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HIGH PREVALENCE OF DIABETES BEFORE AND AFTER LUNG TRANSPLANTATION: TARGET FOR IMPROVING OUTCOME?

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Abstract

Background

Diabetes increases morbidity and mortality of lung transplantation. However, the reported prevalence of diabetes varies post-transplantation partly due to lack of detection protocols.

Aims

We determined the prevalence of diabetes in patients (i) waitlisted for lung transplant and (ii) early post-transplantation.

Methods

We analyzed patients on the St Vincent's Heart Lung database from 1/4/14 to 30/9/15 on the waitlist (Study 1) and those transplanted (Study 2). Standard of care required all non-diabetic patients to have an oral glucose tolerance test (OGTT) (modified for patients with cystic fibrosis [CF] to screen for CF-related hyperglycemia (CFRH) (plasma glucose e 8.2 mmol/L at 60 or 90 minutes).

Results

Study 1 included 114 patients (32 with CF, 82 without CF). Twenty-seven of 30 CF patients (90%) with glycemic data had abnormal glucose metabolism: 18 had diabetes and 9 had CFRH. In 50 patients without CF, 20 (40%) had abnormal glucose metabolism; 8 had diabetes and 12 had impaired fasting glucose and/or impaired glucose tolerance. Study 2 included 78 transplanted patients (25 with CF, 53 without CF). Fourteen CF patients had pre-existing diabetes and 7 had pre-existing CFRH. All but 1 patient were diagnosed with diabetes post-transplantation. Hence, diabetes

prevalence in CF patients post-transplantation was 96%. Among 53 transplanted patients without CF, 7 (13%) had abnormal glucose metabolism but thirty (57%) were diagnosed with post-transplant diabetes.

Conclusion

There is a high prevalence of diabetes in lung transplant patients. Earlier endocrine participation in lung transplant services is likely to lower diabetes-related morbidity and mortality further.

Introduction

Post-transplant diabetes mellitus following lung transplantation is associated with an increased risk of graft failure and reduced survival (1). Importantly, patients with pre-existing diabetes or post-transplant diabetes mellitus (PTDM) have a 50% reduction in life expectancy post-transplantation (1). However, the prevalence of diabetes in lung transplant populations is poorly documented, partly due to the absence of an active detection strategy. One study reported a 40% incidence of PTDM in lung transplant patients three months post-transplantation using 2006 World Health Organization criteria of fasting glucose e 7.0 mmol/l and/or random glucose e 11.1 mmol/l on two occasions, single HbA1c e 7.0% and/or HbA1c e 6.5% and diabetic range glucose measurement (1) but an oral glucose tolerance test (OGTT) was not routinely performed. Risk factors for diabetes in transplant populations include older age, higher weight, underlying lung conditions such as cystic fibrosis, family history of diabetes and treatments that promote diabetes, particularly glucocorticoids and tacrolimus, two of the main immunosuppressant agents used post-transplantation (2, 3).

The two hour 75g OGTT is recommended as part of routine care in transplantation preparation (4). The existing diagnostic criteria for diabetes are based on the American Diabetes Association (ADA) guidelines (5). There has been criticism regarding the use of these guidelines in patients with CF, as they are based on risk of microvascular complications and not CF-specific outcomes (6). It has been shown that in patients with CF, even 'mild' abnormal glucose levels (blood glucose peak e 8.2 mmol/l at 60 or 90 minutes on OGTT) are associated with lower body weight and impaired lung function in the preceding 12 months (6) We have also published that

CF patients with pre-existing diabetes have higher morbidity and mortality post-transplantation (7). It has been proposed by Hameed and colleagues that the decline in body weight and lung function is a more clinically relevant way of identifying patients with CF who are at high risk of developing diabetes (6). Both Australian and International guidelines on the standards of care for Cystic Fibrosis Related Diabetes (CFRD) currently use the standard 75g OGTT with diagnostic criteria based on time 0 and 120 minute values. However, they acknowledge that many patients with normal fasting and 2 h glucose levels may have elevated glucose readings at other points during the OGTT or when assessed by continuous glucose monitoring. This glucose elevation may be more predictive of clinical decline in lung function than the fasting or 2 hour glucose level. However, until sufficient outcome-based data are generated documenting detection of hyperglycaemia at intermediate time points and clinical risk, the standard diagnostic criteria persist as the gold standard for diagnosing CFRD (8-10).

The aim of this study was to determine the prevalence of diagnosed and undiagnosed diabetes in patients actively wait-listed for, or having had, lung transplantation at a state-wide quaternary referral service for lung transplantation. We used the standard OGTT criteria based on 0 and 120 min glucose levels to define diabetes and CFRD. Based on the findings by Hameed et al (6), we performed a modified OGTT in the CF population with additional sampling at 60 and 90 min; we used a cut-off blood glucose e 8.2 mmol/l at 60 or 90 min as as an indication of CF-related hyperglycemia (CFRH) in those patients that did not meet the classical criteria for CFRD to determine how common CFRH, a pre-diabetic state, was in the CF population.

Materials and Methods

The study was designed by four of the authors, the first two and the last two authors. It was approved by the St Vincent's Hospital Research Ethics committee (LNR/15/SVH/303). The study had no commercial sponsorship.

The prospective cardiothoracic surgery and transplantation database was interrogated for patients on the active lung transplant waitlist from April 1, 2014 to September 30, 2015 (Study 1) and those transplanted between April 1, 2014 and September 30, 2015 (Study 2).

Study 1

Of 128 patients on the active transplant waitlist, 14 were excluded (unfit or died). Therefore, 114 patients were included in Study 1 (Figure 1). Based on our review of the literature in early 2014, standard of care in our Unit from April 2014 required all patients without known diabetes to have an OGTT before and after transplantation. Medical records were reviewed and information was collected on age, gender, weight, body mass index (BMI), underlying lung condition, prior glucocorticoid use, pre-existing diabetes and, in non-diabetic patients, pre-transplant fasting and/or random blood glucose levels and OGTT results to determine whether patients met the ADA criteria for diabetes (any one of HbA1c e 6.5% [48 mmol/mol], fasting plasma glucose level [fBGL] e 7.0 mmol/l, 2 h BGL on OGTT e 11.1 mmol/l or random BGL e 11.1 mmol/l). In patients without CF, a standard OGTT was performed with sampling at time 0 and 120 minutes. In patients with CF, the traditional OGTT was performed, with additional glucose levels at 60 and 90 minutes. A BGL of e 7.0 mmol/l and/or 2 h BGL e 11.1 mmol/l was considered consistent with diabetes in

patients with and without CF. In CF patients, a BGL e 8.2 mmol/l at 60 and/or 90 min was considered to be consistent with CFRH (Figure 2). According to the ADA criteria, impaired fasting glucose is met if fasting BGL is between 5.6 to 6.9 mmol/l and impaired glucose tolerance if 2hr BGL on OGTT is 7.8 – 11.0 mmol/l (5).

Study 2

Seventy eight patients who were actively waitlisted were transplanted between April 1, 2014 and September 30, 2015; 74 had bilateral lung transplant. Information was collected on duration of hospital stay, immunosuppressive therapy, prednisone dose on discharge, diabetes on hospital discharge, OGTT results from 6 to 12 weeks post-transplantation and whether any deaths occurred in the first six months post transplantation. The same OGTT criteria were used pre and post-transplantation to diagnose post-transplant diabetes mellitus and pre-diabetes (ie impaired fasting glucose and/or impaired glucose tolerance) (Figure 2).

Lung transplant donor assessment, recipient selection, transplantation and management is based on international guidelines (11). All patients received IV methylprednisolone 500 mg peri-operatively followed by 125 mg eight-hourly for 24 hours. This was followed by oral prednisolone 1 mg/kg/day with tapering by 5 mg second daily to daily dose of 0.2 mg/kg/day (until first transbronchial biopsy). They received IV tacrolimus 0.01 mg/kg/day that was increased to 0.02 mg/kg aiming for first steady state level between 12-15 mcg/l and were transitioned to oral tacrolimus once extubated. IV/oral mycophenolate mofetil 1500 mg bd or IV/oral azathioprine 2 mg/kg nightly was given. Six patients received azathioprine instead of mycophenolate

mofetil. Treatment was monitored and modified if there was significant rejection, renal impairment, or systemic sepsis.

Statistical analysis was performed using SPPS (version 24). Normally distributed data were expressed as mean ± standard deviation or as number and percentages. Unpaired two-sided *t* tests or Pearson Chi-square tests were used to compare patients with and without CF. A probability of < 0.05 was considered statistically significant.

Results

Study 1

Thirty-two patients with CF and 82 without CF were studied pre-transplantation. Baseline demographic data are summarized in Table 1. CF patients were younger with mean age 30.4 ± 9.5 compared with 54.2 ± 11.0 years in patients without CF ($p<0.00x$), had lower body mass index (19.9 ± 3.8 vs 25.8 ± 7.3 kg/m^2, $p<0.00x$), longer duration of lung disease (29. 5 ± 8.1 vs 8.1 ± 8.7 years, $p<0.00x$) and they had higher prevalence of diabetes pre-transplantation (60% vs 16%, $p<0.00x$).

Diabetes and CFRH prevalence pre-transplantation

Thirty patients with CF had available glycemic data: 60% of patients (n=18) had pre-existing CFRD; 17 had prior diabetes and were on insulin; 1 patient was identified by the pre-transplant 75 g OGTT using standard diagnostic criteria using 0 and 120 min time points. Thirty percent (n=9) that did not meet standard diagnostic criteria for CFRD with 0 and 120 min time points on the 75 g OGTT had CFRH using the OGTT with additional time points 60 and 90 min and BGL ≥ 8.2 mmol/l (Figure 3A). Four had been transplanted previously and were waiting re-transplantation for bronchiolitis obliterans syndrome. All 4 had CFRD: one from childhood and 3 post-transplant.

Fifty patients with conditions other than CF had available diabetes/glycaemic data pre-transplantation. Sixty percent (n=30) had normal glucose tolerance. Sixteen percent (n=8) had pre-existing diabetes. Twenty four percent (n=12) had pre-diabetes: 9 patients had impaired glucose tolerance (IGT) and 3 had impaired fasting glucose (IFG) (Figure 3B). Thirty-two patients did not have an OGTT performed pre-transplantation.

Study 2

Twenty-five patients with CF were transplanted (including 2 patients who were re-transplanted) and 53 patients without CF. CF patients had shorter hospital stay post-transplantation (21.2 ± 10.4 vs 32.7 ± 30.8 days, p=0.02) and higher prevalence of diabetes on hospital discharge (96% vs 47%, p<0.00x).

As shown in Table 2, patients without CF had poorer renal function than CF patients at 6 weeks post transplantation and at 6 months post transplantation. All patients were treated with glucocorticoids and tacrolimus.

Diabetes and CFRH prevalence post-transplantation

As in Study 1, diabetes and CFRH were common in patients with CF: 56% (n=14) had pre-existing CFRD. All 7 transplanted patients with pre-transplant CFRH developed CFRD post-transplant, and had continuing insulin therapy at 12 weeks post-transplantation; therefore the 75 g OGTT was not performed. Of 4 patients without pre-transplant abnormal glucose metabolism, all except one developed CFRD post-transplant. Therefore, as in Study 1, the prevalence of CFRD post-transplant was 96% (Figure 4A). One patient with new CFRD died within 30 days post-transplantation from respiratory failure secondary to early antibody-mediated rejection and ventilator-associated pneumonia.

As outlined in Table 3, CF patients with CFRD pre-transplantation tended to have higher baseline creatinine than CFRH patients and lower eGFR .Post-transplant,

CFRD patients tended to have higher creatinine than CFRH patients at 6 weeks and at 6 months , with no difference in eGFR (Table 3).

Fifty-three patients without CF were transplanted. Three had pre-existing diabetes. Three of four with pre-diabetes (impaired glucose tolerance (n=3) and impaired fasting glucose (n=1)) developed PTDM. One of these patients died on day 12 from *Klebsiella pneumonia* and irreversible hypoxic brain injury. Eleven patients without diabetes pre-transplant (n=21) developed PTDM and 16 with unknown diabetes status pre-transplant (n=25) developed PTDM; overall PTDM prevalence was 57%. Thirty six percent (n=19) developed it during or shortly after hospital admission and 9.4% (n=8) were identified on OGTT 6 to 12 weeks post-transplant. All except one continued taking oral diabetes therapy or insulin at 12 weeks. Eleven percent (n=6) had pre-diabetes on 6 to 12 week OGTT and 9% (n=5) had a negative OGTT. Nine patients without diabetes, or with unknown diabetes status, had normal glycemic control post-transplant; however, they did not follow up with an OGTT post-transplant (Figure 4B). Four of these patients died in hospital, 1 week - 4 months post-transplant. The overall mortality in patients with PTDM was 10% (n=5).

Discussion

There are limited data on diabetes prevalence in lung transplant populations in registry-based studies, reflecting a lack of universal screening programs. As diabetes is associated with reduced life expectancy, we evaluated the glucose tolerance in our Lung Transplant Unit with a formal OGTT before and after transplantation in all non-diabetic patients. We found a high prevalence of diabetes before and early-post transplantation. Importantly, 60% of patients with CF and 16% without CF had

diabetes before lung transplantation. Furthermore, 9 patients with CF had CFRH with overall 90% of CF patients documented to have abnormal glucose metabolism before transplantation.

After lung transplantation, 96% of patients with CF had diabetes. As all patients with CFRH before transplantation developed diabetes after transplantation, it is a strong predictor of post-transplant diabetes. Sixty percent of patients without CF also developed PTDM.

In study 1, 90% patients with CF and 40% of patients without CF had abnormal glucose metabolism (overall prevalence 59%). In study 2, 96% patients with CF and 74% of patients without CF had abnormal glucose metabolism (overall prevalence 81%). A previous study with 156 patients reported 25% had diabetes pre-lung transplantation and a further 15% had impaired glucose tolerance and/or impaired fasting glucose based on screening with the OGTT, yielding a 40% prevalence of abnormal glucose metabolism in their cohort (12). There are very limited data on diabetes prevalence pre-transplantation as most data come from large registries or retrospective studies without standard requirements for diabetes screening (12). The 2004 International Consensus guidelines on PTDM have recommended performing a fasting BGL at regular intervals and a 2 h OGTT in patients with normal fasting BGL (4). Whether this is currently routine in clinical practice is unclear.

CFRD is the most common comorbidity in people with CF, with 20% of adolescents and 40 – 50% of adults affected (8, 13). CFRD is associated with increased mortality (6) . We report a higher prevalence of CFRD in our pre-lung transplant recipients with

60% affected, most likely due to the association between CFRD and progression of CF-related lung disease, an indication for lung transplantation. (9, 14) Additionally, because the mean age of our CF cohort was 30.4 ± 15.3 years, patients in our study were more likely to have developed CF-related comorbidities.

Thirty percent of patients with CF that did not meet criteria for CFRD based on the standard 75g OGTT criteria demonstrated early glucose abnormalities defined as CFRH (6). Multiple guidelines have been published regarding the diagnostic criteria for CFRD (8, 9, 15). These criteria were not designed with CF-specific outcomes in mind, such as catabolic weight reduction and lung function decline that are likely to be more relevant outcomes (6). CFRD is a late event and is preceded by more subtle glucose abnormalities on OGTT, with peak glucose e 8.2 mmol/l at 60 and 90 min associated with reduced weight and lung function in the preceding 12 months (6). The Australian criteria for diagnosing CFRD are based on the 75 g OGTT (9); however, testing at 30, 60 and 90 min increases the recognition of peak glucose value (9). There was 100% progression in all 7 transplanted patients with CFRH to diabetes post-transplantation. Therefore, it appears to be an easily measured early marker of glucose abnormalities which indicate a poorer prognosis (6). We have previously shown in 25 patients with CF post bilateral lung transplantation that pre-transplant diagnosis of CFRD was associated with a worse post-transplant outcome with increased hospitalizations for infections in the diabetes group (3.9 vs 1.2, p=0.01) and increased hospitalizations for rejection (1.4 vs 0.5, p=0.04) (7). The identification of pre-transplant abnormal glucose metabolism is indicative of pre-transplant pancreatic dysfunction that is irreversible post-transplantation due to high dose glucocorticoids and is a predictor of post transplant diabetes. It is now important to test whether

recognition and early treatment of abnormal glucose metabolism improve post-transplant outcomes.

Renal dysfunction is common after lung transplantation with immunosuppressive therapy with calcineurin inhibitors playing a large role (16). A decline in renal function post-transplantation complicates management and may be associated with a reduction in immunosuppressive therapy or a change in medications and can lead to end-stage chronic renal failure that is associated with reduced survival (16). It has been shown that both CFRD requiring insulin therapy (hazard ratio 1.30; 95% CI, 1.02-1.67) and pre-transplant renal function impairment with eGFR 60-90 ml/min/m^2 vs >90 ml/min/m^2 (hazard ratio 1.58; 95% CI, 1.19-2.12) are risk factors for post lung transplant renal dysfunction (16). CFRD requiring insulin is also a risk factor for chronic kidney disease in non-transplanted adult CF patients and highlights the importance of active management. (17) In our study CF patients with pre-existing CFRD prior to transplantation had higher baseline creatinine and lower baseline eGFR than CFRH patients, which was also seen at 6 weeks and 6 months post-transplant. While this was not statistically significant due to small sample size, it is consistent with the literature and supports the need for optimal CFRD management pre-transplant to minimize post transplant renal dysfunction and other adverse outcomes. Whether early detection and treatment of patients with CFRH reduces post transplant renal dysfunction is currently unknown.

The reported prevalence of diabetes after lung transplantation and incidence of PTDM depends on timing of screening and follow-up duration. Most reports estimate a prevalence of 25-40% (18), (19) and an incidence of 6-43% at 1 year (20, 21) and 21-

60% at 3-5 years (1, 12, 19, 21-23). The lower figures were found in earlier studies of patients treated with cyclosporine that causes less diabetes than tacrolimus (12, 18, 22). The International Society for Heart and Lung Transplantation (ISHLT) has data on 51,440 adult lung transplants and has reported diabetes prevalence of 23% one year post-transplantation, with cumulative prevalence of 40% within 5 years. Importantly, these data have been collected from multiple sources and retrospective studies without specific screening criteria for diabetes (24) .

Hackman and colleagues performed the first prospective study evaluating incidence and prevalence of diabetes post-lung transplantation. They found that diabetes prevalence was 47%, 44% and 40% at 3, 12 and 24 months, respectively, and the incidence was 32%, 30% and 24% at 3, 12 and 24 months, respectively (12). In our study, we found almost all patients with CF (96%) had diabetes post-transplantation, with 10 cases of newly diagnosed CFRD (40%). In patients without CF, 57% developed PTDM. The PTDM incidence is higher than previously reported (22), most likely due to the older age and higher BMI of our cohort.

One of the limitations of our study was that 32 of 82 (39%) patients without CF did not have available glycaemic data prior to lung transplantation hence under-estimating the prevalence of abnormal glucose metabolism in patients without CF pre-transplant.

Conclusion

In conclusion, there is a high prevalence of diabetes before and after lung transplantation. There are no currently agreed guidelines to screen for diabetes in this setting. As diabetes is associated with poorer outcomes and reduced life expectancy post-transplantation, we propose that formal diabetes screening, using the modified criteria described above, should be routine both before and after transplantation, and repeated in non-diabetic patients maintained on higher dose glucocorticoid therapy.

Our data demonstrate that CFRH is a pre-diabetic state and a strong predictor of post-transplant CFRD, which has previously been shown to be a poor prognostic factor. Therefore, identification of abnormal glucose metabolism pre-transplantation coupled with early initiation of treatment is likely to make a major improvement in outcome. Further studies to assess whether early detection and treatment of diabetes both pre- and post-transplant improves post-transplant outcomes are necessary.

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Figure Legends

Figure 1. Study profile of patients actively waitlisted and transplanted during study period

Figure 2. St Vincent's Hospital protocol for diabetes screening pre and post lung transplantation. CFRH – Cystic Fibrosis Related Hyperglycaemia, PTDM – Post-Transplant Diabetes Mellitus, OGTT – Oral glucose tolerance test.

Figure 3. Study 1 - Prevalence of diabetes before lung transplantation. Panel A. Prevalence of pre-existing CF-related diabetes (CFRD), CF-related hyperglycaemia (CFRH) or no CFRD/CFRH based on oral glucose tolerance test (OGTT) before lung transplantation with number of patients (N) in each group and percentage of the total cohort in brackets in patients with CF. Panel B: Prevalence of pre-existing diabetes mellitus (DM), impaired glucose tolerance (IGT) or impaired fasting glucose (IFG) in lung transplant patients without CF actively waitlisted for lung transplant as based on OGTT before lung transplantation with number of patients (N) in each group and percentage of the total cohort in brackets.

- Only patients with available glycaemic data included.

Figure 4. Study 2 - Prevalence of diabetes early post lung transplantation based on glycaemic status before transplantation and on hospital discharge or oral glucose tolerance test (OGTT) 6 to 12 weeks post transplantation. Panel A. In patients with CF and Panel B in patients without CF. PTDM –Post-transplant diabetes mellitus; Tx – transplant

Table 1. Characteristics of pre-lung transplant patients (mean ± SD or number and percentage) – Study 1

	CF Recipients (32)	**Non-CF Recipients (82)**	**p-value**
Mean age (yrs)	30.4 ± 9.5	54.2 ± 11.0	<0.00x
Gender – males (%)	15 (47%)	40 (49%)	0.86
Body Mass Index (kg/m2)	19.9 ± 3.8	25.8 ± 7.3	<0.00x
Mean duration lung disease (yrs)	29.5 ± 8.1	8.1 ± 8.7	<0.00x
Lung disease type Obstructive (n) Restrictive (n) PAH/other (n)	 N/A	 32/82 (39%) 32/82 (39%) 18/82 (22%)	<0.00x
Known diabetes pre transplantation (n)	18/30 (60%)*	8/50 (16%)*	<0.00x
Diabetes duration - yrs	10.1 ± 7.0	4.8 ± 5.7	0.12
Diabetes therapy insulin (n) oral agents (n) Diet/lifestyle	 17/18 (94%) 0 1/18 (6%)	 1/8 (13%) 4/8 (50%) 3/8 (37%)	<0.00x
Diabetes complications			

– microvascular (n) macrovascular (n)	3/18 (17%) 0	0 0	0.03
Baseline renal function Mean creatinine (umol/l) Mean eGFR (ml/min)	 67.3 ± 21.0 95.9 ± 32.6	 73.2 ± 18.4 84.9 ± 20.6	 0.15 0.09
Prior regular glucocorticoids (n) before transplantation	8/32 (25%)	12/82 (15%)	0.19
Duration of daily glucocorticoids pre-transplant (yrs)	1.9 ± 1.0	3.1 ± 2.6	0.16
Mean glucocorticoid dose pre-transplant (mg)	8.5 ± 3.9	11.0 ± 7.2	0.38
Exocrine pancreatic insufficiency (n)	30 (94%)	N/A	N/A

*Patients with diabetes in those with known glycemic data

Legend: PAH = pulmonary artery hypertension

Table 2. Characteristics of post-lung transplant patients (mean ± SD or number and percentage) – Study 2

	CF Recipients (25)	**Non-CF Recipients (53)**	**p-value**
Mean age (yrs)	30.4 ± 9.4	56.8 ± 9.2	<0.00x
Gender – males (%)	12 (48%)	30 (57%)	0.48
Transplant type -Bilateral lung transplant (n)	25 (100%)	49 (93%)	0.30
Mean hospital stay post transplantation (d)	21.2 ± 10.4	32.7 ± 30.8	0.02
Immunosuppressive therapy on discharge -glucocorticoids (n) -tacrolimus (n) -azathioprine (n) -mycophenolate mofetil (n)	 25 (100%) 25 (100%) 2 (8.0%) 23 (92%)	 53 (100%) 53 (100%) 4 (7.5%) 49 (93%)	 1.00 1.00
Prednisone dose on discharge (mg)	20.8 ± 8.6	24.6 ± 14.6	0.25
Diabetes on discharge post transplantation (n)	24 (96%)	25 (47%)	<0.00x

6-12 wks post transplant OGTT results: - newly diagnosed diabetes (n) -Impaired fasting glucose and/or impaired glucose tolerance (n)		8 (15%) 6 (11%)	
Renal function 6 weeks post transplant: Mean creatinine (umol/l) Mean eGFR (ml/min)	80.4 ± 27.1 79.6 ± 15.2	102.8 ± 55.5 66.4 ± 22.7	0.02 <0.00x
Renal function 6 months post transplant: Mean creatinine (umol/l) Mean eGFR (ml/min)	93.2 ± 25.0 78.3 ± 14.6	107.5 ± 33.3 60.4 ± 17.0	0.08 <0.00x
Death post transplant during 1st 6 months	1 (4.0%)	5 (9.4%)	0.66

Table 3. Renal function pre- and post-transplant in transplanted CF patients based on diabetes status before transplantation

	CFRH (n=7)	CFRD (n=14)	p-value
Pre transplant:			
mean creatinine (umol/l)	51.7 ± 11.2	70.1 ± 22.6	0.06
Mean eGFR (ml/min)	110.0 ± 40.5	88.5 ± 21.5	0.133
6 weeks post transplant:			
Mean creatinine (umol/l)	68.0 ± 15.6 (n=6)	89.2 ± 31.3 (n=13)	0.11
Mean eGFR (ml/min)	83.7 ± 11.3	74.6 ± 17.3	0.22
6 months post transplant:			
Mean creatinine (umol/l)	77.3 ± 12.8 (n=6)	101.4 ±29.1 (n=13)	0.07
Mean eGFR (ml/min)	83.2 ± 10.0	73.7 ± 17.0	0.23