

Effect of sputum bacteriology on the quality of life of patients with bronchiectasis

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Effect of sputum bacteriology on the quality of life of patients with bronchiectasis. C.B. Wilson, P.W. Jones, C.J. O'Leary, D.M. Hansell, P.J. Cole, R. Wilson. ©ERS Journals Ltd 1997.

ABSTRACT: Bronchiectatic patients have impaired health-related quality of life (QoL) and are prone to chronic lower respiratory tract infections. We have investigated whether impaired QoL is related to sputum bacteriology.

Eighty seven patients with non-cystic fibrosis (non-CF) bronchiectasis, in a stable phase of their illness, completed three QoL measures, underwent a computed tomography (CT) scan and lung function tests, and provided a fresh sputum sample for microscopy and culture.

The QoL of patients colonized by *Pseudomonas aeruginosa* (*Pa* group) was significantly worse than all other patients grouped together (non-*Pa* group), and specifically those infected by *Haemophilus influenzae* (*Hi* group) or who had no bacterial growth (NG group) ($p < 0.05$), but not those infected by other bacterial species (O group). The *Pa* group had worse lung function, but no significant differences were found between the groups for forced expiratory volume in one second (FEV₁) and peak expiratory flow rate. The *Pa* group had significantly worse bronchiectasis scores than the O, NG and non-*Pa* groups, but not the *Hi* group. There were no significant differences between the groups with respect to the number of infective exacerbations in the last year, but the *Pa* group had significantly more hospital admissions. Patients infected by *P. aeruginosa* for more than 3 yrs had significantly worse FEV₁ ($p < 0.03$) and bronchiectasis scores ($p < 0.05$) than those infected with *P. aeruginosa* for less time, but not significantly worse QoL.

We conclude that, overall, patients infected with *P. aeruginosa* have worse quality of life, and that *P. aeruginosa* is associated with a greater extent of disease and worse lung function. Although patients infected with *H. influenzae* had extensive bronchiectasis their quality of life was better than the *P. aeruginosa* infected group. *Eur Respir J* 1997; 10: 1754–1760.

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Patients with bronchiectasis suffer from chronic cough and sputum production, and are predisposed to recurrent or chronic lower respiratory tract infections. Although several studies conducted over the past 50 yrs have suggested that the longevity of this population has increased and that their prognosis is good [1–4], the disease can produce significant morbidity, which may be partly due to recurrent or chronic bacterial infection [5]. The bacteria most commonly isolated from the sputum and bronchial secretions of bronchiectatic patients include uncapsulated, nontypable *Haemophilus influenzae*, *Streptococcus pneumoniae*, *Moraxella catarrhalis*, and non-mucoid and mucoid *Pseudomonas aeruginosa* [6, 7].

The type of bacterial infection may be an important determinant of the patient's prognosis. For example, colonization by *P. aeruginosa* is thought to be involved in the deterioration of pulmonary function and respiratory failure that ultimately leads to almost all deaths in cystic fibrosis (CF) patients [8–11].

In the non-CF bronchiectasis population, it has also been suggested that *P. aeruginosa* is associated with

extensive lung disease and severe airflow obstruction [12], and that decline in lung function is faster in those colonized by *P. aeruginosa* than those colonized by other organisms [13]. However, other authors have not found *P. aeruginosa* infection to be associated with clinical deterioration in CF [14], and more clinical studies both in CF and non-CF bronchiectasis are needed, because a cause and effect relationship between *P. aeruginosa* and deterioration in health has not so far been proven.

Studies have tended to focus on clinical findings rather than the patient's perception of their own health. Although clinical measures, such as lung function scores, may provide important information to clinicians, and may affect prognosis, they are usually poorly correlated with functional capacity and health-related quality of life (QoL) [15–17]. The purpose of the present study was to examine the relationship between bacterial infection and impaired QoL in a non-CF bronchiectasis population in a stable phase of their illness, and to determine whether certain bacterial species are associated with a greater impairment of QoL. Specifically, we wanted to

investigate whether patients colonized with *P. aeruginosa* had significantly worse QoL, and, if so, was this related to a greater impairment of pulmonary function, a greater extent of disease as measured by high resolution computed tomography (CT), and/or a greater frequency of infective exacerbations and hospital admissions compared with patients who had no bacterial infection or who were infected with other bacterial species. In addition, we compared patients who had been colonized by *P. aeruginosa* for ≤ 3 yrs to those that had been colonized by *P. aeruginosa* for >3 yrs, and patients who were on long-term antibiotics to those who were not.

Materials and methods

One hundred and twenty patients with bronchiectasis diagnosed clinically and by CT scan were approached over a 4 month period to participate in this prospective study in the Host Defence Unit out-patient clinics at the Royal Brompton Hospital, a tertiary referral centre. Of these, nine patients refused to participate and 24 were excluded because of an exacerbation within the preceding 6 weeks.

Study population

The remaining 87 patients (49 females and 38 males) were recruited into the study. Their mean age was 54 ± 13 (range 23–77) yrs. The population covered a wide spectrum of disease severity, as measured by CT scan, medical history, and clinical and physiological assessments.

Aetiologies included: idiopathic 63%; allergic bronchopulmonary aspergillosis 9%; hypogammaglobulinaemia 7%; postinfective (defined as chronic cough and sputum production directly following pneumonia in childhood, *e.g.* whooping cough or measles; or following adult tuberculosis or pneumonia where bronchiectasis was predominantly localized to the area affected by the illness) 10%; primary ciliary dyskinesia or Young's Syndrome 8%; and association with inflammatory bowel disease 2%. All patients had a normal sweat test. Ten patients had previously undergone surgery to remove bronchiectatic lung but had residual bronchiectasis; five patients had coexisting emphysema, and one patient had mild pulmonary fibrosis by CT scan criteria, but in all cases bronchiectasis was the predominant pathology.

Study protocol

In order to be enrolled in the study, patients had to have been free of severe exacerbations of their symptoms during the preceding 6 weeks, although some patients were chronically unwell. On the day of testing, each of the 87 patients completed three QoL measures: the St George's Respiratory Questionnaire (SGRQ) [18], the SF-36 Health Survey Questionnaire, UK Version (SF-36) [19], and a 14-item Fatigue Scale [20]. The questionnaires were presented to the patients in a randomized order. Each patient also performed comprehensive lung function tests, which included measurement of arterial blood gas values by earlobe sampling, and provided a fresh sputum sample for microscopy and culture. In addition, the patients were asked to report the number of infective exacerbations which had required

a course of antibiotics, and hospital admissions that they had experienced over the past year.

QoL measures

The aim of QoL measures is to quantify the impact of disease on daily life and well-being in a standardized manner for a given population. Both general and disease-specific QoL measures, including the ones used in our study, have been validated for patients with respiratory conditions.

The SGRQ is a disease-specific measure containing 76 weighted responses divided into three domains: Symptoms, Activity and Impacts. Component scores, ranging 0–100, are calculated for each domain, as well as a total score summarizing the responses to all items.

The SF-36 is a general measure with 36 items covering functional status, well-being, and overall evaluation of health. The responses can be summarized into two component scores, the physical component summary (PCS) and the mental component summary (MCS).

The Fatigue Scale consists of eight items covering physical aspects of fatigue and six items covering mental aspects of fatigue.

All three measures are self-administered. Poor QoL is indicated by a higher score on the SGRQ and the Fatigue Scale, and a lower score on the SF-36.

CT scan

A recent high resolution CT scan of 80 of the patients was assessed and scored by the same consultant pulmonary radiologist, who was blinded to all other details concerning the patient. Six scans were unavailable for scoring and these patients were excluded from all analyses involving CT scores. Each lobe of both lungs was graded for bronchiectatic changes on a 0–3 scale (the lingula was scored as a separate lobe), giving a maximum of 18 points: 0 = no bronchiectasis; 1 = one or less than one bronchopulmonary segment involved; 2 = more than one bronchopulmonary segment involved; 3 = gross cystic bronchiectasis. This scoring system has been used in previous studies and is associated with low interobserver variation [21, 22]. In order to adjust the scores of those patients who had had lobectomies, the bronchiectasis score was calculated as the sum of all points divided by the maximum points available for the individual and multiplied by 100. Thus, if one lobe had been resected, that individual had a maximum of 15 points available.

Statistical analysis

Summary results are presented as mean \pm standard deviation (SD). The Kruskal-Wallis test and Mann-Whitney U-test were used to compare characteristics between different groups of patients. All correlational analyses were performed using the Spearman Rho-test. Multiple linear regression analysis was performed to evaluate individual contributions of the different clinical parameters (independent variables) to the QoL scores (dependent variables). Statistical significance was accepted at a *p*-value of less than 0.05, unless otherwise stated.

Table 1. – Component and total scores of the St George's Respiratory Questionnaire, the SF-36, and the Fatigue Scale for the five different groups

	<i>Pa</i> gp (n=22)	<i>Hi</i> gp (n=17)	O gp (n=15)	NG gp (n=33)	Non- <i>Pa</i> gp (n=65)	p-value*
SGRQ Symptom	80.2±11.1	66.3±20.3	73.9±16.7	66.8±23.4	68.3±21.1	0.1
SGRQ Activity	65.0±18.8 ⁺	39.9±22.6	50.7±22.6	40.4±21.7	42.6±22.2	0.001
SGRQ Impacts	43.9±16.7 ⁺	27.5±24.3	42.0±24.3 ^{†‡}	27.0±16.1	30.6±19.4	0.004
SGRQ Total	56.3±14.4 ⁺	37.7±17.0	50.0±19.7 ^{†‡}	37.7±16.8	40.5±18.0	0.001
SF-36PCS	32.4±9.3 ⁺	45.2±9.8	34.1±11.3 [§]	40.2±9.5	40.1±10.6	0.002
SF-36MCS	45.3±10.1	51.1±9.5	50.8±10.6	49.9±9.5	50.4±9.6	0.2
Fatigue Physical	6.0±1.8 ⁺	3.5±3.0	4.3±2.7	4.4±2.2	4.1±2.5	0.03
Fatigue Mental	2.4±2.1	1.9±1.7	2.8±2.2	1.7±1.7	2.1±1.9	0.3
Fatigue Total	7.9±3.3	5.5±4.2	7.1±4.7	6.1±3.4	6.1±3.9	0.2

Values are presented as mean±SD. Higher score on SGRQ and fatigue scale = worse quality of life, lower score on the SF-36 = worse quality of life. *Pa*: *Pseudomonas aeruginosa*; *Hi*: *Haemophilus influenzae*; O: other species; NG: no bacterial growth; Non-*Pa*: all patients who did not culture *Pa* grouped together; gp: group; SGRQ: St George's Respiratory Questionnaire; PCS: physical component summary; MCS: mental component summary. *: comparison of the *Pa*, *Hi*, O and NG groups; ⁺: p<0.01, vs *Hi*, NG and non-*Pa*; [†]: p<0.05, vs *Hi*; [‡]: p<0.02, vs NG; [§]: p<0.01, vs *Hi*.

Results

Patients were grouped according to the results of their sputum cultures. Thirty three patients had no bacterial growth (NG group) at the time of testing, *P. aeruginosa* was cultured from 22 patients (*Pa* Group) (19 with a mucoid strain), *H. influenzae* was cultured from 17 patients (*Hi* group), and other species were cultured from 15 patients (O group) who were grouped together because of low individual numbers. The O group consisted of *Staphylococcus aureus* (n=4), *M. catarrhalis* (n=3), *S. pneumoniae* (n=5), and coliforms (n=3). Statistical comparisons were made between each of the individual groups, and between the *Pa* group and all other patients who did not grow *P. aeruginosa* (non-*Pa* group) combined. There were no significant differences in age or sex among the five groups.

QoL questionnaires

The scores of the QoL questionnaires from the five groups are summarized in table 1. Comparative analyses of these results showed that, overall, the *Pa* group had significantly worse scores on the SGRQ Activity, Impacts, and Total scores, and the physical components of the SF-36 and the Fatigue Scale, than the *Hi*, NG, and non-*Pa* groups. There were no differences between the groups with respect to the SGRQ Symptom score, the MCS score of SF-36 and the mental component and total scores of the Fatigue Scale (p-values >0.05). There were no significant differences between the *Pa* group

and the O group on any of the QoL measures. Additionally, the O group scored significantly worse than the *Hi* group and the NG group on the Impacts component and the Total scores of the SGRQ, and significantly worse than the *Hi* group on the PCS score of the SF-36.

To assess whether any of the individual organisms had significantly greater impaired QoL in the O group, additional comparative analyses were performed separately within this group. The only significant differences found between any of the four species were between the *M. catarrhalis* group and the *S. aureus* group with respect to the PCS score of the SF-36 and the Impacts component score and Total score of the SGRQ, with *M. catarrhalis* group having the worse scores (p<0.05). When the *M. catarrhalis* group was removed from the O group, there were still no significant differences on the QoL measures between the O group and the *Pa* group. However, the power of this particular analysis was low because of the small numbers.

Lung function

Results from the lung function measures of the different bacterial groups are summarized in table 2. Overall, the *Pa* group had the worse score on all the measures, although no significant differences were found between the groups with respect to any of the measurements performed (p-values >0.05) including forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), peak expiratory flow rate (PEFR), residual volume (RV),

Table 2. – Results from the lung function tests for the five different groups

	<i>Pa</i> gp	<i>Hi</i> gp	O gp	NG gp	Non- <i>Pa</i> gp	p-value*
FEV ₁ % pred	55±22	62±18	70±33	66±33	66±29	0.5
FVC % pred	79±22	82±18	93±21	91±25	89±22	0.1
PEFR % pred	80±26	80±28	92±34	87±33	86±32	0.8
RV % pred	160±63	138±42	136±47	130±37	134±40	0.3
VA % pred	74±18	78±15	84±16	86±18	83±16	0.1
<i>P</i> _a O ₂ kPa	9.4±1.6	10.0±1.2	10.4±1.2	10.7±1.2	10.5±1.2	0.06

Values are presented as mean±SD. FEV₁: forced expiratory volume in one second; FVC: forced vital capacity; PEFR: peak expiratory flow rate; RV: residual volume; VA: alveolar volume; *P*_aO₂: arterial oxygen tension. *: comparison of the *Pa*, *Hi*, O and NG groups. For further definitions see legend to table 1.

alveolar volume (V_A), and arterial oxygen tension (Pa_{a,O_2}) by earlobe sampling. The percentage of patients with Pa_{a,O_2} measures below 10.0 kPa for each of the individual groups were: *Pa* group 61%; *Hi* group 43%; *O* group 40%; and *NG* group 18%. Analysis showed this distribution to be significant (Chi-squared=8.6; $p < 0.03$) indicating that there was a significant association between bacteriology and whether a patient's Pa_{a,O_2} level fell below 10.0 kPa.

Correlation analyses performed between the different lung function measures and the three QoL questionnaires showed no significant associations with RV, whilst FEV₁, FVC, and PEFR correlated significantly with only the SGRQ Activity score (rho values= -0.232, -0.231, and -0.223, respectively; $p < 0.05$). V_A and Pa_{a,O_2} correlated significantly with the Activity and Total scores of the SGRQ (rho = -0.271 to -0.331; $p < 0.01$). In addition, Pa_{a,O_2} was significantly associated with the Impacts component of the SGRQ (rho = -0.295; $p = 0.01$) and V_A correlated significantly with the Symptoms component of the SGRQ (rho = -0.251; $p < 0.02$) and the PCS score of the SF-36 (rho = 0.284; $p < 0.01$). None of the measures correlated significantly with the Fatigue Scale. The QoL scores of the five patients with coexisting emphysema were not significantly different from those without, suggesting that this condition had no additional effect on the QoL of those patients.

CT scan bronchiectasis scores

The CT bronchiectasis scores for the study population ranged 6–94%, with a median score of 44%. Comparative analyses between each of the different bacterial groups showed the *Pa* group to have significantly worse bronchiectasis scores than the *O*, *NG*, and non-*Pa* groups ($p < 0.001$) (fig. 1). In addition, the *Hi* group also had significantly worse CT scan bronchiectasis scores than the *O* group ($p < 0.03$) and the *NG* group ($p < 0.04$).

In order to assess whether extent of disease was associated with poor QoL, correlations were performed

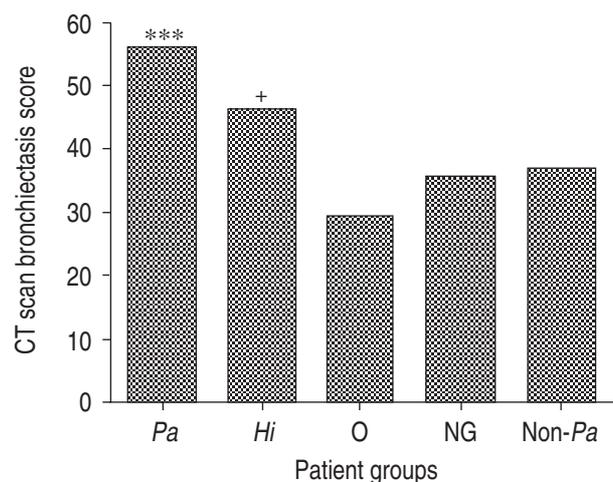


Fig. 1. – Comparative analyses showing the effect of bacteriology on the extent of bronchiectasis as measured by high resolution computed tomography (CT) scanning. Six results were missing as the CT scan was not available for review. ***: $p < 0.001$, vs *O*, *NG* and non-*Pa*; +: $p < 0.03$, vs *O*, and $p < 0.04$, vs *NG*. For definitions see legend to table 1.

between each of the three QoL measures and the CT scan bronchiectasis scores of the patients. The only statistically significant association found with extent of bronchiectasis was with the SGRQ Activity component (rho = 0.241; $p < 0.04$). No other associations were found with any of the other component or total scores. Lung resection had no effect on the QoL results.

Infective exacerbations and hospital admissions

The mean number of infective exacerbations and mean number of hospital admissions that the patients from each of the bacterial groups reported experiencing over the past 12 months are displayed in figure 2. There were no significant differences in the number of infective exacerbations between the five groups. However, the *Pa* group had significantly more hospital admissions in the past 12 months than the *Hi*, and non-*Pa* groups (p -values < 0.01) and *NG* group ($p < 0.001$).

There were significant correlations between the number of infective exacerbations and all of the component scores of the three QoL measures (rho values = 0.264–0.398; p -values ≤ 0.01) except for the mental component of the Fatigue Scale (rho = 0.161; $p > 0.05$). The number of hospital admissions only correlated significantly with the Impacts and Total scores of the SGRQ (rho = 0.230 and 0.222, respectively; $p < 0.05$), not with the SF-36 or the Fatigue Scale.

Duration of P. aeruginosa colonization

Comparative analyses were performed within the *Pa* group alone to determine whether the length of time a patient had been colonized by *P. aeruginosa* affected any of the clinical measures or QoL. All 22 patients from whom a *P. aeruginosa* culture was obtained on the day of testing were chronically colonized with the bacterium, having cultured *P. aeruginosa* from three separate sputum samples over a period of more than 3 months.

For purposes of the analyses, the patients were divided into two groups. Seven of the patients, who had been

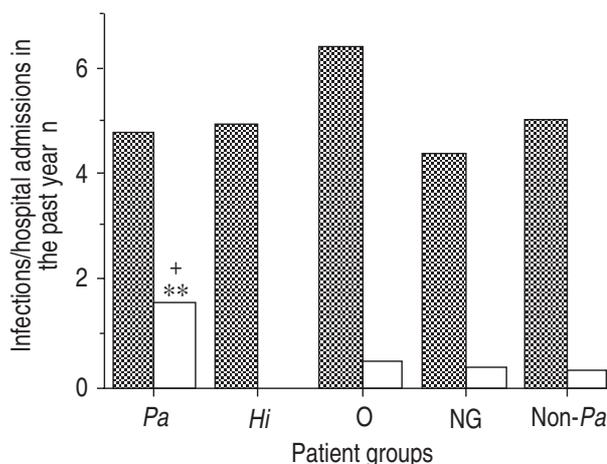


Fig. 2. – Comparative analyses showing the effect of bacteriology on the number of infective exacerbations and number of hospital admissions that the patient reported experiencing over the past year. ▨ : infections; □ : hospital admissions. **: $p < 0.01$, *Hi* and non-*Pa*; +: $p < 0.02$, vs *NG*. For definitions see legend to table 1

colonized with *P. aeruginosa* for 3 yrs or less (≤ 3 group), were compared to the other 15 who had been colonized for over 3 yrs (> 3 group). There was no significant difference in the QoL of the two groups, although the > 3 group had consistently worse scores. In analysing the clinical measures, the only significant differences found between the two groups were with respect to their FEV1 values (≤ 3 group 70% predicted, > 3 group 48% pred; $p < 0.03$) and their CT scan bronchiectasis scores (≤ 3 group 44%, > 3 group 63%; $p < 0.05$), with the > 3 group having significantly worse scores in both cases.

Antibiotics

None of the patients in the NG or *Hi* groups were receiving antibiotics at the time of testing. In the *Pa* group, seven patients were receiving long-term nebulized antibiotics, seven were taking long-term oral antibiotics, and eight were not receiving any antibiotics at the time of testing. In the O group, eight patients were receiving long-term oral antibiotics and seven were not receiving any antibiotics at the time of testing.

In order to assess whether the QoL of patients receiving long-term antibiotic therapy differed from that of those not receiving antibiotics, the patients from the *Pa* and O groups were divided into three groups: those on long-term oral antibiotics ($n=15$); those on long-term nebulized antibiotics ($n=7$); and those not on any antibiotics ($n=15$). There were no significant differences found between the three groups with respect to any of the QoL scores.

Multivariate analysis

The univariate analyses showed that individual clinical measures correlated with the QoL scores of this population. To examine the interactions and contributions of these factors on QoL, a multivariate analysis was performed with the SGRQ scores as the dependent variable. The combined effect of bacteriology, number of infections experienced over the previous year, and P_{a,O_2} on each of the SGRQ scores is presented in table 3.

The number of infections was the dominant covariate with the SGRQ Symptom score, but a significant proportion of this domain was also associated with P_{a,O_2} . Bacteriology had no additional effect. All three covariates contributed significantly to the variance of the SGRQ Activity score, although bacteriology was the dominant correlate. The number of infections and bacteriology

accounted for similar, significant proportions of the variance of the SGRQ Impact score, while P_{a,O_2} made no additional contribution in the presence of the other two covariates in this model. The SGRQ Total score correlated significantly with all three measures of disease activity, but the number of infections experienced over the previous year was the dominant covariate.

Discussion

The QoL for bronchiectasis patients colonized by *P. aeruginosa* was significantly worse than for patients who were not (table 1). There were significant differences between patients colonized by *P. aeruginosa* and those who were colonized by *H. influenzae* or from whom no bacteria were cultured at the time of testing, but not patients who were colonized by other bacteria (*S. aureus*, *M. catarrhalis*, *S. pneumoniae* and coliforms). Clinical studies of the effect of lung infections in CF and non-CF bronchiectasis have focused on what happens to the patient after colonization by *P. aeruginosa*, or have compared those infected by *P. aeruginosa* to those that are infected by other organisms grouped together [8, 10, 11, 13, 14, 23]. Our study suggests that this way of examining a study population may not give a complete picture, and that bacteria other than *P. aeruginosa* are associated with poor QoL. Conversely, the fact that the QoL of the *Hi* group was the same, or sometimes better, than the NG group suggests that infection by certain bacterial species, such as *H. influenzae*, does not necessarily impair QoL. This is not to suggest that infection by *H. influenzae* may not have an effect on other parameters of disease activity, since we have shown that CT scan bronchiectasis scores are similar in patients infected either by *P. aeruginosa* or *H. influenzae*, and the frequency of exacerbations was the same in the two groups.

The *Pa* group had the worst lung function scores of the five groups on all measures, although no significant differences were found between the various groups (table 2). Our results revealed no significant differences between the *Pa* group and the *Hi* group, even though the *Hi* group had a significantly better QoL. Furthermore, contrary to the study by EVANS *et al.* [13], we found no significant differences in FEV1, FVC, and PEFr between the *Pa* group and the non-*Pa* group, or between the *Pa* group and the NG group. Our results are similar to studies in chronic obstructive pulmonary disease (COPD) in finding a weak correlation between QoL and spirometry and PEFr [15–17]. The present study suggests that V_A and P_{a,O_2} may be better markers of impaired QoL in this population.

Although we did not examine rate of decline of lung function in the present patients, those colonized by *P. aeruginosa* for more than 3 yrs had significantly worse FEV1 compared to those colonized for less time. However, since, overall, the *Pa* group had lung function measures that did not

Table 3. – Analysis of variance (ANOVA) table for four multivariate models examining the summative contributions of bacteriology, number of infections, and P_{a,O_2} to the SGRQ component scores and Total score

Source	DF	Symptoms		Activity		Impacts		Total	
		SS	p-value	SS	p-value	Ss	p-value	SS	p-value
Infections	1	4068	0.001	2677	0.02	2279	0.007	2672	0.002
Bacteriology	3	1127	0.34	4223	0.03	2897	0.03	2645	0.02
P_{a,O_2}	1	1777	0.02	2379	0.02	1142	0.053	1580	0.01
Residual	69	29592		39090		26673		23923	
Adjusted r^2			0.19		0.23		0.24		0.29

P_{a,O_2} : arterial oxygen tension by earlobe sampling; SGRQ: St George's Respiratory Questionnaire; DF: degrees of freedom; SS: sum of squares.

differ significantly from other bacterial species, our results do not support the contention that colonization by *P. aeruginosa* necessarily causes a rapid decline in lung function [13]. Results from a large, longitudinal study by KEREM *et al.* [14] in CF patients also suggested that although colonization by *P. aeruginosa* is associated with some decrease in FEV₁, it does not cause sudden deterioration in pulmonary function. EVANS *et al.* [13] found that bronchiectatic patients may already have worse lung function at the time of *P. aeruginosa* infection, suggesting that *P. aeruginosa* infection is a marker of poor lung function rather than the cause.

A previous study by our group suggested that patients chronically infected by *P. aeruginosa* had disease of greater severity on CT scanning compared to those infected with other organisms [12]. In the present study, the *Pa* group had significantly worse bronchiectasis than the non-*Pa* group (fig. 1). However, when we compared the individual groups, we found no significant difference between the *Pa* group and the *Hi* group, despite the *Pa* group having significantly worse QoL. No significant correlations were found between QoL and extent of disease measured by high resolution CT scanning. This suggests that the extent of disease, as measured by CT scanning, is not a good direct predictor of QoL in this population. High resolution CT scanning is the imaging technique of choice for diagnosis of bronchiectasis [24, 25], but our findings question whether clinical criteria can be used to select patients in whom the investigation should be repeated to assess disease progression. Since prevention of disease progression should be a major aim of all treatment strategies, these results suggest that scans should be repeated at intervals in all bronchiectatic patients to assess progression. A balance must be struck between the useful information that could be gained and exposure to radiation.

The number of infective exacerbations was shown to correlate significantly with QoL, but when we compared this parameter between the five groups we found no significant differences (fig. 2). It would appear from the data in table 3 that infective exacerbations exert an independent influence on the impairment of QoL in this population, whatever the sputum microbiology. It must be noted that the patients were asked to report this number, so the answers depended, to a large extent, on the patients' memory and their interpretation of an infective exacerbation. In order to reduce the effect of the patients' interpretation, we asked patients to record only those exacerbations requiring a course of antibiotics. However, it cannot be assumed that a lower number of exacerbations over the past 12 months equated to fewer days of feeling unwell. Whilst some patients reported exacerbations lasting up to 6 weeks, others reported several exacerbations that only lasted a couple of days.

When the number of hospital admissions was compared between the five groups, the *Pa* group was found to have significantly more admissions than the *Hi*, NG and non-*Pa* groups (fig. 2). This may be due to resistance of *P. aeruginosa* to oral antibiotics, thus requiring more frequent admission of the patient to hospital for treatment with intravenous antibiotics. Since hospital admissions would directly affect and disrupt the patient's daily life, it should follow that they play a role in the impairment of QoL. However, we found that hos-

pital admissions did not correlate with QoL as strongly as the number of infections. A possible explanation for this may be that hospital admissions occurred less frequently during the period covered in the questionnaires, since only patients in a relatively stable phase of their disease were enrolled. If a patient had had six exacerbations but only one hospital admission during the previous year, the number of exacerbations would probably have a greater effect on his/her QoL.

Treatment of bronchiectasis should be directed towards reduction of the severity and frequency of acute exacerbations, limitation of the impact of the disease on the patient's life, and prevention of disease progression. Patients in the *Pa* or O groups had worse scores on many of the components of the QoL measures, and many were also receiving long-term oral or nebulized antibiotics. Long-term antibiotic therapy is used in bronchiectasis to suppress bacterial growth, thus improving symptoms and reducing the incidence of exacerbations in patients in whom these are frequent, and in those patients whose sputum quickly becomes purulent again after treatment [5, 26]. We found no evidence to suggest that QoL was improved by long-term antibiotics. It is likely that administration of long-term antibiotics was initiated because of poor QoL. However, since we have no data on the QoL of these patients prior to commencing on long-term antibiotic therapy, we can make no assessment of the overall efficacy of this therapeutic strategy.

The present study has highlighted some important issues concerning the assessment of bronchiectatic patients and the QoL of this population. It emphasized the importance of how populations are grouped for comparison. Our results comparing the *Pa* group to the non-*Pa* group showed significant differences between these two populations. However, when the non-*Pa* group was broken down into individual groups, the differences did not always remain. Patients in the O group were shown to have similar scores on the QoL measures to the *Pa* group, and although the QoL results of the *Hi* group were better than the *Pa* group, the CT scan bronchiectasis scores and lung function results were similar for these two groups.

However, the *Pa* group was always worse, whichever clinical measure was compared. Although the differences did not always reach significance, it may be the composite effect of many different factors that leads to the poorer QoL of patients infected by *P. aeruginosa*. The large number of toxins and virulence factors produced by *P. aeruginosa*, which interfere with host defence mechanisms, may contribute to the persistence of the bacterium in the bronchial tree, as has been suggested previously [27, 28], but this does not cause a rapid deterioration in non-CF bronchiectatic patients. Chronic infection stimulates an inflammatory response [7], which could influence QoL *via* cytokine production or other mechanisms.

The results also emphasize the complexity of QoL and demonstrate that measures such as lung function and CT scanning are limited in their ability to predict QoL of bronchiectatic patients. The number of infections a patient experienced over the previous year, bacteriology and, to a lesser extent, *Pa*:O₂, were shown to be strong correlates of QoL, yet even these measures of

disease activity accounted for less than 30% (table 3) of the total variance of the SGRQ Total score. A QoL assessment should be included when assessing any treatment of chronic airways infection to supplement the information gained from standard clinical measures.

Finally, this study has highlighted the need for a longitudinal, prospective study of this population which charts their improvements and deteriorations over time in order to obtain a more accurate picture of their quality of life and what influences it. It is only by such a study that the role of *Pseudomonas aeruginosa* in causing or accelerating deterioration in structure, function and quality of life can be determined accurately.

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