country like Pakistan, where risk factors for mortality like *P. aeruginosa* growth and great extent of lung involvement are high, there should be regular follow-ups in clinics to ensure a better quality of life and survival.

HRCT scans showed bilateral lung involvement in 63.2% of the patients in our study, which means at least two lobes were affected in these patients. According to previous studies, the number of lobes affected and the extent of bronchiectasis are significantly associated with an increased risk of mortality [17-19]. Since we could only note the lateralization (unilateral or bilateral) and whether upper, middle, or lower lobes were involved separately and not together (*e.g.*, RUL or LLL), we were unable to calculate the exact number of lobes. This was because actual HRCT scan films of all patients were not available, so they could not be crosschecked; hence, we had to rely on the findings noted in the patient files. However, since the majority of our subjects had bilateral involvement, it indicates an increased risk for mortality and an increasing need to follow up on these patients.

Our study highlighted hemoptysis as the most frequent complication (n=75; 22.1%), followed by pneumonia (n=65; 19.1%). Both of these complications were most pronounced in cases that had a post-TB etiology; 41 (12.1%) patients developed respiratory failure as a complication of bronchiectasis. These complications are similar to previous study findings as done by Sharif *et al.* which also had hemoptysis as the most frequent complication [8].

Our study, however, has some limitations. This study was designed to retrospectively analyze patients presenting to a single tertiary care hospital. Therefore, the results of the patients from the catchment population may not be representative of the entire population. Due to financial constraints reflecting within the backdrop of an LMIC such as Pakistan, a large number of patients were unable to afford an HRCT scan, which is the gold standard of diagnosis for bronchiectasis. With this limitation, some patients were diagnosed with bronchiectasis mentioned in the ICD-9 using only chest X-rays accompanied by clinical diagnosis. These patients were not recorded in our study as they did not meet the selection criteria hence significantly reducing the study population.

The retrospective nature of the study meant that we were unable to closely follow the progression of disease and patients' clinical features in detail or follow patients' progress after discharge to check mortality rates. Additionally, some patient records of sputum cultures and pulmonary function tests were not available and could not be compensated for because of the retrospective analysis. Furthermore, the standard tests done in bronchiectasis patients to determine etiology, like immunoglobulin subtypes, sputum culture, workup for CTD, *etc.,* were not done in all patients. Another point to note was that since sputum cultures were mostly done when patients presented with exacerbations, we were not able to tell if these patients were colonizers of these organisms or not.

Therefore, in order to evaluate and attempt to improve the dogma with which non-CF bronchiectasis patients are diagnosed, followed, and managed, further studies need to be conducted that are prospective in nature and involve a larger sample population through a multi-center collaborative approach. As seen with other diseases and the success of national and international registries of bronchiectasis, our study aims to pave the way towards the development of a bronchiectasis registry in Pakistan through data-sharing alliances and collaborative partnerships.

Conclusions

In conclusion, our study points out both similarities and differences compared to data from previous studies. One important difference was that post-TB bronchiectasis was the most common etiology seen in non-CF bronchiectasis patients, which can be explained by Pakistan being the 5th highest TB burden country in the world. *P. aeruginosa* was the most commonly isolated organism, and a significant difference (p<0.001) was seen in *P. aeruginosa* growth between different etiologies. Moreover, the majority of the patients showed bilateral lung involvement in our study. Considering *P. aeruginosa* growth and the high extent of lung involvement have been associated with poor prognosis and higher mortality risk, we suggest that in developing countries like Pakistan, better measures for infection control, improved empirical and definitive treatment regimens, and regular clinic follow-ups should be ensured to improve the quality of life and survival of patients. The high incidence of post-TB bronchiectasis also calls for investigating non-compliance with TB therapy as a reason for the increased incidence of bronchiectasis. We also suggest that further studies need to be conducted that are prospective in nature and involve a larger sample population through a multi-center collaborative approach.

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