Qual Life Res (2012) 21:299–307
DOI 10.1007/s11136-011-9942-3

Differences in quality of life of hemodialysis patients between dialysis centers

Albert H. A. Mazairac · Muriel P. C. Grooteman · Peter J. Blankestijn · E. Lars Penne · Neelke C. van der Weerd · Claire H. den Hoedt · Marinus A. van den Dorpel · Erik Buskens · Menso J. Nubé · Piet M. ter Wee · G. Ardine de Wit · Michiel L. Bots

Accepted: 19 May 2011 / Published online: 2 June 2011

Abstract
Purpose Hemodialysis patients undergo frequent and long visits to the clinic to receive adequate dialysis treatment, medical guidance, and support. This may affect health-related quality of life (HRQOL). Although HRQOL is a very important management aspect in hemodialysis patients, there is a paucity of information on the differences in HRQOL between centers. We set out to assess the differences in HRQOL of hemodialysis patients between dialysis centers and explore which modifiable center characteristics could explain possible differences.
Methods This cross-sectional study evaluated 570 hemodialysis patients from 24 Dutch dialysis centers. HRQOL was measured with the Kidney Disease Quality Of Life-Short Form (KDQOL-SF).
Results After adjustment for differences in case-mix, three HRQOL domains differed between dialysis centers: the physical composite score (PCS, $P = 0.01$), quality of social interaction ($P = 0.04$), and dialysis staff encouragement ($P = 0.001$). These center differences had a range of 11–21 points on a scale of 0–100, depending on the domain. Two center characteristics showed a clinical relevant relation with patients' HRQOL: dieticians' fulltime-equivalent and the type of dialysis center.
Conclusion This study showed that clinical relevant differences exist between dialysis centers in multiple HRQOL domains. This is especially remarkable as hemodialysis is a highly standardized therapy.

Keywords Quality of life · Center differences · Hemodialysis · Dialysis staff encouragement

Abbreviations

HRQOL	Health-related quality of life
KDQOL-SF	Kidney Disease Quality Of Life-Short Form

This study is conducted on behalf of the CONTRAST investigators. See "Appendix" for list of CONTRAST investigators.

A. H. A. Mazairac · P. J. Blankestijn · E. Lars Penne · N. C. van der Weerd · C. H. den Hoedt
Department of Nephrology, University Medical Center Utrecht, Utrecht, The Netherlands

M. P. C. Grooteman · E. Lars Penne · N. C. van der Weerd · M. J. Nubé · P. M. ter Wee
Department of Nephrology, VU Medical Center, Amsterdam, The Netherlands

M. P. C. Grooteman · M. J. Nubé · P. M. ter Wee
Institute for Cardiovascular Research VU Medical Center (ICaR-VU), VU Medical Center, Amsterdam, The Netherlands

C. H. den Hoedt · M. A. van den Dorpel
Department of Internal Medicine, Maasstad Hospital, Rotterdam, The Netherlands

E. Buskens
MTA Unit, Department of Epidemiology, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands

G. A. de Wit · M. L. Bots (✉)
Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, PO Box 85500, 3508 GA Utrecht, The Netherlands
e-mail: M.L.Bots@umcutrecht.nl

G. A. de Wit
National Institute for Public Health and the Environment, Bilthoven, The Netherlands

SF-36	Short Form 36
CONTRAST	Convective transport study
BMI	Body mass index
eGFR	Estimated glomerular filtration rate
PCS	Physical component summary
MCS	Mental component summary
SD	Standard deviation
FTE	Fulltime equivalent

Introduction

Health-related quality of life (HRQOL) can be defined as the perceived health status in physical, social, and mental domains [1]. Attention to and focus on HRQOL is illustrated by the growing number of studies on HRQOL [2]. Different clinical variables that contribute to HRQOL have been evaluated [3], but a paucity of information remains on the potential important role of the clinic itself.

The HRQOL of hemodialysis patients is hard-pressed. They not only face the chronic health problems of renal failure but also the intrusiveness of a time-consuming therapy. As a result, the HRQOL of hemodialysis patients is lower than in patients with congestive heart failure, chronic lung disease, or cancer [4]. For in-center hemodialysis patients, frequent and long visits to the clinic are required in order to receive adequate dialysis treatment, medical guidance, and support. Does this entwinement lead to differences between dialysis centers in patients' HRQOL? And if so, can modifiable center characteristics be identified that are related with HRQOL? Relevant differences between dialysis centers have been shown for mortality [5–9] and intermediate outcomes such as dialysis adequacy [10], hematocrit [11], and vascular access [12]. It was our aim to assess differences in HRQOL between dialysis centers using the Kidney Disease Quality of Life-Short Form (KDQOL-SF), which combines the well-known, generic Short Form 36 (SF-36) with a kidney disease-specific assessment of HRQOL [13]. Our second aim was to explore center characteristics that were related to HRQOL.

Materials and methods

Patients and study design

This cross-sectional study used baseline data of the Convective Transport Study (CONTRAST) [14]. The analyses are based on 570 participating hemodialysis patients from 24 dialysis centers in The Netherlands. Centers were only included in this analysis if at least 10 patients participated in CONTRAST. CONTRAST is a randomized controlled trial (ISRCTN38365125) comparing the effects of low-flux hemodialysis with online hemodiafiltration on all-cause mortality and cardiovascular events, as described elsewhere [14]. In short, patients were eligible if treated with hemodialysis 2 or 3 times a week, for at least 2 months, with a minimum dialysis urea Kt/V $\geq$ 1.2, and able to understand the study procedures. Exclusion criteria were age <18 years, treatment by hemodiafiltration or high-flux hemodialysis in the 6 months preceding randomization, severe incompliance defined as non-adherence to the dialysis prescription, a life expectancy <3 months due to causes other than kidney disease, and participation in another clinical trial. The study was conducted in accordance with the Declaration of Helsinki and approved by the medical ethics review boards of all participating hospitals. Written informed consent was obtained from all patients prior to enrollment.

Data collection

At baseline, standardized forms were used to collect demographic, clinical and laboratory data. Demographic data included age, gender, race, and educational level. Clinical characteristics included cause of kidney failure, diabetic state and previous cardiovascular disease, vascular access, hemodialysis dose (single pool Kt/V urea), time on renal replacement therapy in years, treatment time in hours, blood pressure, body mass index (BMI), dialysis frequency, residual kidney function, and smoking habit (yes/no). Laboratory values were measured using standard techniques. The second generation Daugirdas formula was used to calculate single pool Kt/V for urea [15]. Residual kidney function was expressed as estimated glomerular filtration rate (eGFR), calculated as the mean of creatinine and urea clearance and adjusted for body surface area [16]. Center characteristics included the number of dialysis patients per center, nurse, and dialysis session; the proportion of available patients enrolled in CONTRAST; frequency of patient—physician (assistant) contacts; the fulltime-equivalent (FTE) of nephrologists, nurses, social workers, and dieticians; availability of exercise during dialysis (yes/no); dialysis modalities offered (peritoneal, home, and nocturnal dialysis); university hospital (yes/no) and regional satellite unit (yes/no).

Kidney Disease Quality of Life-Short Form

HRQOL was assessed with the validated KDQOL-SF version 1.3 (http://gim.med.ucla.edu/kdqol/downloads/-download.html) [13, 17]. It covers different domains to face the multidimensional nature of HRQOL. The KDQOL-SF can be split in a generic part and a disease-

Table 1 The Kidney Disease Quality of Life-Short Form (KDQOL-SF): the kidney disease-specific scales

Domains	Meaning	
	Low	High
Symptom/problem list	Extremely bothered by dialysis-related symptoms such as muscle cramps, pruritus, anorexia, and/or access problems	Not at all bothered
Effect of kidney disease on daily life	Extremely bothered by fluid and dietary restriction, by an inability to travel and dependency on doctors	Not at all bothered
Burden of kidney disease	Extremely bothered by the time consumed by dialysis, its intrusiveness and degree burden on family	Not at all bothered
Work status	Unemployed due to health	Employed, health not an issue
Cognitive function	Affected all of the time by inability to concentrate, confused with poor reaction time	Not at all affected
Quality of social interaction	Continual irritation and failure to get along with people with virtual isolation	No problem, socially interactive
Sexual function	Experiencing severe problems with enjoyment and arousal	No problems
Sleep	Very poor sleep with day time somnolence	No problem with sleep
Social support	Very dissatisfied	Satisfied with level of social support
Dialysis staff encouragement	High perceived encouragement and support	Low perceived encouragement and support
Overall health	Rates health as worst possible	Rates health as best possible
Patient satisfaction	Very poor	The best

Modified from Carmichael et al. [37]

specific part. First, the generic part is formed by the SF-36 version 1. The domains of the SF-36 can be summarized in two summary scores, one for physical functioning (physical component summary—PCS) and one for mental functioning (mental component summary—MCS). These summaries are constructed so that a score of 50 represents the mean of the general United States population with a standard deviation of 10 [18]. Second, the disease-specific part of the KDQOL-SF consists of 44 kidney disease-targeted questions. The responses to these items are condensed in 12 domains (Table 1). These domains have a score from 0 to 100, with higher scores indicating the absence of problems. A difference of 5 points has been proposed to be clinical relevant with regard to individual domains, and a difference of 3 points with regard to the composite scores [18, 19].

Data analysis

Patient characteristics were reported as means with standard deviation (SD), medians with interquartile ranges, or proportions when appropriate. First, differences in HRQOL between dialysis centers were assessed, while adjusting for case-mix covariates and the variation in the proportion of enrolled patients. Case-mix covariates were age, gender, race, educational status, history of cardiovascular disease, diabetes, eGFR, and time on renal replacement therapy in years. Second, additional adjustments were made for process variables. Process variables are characteristics that may be influenced by patient factors as well as dialysis staff modifications e.g. Kt/V, type of vascular access, hemoglobin, albumin, and phosphate levels [20]. The relation between center characteristics and HRQOL was evaluated independent of case-mix covariates. Multilevel linear models or logistic regression was applied, depending on the distribution of the residuals: parametric or non-parametric. To facilitate logistic regression, non-parametrically distributed domains were dichotomized using the median as cut-off value. We used single regression analysis to account for missing values [21]. The median extent of missing was 5% in the HRQOL domains analyzed, 2% of case-mix covariates, 0% of center variables, and 0% of process variables. Results were considered statistically significant if $P < 0.05$ (two-tailed comparison). All analyses were conducted using SPSS 18 (SPSS Inc. Headquarters, Chicago, Illinois, USA).

Results

Patient characteristics

The characteristics of the 570 hemodialysis patients are summarized in Table 2. The mean age was 64 ± 14 (SD) years, 62% of the patients were male, and 93% dialyzed 3 times per week.

Table 2 Patient characteristics (N = 570)

Demographic	
Age (years)	64 ± 14
Gender (% male)	62
Caucasian (%)	86
High educational status[a] (%)	24
Clinical parameters	
Dialysis vintage (years)	1.9 (1.0–4.2)
Dialysis frequency (%)	
2× per week	6
3× per week	93
4× per week	1
Session duration (hours)	4.0 (3.5–4.0)
spKt/V urea	1.4 ± 0.2
eGFR (mL/min/1.73 m^2)[b]	2.8 (1.2–5.2)
Vascular access (% fistula)	84
Body mass index (kg/m^2), after dialysis	25 ± 4
Systolic blood pressure (mmHg), before dialysis	142 ± 20
Diastolic blood pressure (mmHg), before dialysis	73 ± 11
Current smoker (%)	21
Diabetes mellitus (%)	20
History of cardiovascular disease (%)	42
Hemoglobin (mmol/L)	7.3 ± 0.8
Albumin (g/L)	36 ± 5
Calcium (mmol/L)	2.3 ± 0.2
Phosphate (mmol/L)	1.6 ± 0.5

Mean ± SD or median (interquartile range)

To convert hemoglobin in mmol/L to g/dL divide by 0.62; albumin in g/L to g/dL, divide by 10; calcium in mmol/L to mg/dL, divide by 0.25; phosphate in mmol/L to mg/dL, divide by 0.323

eGFR estimated glomerular filtration rate

[a] high educational status: college or university level

[b] In 278 patients with diuresis ≥100 mL/24 h (52%)

Table 3 Center characteristics ($N = 24$ centers)

Number of patients treated	
Total	109 (85–155)
On HD or HDF	81 (64–125)
Per dialysis shift	20 (15–25)
Per nurse	
2–2.5	5 (21%)
3–3.5	17 (71%)
4–4.5	2 (8%)
Setting	
General hospital	18 (75%)
University hospital	4 (17%)
Regional satellite unit	2 (8%)
Offered dialysis modalities	
Peritoneal dialysis	23 (96%)
Home dialysis	14 (58%)
Nocturnal dialysis	13 (54%)
FTE dialysis staff per 100 patients	
Nephrologist	2.6 (2.1–3.2)
Nurse	30 (26–34)
Social worker	1.6 (1.3–1.8)
Dietician	0.9 (0.6–1.2)
Patient–physician (assistant) contacts per month	
2×	3 (13%)
4×	18 (75%)
>4×	3 (13%)
Availability of physical exercise during dialysis	20 (83%)

Center medians (interquartile ranges) or percentages

HD hemodialysis, *HDF* hemodiafiltration, *FTE* fulltime-equivalent

Dialysis center characteristics

Table 3 depicts the center characteristics ($N = 24$ centers). The median number of dialysis patients that was treated in a participating center was 109 (interquartile range 85–155) of which 81 (64–125) were on HD or HDF. Twenty-seven percent (17–35) of these patients were enrolled for the current study. Based on the median FTE per patient, there were 2.6 (2.1–3.2) nephrologists per 100 dialysis patients. Fourteen centers (58%) offered home dialysis, and 4 (17%) were part of a university hospital.

Quality of life differences between dialysis centers

Three HRQOL domains differed between the dialysis centers when the variation in case-mix covariates and proportion of enrolled patients was taken into account (Table 4, Fig. 1): the PCS ($P = 0.01$), quality of social interaction ($P = 0.04$), and dialysis staff encouragement ($P = 0.001$). These results did not change if the differences in HRQOL between centers were furthermore adjusted for process variables. The differences in HRQOL had a maximum range of 11–21 points.

Center characteristics and quality of life

Two center characteristics showed a clinical relevant relation with patients' HRQOL (Table 5): dieticians' FTE and the type of center. Dieticians' FTE per patient was positively related to perceived dialysis staff encouragement. Multiple HRQOL domains were better in satellite units and worse in university hospitals.

Discussion

This study showed clinical relevant differences in the HRQOL of hemodialysis patients between dialysis centers in three domains: the PCS, quality of social interaction, and

Table 4 Differences in quality of life between dialysis centers ($N = 24$ centers)

	Score	P-value		
		Crude	Adjusted	
			Case-mix	Case-mix + process variables
Generic domains (SF-36)				
Physical component summary (PCS)	40 ± 4	**0.002**	**0.01**	**0.01**
Mental component summary (MCS)	51 ± 3	**0.01**	0.20	0.27
Kidney disease-specific domains				
Symptom/problem list	80 ± 4	0.06	0.68	0.94
Effects of kidney disease on daily life	73 ± 5	0.35	0.59	0.48
Burden of kidney disease	47 ± 8	**0.01**	0.46	0.54
Work status	0 (0–0)	0.71	0.67	0.58
Cognitive function	80 ± 6	**0.01**	0.11	0.19
Quality of social interaction	83 ± 5	**0.04**	**0.04**	**0.02**
Sleep	62 ± 7	**0.08**	0.20	0.42
Social support	78 ± 7	0.44	0.33	0.18
Dialysis staff encouragement	78 ± 7	**<0.001**	**0.001**	**0.001**
Overall health	60 ± 4	**0.04**	0.98	0.76
Patient satisfaction	70 ± 5	0.99	0.99	0.99

Center mean ± SD or median (interquartile range). The *P*-values depict the difference in quality of life between dialysis centers as assessed with mixed effect modeling, both crude and adjusted. Case-mix covariates were: age, gender, race, educational status, history of cardiovascular disease, diabetes, eGFR and time on renal replacement therapy in years. Process variables were: Kt/V, type of vascular access, hemoglobin, albumin and phosphate level. Adjusted comparisons were also corrected for the proportion of enrolled patients

Bold *P*-values are significant ($P < 0.05$)

The domains have a range from 0 to 100, with higher scores indicating a preferable health status or relative absence of problems

dialysis staff encouragement. Two center characteristics showed a clinical relevant relation with patients' HRQOL: dieticians' FTE and the type of dialysis center. Perceived dialysis staff encouragement was higher if more dieticians were available per patient. HRQOL was worse in patients that dialyzed in a university hospital and better in regional satellite units.

In the nineties, an Israeli study evaluated the differences in generic HRQOL of dialysis patients between seven centers in Tel Aviv with the Spitzer's QL-index [20]. In accordance with our results, they found that the variance in HRQOL was not entirely explained by known case-mix covariates. We now expand these results with more recent data from a larger number of dialysis centers using the KDQOL-SF, a kidney disease-specific HRQOL questionnaire that includes the SF-36.

While there is a lack of information on the differences in HRQOL between dialysis centers, multiple studies have been conducted on center variability in mortality [5–8]. Center characteristics that were related to improved survival were: pre-dialysis care [6], center access to transplantation [5], non-profit vs. for-profit [5, 7], and length of ownership [8]. It would be of interest to explore these factors in relation to HRQOL. In the Netherlands, all centers are non-profit organizations and all have access to renal transplantation. Differences in pre-dialysis care have been described [22], which may lead to differences in case-mix between centers. We did, however, adjust for case-mix, so it is unlikely that pre-dialysis care explain our findings.

The FTE of dieticians per patient was positively related to perceived dialysis staff encouragement. This might reflect patients' appreciation of dietary advice [23], the relatively large variation in dieticians' FTE per patient, or the positive relation between nutritional status and HRQOL [24]. No relevant associations were found between the FTE of other dialysis staff professionals and HRQOL. Plantinga et al. [25] showed that less frequent patient–physician contact in the United States was associated with lower patient satisfaction and with a higher non-adherence to dialysis treatment, but not with generic HRQOL, hospitalization, and mortality. We found no relation between the frequency of patient–physician contact and HRQOL, which included patient satisfaction. The discrepancy with regard to the latter result may be caused by a somewhat larger variation in the frequency of patient–physician contact in US dialysis centers as compared to The Netherlands (>4× patient–physician contacts per month: 11% in US centers

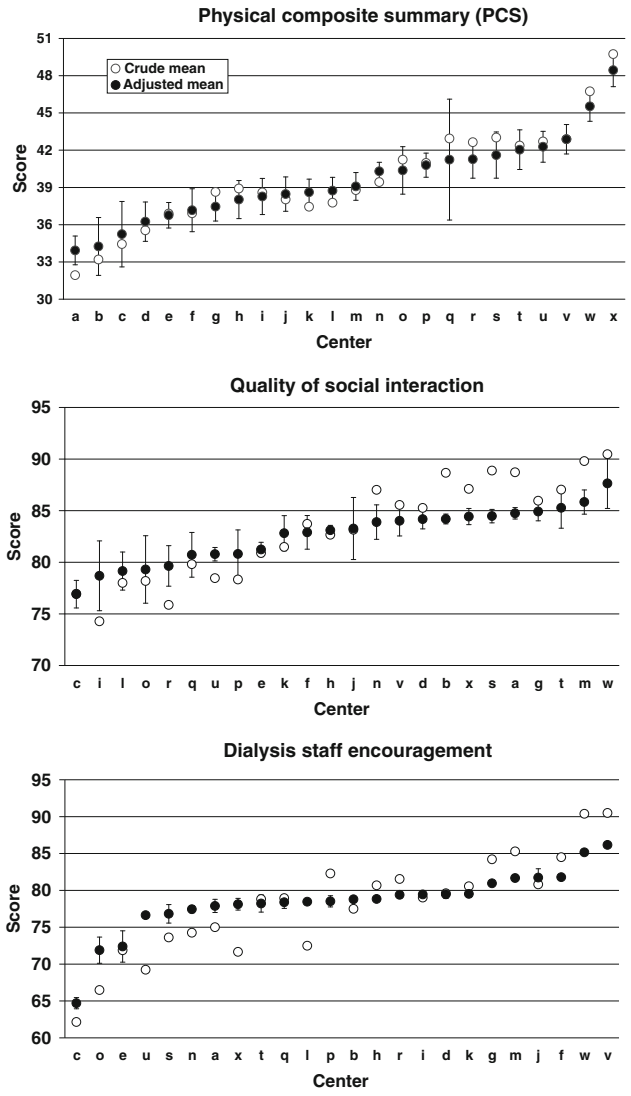

Fig. 1 Mean quality of life scores per dialysis center. Depicted are the mean quality of life scores per clinical center, both crude (*white circles*) and adjusted for case-mix covariates (*black circles*) with standard deviations. Case-mix covariates were: age, gender, race, educational status, history of cardiovascular disease, diabetes, eGFR, and time on renal replacement therapy in years. The domains have a range from 0 to 100, with higher scores indicating a preferable health status or a relative absence of problems. A difference of 5 points has been proposed to be clinical relevant with regard to individual domains, and a difference of 3 points with regard to the composite scores [18, 19]. Please note that both the scales on the *y*-axis and the ranking on the *x*-axis are different for each graph

versus 13% in Dutch; >1×/month: 71 vs. 88%; ≤1×/month: 19 vs. 0%) [25]. It should be noted that only the frequency and not the length or quality of the contact was studied. This might explain the absence of a relation with HRQOL. Furthermore, the physician is engaged in more activities than face-to-face contact to promote the care of the individual patient [25].

HRQOL was lower in patients who received dialysis in a university hospitals and higher in regional satellite units. This may indicate patient selection. For instance, patients with a higher disease burden might be urged to dialyze in a university hospital, and healthier patients may be more likely to visit a satellite facility. However, irrespective of patient characteristics, type of center may still affect HRQOL. The improved HRQOL in regional satellite units has been attributed to improved geographic access and reduced patients' travel time [26, 27]. In a study that compared in-hospital dialysis with regional satellite units ($N = 12$ centers) [26], patient satisfaction was higher in satellite units. We did not find a difference in patient satisfaction between in-hospital versus satellite dialysis, but only 2 out of 24 dialysis centers were satellite units in our analysis. A more recent analysis ($N = 9$ centers) suggested that patients in satellite units experienced less stress [27].

Adjustment for process variables did not change the differences in HRQOL between centers. Whereas a relation between serum albumin and HRQOL has been described; variable results were found for Kt/V, hemoglobin, phosphorus, and the type of vascular access [4, 20, 24, 27–34]. If anything, these results attenuate the role of medical interventions on HRQOL as perceived by dialysis patients.

A difference of 5 points has been proposed to be clinical relevant with regard to individual HRQOL domains and a difference of 3 points with regard to the composite scores [18, 19]. Figure 1 thus indicates that the differences in HRQOL between the centers not only have statistical but also clinical relevance. The largest variation was found in the perceived dialysis staff encouragement. To evaluate this domain, the patient has to value two statements on a scale of 1 (definitely true) to 5 (definitely false), namely "The dialysis staff encourages me to be as independent as possible" and "The dialysis staff supports me in coping with my kidney disease". As health promotion is the desired objective of dialysis treatment [35], it is striking that in some centers patients experience far less encouragement and support than in others. Dialysis staff encouragement has been associated with better compliance, e.g., improved adherence to dialysis treatment and improved fluid control [25, 36].

The variation in perceived dialysis staff encouragement was not explained by center characteristics like differences in the frequency of patient–physician (assistant) contacts, the amount of patients per nurse, or the FTE of nephrologists, nurses, and social workers. Future studies should evaluate other aspects of care to enhance center performance on encouragement. The variation in dialysis staff encouragement furthermore underlines the need for a regular evaluation of patient-centered care. When it is made clear that patients' perceptions on encouragement are

Table 5 Center variables and quality of life: the clinical relevant relations

	β	95% CI	*P*-value
FTE dietician per 100 patients			
Dialysis staff encouragement	7.1	0.8 to 13.5	0.03
University hospital			
Mental component summary (MCS)	−3.7	−7.1 to −0.3	0.03
Effects of kidney disease on daily life	−7.0	−11.4 to −2.6	0.002
Burden of kidney disease	−11.5	−18.9 to −4.1	0.004
Cognitive function	−8.0	−13.7 to −2.2	0.01
Quality of social interaction	−5.7	−10.6 to −0.8	0.02
Social support	−8.0	−14.0 to −2.0	0.01
Overall health	−5.1	−9.5 to −0.7	0.03
Satellite unit			
Physical component summary (PCS)	8.4	2.3 to 14.6	0.01
Symptom/problem list	8.9	1.9 to 15.8	0.01
Effects of kidney disease on daily life	9.3	1.0 to 17.7	0.03
Burden of kidney disease	15.1	1.6 to 28.6	0.03
Sleep	11.1	1.6 to 20.7	0.02

Depicted are the clinical relevant relations between center variables (determinant) and quality of life domains (outcome) i.e. $\beta \geq 3$ for composite summaries and ≥ 5 for individual domains. All comparisons were analyzed with multilevel linear models and adjusted for case-mix covariates. The β shows the amount of change in quality of life if the FTE of dieticians increases with 1 per 100 patients or if patients in a university or satellite dialysis center are compared with a non-university or non-satellite center

CI confidence interval, *FTE* fulltime-equivalent

relatively low, the dialysis staff may be motivated to make an additional effort.

This study has several limitations. First, the cross-sectional design excludes assessment of the temporal relation, and second, potential significant relations due to multiplicity should be taken into account. As this is an exploratory analysis, we refrained from an adjustment for multiple comparisons and instead facilitated the interpretation of differences found by providing quantitative measures and focusing on clinical relevance. Finally, although we have adjusted for a large amount of case-mix covariates and center characteristics, bias due to unmeasured center- and patient-level parameters may still be present. An example of this latter limitation might be the unknown rate of patient agreement to participate.

In conclusion, this study showed that between dialysis centers, relevant differences exist in HRQOL. The differences in HRQOL include both generic and disease-specific domains like perceived dialysis staff encouragement. The latter is a modifiable factor that affects compliance, which underlines that patient encouragement should be a continuous effort of the dialysis staff. Furthermore, although the number of satellites and university hospitals was relatively low, our results show a better HRQOL in the first and a worse HRQOL in the latter. Whether these findings are due to patient selection is not readily apparent from our data and should be a topic for further research.

Acknowledgments We are grateful to all patients and technical and medical staff that participated in this project. This work was made possible by a grant from ZonMw (the Netherlands Organization for Health Research and Development, grant 170882802). The CONTRAST trial is financially supported by the Dutch Kidney Foundation (Nierstichting Nederland, grant C02.2019), and unrestricted grants from Fresenius Medical Care Netherlands, and Gambro Lundia AB, Sweden. Additional support was received from the Dr E.E. Twiss Fund, Roche Netherlands, and the International Society of Nephrology/Baxter Extramural Grant Program.

Appendix

Collaborators: MG Koopman, Academic Medical Center, Amsterdam; CJAM Konings, Catharina Hospital, Eindhoven; WP Haanstra, Dialysis Clinic Noord, Beilen; M Kooistra, Dianet Dialysis Centers, Utrecht; T Noordzij, Fransiscus Hospital, Roosendaal; GW Feith, Gelderse Vallei Hospital, Ede; M van Buren, Haga Hospital, The Hague; JJG Offerman, Isala Clinics, Zwolle; EK Hoogeveen, Jeroen Bosch Hospital, 's Hertogenbosch; F de Heer, Maasland Hospital, Sittard; PJ van de Ven, Maasstad Hospital, Rotterdam; TK Kremer Hovinga, Martini

Hospital, Groningen; WA Bax, Medical Center Alkmaar, Alkmaar; JO Groeneveld, Onze Lieve Vrouwe Gasthuis, Amsterdam; ATJ Lavrijssen, Oosterschelde Hospital, Goes; AM Schrander-Van der Meer, Rijnland Hospital, Leiderdorp; LJM Reichert, Rijnstate Hospital, Arnhem; J Huussen, Slingeland Hospital, Doetinchem; PL Rensma, St Elisabeth Hospital, Tilburg; Y Schrama, St Fransiscus Gasthuis, Rotterdam; HW van Hamersvelt, University Medical Center St Radboud, Nijmegen; WH Boer, University Medical Center Utrecht, Utrecht; WH van Kuijk, VieCuri Medical Center, Venlo; MG Vervloet, VU Medical Center, Amsterdam; and IMPMJ Wauters, Zeeuws-Vlaanderen Hospital, Terneuzen.

References

1. Testa, M. A., & Simonson, D. C. (1996). Assesment of quality-of-life outcomes. *New England Journal of Medicine, 334*, 835–840.
2. Liem, Y. S., Bosch, J. L., Arends, L. R., Heijenbrok-Kal, M. H., & Hunink, M. G. (2007). 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, 10*, 390–397.
3. Valderrabano, F., Jofre, R., & Lopez-Gomez, J. M. (2001). Quality of life in end-stage renal disease patients. *American Journal of Kidney Diseases, 38*, 443–464.
4. Mittal, S. K., Ahern, L., Flaster, E., Maesaka, J. K., & Fishbane, S. (2001). Self-assessed physical and mental function of haemodialysis patients. *Nephrology, Dialysis, Transplantation, 16*, 1387–1394.
5. Garg, P. P., Frick, K. D., Diener-West, M., & Powe, N. R. (1999). Effect of the ownership of dialysis facilities on patients' survival and referral for transplantation. *New England Journal of Medicine, 341*, 1653–1660.
6. McClellan, W. M., Wasse, H., McClellan, A. C., Kipp, A., Waller, L. A., & Rocco, M. V. (2009). Treatment center and geographic variability in pre-ESRD care associate with increased mortality. *Journal of the American Society of Nephrology, 20*, 1078–1085.
7. Devereaux, P. J., Schunemann, H. J., Ravindran, N., Bhandari, M., Garg, A. X., Choi, P. T., et al. (2002). Comparison of mortality between private for-profit and private not-for-profit hemodialysis centers: A systematic review and meta-analysis. *JAMA, 288*, 2449–2457.
8. Van Wyck, D., Robertson, J., Nissenson, A., Provenzano, R., & Kogod, D. (2010). Relationship among length of facility ownership, clinical performance, and mortality. *Clinical Journal of American Society of Nephrology, 5*, 248–251.
9. Khan, I. H., Campbell, M. K., Cantarovich, D., Catto, G. R., Delcroix, C., Edward, N., et al. (1996). Survival on renal replacement therapy in Europe: Is there a 'centre effect'? *Nephrology, Dialysis, Transplantation, 11*, 300–307.
10. Fink, J. C., Zhan, M., Blahut, S. A., Soucie, M., & McClellan, W. M. (2002). Measuring the efficacy of a quality improvement program in dialysis adequacy with changes in center effects. *Journal of the American Society of Nephrology, 13*, 2338–2344.
11. Fink, J. C., Hsu, V. D., Zhan, M., Walker, L. D., Mullins, C. D., Jones-Burton, C., et al. (2007). Center effects in anemia management of dialysis patients. *Journal of the American Society of Nephrology, 18*, 646–653.
12. Huijbregts, H. J., Bots, M. L., Moll, F. L., & Blankestijn, P. J. (2007). Hospital specific aspects predominantly determine primary failure of hemodialysis arteriovenous fistulas. *Journal of Vascular Surgery, 45*, 962–967.
13. Hays, R. D., Kallich, J. D., Mapes, D. L., Coons, S. J., & Carter, W. B. (1994). Development of the kidney disease quality of life (KDQOL) instrument. *Quality of Life Research, 3*, 329–338.
14. Penne, E. L., Blankestijn, P. J., Bots, M. L., van den Dorpel, M. A., Grooteman, M. P., Nube, M. J., et al. (2005). Effect of increased convective clearance by on-line hemodiafiltration on all cause and cardiovascular mortality in chronic hemodialysis patients—the Dutch CONvective TRAnsport STudy (CONTRAST): Rationale and design of a randomised controlled trial [ISRCTN38365125]. *Current Controlled Trials in Cardiovascular Medicine, 6*, 8.
15. Daugirdas, J. T. (1993). Second generation logarithmic estimates of single-pool variable volume Kt/V: An analysis of error. *Journal of the American Society of Nephrology, 4*, 1205–1213.
16. Fouque, D., Vennegoor, M., ter Wee, P., Wanner, C., Basci, A., Canaud, B., et al. (2007). EBPG guideline on nutrition. *Nephrology, Dialysis, Transplantation, 22*(Suppl 2), ii45–ii87.
17. Korevaar, J. C., Merkus, M. P., Jansen, M. A., Dekker, F. W., Boeschoten, E. W., & Krediet, R. T. (2002). Validation of the KDQOL-SF: A dialysis-targeted health measure. *Quality of Life Research, 11*, 437–447.
18. Ware, J. E., Kosinski, M., & Keller, S. D. (1994). *SF-36 physical and mental health summary scales: A user's manual* (2nd ed.). New England Medical Center, Boston, MA: The Health Institute.
19. Ware, J. E., Snow, K. K., Kosinski, M., & Gandek, B. (1993). *SF-36 health survey-manual and interpretation guide*. Boston: The Health Institute, New England Medical Center.
20. Mozes, B., Shabtai, E., & Zucker, D. (1997). Differences in quality of life among patients receiving dialysis replacement therapy at seven medical centers. *Journal of Clinical Epidemiology, 50*, 1035–1043.
21. Donders, A. R., van der Heijden, G. J., Stijnen, T., & Moons, K. G. (2006). Review: A gentle introduction to imputation of missing values. *Journal of Clinical Epidemiology, 59*, 1087–1091.
22. van Zuilen, A. D., Blankestijn, P. J., van Buren, M., Ten Dam, M. A., Kaasjager, K. A., Ligtenberg, G., et al. (2010). Quality of care in patients with chronic kidney disease is determined by hospital specific factors. *Nephrology, Dialysis, Transplantation, 25*, 3647–3654.
23. Hollingdale, R., Sutton, D., & Hart, K. (2008). Facilitating dietary change in renal disease: Investigating patients' perspectives. *Journal of Renal Care, 34*, 136–142.
24. Mazairac, A. H., de Wit, G. A., Penne, E. L., van der Weerd, N. C., Grooteman, M. P., van den Dorpel, M. A., et al. (2010). Protein-energy nutritional status and kidney disease-specific quality of life in hemodialysis patients. *Journal of Renal Nutrition* (in press).
25. Plantinga, L. C., Fink, N. E., Sadler, J. H., Levey, A. S., Levin, N. W., Rubin, H. R., et al. (2004). Frequency of patient-physician contact and patient outcomes in hemodialysis care. *Journal of the American Society of Nephrology, 15*, 210–218.
26. Roderick, P., Nicholson, T., Armitage, A., Mehta, R., Mullee, M., Gerard, K., et al. (2005). An evaluation of the costs, effectiveness and quality of renal replacement therapy provision in renal satellite units in England and Wales. *Health Technology Assessment, 9*, 1–178.
27. Diamant, M. J., Harwood, L., Movva, S., Wilson, B., Stitt, L., Lindsay, R. M., et al. (2010). A comparison of quality of life and travel-related factors between in-center and satellite-based

hemodialysis patients. *Clinical Journal of American Society of Nephrology, 5*, 268–274.
28. Kalantar-Zadeh, K., Kopple, J. D., Block, G., & Humphreys, M. H. (2001). Association among SF36 quality of life measures and nutrition, hospitalization, and mortality in hemodialysis. *Journal of the American Society of Nephrology, 12*, 2797–2806.
29. Lopes, A. A., Bragg-Gresham, J. L., Goodkin, D. A., Fukuhara, S., Mapes, D. L., Young, E. W., et al. (2007). Factors associated with health-related quality of life among hemodialysis patients in the DOPPS. *Quality of Life Research, 16*, 545–557.
30. Merkus, M. P., Jager, K. J., Dekker, F. W., Boeschoten, E. W., Stevens, P., & Krediet, R. T. (1997). Quality of life in patients on chronic dialysis: Self-assessment 3 months after the start of treatment. The Necosad Study Group. *American Journal of Kidney Diseases, 29*, 584–592.
31. Clement, F. M., Klarenbach, S., Tonelli, M., Johnson, J. A., & Manns, B. J. (2009). The impact of selecting a high hemoglobin target level on health-related quality of life for patients with chronic kidney disease: A systematic review and meta-analysis. *Archives of Internal Medicine, 169*, 1104–1112.
32. Chiu, Y. W., Teitelbaum, I., Misra, M., de Leon, E. M., Adzize, T., & Mehrotra, R. (2009). Pill burden, adherence, hyperphosphatemia, and quality of life in maintenance dialysis patients. *Clinical Journal of American Society of Nephrology, 4*, 1089–1096.
33. Wasse, H., Kutner, N., Zhang, R., & Huang, Y. (2007). Association of initial hemodialysis vascular access with patient-reported health status and quality of life. *Clinical Journal of American Society of Nephrology, 2*, 708–714.
34. Unruh, M., Benz, R., Greene, T., Yan, G., Beddhu, S., DeVita, M., et al. (2004). Effects of hemodialysis dose and membrane flux on health-related quality of life in the HEMO Study. *Kidney International, 66*, 355–366.
35. Sadler, J. H. (1998). Health promotion for end-stage renal disease patients. *Advances in Renal Replacement Therapy, 5*, 275–285.
36. Yokoyama, Y., Suzukamo, Y., Hotta, O., Yamazaki, S., Kawaguchi, T., Hasegawa, T., et al. (2009). Dialysis staff encouragement and fluid control adherence in patients on hemodialysis. *Nephrology Nurses Journal, 36*, 289–297.
37. Carmichael, P., Popoola, J., John, I., Stevens, P. E., & Carmichael, A. R. (2000). Assessment of quality of life in a single centre dialysis population using the KDQOL-SF questionnaire. *Quality of Life Research, 9*, 195–205.