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Health-related quality of life after kidney transplantation: who benefits the most?

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Summary

The influence of dialysis modalities on HRQoL before and after kidney transplantation (KT) and the role of adherence to medication on HRQoL have not been fully studied. Sixty four dialysis patients who answered the 15D HRQoL survey during dialysis were surveyed again after KT. Adherence and employment were also investigated. The mean 15D score was highest among home hemodialysis patients (HHD) and lowest among in-center hemodialysis patients (icHD). After KT, the mean 15D score improved significantly in 78.6% of peritoneal dialysis patients (PD), 47.6% of HHD, and 53.8% of icHD. Then, mean 15D score remained unchanged in 28.6% of HHD and in 23.1% of icHD patients. A deterioration in the 15D score occurred in 14.3% of PD, 23.1% of icHD, and 23.8% of HHD patients, and this was influenced by the number of pills ($P = 0.04$). Adherence to medication was the lowest in PD, timing being the most challenging task showing a connection to higher creatinine concentration (never forgot 1.41 mg/dl vs. forgot 2.08 mg/dl $P = 0.05$). Employed patients had a higher mean 15D score. The icHD and PD patients benefited the most from KT and HHD the least. Low pill burden and employment were linked to a better HRQoL.

Introduction

The success of kidney transplantation (KT) could be achieved by prolonging patients' survival and by enhancing patients' well-being after receiving this treatment as well. Tools for measuring well-being are mainly those evaluating the health-related quality of life (HRQoL). Several generic and disease-specific instruments are available for measuring HRQoL. While generic instruments measure general physical, mental, and social health, allowing comparisons with general population or across different morbidities, the specific instruments target a specific disease and permit the detection of specific symptoms and subtle changes in the quality of life [1].

In the case of end-stage renal disease (ESRD), different treatment modalities affect the HRQoL to a variable degree. The differences in HRQoL among hemodialysis (HD) and peritoneal dialysis (PD) patients have been difficult to interpret because of patient selection bias [2]. The Freedom study demonstrated an improvement in HRQoL after switching patients from in-center hemodialysis (icHD) to frequent home hemodialysis (HHD) [3]. Several studies have revealed that HRQoL is better in KT patients compared with dialysis patients and that graft loss is associated with a worsening HRQoL [4]. In a metanalysis involving HD, PD, and KT patients, the authors concluded that transplant patients had and improved HRQoL, but not as remarkable as expected after adjustment for age and

presence of diabetes [5]. Jofre reported in a longitudinal study an improvement in HRQoL in icHD patients after KT, although the benefit was smaller in older patients with several comorbidities [6]. These variables cannot be modified, but Morales demonstrated that medication complexity is a controllable barrier that affected negatively both transplant patients' adherence to the treatment and HRQoL [7].

There is an increased interest in HRQoL assessment in ESRD. However, there is scanty data in the literature evaluating the changes in HRQoL of HHD, icHD, and PD after KT. Most of the studies are cross-sectional, comparing HD and PD with KT or icHD versus KT [2,4,6,8–10]. In a small study by Park *et al.*, 16 patients were longitudinally followed up 10 days before KT and 3 months after, and found an improvement in several domains of HRQoL [10]. This issue is highly relevant, since the measurement of HRQoL has been proposed, not only as a measure of outcome in chronic disease, but also as an adjustment factor in economic evaluation [5].

The aim of this study is to investigate the association between dialysis modality and HRQoL before and after KT and, secondarily, the association of adherence to the medical treatment and its complexity with HRQoL.

Study population and methods

Study design and participants

Between years 2004 and 2006, 220 patients started dialysis treatment at the Helsinki University Central Hospital. From this initial cohort, 156 incidental dialysis patients responded to a HRQoL survey employing the 15D instrument. Details about the study population included are shown as a flow chart in Fig. 1. Patients that responded to the 15D questionnaire and had a functional kidney graft as of October 31, 2012, were invited to participate in this longitudinal survey. They received a letter explaining the rationale for the study and a consent form, along with a prepaid envelope for returning it. Additionally, they were asked about their education (elementary, high school, tertiary, or university) and both current and pretransplant employment (employed, retired, unemployed, or student). The 15D results obtained from this cohort were compared with those obtained from the Finnish general population (GP) in the National Health 2000 Health Examination Survey [11]. The data in the age range of the study population were weighted to correspond the age and sex distribution of the patients.

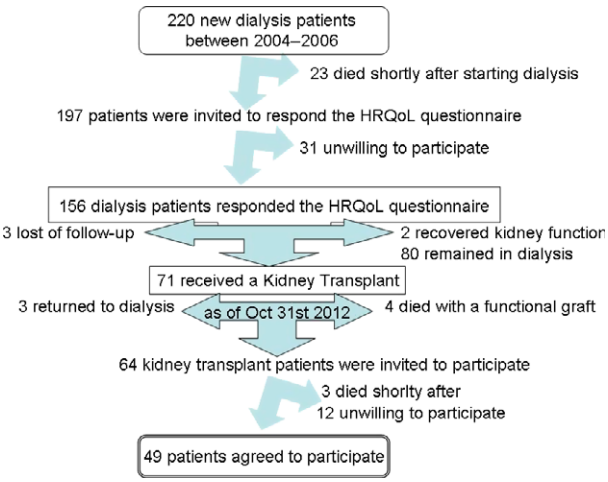

Figure 1 Flow chart detailing the patients included in this study from the initial population.

Measurements

Demographics, etiology of ESRD, the time on dialysis and comorbidities at the start of dialysis treatment, last plasma creatinine concentration, estimated GFR, and current medical treatment were retrieved from patient charts using the CKD-EPI formula [12]. Recipient Risk Score (RRS) was used to compare comorbidities across groups. It considers the time on dialysis, history of diabetes, interaction between diabetes and age, and the presence of coronary artery disease [13].

Health-related quality of life assessment

The 15D instrument is a generic, 15-dimensional, standardized, and self-administered measure of HRQoL [14]. It can be used both as a profile and as a single-index score measure. For each of the 15 dimensions (moving, seeing, hearing, breathing, sleeping, eating, speech, excretion, usual activities, mental function, discomfort and symptoms, depression, distress, vitality, and sexual activity), the respondent chooses the level that best describes his or her present health status (the best being 1 and the worst 5). The valuation system of the 15D is based on an application of the multi-attribute utility theory. The single-index score (15D score), representing the overall HRQoL, and the dimension level values, reflecting the goodness of the levels relative to no problems on the dimension and to being dead, both on a 0–1 scale, are calculated from the health state descriptive system using a set of population-based preference or utility weights. The maximum 15D score is 1 (no problems on any dimension), and minimum score 0 (equal to being dead). The higher the score, the better the HRQoL. This instrument has been used before in dialysis patients [15].

Adherence assessment

Adherence to the treatment was assessed with the self-report BAASIS written questionnaire and the visual analog

scale (VAS). BAASIS consists of four questions that need to be answered yes or no; if yes, it is asked how often this happened in the last month [16]. The VAS assesses overall medication adherence over the latest month from the patient's point of view from 100% (perfect adherence) to 0% (never took the medication as prescribed). It is worth to mention that in Finland, immunosuppressive medications are fully reimbursed lifetime and the prescriptions are renewed during their visit to the outpatient clinic, by phone or electronically.

Evaluation of the medical treatment complexity

We chose the Medication Regimen Complexity Index (MRCI) [17], which has previously been used in HHD patients [18]. It takes into account pill burden, number of medications, frequency, and types of administration.

The study design was approved by the internal review board and the ethics committee of the Helsinki University Hospital. The clinical and research activities being reported are consistent with the Principles of the Declaration of Istanbul as outlined in the 'Declaration of Istanbul on Organ Trafficking and Transplant Tourism' [19].

Statistical analysis

Descriptive statistics are presented as mean and standard deviation. We tested continuous variables for normality with Shapiro–Wilk, analyzing histograms and Q-Q plots. Pill number, time on dialysis, and VAS were transformed for normality. Specifically for VAS, data were first reflected and log10 transformation used afterward to allow the use of ANOVA, and Tamhane's *post hoc* test to assess differences between groups. Chi-square test was applied for categorical variables.

If a respondent left up to 3 questions of the 15D unanswered, the missing data were imputed by regression models with age, sex, and the responses on the other dimensions as explanatory variables. The minimal clinically important change in the 15D score has been estimated at 0.018 for improvement and −0.045 for deterioration [20].

Dropout from the follow-up was assessed with Bayesian logistic regression using MCMClogit function. (MCMCpack, MARTIN JSTAT Software 2011 (Berkeley, CA, USA)). To account for the possibility that the missingness of data was not completely at random, we used mean matching or linear regression to generate an imputed data set. A P-value < 0.05 was considered statistically significant. Statistical software SPSS 19 and R3.0.1 (IBM, Armonk, NY, USA) was used for analyses.

Results

Response rate was 80.3%. The description of the population is depicted in Table 1. The mean time elapsed between the 15D measurements was 4.5 years. The analysis of missingness revealed that lower baseline 15D score, older age, being female, longer time spent in dialysis, longer time

Table 1. Demographics and immunosuppressive treatment in 49 patients after KT.

	Total	HHD	PD	icHD
Age, mean in years (SD)	52 (11)	54 (10)	49 (13)	59 (8)
Males, %	59	78	40	52
Time on dialysis, mean in months (range)	29 (1–77)	22 (3–66)	25 (5–58)	30 (1–77)
Time from transplantation, mean in years (SD)	3.5 (2)	4.3 (2)	3.5 (1.9)	2.9 (2)
Kidney graft function, %				
CKD-stage 1	6	6	0	9
CKD-stage 2	41	33	60	38
CKD-stage 3	45	55	30	43
CKD-stage 4	6	6	0	10
CKD-stage 5	2	0	10	0
Most common etiologies;%				
Polycystic kidney disease	29	29	20	33
Diabetic nephropathy	24	17	40	24
Chronic glomerulonephritis	16	28	0	14
Immunosuppression therapy, %				
Cyclosporin A	63	72	60	57
Tacrolimus (twice daily)	12	17	10	10
Tacrolimus (once daily)	22	11	30	29
Mycophenolic acid	90	94	100	81
Steroids	24	11	20	33

CKD, chronic kidney disease.

from transplantation, greater number of pills per day, and lower RRS predicted the dropping out from the follow-up. Therefore, we report comparison with general population using both complete ($N = 49$) and imputed data sets ($N = 61$).

15D scores during dialysis compared with those of general population

Compared with the GP matched for age and sex, the dialysis patients had a lower mean 15D score. The dialysis patients were statistically significantly worse off on the dimensions of "moving', 'usual activities', 'discomfort and symptoms', 'depression', 'vitality', and 'sexual activity'. Generally, male dialysis patients expressed more discomfort ($P = 0.04$). Older patients were more depressed ($P = 0.02$), and the number of comorbidities correlated with depression ($P = 0.04$). Patients with diabetes had a significantly lower mean 'see' score (0.74 in diabetics and 0.93 in nondiabetics, $P < 0.001$). The 15D score was influenced by the type of dialysis: HHD patients had the highest and icHD patients the lowest ($P < 0.001$) mean 15D score compared with the GP (Fig. 2 panel A). The dimensions of 'usual activities', 'discomfort and symptoms', 'depression', 'vitality', and 'sexual activity' expressed more variation between dialysis modalities and compared with the GP. Although HHD patients had the highest scores of all the dialysis modalities, 'usual activities' and 'sexual activity' were statistically significantly worse compared with the GP.

Changes in HRQoL after kidney transplantation

As lower HRQoL during dialysis appeared to affect the response rate negatively, we explored the change in the 15D score after KT in both the respondents ($N = 49$) and in the entire population ($N = 61$) for whom the missing data were imputed. There was an improvement in the mean 15D score in all three groups of respondents. However, pre-

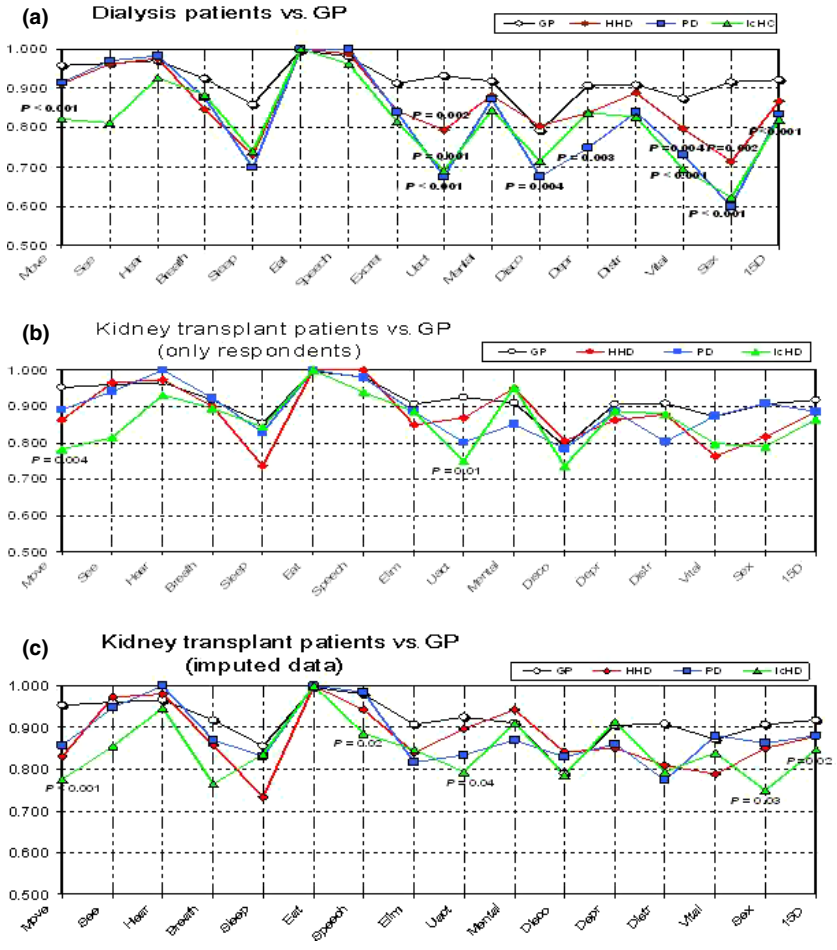

Figure 2 Health-related quality of life in chronic kidney disease patients compared with the general Finnish population standardized for age and sex. Panel A: dialysis population. Panel B: after transplantation, considering only respondents. Panel C: after transplantation, considering the entire cohort after imputing the values of the nonrespondents.

vious icHD patients scored after KT statistically significantly worse than GP on the dimensions of 'moving' and 'usual activities' and in the 15D score. The patients who had been on PD or HHD showed an improvement in all the dimensions and the mean 15D score which were comparable to the GP (Fig. 2 panels B and C).

When classifying the change in the 15D score into three groups (better, unchanged, or worse) using the previously described cutoff points for a clinically significant change, 57% of all dialysis patients improved their HRQoL after transplantation, 21.3% remained unchanged, and 21.3% deteriorated (Fig. 3). Although there were some differences in the degree of change between the dialysis modalities, they were not statistically significant. The individual dimensions that improved the most in PD patients were 'sleep', 'usual activities', 'discomfort and symptoms', 'depression', 'vitality', and 'sexual activity'. In HHD patients, the largest improvement was seen on the dimensions of 'usual activities', 'mental function', 'discomfort and symptoms', and 'sexual activity' and in icHD patients on the dimensions of 'seeing', 'sleeping', 'excretion', 'usual activities', 'mental function', 'discomfort and symptoms', 'depression', 'vitality', and 'sexual activity'. By contrast, both HHD and icHD patients were worse off on the dimension of 'distress' after transplantation than before it. Surprisingly, all the three groups of patients scored lower for the dimension 'moving' after transplantation. Changes on the 15 dimensions are shown in Fig. 4.

The modality of dialysis appeared to have an effect on the proportion of patients with deteriorated HRQoL after transplantation, as 14.3% of previous PD patients, 23.1% of icHD patients, and 23.8% of HHD patients had a clinically significantly worse 15D score. The deterioration in the 15D score was not linked to age, dialysis modality, time on dialysis, time from transplantation, etiology of ESRD, eGFR, or RRS.

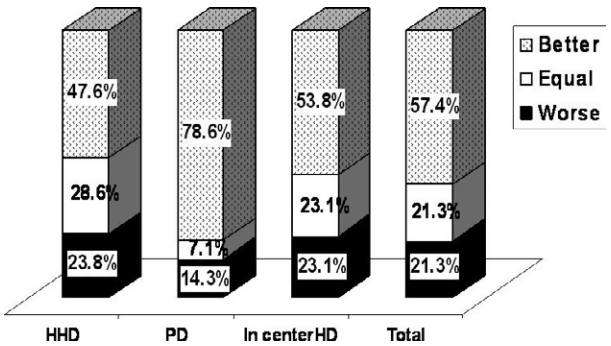

Figure 3 Change in 15D score according the previous dialysis modality in respondents. The minimal clinically important difference in the 15D has been estimated at 0.018 for improvement and −0.045 for deterioration. The differences between groups were not statistically significant.

Adherence to medication after transplantation and its impact on the 15D scores

There was a wide range of medications prescribed (from 4 to 22) and number of pills as well (from 6 to 40), but none of them correlated with the RRS ($P = 0.10$ and $P = 0.68$, respectively). There were no statistically significant differences in the RRS between previous HHD, PD, and icHD patients, although previous icHD patients scored the highest, as displayed in Table 2.

Despite the patients perception about taking immunosuppressive medications measured with VAS was over 95%, 25% of previous PD patients and 20% of previous icHD patients missed one dose of immunosuppressives. Timing was the most challenging task. Forgetfulness to take the medications on time was not linked to age, time from transplantation, RRS, number of medications or pills, but we observed a higher creatinine concentration in the forgetful patients (never forgot 1.41 mg/dl vs. forgot 2.08 mg/dl $P = 0.05$). MRCI and number of medications did not influence the mean 15D scores. The number of pills was statistically significant different in HHD patients with deteriorated HRQoL compared with those who remained unchanged or improved after transplantation (18.9 pills vs. 14.9 pills $P = 0.04$) but was not difference in the other dialysis modalities.

Educational level and employment and their relationship with HRQoL

Home hemodialysis patients were more highly educated, as 93.8% of them had completed high school, tertiary, or university studies. The corresponding figure was 62.5% for

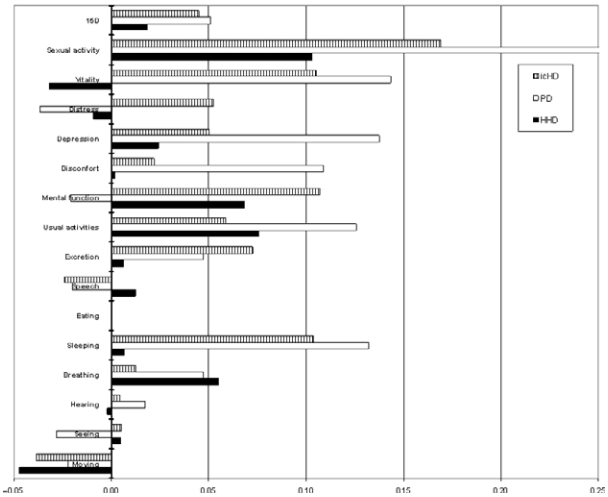

Figure 4 Changes on 15 dimensions and in mean 15D scores from dialysis to transplantation.

Table 2. Adherence to medication assessed by VAS and BAASIS in 49 respondents.

Type of dialysis			HHD	PD	icHD	*F*	Sig
RRS, mean and SD			3.9 (0.76)	4.1 (1.12)	4.4 (0.89)	2.51	0.09
eGFR, mean and SD			57 (25)	58 (20)	59 (26)	0.02	0.97
Number of medicines, mean (SD)			11.4 (3.4)	9.2 (2.7)	11.2 (3.1)	1.88	0.16
Number of pills, mean (SD)			17.3 (5.7)	13.4 (4.7)	15.5 (6.5)	2.36	0.11
MRCI, mean (SD)			16.7 (5.6)	13.6 (4.4)	15.5 (4.9)	1.69	0.19
VAS for IS			96.4	96.7	99.8	6.48	0.004†
VAS for other medications			95.6	90.6	98.6	4.82	0.01*
BAASIS ($N = 49$)	Prepare myself (%)		100	100	90.5		0.27
	Take myself (%)		100	100	100		1
	Forgot medication (%)	Once	0	25%	20%		0.13
		Repeatedly	0	0	0		1
	Take medication (%)	On time	75	37.5	100		0.03*
		Once later	12.5	37.5	0		
		2–3 times later	12.5	12.5	0		
		Almost every day later	0	12.5	0		
	Modified doses (%)		0	0	0		1
	Stopped IS medication (%)		0	0	0		1

VAS, visual analog scale; IS, immunosuppression; eGFR, estimated glomerular filtration rate; MRCI, Medication Regimen Complexity Index; RRS, Recipient Risk Score.

Continuous data were analyzed with ANOVA and Tamhane's *post hoc* test. BAASIS questionnaire answers were tested with chi square.

*Statistical significant difference between HHD and icHD.

†Statistical significant difference between HHD versus icHD and PD versus icHD.

icHD patients and 77.7% for PD patients. HHD patients were also more commonly employed than PD and icHD patients (62% vs. 50% vs. 19%, respectively) and more likely to preserve their working status after transplantation (57.1% vs. 42.9% vs. 23.1% respectively, $P = 0.03$). Patients with a low education level scored worse than patients with higher education only for the dimension of 'mental function' ($P = 0.03$). Patients in employment after transplantation scored significantly higher on 14 of 15 dimensions, with the only exception of 'depression' than those not employed. Also the mean 15D score was higher in these patients.

Discussion

In our study, we observed that the benefit of kidney transplantation in terms of HRQoL was different for each dialysis modality and somehow lower than expected. Our cohort of HHD patients had the best mean HRQoL score compared with other dialysis modalities, but lower than that of GP. However, the only group which differed statistically significantly from the GP was icHD. These differences can be explained by the policy in our institution: 'home first'. Those not suitable for self-treatment remain to be treated by icHD with the assistance of trained nurses. In our population, this inevitable bias is the result of patient's choice and disease burden. There is a logical selection of less sick patients to be on self-dialysis modalities, fact that explains the differences observed in HRQoL at baseline.

Only few studies have compared the HRQoL of dialysis patients with the GP. Mazairac *et al.* [9] reported on Dutch icHD patients compared with the GP and concluded that dialysis patients scored lower in all Short Form-36 (SF-36) domains except for role physical and social functioning. Stavrianou *et al.* [21] investigated Greek icHD patients and compared them with the GP and found that all SF-36 domains except pain were statistically lower in icHD patients. The 15D is a different instrument for measuring HRQoL, but in a similar way, we found that icHD patients scored lower on six of the 15 dimensions, namely 'moving', 'usual activities', 'discomfort and symptoms', 'depression', 'vitality', and 'sexual activity'. Varela *et al.* [22] reported on PD patients' HRQoL compared with the Spanish GP and found lower score in SF-36, particularly in physical dimensions, depression and anxiety. In our cohort, we only detected a significant difference on the dimensions of 'usual activities', 'vitality', and 'sexual activity', suggesting that our PD cohort was to some degree healthier. Wu *et al.* [2] compared icHD and PD patients with the SF-36 instrument and found that both groups had similar generic HRQoL. There is evidence that more frequent hemodialysis has a positive effect on HRQoL, as demonstrated by the Freedom study [3]. In this respect, our results are comparable to those reported in the literature.

The benefit of KT in terms of HRQoL in our study appears clear and in accordance with what has been reported in the literature, however lower than expected [1,21,22]. A clinically significant improvement in the 15D

score was observed in only 57.4% of the entire cohort. Specifically, the dimensions of 'distress' and 'moving' deteriorated after transplantation. This suggests that although KT is in most cases the best treatment for ESRD, progression of comorbidities together with potential new medical and psychological issues (such as immunosuppression side effects or the fear of losing the graft) may impair HRQoL.

Previous PD patients appeared to benefit the most and previous HHD patients the least from KT, in terms of HRQoL. However, in both groups, HRQoL was comparable to that of the GP. The differences in the benefit between home modalities could be explained by a better HRQoL during dialysis of HHD patients compared with PD patients. It can be argued the HHD patients had a baseline 15D score high enough that there was not much room for improvement, and this could have affected the 15D score after transplantation. Although the 15D score was improved in this subset of patients (as shown in Fig. 3), it is worth to note that 23.8% of them experienced a deterioration in HRQoL after transplantation, specifically in terms of the dimensions 'move', 'distress', and 'vitality'. Despite the increase in the 15D score in 53.8% of icHD patients, the dimensions of 'moving', 'speech', 'usual activities', 'sexual activity' as well as the 15D score remained statistically significantly lower than those of the GP, indicating the higher comorbidity of this population. Jofre *et al.* [6] applied a similar study design involving almost exclusively icHD patients (96%). He observed a significant improvement in the HRQoL, but the proportion of patients who actually benefited from KT was not reported. Liem at al concluded, after a meta-analysis involving HD, PD and KT patients, that transplant patients had an improved HRQoL, but not as remarkable as expected after adjustment for age and presence of diabetes [5]. In our study, we could not observe a link between age, dialysis modality, time on dialysis, time from transplantation, etiology of ESRD, eGFR or RRS, and a deterioration in the 15D score. The disagreement in the conclusions could be due to the small number of patients included in our study.

Employment was more common in HHD patients, in accordance with a previous study on Finnish patients on renal replacement therapy [23]. We observed a statistically significantly higher mean HRQoL score in patients who were employed after transplantation, except for 'depression'. Similar findings were observed in Finnish liver transplant patients [24]. Chisholm-Burns *et al.* [25] established a positive association between employment and HRQoL and a higher level of education. We observed a similar association between employment and education, but the mean 15D score did not differ between patients with low or high education.

Our study showed 23% of the KT patients skipped at least one dose of immunosuppressants during the past month and 29% admitted not taking them on time. These figures are similar to the nonadherence in KT reported in the literature [26–28]. We observed that PD patients were the least adherent after KT. This observation was unexpected, being that home dialysis patients have been trained for self-care, therefore provided with knowledge about risks and benefits of each renal replacement treatment options. This issue has been highlighted in a recent publication where the authors proposed a questionnaire evaluating the degree of information transmitted to the patients systematically [29]. Our findings could be the result of given proper information to the patients about dialysis treatment but not strong enough about kidney transplantation and the risks of nonadherence. We observed that patients who forgot to take the medication on time had a worse kidney graft function, suggesting that this minimal deviation from the prescription may have an impact on the prognosis of KT, mainly caused by the development of donor-specific antibodies leading to chronic rejection [30,31].

It is well known that medication and pill burden in ESRD is one of the highest reported [32]. The pill burden in our cohort of KT patients was similar to that reported in the literature [33]. The medication complexity regimen has been associated with nonadherence [34], but we were unable to confirm this. However, we observed that patients prescribed with higher number of pills had a lower HRQoL even when the comorbidity score was similar across groups.

The interpretation of the results in our study is limited by the relatively small number of patients from a single study center and by the lack of randomization for dialysis modality. However, the policy in our institution is to individualize the treatment modality that best fits to the patient, promoting home dialysis as the first choice. The limited number of participants did not allow more sophisticated statistical analysis. Another limitation is that adherence was measured only once after transplantation. Also dropout from the study was not completely random. And lastly, as we used a generic instrument for measuring the changes in HRQoL, subtle changes between dialysis modalities might have remained undetected. However, this allowed a comparison with the GP and put into perspective the benefits from KT. We believe that one of the strength of our study is the longitudinal follow-up on a well-defined ESRD population in an institution that offered all dialysis treatment modalities, including the follow-up after transplantation.

In conclusion, this study showed that the improvement in HRQoL obtained after KT is linked to the previous dialysis modality, with PD patients benefiting the most. In-center dialyzed patients had the poorest HRQoL, but it was substantially improved with KT. We also showed that HHD patients had the highest HRQoL during dialysis and

less than half of them improve their HRQoL after KT. A higher HRQoL was more common in patients who were employed and needed lower number of pills after transplantation. Because of this, in future, we should strive to reduce the number of pills and facilitate retention in working life. Future studies in a large patient populations will allow to put our observations into perspective and focus also on the economic impact of each renal replacement treatment.

Authorship

FO and RR: designed the study. FO, RM and PA: collected the data. FO, PA and RR: performed the statistical analysis. FO, PK, RR, PF, EH, HS and RR: wrote the manuscript.

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References

1. Butt Z, Yount SE, Caicedo JC, Abecassis MM, Cella D. Quality of life assessment in renal transplant: review and future directions. *Clin Transplant* 2008; **22**: 292.
2. Wu AW, Fink NE, Marsh-Manzi JV, *et al.* Changes in quality of life during hemodialysis and peritoneal dialysis treatment: generic and disease specific measures. *J American Soc Nephrol* 2004; **15**: 743.
3. Finkelstein FO, Schiller B, Daoui R, *et al.* At-home short daily hemodialysis improves the long-term health-related quality of life. *Kidney Int* 2012; **82**: 561.
4. Maglakelidze N, Pantsulaia T, Tchokhonelidze I, Managadze L, Chkhotua A. Assessment of health-related quality of life in renal transplant recipients and dialysis patients. *Transplant Proc* 2011; **43**: 376.
5. Liem YS, Bosch JL, Arends LR, Heijenbrok-Kal MH, Hunink MG. Quality of life assessed with the medical outcomes study short form 36-item health survey of patients on renal replacement therapy: a systematic review and meta-analysis. *Value Health* 2007; **10**: 390.
6. Jofre R, Lopez-Gomez JM, Moreno F, Sanz-Guajardo D, Valderrabano F. Changes in quality of life after renal transplantation. *Am J Kidney Dis* 1998; **32**: 93.
7. Morales JM, Varo E, Lazaro P. Immunosuppressant treatment adherence, barriers to adherence and quality of life in renal and liver transplant recipients in Spain. *Clin Transplant* 2012; **26**: 369.
8. Ogutmen B, Yildirim A, Sever MS, *et al.* Health-related quality of life after kidney transplantation in comparison intermittent hemodialysis, peritoneal dialysis, and normal controls. *Transplant Proc* 2006; **38**: 419.
9. Mazairac AH, de Wit GA, Penne EL, *et al.* Changes in quality of life over time-Dutch haemodialysis patients and general population compared. *Nephrol Dial Transplant* 2011; **26**: 1984.
10. Park IH, Yoo HJ, Han DJ, *et al.* Changes in the quality of life before and after renal transplantation and comparison of the quality of life between kidney transplant recipients, dialysis patients, and normal controls. *Transplant Proc* 1996; **28**: 1937.
11. Aromaa A, Koskinen S. Health and functional capacity in Finland: baseline results of the health 2000 Health Examination Survey. *Nat Pub Health Inst* 2004; **B12/2004**: 1.
12. Matsushita K, Mahmoodi BK, Woodward M, *et al.* Comparison of risk prediction using the CKD-EPI equation and the MDRD study equation for estimated glomerular filtration rate. *JAMA* 2012; **307**: 1941.
13. Moore J, He X, Liu X, *et al.* Mortality prediction after kidney transplantation: comparative clinical use of 7 comorbidity indices. *Exp Clin Transplant* 2011; **9**: 32.
14. Sintonen H. 15D© the Health-Related Quality of Life Instrument. Available at http://www.15dinstrument.net/15d.
15. Malmström RK, Roine RP, Heikkilä A, *et al.* Cost analysis and health-related quality of life of home and self-care satellite haemodialysis. *Nephrol Dial Transplant* 2008; **23**: 1990.
16. Dobbels F, Berben L, De Geest S, *et al.* The psychometric properties and practicability of self-report instruments to identify medication nonadherence in adult transplant patients: a systematic review. *Transplantation* 2010; **90**: 205.
17. George J, Phun YT, Bailey MJ, Kong DC, Stewart K. Development and validation of the Medication Regimen Complexity Index. *Ann Pharmacother* 2004; **38**: 1369.
18. Cardone KE, Manley HJ, Grabe DW, Meola S, Hoy CD, Bailie GR. Quantifying home medication regimen changes and quality of life in patients receiving nocturnal home hemodialysis. *Hemodial Int* 2011; **15**: 234.
19. Steering Committee of the Istanbul, Summit. Organ trafficking and transplant tourism and commercialism: the declaration of Istanbul. *Lancet* 2008; **372**: 5.
20. Alanne S. *Subjectively Significant Change in the Measurement of Health-Related Quality of Life*. Kuopio: University of Eastern Finland, Faculty of Social Sciences and business studies, Department of Health Policy and Management, 2011:1–64.
21. Stavrianou K, Pallikarakis N. Quality of life of end-stage renal disease patients and study on the implementation of nocturnal home hemodialysis in Greece. *Hemodial Int* 2007; **11**: 204.
22. Varela L, Vazquez MI, Bolanos L, Alonso R. Psychological predictors for health-related quality of life in patients on peritoneal dialysis. *Nefrologia* 2011; **31**: 97.

23. Helanterä I, Haapio M, Koskinen P, Grönhagen-Riska C, Finne P. Employment of patients receiving maintenance dialysis and after kidney transplant: a cross-sectional study from Finland. *Am J Kidney Dis* 2012; **59**: 700.
24. Åberg F, Rissanen AM, Sintonen H, Roine RP, Hockerstedt K, Isoniemi H. Health-related quality of life and employment status of liver transplant patients. *Liver Transpl* 2009; **15**: 64.
25. Chisholm-Burns MA, Erickson SR, Spivey CA, Kaplan B. Health-related quality of life and employment among renal transplant recipients. *Clin Transplant* 2012; **26**: 411.
26. Massey EK, Tielen M, Laging M, *et al.* The role of goal cognitions, illness perceptions and treatment beliefs in self-reported adherence after kidney transplantation: a cohort study. *J Psychosom Res* 2013; **75**: 229.
27. Butler JA, Peveler RC, Roderick P, Horne R, Mason JC. Measuring compliance with drug regimens after renal transplantation: comparison of self-report and clinician rating with electronic monitoring. *Transplantation* 2004; **77**: 786.
28. Fine RN, Becker Y, De Geest S, *et al.* Nonadherence consensus conference summary report. *Am J Transplant* 2009; **9**: 35.
29. Ismail SY, Timmerman L, Timman R, *et al.* A psychometric analysis of the Rotterdam Renal Replacement Knowledge-Test (R3K-T) using item response theory. *Transplant Int* 2013; **26**: 1164.
30. De Geest S, Dobbels F. Transplantation: increasing adherence to immunosuppression: a clinical priority. *Nat Rev Nephrol* 2010; **6**: 139.
31. Legendre C, Canaud G, Martinez F. Factors influencing long-term outcome after kidney transplantation. *Transplant Int* 2014; **27**: 19.
32. Chiu YW, Teitelbaum I, Misra M, de Leon EM, Adzize T, Mehrotra R. Pill burden, adherence, hyperphosphatemia, and quality of life in maintenance dialysis patients. *Clin J Am Soc Nephrol* 2009; **4**: 1089.
33. Hardinger KL, Hutcherson T, Preston D, Murillo D. Influence of pill burden and drug cost on renal function after transplantation. *Pharmacotherapy* 2012; **32**: 427.
34. Gordon EJ, Gallant M, Sehgal AR, Conti D, Siminoff LA. Medication-taking among adult renal transplant recipients: barriers and strategies. *Transplant Int* 2009; **22**: 534.