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Idiopathic Pulmonary Fibrosis in the United Kingdom: Analysis of the British Thoracic Society Electronic Registry between 2013 and 2019

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Abstract

Idiopathic pulmonary fibrosis (IPF) is a chronic, progressive and terminal interstitial lung disease (ILD) with a median survival of 3-5 years. The British Thoracic Society (BTS) established the UK IPF Registry in 2013 as a platform to collect data on clinical characteristics, treatments and outcomes for this cohort in the UK.

Between 1st January 2013 and 31st October 2019, 2,474 cases were registered. Most patients were male (79%) with a mean (SD) age of 74±8.3 and 66% were ex-smokers. Over time we observed an increase in the number of patients aged over 70. However, we have not seen a trend towards earlier presentation as symptoms of breathless and/or cough were present for more than 12 months in 63% of the cohort. At presentation, mean (SD) percent predicted FVC was 78.2±18.3, median 76.2 (IQR 65.8,88.2) and TLco 48.4±16.0, median 47.5 (IQR 37.3, 57.4). Most cases were discussed at an ILD multi-disciplinary meeting, with an increase over this time in the number of cases reported as having possible UIP pattern on HRCT thorax. We noted a reduction in the number of patients undergoing surgical lung biopsy or bronchoalveolar lavage. Although more patients were prescribed anti-fibrotic therapies from 2013 to 2019, 43% were ineligible for treatment based upon NICE prescribing criteria. Hypertension, ischaemic heart disease, diabetes mellitus and gastro-oesophageal reflux were the most common co-morbidities.

In conclusion, we have presented baseline demographics as well as diagnostic and treatment strategies from the largest single-country IPF registry, reflecting changes in UK practices over this period.

Introduction

Idiopathic pulmonary fibrosis (IPF) is a chronic, progressive lung disease characterised by the excessive deposition of extracellular matrix (ECM) in the interstitium, which ultimately leads to respiratory failure and death. Median survival is only three to five years(1, 2). Although there are no curative therapies for IPF, there have been considerable treatment

advances during the last 6 years. The anti-fibrotic therapies, nintedanib and pirfenidone, slow disease progression and improve survival(3-7). However, studies report that treatment-associated adverse events limit tolerability and lead to drug discontinuation in 26% of patients(8). This suggests there is a need for more tolerable and efficacious therapies. Currently, several novel treatments are being evaluated in phase III clinical trials.

To improve the quality of life for patients with IPF, the National Institute of Health and Care Excellence (NICE) developed clinical guidelines(9) and quality standards(10) for the diagnosis and management of suspected IPF. In particular, a set of prioritised statements was designed to drive measurable quality improvements in patient care. It includes diagnosis by a multidisciplinary team meeting (MDM), managing symptoms and palliative care. The guidelines are supported by NICE technical appraisals for the anti-fibrotic therapies pirfenidone(11) and nintedanib(12), which led to the implementation of specific prescribing criteria for these treatments in the UK.

Over the last decade, there has been a significant increase in the incidence and prevalence of IPF worldwide(13). Analysis of GP databases estimate that there are 6000 new cases/year and more than 32,000 patients living with IPF in the UK(14). With IPF accounting for 1 in 100 deaths in the UK and increasing rates of hospital admissions worldwide, it is becoming a major health concern(15-17). However, these data may not truly reflect the disease burden and utilisation of healthcare resources in the UK.

In order to provide the appropriate clinical services and treatments for this patient cohort, there is an urgent need for more representative, “real world” data concerning the incidence and prevalence of IPF in the UK. To address this, the British Thoracic Society (BTS) established a national electronic registry for patients with IPF. The UK IPF Registry enables the collection of longitudinal data on patient demographics, diagnostic investigations including lung biopsy, lung function, treatments and outcome with the long term aims to:

1) obtain a better understanding of the burden of disease, clinical characteristics and the disease course in the UK population;

2) provide information that will allow clinicians to improve patient pathways and make more informed decisions on best management strategies;

3) evaluate the impact of any changes in practice on key outcome measures such as hospitalisations and mortality;

4) facilitate research in an uncommon disease entity from a large patient population with a broad spectrum of disease severity and comorbidities.

The UK IPF Registry is funded by the British Thoracic Society. In addition, a grant from the Healthcare Quality Improvement Partnership (HQIP) (2012-2014) contributed to the initial development of the Registry and financial assistance was provided by Boehringer Ingelheim and InterMune for the enhancement of the data collection software in 2014.

We present a review of baseline data collected over the first 6 years of the UK IPF Registry and results of a survey of the participating hospital sites in the UK.

Methods

The UK IPF Registry was launched on 1st February 2013 and permitted data collection from 1st January 2013. Ethical approval was obtained (NRES reference: 12/EE/0381 and renewal 17/EE/0346). The Registry is voluntary and open to all respiratory physicians in the UK. All patients diagnosed with definite or probable IPF, in accordance with ATS/ERS/JRS/ALAT clinical practice guideline(18, 19), can be enrolled in the Registry provided that written consent has been obtained. Data including age, smoking history, duration of symptoms, pattern of interstitial lung disease (ILD) (usual interstitial pneumonia (UIP), possible UIP, or inconsistent with UIP) on thoracic high-resolution computed tomography (HRCT) scan and lung biopsy (UIP, probable UIP, possible UIP, or inconsistent with UIP) are collected at baseline. In addition, lung function (forced expiratory volume in 1 second (FEV1), forced vital

capacity (FVC), total diffusion capacity for carbon monoxide (TLco) and transfer coefficient (Kco)), 6 minute walk test (6MWT), treatments, hospitalisations and outcomes are collected at baseline and at least every 12 months. Data may be included both prospectively and retrospectively, and throughout this paper 'calendar years' refer to the year of the first clinic visit for each patient. The data are entered into a bespoke web-based platform by the hospital teams (details can be found at https://www.brit-thoracic.org.uk/quality-improvement/lung-disease-registries/bts-ild-registry/). All patient identifiable data are encrypted at the time of submission to the secure BTS database. Baseline data collected by 46 hospitals out of the 64 sites participating in the BTS Lung Disease Registry Programme (Appendix 1) up to 31st October 2019 have been analysed. As not all data sets were complete, data have been presented as percentages, rather than number of patients, where applicable. All percentages have been rounded to the nearest whole number, therefore rounding errors may result in total percentages not being equal to 100%. Descriptive statistics have been used to summarise the demographic and clinical characteristics at enrolment to the UK IPF Registry. Statistical analysis was performed using either the one-way analysis of variance (ANOVA) with Kruskall Wallis or two-way ANOVA with Bonferroni correction as indicated. Data have been censored up to 31st October 2019.

Prior to 2019 the UK IPF Registry was unable to collect data pertaining to the majority of NICE Quality Standards for IPF(10). Therefore, where additional information was required, a supplementary survey (Appendix 2) was sent to all the hospitals participating in the UK IPF Registry in 2017.

The complete dataset can be accessed only by the BTS ILD Registry team, whilst individual participating sites have access to their own data at any time. Initial reviews of earlier data sets have been presented at an international conference (20).

Results

Between 1st January 2013 and 31st October 2019, 2,474 incident cases of IPF were enrolled on the Registry. The Registry includes data on over 300 patients per calendar year since 2014, with 2019 data incomplete (Table 1). Most patients were male (79%) with a mean (SD) age of 74±8.3 years, median 74 (IQR 68, 79) (with a range of 43 to 97). Over the 6.5 years of data collection, the proportion of patients aged >70 years has increased from 59% in 2013 to 80% in 2019, p>0.05 (Supplemental Table S1). As shown in Table 1, the majority were ex-smokers (66%) whilst a few patients were current smokers (4%). Information regarding first degree relative with IPF has been collected from 2013. Our results suggest that 5% of patients have at least one first degree relative with IPF.

Patients had a mean (SD) of 1.8±1.2 reported co-morbidities, median 2 (IQR 1, 3), with a range of 0 to 7 per patient. One or more co-morbidities were reported in more than 80% of patients (Table 1). The most common co-morbidities were hypertension (34%), ischaemic heart disease (21%), diabetes mellitus (20%) and gastro-oesophageal reflux (18%) (Figure 1). Co-existing COPD was only reported in 6% of patients. Of note, 12% of patients did not report any co-morbidities.

The majority of patients (66**%**) had experienced symptoms of exertional dyspnoea and/or cough for more than 12 months (Table 2). Few patients (9**%**) had symptoms for less than 6 months whilst 40% had symptoms for more than 24 months. Over the 6 years, we have not observed any change in the proportion of patients presenting earlier (p>0.05). At presentation, mean (SD) percent predicted FVC was 78.2±18.3, median 76.2 (IQR 65.8, 88.2) and TLco 48.4±16.0, median 47.5 (IQR 37.3, 57.4). Serial data show little change in FVC but there is a trend towards lower gas transfer at initial presentation, which was not statistically significant (p>0.05) (Table 3 and Supplemental Table S2). At time of enrolment to the Registry, the distribution of GAP stage was I (35%), II (55%) and III (10%). As shown in Table 1, we have observed a decrease in the proportion of patients in GAP stage I (45% in 2013 compared to 30% in 2019) and an increase in those in GAP stage II (48% in 2013 compared to 64% in 2019). Where oxygen saturation at rest (on room air) was recorded, 3%

of patients had SpO2<88%, 28% of patients had 88-94%, and 69% of patients had ≥95% (data not shown). Although 74% of patients were felt able to perform a 6MWT, only about a third of patients (638/1812) completed the investigation at baseline. Of those who completed the 6MWT, 327 individuals walked ≥300 metres whilst 147 patients walked < 150 metres (data not shown).

The ATS/ERS/JRS/ALAT clinical practice guideline(6) and NICE IPF diagnosis and management guideline(9) advocate MDM assessment for diagnosis of IPF. The majority (89%) of cases diagnosed as IPF had been discussed at an ILD MDM (data not shown). Based on HRCT, patients were identified as having a diagnosis of definite UIP pattern in 44% of cases, possible UIP in 50% and findings inconsistent with UIP in 4% in accordance with the ATS/ERS/JRS/ALAT 2011 consensus statement(18). Over time, we observed a slight increase in the proportion of patients being classified with possible UIP ($p>0.05$) and a comparable decrease in those with definite UIP pattern on HRCT ($p>0.05$) (Table 4). More importantly, our data show a reduction in the number of patients undergoing a diagnostic surgical lung biopsy from 16% in 2013 to 3% in 2018, which was not statistically significant ($p=0.42$) (Table 5). Of those who had a lung biopsy, 88% had either UIP or probable UIP histology (Table 4). Unclassifiable fibrosis was diagnosed in a small proportion (4%) of this cohort. A similar decline in the proportion of patients undergoing bronchoalveolar lavage (12% in 2013 compared to 4% in 2018, $p=0.43$) has also been noted (Table 5).

In England and Wales, NICE has established specific treatment criteria for IPF and anti-fibrotic therapies can be used in patients with FVC 50-80% predicted(11, 12). From our data, only 57% of patients are eligible for anti-fibrotic therapy (data not shown). In particular 38% of those patients currently ineligible for anti-fibrotic therapy have a FVC>80% (data not shown). Our data show an increased use of anti-fibrotic therapies from 2013 to 2019 (Table 6). Furthermore, there has been an increase in use of nintedanib between 2016 and 2019, which was not statistically significant ($p=0.42$). In total, 44% of the cohort has received anti-fibrotic therapies (data not shown) but this is less than the 57% of patients who fulfill

eligibility criteria for these treatments. At first clinic visit 3% of patients with IPF (53 out of 1809) were referred for lung transplant and 63% were deemed unsuitable. Of those referred at first clinic visit, 7 patients were recorded as having received a transplant, either initially or at follow up (follow up data were available for 43% of patients referred for transplant at first clinic visit).

In terms of supportive therapies, 21% of patients with IPF were receiving supplemental oxygen therapy, including short burst, ambulatory and continuous oxygen (Table 6). We have observed an increase in the assessment and referral for pulmonary rehabilitation from 55% in 2013 to 84% in 2019, p=0.42. Data have been collected on referral to palliative care since 2017, with 62% of patients referred for palliative care services at first clinic visit. In late 2019 the UK IPF Registry dataset were updated to capture assessment of palliative care needs.

The UK IPF Registry dataset was initially designed before the NICE Quality Standards for IPF (10) were published, and questions were updated in late 2019 to ensure information was captured against each standard. In June 2017 a survey was circulated to the 52 participating sites, collecting information which was not available through the Registry at that time. Responses were collected from 15 sites (29%), with 74% reporting a specialist nurse was 'always' or 'sometimes' present at the ILD clinic. Additionally, 73% of sites reported having nurse-led ILD clinics.

From data censored to 31st October 2019**,** the median survival was 496.5 days (ranging from 16 days to 3940 days) and mortality rate 10%. IPF disease progression or acute exacerbation accounted for 55% of deaths (Figure 2). Although 1% of patients had concomitant lung cancer at time of presentation, this was associated with a worse prognosis and accounted for 3% of all IPF deaths.

Discussion

Patient registries offer a unique opportunity to collect longitudinal data in uncommon diseases, such as IPF. They may help to identify specific clinical phenotypes, understand current practices in diagnosis and treatment stratification, ultimately leading to a more personalised medicine approach to individual patient care. Over the 6 years since it was established, the UK IPF Registry has collected baseline clinical data on over 2,400 patients, which is the largest single-country IPF registry reported to date. Unlike clinical trials, which exclude patients based upon lung function impairment, co-morbidities and concurrent mediations, this retrospective analysis provides a more "real world" overview of patients with IPF in the UK.

Our baseline demographics are similar to other reported registries(5, 19, 21-26) as well as the inclusion criteria for the ASCEND(3) and INPULSIS(4) clinical trials with patients being predominantly male, over the age of 60 years and ex-smokers. However, our mean (SD) age at enrolment is higher than that reported by a number of worldwide registries (67-71±8 years)(5, 19-25) but comparable to the FinnishIPF Registry (73±9.0 years)(27). This may be explained, in part, by an increase in the number and proportion of individuals aged 79 years or more diagnosed with IPF in our Registry. It may also reflect delays in presentation to primary care, referral to a respiratory physician or diagnosis as approximately 40% of patients had symptoms for at least 2 years at time of inclusion to the UK IPF Registry. Delays in diagnosis may arise due to lack of awareness regarding IPF(28), misdiagnosis with another respiratory disorder, as well as the complexities of the diagnostic pathway for IPF(29), although these cannot be evaluated using our Registry data.

The baseline lung function is analogous to that reported in the AIPFR(5), PROOF(22), SEPAR(26) and EMPIRE(24) registries as well as the INPULSIS study(4). Although the gas transfer measurement was comparable, the mean FVC reported in our Registry was higher than that from the eurIPFreg(23), IPF-PRO(19) and ASCEND study(3). Moreover, our cumulative data show that whilst the percent predicted FVC at inclusion is relatively unchanged, the TLco value has reduced. From our data, the higher FVC and lower gas

transfer values cannot be explained by an increase in the proportion of patients with co-existing emphysema. It may reflect more severe pulmonary fibrosis as supported by an increase in the proportion of patients in GAP stage II or more over this time. But other factors, such as pulmonary hypertension, can contribute to a reduction in gas transfer. However, Registry data concerning the presence of pulmonary hypertension are insufficient to draw any conclusions. Only a third of patients had performed a 6MWT at time of enrolment to the Registry. Given the limited data, we are unable to interpret these results. The Registry does not collect information about why the 6MWT was not performed. It may be due to lack of resources for testing and/or patient choice.

We identified a family history of IPF in less than 10% of cases, which is similar to that reported by the FinnishIPF(27), SEPAR(26) and PROOF(22) registries. However, a higher percentage of an affected first degree relative has been observed in other registries(5, 23).

Data from patient registries have confirmed the presence of co-morbidities in IPF and their association with poorer quality of life(30). Our findings show that the majority of patients with IPF have a mean of 1.8 co-morbidities. The most prevalent co-morbidities were cardiovascular, including hypertension and ischaemic heart disease, and gastro-oesophageal reflux disease. These results are similar to those from the AIPFR(5), PROOF(22), eurIPFreg(23) and INSIGHTS(21) IPF registries. In contrast, the prevalence of diabetes mellitus was greater (38%) in the FinnishIPF Registry(27) versus 15-22% as described by BTS, as well as European and Australian registries(5, 21-23, 26). These co-morbidities were collected at time of enrolment to the UK IPF Registry and longitudinal data are required to determine their impact on treatment strategies, hospitalisations and mortality.

Our results demonstrate that the majority of patients had symptoms of exertional breathlessness and/or cough for 12 months or more, prior to diagnosis and enrolment on the UK IPF Registry. Similar findings have been reported by other registries, such as eurIPFreg where the average time between the onset of symptoms and diagnosis of IPF was 21.8 months(23). Determining the time from onset of symptoms to diagnosis of IPF can be

confounded by several factors. It is well recognised that there may be a prolonged period, up to 4-5 years, between symptom onset and diagnosis(31). In addition, patients may be at different stages in their disease course at the time of enrolment and it may be difficult to ascertain precisely when their symptoms first started. Although patients may have been diagnosed with IPF by local physicians prior to referral to a specialist ILD centre, the time taken to refer to an ILD service can be very variable. Overall 90% of Registry cases were submitted from specialist centres, where patient referral may be delayed until the FVC is within the treatment criteria defined by NICE. Hence the date of assessment or MDM is unlikely to be equivalent to the date of diagnosis. Furthermore, we have not observed an increase in the proportion of patients presenting with shorter symptom duration over the course of the UK IPF Registry. This suggests that there is a need for education and raising awareness about the condition to promote earlier diagnosis, especially amongst primary care physicians who frequently undertake the initial patient assessment.

The gold standard for diagnosis of IPF is MDM(6), however not all patients were reviewed at MDM. This may reflect that patients can be enrolled by secondary care teams without evaluation in a specialist centre MDM. In comparison to other registries, the UK IPF Registry has a higher number of cases being reviewed at MDM. This difference may be due to easier access to a specialist ILD MDM as the majority of the patients were enrolled from ILD centres who have regular MDMs. In comparison, limited access to local ILD multi-disciplinary meeting was a major concern for the Australian IPF Registry who implemented a central MDM review to overcome this barrier(5).

Since the UK IPF Registry was established, there has been an update to the clinical practice guidelines(32), which reflects changes in the radiological diagnostic criteria for IPF(33). However, the data presented have been collected using the previous ATS/ERS/JRS/ALAT guideline(18). They show an increase in the number of cases reported with a possible UIP pattern on thoracic HRCT scan over this time. As the Registry does not independently evaluate the thoracic HRCT scans, these results suggest an increased awareness of the

spectrum of radiological characteristics and clinical predictors of IPF(33, 34) amongst ILD physicians and MDM in the UK. From late 2019 onwards, the UK IPF Registry dataset was modified to reflect the newer clinical practice guidelines(32).

In the setting of possible UIP pattern pulmonary fibrosis, the clinical guideline advises lung biopsy provided there are no contra-indications. Despite these recommendations, the surgical lung biopsy rate (<10%) was lower than the 20-30% reported by the IPF-PRO, PROOF, FinnishIPF, AIPFR and Swedish IPF registries(5, 19, 22, 25, 27). Furthermore, we observed a reduction in surgical lung biopsy rates over this time. This could not be explained by an increase in bronchoalveolar lavage or use of cryobiopsy as this was not routinely available at most enrolling sites. A similar decline in open or thoracoscopic lung biopsy procedures has been observed by the eurIPFreg(23). The UK IPF Registry does not collect information as to why investigations such as surgical lung biopsy or BAL were not performed. We speculate that the decline in lung biopsy indicates a growing awareness and recognition of the risk of acute exacerbation and progression of pulmonary fibrosis associated with the procedure(35) amongst specialist ILD MDMs in the UK. In addition, the rates of bronchoscopy and analysis of bronchoalveolar lavage fluid (BALF) vary widely across registries, with analysis of BALF conducted in 85% of patients in eurIPFreg(23), 62% of patients in INSIGHTS-IPF(21), about 20% of patients in AIPFR(5) and 10% of patients in the IPF-PRO Registry(19). This is in contrast to the lower number of bronchoalveolar lavage (4%) reported here. Although bronchoscopy is available at most UK IPF Registry enrolling sites, not all services can provide differential cell count analysis of the BALF. Furthermore, other factors such as co-morbidities, patient and/or physician preference may influence a lower uptake of bronchoscopy in the diagnostic pathway for IPF in the UK.

Over the duration of the UK IPF Registry, there has been an increase in the use of anti-fibrotic therapies at time of enrolment supporting a change in patient management. Our data also show differences in prescribing practice which likely reflects the availability of these therapies in the UK as pirfenidone was first approved for IPF in 2013(11) but it was not until

2016 when access to nintedanib was granted by NICE(12). Of note, not all eligible patients with IPF were receiving anti-fibrotic therapy. This may be due to several reasons including patient choice and contraindications to treatment. As only specialist ILD centres can prescribe anti-fibrotic therapies in England and Wales, any eligible patients enrolled by secondary care sites will not have access to these treatments until they are reviewed at a prescribing centre.

The UK IPF Registry confirmed that many patients are receiving supportive care. Approximately a quarter of patients have supplemental oxygen therapy at baseline, which is similar to that reported in the IPF-PRO Registry(19). This has not significantly changed over the 6 years of the Registry. However, the observed increase use of pulmonary rehabilitation may reflect implementation of NICE Quality Standards for IPF(10) as well as the accumulating evidence that pulmonary rehabilitation improves quality of life and symptoms in patients with IPF(36). As reported by other registries, the proportion of patients assessed and listed for lung transplantation remains small(19, 23). Given the stringent suitability criteria, lung transplantation is only an option for a highly selected cohort of IPF patients.

The published registries have confirmed the high mortality associated with IPF. In support of this, the eurIPFreg reported a mortality rate of 38% during the follow up period(23), the INSIGHTS-IPF Registry reported that 26.7% of patients died during follow up(30) and 15% of patients died within 30 months as detailed by the IPF-PRO Registry(19). Advanced age and worse lung function (FVC and TLco) have consistently been shown to be predictors of mortality in IPF registries(19). A more recent analysis of data from 662 patients in the IPF-PRO Registry demonstrated that use of supplemental oxygen at rest was the strongest predictor of mortality over a follow-up period of 30 months(19). Compared to other registries, the mortality rate reported here is lower. It is unlikely to be a true representation of IPF mortality in the UK as the survival data are incomplete. Longitudinal follow up data are required for a more precise assessment of mortality. Hence we are not able to draw

specific conclusions about IPF related mortality in the UK in comparison to other worldwide registries.

The UK IPF Registry dataset has been modified in order to capture information relating to the NICE Quality Standards for IPF.

There are several limitations to these data, in particular incomplete data sets. In order to address this, the data have been presented as percentages and absolute numbers of patients shown where applicable.

In conclusion, we have reported the largest single-country IPF cohort that may provide insights in the phenotypes and natural course of the disease as well as changes in the clinical management of these patients. Our results have identified key changes in the diagnostic evaluation of patients with suspected IPF in the UK between 2013 and 2019 suggesting a better understanding of the clinical and radiological predictors of IPF. We have also observed vital improvements in patient care. How these changes will impact longer-term outcomes such as hospitalisation and survival, as well as informing development of healthcare policies, remains to be determined. In addition, our findings have highlighted critical areas to target for research, especially the need for earlier diagnosis. Longitudinal data are essential to achieve these aims of the Registry. However ongoing challenges remain, in particular how to maintain the quality and completeness of the Registry data, which present both resourcing and administrative challenges.

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grant from AstraZeneca; fees for consulting from Chiesi Pharma AB; fees for lectures and consulting, and costs for attending and international conference from Boehringer-Ingelheim; fees for lectures and consulting from Novartis; fees for lectures from Mundipharma; fees for consulting from GlaxoSmithKline; fees for lectures and consulting from Orion Pharma; and fees for consulting from SanofiGenzyme, all outside the submitted work. Conflict of interest: K. Koli has nothing to disclose. Conflict of interest: T. Vahlberg has nothing to disclose. Conflict of interest: M. Myllarniemi has nothing to disclose.
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Figure Legends

Figure 1: Co-morbidities in patients with IPF

Data presented are the reported patient co-morbidities (% of patients) up to 31st October 2019. Over 200 separate conditions were listed under ”other co-morbidities“ including osteoarthritis, hypothyroidism, several cardiac disorders (the most common included aortic stenosis, atrial fibrillation and cardiomyopathy), and a number of cancers (the most common included prostate, skin, breast, bladder, bowel and colon cancer).

Figure 2: Cause of death in patients with IPF

Data presented are the reported cause of death (% of patients) up to 31st October 2019. Twenty separate causes of death were listed under “other” including a number of cancers (lung, bladder, prostate and stomach cancer), multi-organ failure and sepsis. In 30 cases, the cause of death was not known.

Figure 1

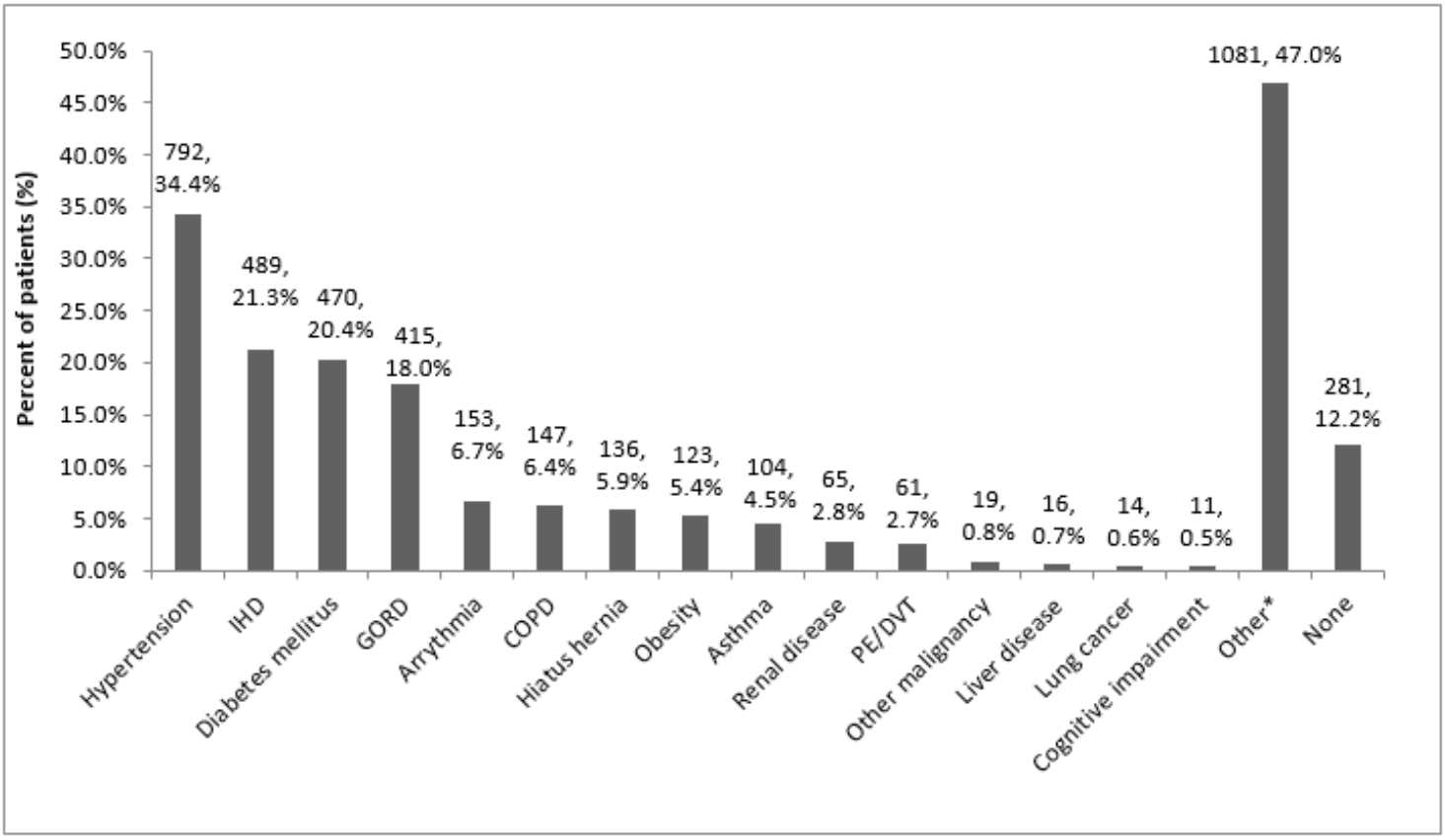
Percent of patients (%)
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
792, 34.4%
489, 21.3%
470, 20.4%
415, 18.0%
153, 6.7%
147, 6.4%
136, 5.9%
123, 5.4%
104, 4.5%
65, 2.8%
61, 2.7%
19, 0.8%
16, 0.7%
14, 0.6%
11, 0.5%
1081, 47.0%
281, 12.2%
Hypertension
IHD
Diabetes mellitus
GORD
Arrythmia
COPD
Hiatus hernia
Obesity
Asthma
Renal disease
PE/DVT
Other malignancy
Liver disease
Lung cancer
Cognitive impairment
Other*
None

Figure 2:

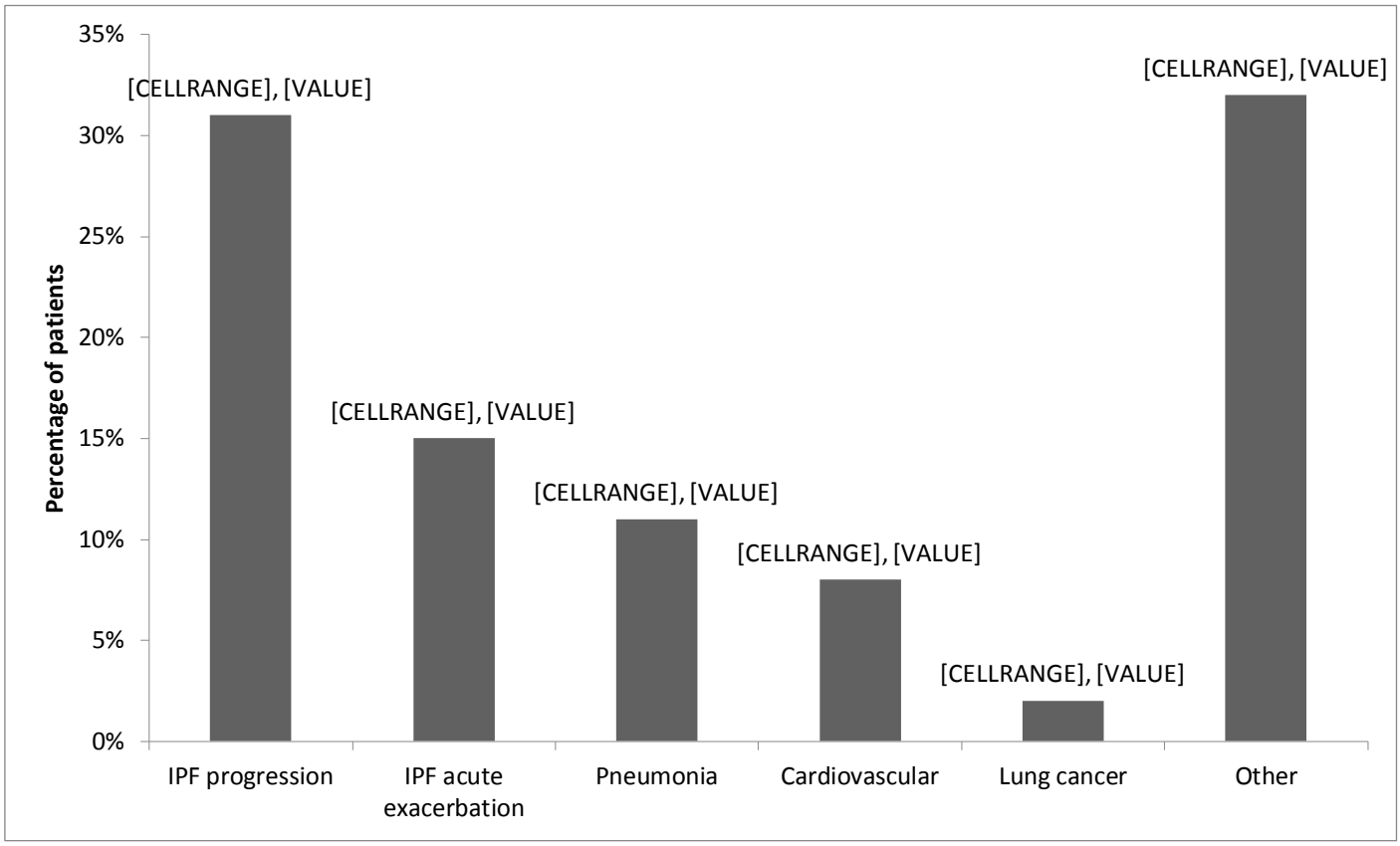
35%
30%
25%
20%
15%
10%
5%
0%
Percentage of patients
[CELLRANGE], [VALUE]
[CELLRANGE], [VALUE]
[CELLRANGE], [VALUE]
[CELLRANGE], [VALUE]
[CELLRANGE], [VALUE]
[CELLRANGE], [VALUE]
IPF progression
IPF acute exacerbation
Pneumonia
Cardiovascular
Lung cancer
Other

Table 1: Baseline patient demographics

Year of first clinic visit	Number of patients enrolled	Age (years) (mean ±SD)	Male (%)	Ex-smokers (%)	Current smokers (%)	Patients with at least one co-morbidity (%)	First degree relative with IPF (%)	GAP staging (%)		
								I	II	III
Unknown	167	69 ±8.2	77	68	6	89	6	45	48	7
2013	160	71 ±8.7	79	68	7	83	6	42	50	9
2014	357	72 ±8.7	75	65	5	82	5	37	50	12
2015	414	73 ±8.4	78	66	3	81	5	36	53	12
2016	322	74 ±7.5	77	65	3	89	6	33	59	7
2017	382	74 ±7.9	81	63	3	89	4	31	61	8
2018	455	75 ±7.4	83	69	3	87	4	35	54	12
2019 (to 31/10/19)	217	76 ±7.7	77	62	1	82	5	30	64	6

Table 2: Symptom duration

Data shown represent percentage of patients (number of patients) for each year

Year	< 6 months	6-12 months	12-24 months	> 24 months	No symptoms	Not known
Unknown	40% (21)	13% (7)	6% (3)	25% (13)	6% (3)	11% (6)
2013	15% (24)	20% (32)	26% (41)	34% (54)	1% (2)	4% (6)
2014	9% (32)	15% (53)	27% (96)	46% (163)	1% (2)	3% (10)
2015	8% (32)	22% (89)	22% (90)	44% (180)	2% (6)	4% (16)
2016	8% (27)	25% (79)	22% (71)	38% (122)	4% (13)	3% (10)
2017	8% (31)	24% (89)	21% (80)	43% (161)	2% (6)	3% (11)
2018	6% (28)	22% (97)	25% (110)	39% (172)	3% (11)	5% (23)
2019 (to 31/10/19)	11% (21)*	26% (50)*	24% (47)*	34% (66)*	0% (0)*	6% (12)

* $p>0.05$ comparing the results by year for each symptom duration was calculated using the two way ANOVA with Bonferroni correction. Cases where the year of presentation was unknown were excluded.

Table 3: Proportion of patients with lung function based upon FVC and TLco

Data shown represent percentage of patients (number of patients)

Year	FVC <50%	FVC 50-80%	FVC>80%	TLco<36%	TLco 36-55%	TLco>55%
Unknown	2% (1)	64% (30)	34% (16)	8% (4)	48% (23)	44% (21)
2013	5% (7)	52% (73)	41% (58)	15% (19)	52% (65)	32% (40)
2014	4% (10)	60% (165)	37% (101)	25% (59)	47% (109)	28% (65)
2015	5% (17)	50% (173)	45% (154)	25% (68)	46% (124)	29% (78)
2016	2% (5)	64% (178)	35% (97)	18% (40)	55% (121)	28% (61)
2017	4% (11)	56% (149)	39% (103)	19% (37)	52% (103)	29% (57)
2018	2% (6)	60% (198)	38% (125)	27% (62)	42% (98)	32% (74)
2019 (to 31/10/19)	1% (1)*	64% (53)*	35% (29)*	23% (16)**	54% (38)**	24% (17)**

* p >0.05 comparing the results by year for % predicted FVC distribution was calculated using the two way ANOVA with Bonferroni correction. Cases where the year of presentation was unknown were excluded.

** p >0.05 comparing the results by year for % predicted TLco was calculated using the two way ANOVA with Bonferroni correction. Cases where the year of presentation was unknown were excluded.

Table 4: IPF Diagnostic Criteria (percentage of patients)

	HRCT pattern			Histological pattern			
Year	Definite UIP (%)	Possible UIP (%)	Inconsistent with UIP (%)	UIP (%)	Probable UIP (%)	Possible UIP (%)	Unclassifiable fibrosis (%)
Unknown	38.0	56.0	6.0	72.7	27.3	0.0	0.0
2013	51.1	41.7	7.2	68.2	27.3	4.5	0.0
2014	46.7	46.3	7.0	65.5	24.1	6.9	3.4
2015	40.1	55.6	4.3	70.3	8.1	10.8	10.8
2016	44.3	51.5	4.2	81.0	19.0	0.0	0.0
2017	45.5	52.4	2.0	75.0	8.3	16.7	0.0
2018	46.0	51.9	2.2	55.6	22.2	11.1	11.1
2019 (to 31/10/19)	46.8*	43.0*	10.1*	100.0**	0.0**	0.0**	0.0**

* $p > 0.05$ comparing the results by year for HRCT pattern was calculated using the two way ANOVA with Bonferroni correction. Cases where the year of presentation was unknown were excluded.

** $p > 0.05$ comparing the results by year for histological pattern was calculated using the two way ANOVA with Bonferroni correction. Cases where the year of presentation was unknown were excluded.

Table 5: Trends in diagnostic investigations

Data represent percentage of patients undergoing surgical lung biopsy and undergoing bronchoalveolar lavage

Year	Surgical Lung Biopsy (%)	Bronchoalveolar lavage (%)
Unknown	21.6	11.8
2013	16.1	11.9
2014	10.5	4.0
2015	11.2	2.2
2016	8.1	4.5
2017	5.1	3.9
2018	2.8	3.8
2019 (to 31/10/19)	1.2*	1.3*

* Comparing the proportion of patients undergoing surgical lung biopsy (p=0.42) and undergoing bronchoalveolar lavage (p=0.43) by year. Statistical analysis performed using the one-way ANOVA with Kruskall Wallis. Cases where the year of presentation was unknown were excluded.

Table 6: Treatments for IPF at first clinic visit (percentage of patients)

Year	Pirfenidone % (n)	Nintedanib % (n)	Refer for lung transplantation % (n)	Oxygen % (n)	Pulmonary rehabilitation (assessed and/or referred)** % (n)
Unknown	14% (7)	12% (6)	6% (3)	18% (9)	100% (4)
2013	28% (37)	4% (6)	4% (5)	22% (31)	55% (12)
2014	40% (111)	4% (10)	6% (17)	22% (62)	54% (21)
2015	33% (111)	13% (45)	4% (14)	22% (76)	46%(31)
2016	20% (57)	21% (59)	2% (5)	16% (45)	60% (75)
2017	15% (40)	30% (79)	2% (6)	16% (44)	77% (208)
2018	21% (66)	29% (93)	1% (2)	15% (48)	83% (281)
2019 (to 31/10/19)	29% (23)*	33% (26)*	1% (1)*	7% (6)*	84% (70)*

* p=0.42 comparing treatments at first clinic visit by year. Statistical analysis performed using the one-way ANOVA with Kruskall Wallis. Cases where the year of presentation was unknown were excluded.

** Pulmonary rehabilitation figures were only collected in this format from January 2017.

Figures are available from 2013 because records may be entered retrospectively.

Appendix 1: List of enrolling hospitals

England

Addenbrooke's Hospital, Cambridge University Hospitals NHS Foundation Trust
Birmingham Heartlands Hospital, Heart of England NHS Trust
Castle Hill Hospital, Hull and East Yorkshire Hospitals NHS Trust
Central Middlesex Hospital, London North West Healthcare NHS Foundation Trust
Cheltenham General Hospital, Gloucestershire Hospitals NHS Foundation Trust
Churchill Hospital, Oxford University Hospitals NHS Trust
City Hospital, Sandwell and West Birmingham NHS Trust
Countess of Chester Hospital, Countess of Chester Hospital NHS Foundation Trust
Croydon University City Hospital, Croydon Health Services NHS Trust
Darlington Memorial Hospital, County Durham and Darlington NHS Foundation Trust
Ealing Hospital, London North West Healthcare NHS Foundation Trust
George Eliot Hospital, George Eliot Hospital NHS Trust
Glenfield Hospital, University Hospitals of Leicester
Gloucestershire Royal Hospital, Gloucestershire Hospitals NHS Foundation Trust
Good Hope Hospital, Heart of England NHS Trust
Guy's Hospital, Guy's and St Thomas' NHS Foundation Trust
Hammersmith Hospital, Imperial College Healthcare NHS Trust
Harrogate District Hospital, Harrogate and District NHS Foundation Trust
Hinchingbrooke Hospital, Hinchingbrooke Health Care NHS Trust
King's College Hospital, King's College Hospital NHS Foundation Trust
King's Mill Hospital, Sherwood Forest Hospitals NHS Foundation Trust
Liverpool Heart & Chest Hospital, Liverpool Heart & Chest Hospital NHS Foundation Trust
Musgrove Park Hospital, Taunton & Somerset NHS Foundation Trust
New Cross Hospital, Royal Wolverhampton Hospitals NHS Trust
Norfolk and Norwich University Hospital, Norfolk & Norwich University Hospitals NHS Foundation Trust
North Devon District Hospital, Northern Devon Healthcare NHS Trust
Northern General Hospital, Sheffield Teaching Hospitals NHS Foundation Trust
North Middlesex University Hospital, North Middlesex University Hospital NHS Trust
Northwick Park Hospital, London North West Healthcare NHS Foundation Trust
Nottingham City Hospital, Nottingham University Hospitals NHS Trust
Papworth Hospital, Papworth Hospital NHS Foundation Trust
Peterborough City Hospital, Peterborough & Stamford Hospitals NHS Foundation Trust
Queen Alexandra Hospital, Portsmouth Hospitals NHS Trust
Queen Elizabeth Hospital, Gateshead Health NHS Foundation Trust
Royal Brompton Hospital, Royal Brompton and Harefield NHS Foundation Trust
Royal Derby Hospital, University Hospitals of Derby & Burton NHS Foundation Trust
Royal Devon and Exeter Hospital, Royal Devon & Exeter Foundation NHS Trust
Royal Free Hospital, Royal Free London NHS Foundation Trust
Royal Lancaster Infirmary, University Hospitals of Morecambe Bay NHS Foundation Trust
Royal Victoria Infirmary, Newcastle upon Tyne Hospitals NHS Foundation Trust
Russells Hall Hospital, The Dudley Group NHS Foundation Trust
Solihull Hospital, Heart of England NHS Trust
Southampton General Hospital, University Hospital Southampton NHS Foundation Trust
Southmead Hospital, North Bristol NHS Trust
St James' University Hospital, Leeds Teaching Hospital NHS Trust
St Mary's Hospital, Imperial College Healthcare NHS Trust
University College Hospital, University College London Hospitals NHS Foundation Trust

University Hospital, University Hospitals Coventry & Warwickshire NHS Trust
University Hospital Aintree, Aintree University Hospitals NHS Foundation Trust
University Hospital of North Midlands, University Hospitals of North Midlands NHS Trust
University Hospital of North Tees, North Tees & Hartlepool NHS Foundation Trust
Wansbeck Hospital, Northumbria Healthcare NHS Foundation Trust
Worcester Royal Hospital, Worcestershire Acute Hospitals NHS Trust
Wythenshawe Hospital, Manchester University NHS Foundation Trust

Scotland

Aberdeen Royal Infirmary, NHS Grampian
Glasgow Royal Infirmary, NHS Greater Glasgow and Clyde
Lorn & Islands District General Hospital, NHS Greater Glasgow and Clyde
Royal Alexandra Hospital, NHS Greater Glasgow and Clyde
Vale of Leven District General Hospital, NHS Greater Glasgow and Clyde

Wales

Glan Clwyd Hospital, Betsi Cadwaladr University Health Board
University Hospital Llandough, Cardiff and Vale University Health Board
Wrexham Maelor Hospital, Betsi Cadwaladr University Health Board

Northern Ireland

Antrim Area Hospital, Northern Health and Social Care Trust
The Ulster Hospital, South Eastern Health and Social Care Trust

Appendix 2: BTS Lung Disease Registry Organisational Survey 2017

The BTS Lung Disease Registry Organisational Survey, circulated in June 2017 to all 52 which were participating at that time.

1	Your name*
2	Your hospital/Trust name*
3	Is your institution a commissioned prescriber of Pirfenidone/Nintedanib? *Yes/No*
4	a) How many NEW ILD referrals does your Institution receive per annum? * *(Please provide an estimate for the last available 12 month period. Please note, this question is referring to all ILD, not just IPF and sarcoidosis.)*
	b) How many patients (new AND follow-up) do you estimate your service is *currently* looking after, as of 1st June 2017?
5	Does your hospital run: *A dedicated ILD clinic which sees only ILD patients* *A respiratory clinic which sees ILD patients alongside other respiratory patients* *Separate dedicated ILD clinics and general respiratory clinics* *Other, please specify*
6	In your ILD team, do you have any of the following colleagues (tick all that apply): *A dedicated ILD specialist nurse* *A respiratory nurse with an interest in ILD* *A dedicated thoracic radiologist (thoracic images only)* *A general radiologist with an interest in thoracic disease* *A dedicated thoracic pathologist* *A general pathologist with an interest in lung pathology* *A specialist respiratory physiotherapist* *A physiotherapist with an interest in respiratory disease* *A palliative care specialist / nurse* *A pharmacist*
7	In your ILD team, please give the number of specialist nurses dedicated to ILD *(whole time equivalents, e.g. one full time nurse dedicated to ILD = 1.0 WTE, a full time specialist nurse who works half of the time on ILD = 0.5 WTE)**
8	Is your specialist nurse present with you in your clinic when you see your ILD patients?*
9	Do your specialist nurses run their own clinic where they see ILD patients?*
10	Do you hold multidisciplinary team meetings specifically for ILD?
11	If you hold MDT meetings specifically for ILD, how frequently do these occur?
12	If you hold MDT meetings specifically for ILD, who attends (tick all that apply): *General chest physician* *Dedicated ILD physician* *Rheumatologist* *Palliative care team* *Thoracic radiologist* *General radiologist* *Thoracic pathologist* *General pathologist* *Thoracic surgeon* *Respiratory Specialist Trainees* *ILD specialist nurse* *Respiratory nurse with an interest in ILD* *Respiratory physiotherapist* *Other, please specify*

13	a)	Do you routinely assess the oxygen needs of your patients at the first clinic visit? (This includes simple informal testing such as pulse oximetry) *For LTOT / For Ambulatory oxygen*
	b)	Is the oxygen saturation level always measured on your ILD patients when they are in clinic? *Always / Often / Sometimes / Rarely*
14	a)	Do you or a member of your ILD/Chest clinic team routinely assess the palliative care needs of your ILD patients in clinic at every visit? Please note you may do this rarely because you are limited by time or under resourced to deliver this care. *Always / Often / Sometimes / Rarely*
	b)	Please select from the options below which statements best describe the palliative care resources you have <u>good</u> access to and <u>use</u> for your ILD patients. You may select more than one option. - *My ILD/chest clinic team and myself can provide palliative care assessments and management for our ILD patients 'in house'* - *I refer and have good access to hospital-based palliative care services* - *I refer and have good access to hospice-based palliative care services* - *I refer patients back to their GP for assessment and management of the patients palliative care needs (this does not mean just asking a GP to prescribe palliative drugs alone that you have identified/assessed a need for)* - *I refer patients and have good access to their community teams e.g. matrons, district nurses, community palliative care nurses* - *I do not have good access to a full range of palliative care services for my ILD patients* - *I cannot deliver routine palliative care assessments and management in my ILD/chest clinics due to limited resources e.g. no respiratory nurse in clinic with me or time restraints*
	c)	Please describe in the free text box below any challenges you face locally in accessing or delivering palliative care services for your ILD patients.
15	a)	Do you or a member of your ILD/Chest clinic team routinely assess your ILD patients for referral to a pulmonary rehabilitation (PR) programme? *Yes / No*
	b)	If 'No' selected please tell us why? Reasons might include [please tick any appropriate]: - *We do not have access to funded ILD PR programmes locally so no point in assessing* - *Time limitations or staff resources prevent us from doing this routinely* - *[Free text box]*
	c)	Please describe in the free text box below any challenges you face locally in accessing or delivering pulmonary rehabilitation services for your ILD patients.
16		Any other comments
17		This survey has included a small number of free text questions. With your permission, we would like to be able to share quotes from this survey anonymously. Do we have your permission to quote from your free text responses to this survey, on the understanding that you and your Trust/hospital would never be able to be identified? *Yes / No*

Supplemental Data

Supplemental Table S1: Age distribution of patients with IPF

Data shown represent percentage of patients (number of patients) from 2013 to 31st October 2019.

Year	<50 yrs	50-59 yrs	60-69 yrs	70-79 yrs	>79 yrs
Unknown	2% (1)	10% (5)	36% (19)	46% (24)	6% (3)
2013	3% (4)	8% (12)	30% (48)	43% (69)	16% (26)
2014	2% (7)	6% (22)	30% (106)	44% (156)	19% (66)
2015	0% (0)	6% (25)	29% (121)	42% (174)	23% (94)
2016	0% (1)	3% (10)	24% (78)	47% (150)	26% (83)
2017	1% (2)	3% (12)	22% (83)	46% (174)	29% (111)
2018	0% (0)	4% (18)	19% (84)	50% (229)	27% (124)
2019 (to 31/10/19)	0% (0)*	3% (6)*	17% (36)*	47% (101)*	33% (72)*

* $p>0.05$ comparing the results by year for each age range was calculated using the two way ANOVA with Bonferroni correction. Cases where the year of presentation was unknown were excluded.

Supplemental Table S2: Baseline Lung Function Parameters (mean±SD)

Year	FEV1 (L)	FEV1 (% pred)	FVC (L)	FVC (% pred)	TLco (mmol/ min/kPa)	TLco (% pred)	Kco (mmol/ min/kPa/l)	Kco (% pred)
Unknown	2.0±0.6	78.1±18.8	2.5±0.8	75.7±20.5	4.6±1.4	55.7±15.4	1.1±0.2	86.5±21.1
2013	2.2±0.6	82.3±17.8	2.7±0.8	80.1±20.1	4.0±1.4	50.3±15.6	1.1±0.5	82.0±20.7
2014	2.0±0.6	78.4±18.6	2.5±0.8	75.7±19.0	3.8±1.7	46.9±15.8	1.1±0.5	80.0±21.8
2015	2.1±0.6	82.9±19.0	2.6±0.8	78.8±19.0	3.9±1.7	47.5±14.8	1.1±0.6	79.8±20.7
2016	2.1±0.5	81.9±16.1	2.6±0.7	78.0±17.7	4.1±1.8	48.9±14.2	1.1±0.5	80.5±21.6
2017	2.1±0.6	81.9±19.5	2.6±0.8	77.1±19.9	4.0±1.5	48.8±14.8	1.1±0.4	80.3±22.5
2018	2.1±0.6	84.0±17.2	2.6±0.7	79.2±17.1	3.7±1.4	47.5±15.9	1.1±0.6	80.6±22.7
2019 (to 31/10/19)	2.0±0.4	81.4±18.5	2.5±0.6	77.1±17.7	3.5±1.2	46.8±14.6	1.0±0.3	78.9±19.2