

Costs of dialysis—a regional population-based analysis

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Abstract

Background. Population-based estimates of costs of renal replacement therapy are scarce in the literature. The aim of our study was to calculate the costs of long-term dialysis in 2006 on the basis of patient-specific data from a well-defined population in a region in western Germany ($n = 310\ 757$).

Methods. Cost estimation was performed from the perspective of the statutory health insurance. All dialysis patients from the study region ($n = 344$, 54% male, mean age (\pm SD) 69 ± 13 years, 42% diabetic) were assessed for the costs of the dialysis procedures, dialysis-related hospital admissions, outpatient contacts outside of our dialysis center, dialysis-related medication, patient transportation and related costs (e.g. reimbursement fees on the basis of the German diagnosis-related group system, price scales). We estimated the cumulative cost per patient year in 2006 (in Euros), along with the 10th and 90th percentiles and the 95% confidence intervals (CI) by using bootstrapping procedures.

Results. The mean total dialysis-related cost in 2006 was 54 777 Euros (95% CI, 51 445–65 705) per patient year. The largest part of the costs (55%) was caused by the dialysis procedures, followed by the costs of medication (22%), hospitalization (14%) and transportation (8%). The total cost increased significantly with increasing age. No significant association was found between total cost and sex, dialysis strategy, end-stage renal disease duration and diabetes.

Conclusions. We present for the first time a cost estimation of dialysis in Germany on the basis of patient-level data in a population-based sample. Except age, patient characteristics were not significantly associated with costs. The largest part of the costs was caused by the dialysis procedures themselves; however, other dialysis-specific health care utilization also strongly contributed to the total cost.

Keywords: cost; dialysis; population-based study

Introduction

Incidence and prevalence of end-stage renal disease (ESRD) are increasing worldwide [1–5]. It is predicted that by the year 2010, the global maintenance dialysis population will exceed 2 million [6]. In most countries, type 2 diabetes is expected to be the most common cause of ESRD and associated with renal replacement therapy [7,8]. As of 31 December 2006, more than 90 000 patients in Germany were on renal replacement therapy, most of them on haemodialysis [9]. In the past few years, about one-third of these patients were also diabetic, with up to 50% incident cases in some regions [10]. Due to the aging of the population, a further increase of the number of patients suffering from ESRD is expected, with a growing proportion of the patients suffering from concurrent diabetes as well.

The cost for renal replacement therapy has been described to be enormous [3,6]. However, national and international estimates of the costs of renal replacement therapy from population-based studies are scarce. In Germany, only the direct dialysis costs for the year 1999 are available from a single-centre study [11], as well as a rough estimate for the year 2002, with a total expenditure of +AH455 000 Euros per ESRD patient [12]. Renal replacement therapy is considered to account for nearly 2% of all healthcare costs [11]. However, these estimates are imprecise, and more recent data are lacking.

Valid cost estimates, including the knowledge of different cost components and distribution of costs among certain patient groups, are important to evaluate cost effectiveness of prevention or treatment programmes.

The aim of our study was to calculate the costs of dialysis on the basis of patient-specific data from a well-defined population in a region in western Germany and to identify possible cost predictors. The analysis was performed from the perspective of the statutory health insurance, which almost completely covers all health care costs for this patient group.

Table 1. Unit costs of dialysis-related health care services in Germany in 2006

Unit	Unit costs (€) (mean, 10th–90th percentile)
1-week dialysis	Range: 504–560 (per week)
Additionally: 1 quarter of dialysis ^a	Range: 20–71 (per quarter)
Additionally:	15.24–18.64 (per day of dialysis)
Physician's fees per day of HD	7.62–9.32 (per day of dialysis)
Physician's fees per day of PD	
Hospital admission ^b	
Total dialysis-related, including	4874 (1704–8909) (per hospital stay)
Shunt or catheter implementation or revision	4657 (1756–8720) (per hospital stay)
Other	6046 (1321–12 839) (per hospital stay)
Medical contact outside of our dialysis centre ^c	
Total dialysis-related, including	32 (1–26) (per consultation)
Laboratory services	13 (1–25) (per consultation)
Outpatient surgery due to shunt or catheter implementation	1051 (34–3500) (per consultation)
Other	135 (49–280) (per consultation)
Drug prescriptions ^d	
Total dialysis-related, including	230 (18–764) (per prescription)
Antianemic drugs	409 (32–957) (per prescription)
Phosphate-binding drugs	86 (15–275) (per prescription)
Vitamin D3	35 (7–65) (per prescription)
Cinacalcet	240 (227–227) ^e (per prescription)
Antihypertensive drugs	37 (14–72) (per prescription)
Urokinase	53 (43–64) (per prescription)
Transportation per year (during 2006)	2765 (0–6356)

^aDialysis fees are (I) paid per week (with an additional fee in case of infection) and (II) per quarter. Covering medical care by all health care professionals and dialysis equipment; depending on age and comorbidity; weekly fees, depending on age (up to 59 years or 60 years or older: 540 vs 520 Euros in additional fees) and comorbidity (diabetic patients: 530 Euros); additional 30 Euros in case of infection. Quarterly fees ranging from 19.71 to 70.76 Euros, with additional fees for physician services, ranging between 7.86 and 18.86 Euros per day of dialysis.

^bDRG-based; individually documented; no dialysis costs included.

^cIncluding all dialysis-related services outside the dialysis center; costs based on the German general physician fees; individually documented.

^dMedication: antianemic drugs, electrolytes, vitamin D, phosphate-binding drugs, urokinase, medication for renal parathyroidism (cinacalcet) and antihypertensive medication; based on the Rote Liste (i.e. the German equivalent of the Physicians' Desk Reference); reimbursement individually documented.

^eRange: 227–612 Euros.

Materials and methods

Study design and population

The study represents a cost-of-illness study, based on a prevalence approach.

The study population comprised all patients with chronic ESRD on dialysis in an outpatient regional dialysis centre located in North Rhine-Westphalia (population $n = 310\,757$) in Germany. Patients from outside the study region as well as guest patients and patients with acute renal failure were excluded. Due to the relatively short travel distance within the study region to our center, it can be assumed that nearly all patients with chronic ESRD who required dialysis were treated in our regional dialysis centre and were thus included in our analysis. Furthermore, we consider our data complete and did not account for missing information, since no additional dialysis centres exist in the defined study region and all hospitalized patients in this region who require dialysis are treated exclusively by our study centre. Treatment of the dialysis patients from our study region in other regions of Germany rarely occurs. The nephrologists from our dialysis center cooperate with the four hospitals in our study region, and almost all patients from this region who require hospitalization due to comorbidities are admitted to these hospitals.

We assessed usage of all health care services and the costs associated with dialysis in the year 2006 from the perspective of the statutory health insurance. Thus, we only included the direct medical costs. Due to the short study period, no discounting was performed.

Variables

Patient characteristics. We summarized sex, date of birth, clinical history and clinical variables for all patients. In particular, we assessed presence of comorbidities, such as diabetes, cardiovascular disease, cancer and infections. The medical histories of renal disease and all information regarding renal replacement therapy were available for all patients.

Healthcare utilization. On the basis of a specific cost-of-illness analysis, the following categories of health care utilization related to dialysis were identified and included in our analysis: dialysis treatment in our dialysis centre, all dialysis-related hospital admissions (in particular, inpatient shunt or catheter implementations and revisions), outpatient contacts outside of our dialysis centre (in particular, laboratory tests and outpatient shunt or catheter implementations), all dialysis-related medications (in particular, antianaemia drugs, vitamin D, phosphate-binding drugs, calcimimetics and antihypertensive medication) and patient transportation to and from our dialysis centre.

Estimating costs. For the dialysis cost estimation, weekly and quarterly dialysis fees and the physician fees per dialysis day were considered according to the uniform value scale (EBM) of the German health insurance system as follows: the weekly rates differ within a small range and are dependent on patient age (up to 59 years or older) and the presence of diabetes mellitus. In the case of infection, an additional fee is paid. The quarterly fee is age dependent, too. The flat rates include all services except transportation and medication, that is, medical care performed by all health care professionals as well as dialysis equipment. Transportation and medication costs are separately reimbursed, namely, on the basis of drug prescriptions and the individual use of transportation services. In regard to transportation costs, however, we do not know the number of patient transportations, but we are reimbursed for the total annual cost for each individual patient, according to the EBM of the German health-care insurance. For estimating the cost of dialysis-related hospitalizations, patient-specific, German diagnosis-related groups (G-DRGs) were assessed by the respective hospitals (<http://www.g-drg.de>). The cost of outpatient care was assessed according to the EBM. The cost of dialysis-related medication was determined on the basis of the sale prices in 2006, subtracting pharmacy discounts and patient copayments [13].

All information about healthcare utilization and costs was collected from the medical records in our dialysis centre or was individually as-

January 1, 2006

262 patients on dialysis in the study centre
 -- one patient starting dialysis on January 1, 2006 (incident case)

During 2006**In-flow**

82 patients admitted to the study centre
 -- 69 patients starting dialysis (incident cases)
 -- 13 patients from other dialysis centers after relocation to the study region

Out-flow

84 patients leaving the study centre
 -- 6 patients due to *restitutio ad integrum*
 -- 64 patients due to death
 -- 7 patients due to renal transplantation
 -- 7 patients due to relocation out of the study region

December 31, 2006

260 patients

Overall: 344 patients during 2006, with 70 patients on incident dialysis

Fig. 1. Flowchart of study patients.

sessed from the data documented in the hospitals or medical offices where the patients received their treatments. Details are summarized in Table 1.

Statistics

The patient characteristics are described as means (SD) or prevalences with 95% confidence intervals (CI), as appropriate.

We estimated the total dialysis-related cost and also stratified for the single cost components (i.e. dialysis treatment, inpatient and outpatient care outside our dialysis centre, medication and transportation costs)

Table 2. Characteristics of the study patients (Dialysis Centre, 2006)

<i>n</i> total in 2006	344
Observation time in 2006 (days; SD, range)	278 (125, 4–365)
Sex (% male)	54
Mean age ^a (years, SD, range)	69 (13; 22–93)
Age distribution: patients aged 65 or older (%)	70
Nationality (% German)	94
Living with a partner (%)	62
Comorbidity (%) ^a	
Diabetes	42
Coronary artery disease	38
Peripheral occlusive disease	21
Stroke	17
Cancer	22
Causes of ESRD	
Diabetic nephropathy	26
Glomerulonephritis	23
Interstitial nephritis	13
Antianaemia drugs	16
Cystic kidney disease	5
Others/unknown	17
Dialysis duration and strategy	
ESRD duration (years; mean, SD, range) ^a	3.3 (5.0, 0–29.7)
Previous renal transplantation (%)	6
Only HD (%) ^b	86
Only PD (%) ^b	11
Strategy change PD/HD (%) ^b	3
Type of access (%) ^a	
Shunt	71
HD catheter	17
PD catheter	12

HD, haemodialysis; PD, peritoneal dialysis.

^aAt baseline (at beginning of 2006 or start of dialysis within 2006 for incident cases).

^bDuring dialysis within observation time.

and for the patient characteristics age, sex, duration of ESRD and presence of diabetes.

Healthcare utilization and costs per unit of healthcare were estimated by proportions and means with 10th and 90th percentiles. Despite the usual skewness in the distribution of costs, it is the arithmetic mean that is the most informative measure. Measures other than the arithmetic mean do not provide information about the total costs that will be incurred by treating all patients, which is needed as the basis for healthcare policy decisions [15].

We estimated the cumulative cost per patient year in 2006 by dividing it by the proportion of the actual observed days. In this calculation, the costs for shunt or catheter implementation before start of dialysis were included as original values and were not divided by the proportion of observed days. We calculated the costs as means with 10th and 90th percentiles and 95% CI by using bootstrapping procedures (i.e. bias-corrected accelerated bootstrap CI), making no specific distributional assumptions regarding costs.

To estimate the association between dialysis-related cost and the patient characteristics sex, age (continuous, at baseline), duration of ESRD (at baseline) and diabetes, a generalized linear model with a logarithmic link function for cost as a dependent variable was fitted, adjusting for the observation time (that is, time of dialysis in 2006). In another model, we included haemodialysis (HD) or peritoneal dialysis (PD) as additional variables.

All analyses were performed in the whole population and were stratified for sex and two age groups (i.e. <65 years of age and 65 years of age or older).

All analyses were performed using SAS version 9.2 TS2M0 or STATA10.1.

Results**Study population**

In 2006, a total of 344 patients were on dialysis treatment in our study centre. Two hundred sixty-two were on treatment on 1 January 2006, 82 patients were additionally included in our centre later in the year and 84 patients left the centre during 2006. Thus, 260 patients were on dialysis by 31 December 2006. Of the 82 patients entering the centre, 70 patients were on incident dialysis (see flowchart in Figure 1). Thus, as of 31 December 2006, the 1-year prevalence (2006) was 1107 per million (95% CI, 993–1230), and the point prevalence was 837 (738–945) per million patient years. Seventy of the 344 patients started their incident dialysis in 2006, yielding an incidence of 225 (172–278) per million patient years. The mean observation time per patient was 278 days (i.e. 9.1 months).

Thirteen patients relocated to the study region, and seven patients relocated out of it in 2006 [overall relocation rate, $n = 20$ (5.8%)]. Thus, we consider the recording of all dialysis treatments in our study population to be almost complete.

Fifty-four percent of the patients were male, with most of them (70%) being 65 years of age or older. Diabetic nephropathy was the most common cause for ESRD. Nearly 90% of the patients were on haemodialysis, and nearly 40% of the patients had cardiovascular comorbidities. About 40% of the patients had diabetes, mostly type 2. From the 70 incident patients, 34 (49%) suffered from diabetes. Additional patient characteristics are shown in Table 2.

Utilization of dialysis-related healthcare

As previously defined, all study patients received dialysis treatment in our dialysis centre. Thirty-two percent of the

Table 3. Dialysis-related healthcare utilization within the study population in 2006

	Mean units per patient year ^a (10th–90th percentile)
Weeks of dialysis	51.8
Hospital admissions	
Total dialysis-related, Including	1.5 (0.0–3.4)
Due to shunt or catheter implementation or revision	1.4 (0.0–3.0)
Medical contacts outside the dialysis center	
Total dialysis-related, Including consultations	30.1 (10.0–47.9)
Laboratory services	29.3 (9.7–47.6)
Outpatient surgery due to shunt or catheter implementation or revision	0.3 (0–1.0)
Drug prescriptions	
Total dialysis-related, Including	49.2 (17.4–81.0)
Antianemic drugs	25.0 (4.0–42.0)
Phosphate-binding drugs	6.1 (0.0–16.0)
Vitamin D3	5.7 (0.0–10.9)
Cinacalcet	1.4 (0.0–5.0)
Antihypertensive drugs	9.8 (0.0–24.0)
Urokinase	1.3 (0.0–0.0)
Transportation in 2006	– ^b

^aMean of units per individual patient years (for each patient).

^bOnly total reimbursement in 2006 available.

patients were at least once admitted to the hospital in 2006 due to dialysis-related issues, that is, mostly shunt or catheter implementation or related problems (i.e. 27% of the patients or 84% of all hospital admissions). Of these 32% hospitalized patients, 31% were admitted more than

once, that is, up to nine times per patient year. The most frequent specific indications were shunt revision, PD-catheter implementation, shunt and HD-catheter implementation [G-DRGs: 5–394.5 (24% of all hospital admissions), 5–549.2 (13%), 5–392.1 (11%) and 5–399.5 (10%)]. A total of 97% of the patients received outpatient care outside of our dialysis centre, mostly in form of laboratory services (97%) or surgery (15%). Ninety-seven percent of the patients received dialysis-related medication, namely, antianaemia drugs (93%), phosphate binders (65%), vitamin D (86%), antihypertensive drugs (83%), cinacalcet (16%) and urokinase (9%). Seventy-nine percent of the patients were reimbursed for transportation costs to and from the dialysis center. Table 3 presents the mean units of healthcare utilization per person year in the study population, along with 10th and 90th percentiles. Notably, the mean may be larger than the 90th percentile if, for example, only few patients with high values are analysed, so that the mean is larger than the 90th percentile. In the case of patients receiving urokinase, for example, only 9% received this treatment and thus the 90th percentile is zero.

Dialysis-related costs

The dialysis-related costs are summarized in Table 4. The mean total dialysis-related cost in 2006 was 54 777 (95% CI, 51 445–65 705) Euros per patient year, with men accounting for 52 149 (95% CI, 49 883–55 770), women for 57 853 (95% CI, 51 527–77 453), patients aged ≤65 years for 49 254 (95% CI, 46 254–55 252) and patients aged 65 years or older for 57 180 (95% CI, 52 956–71 957) Euros. The largest part of the costs (55%) was caused by the dialysis procedures, followed by medication costs, whereby antianaemia drugs account for the largest part of these costs. Hospitalization accounted for

Table 4. Dialysis-related costs per capita of the study population and per patient year in 2006

	2006 costs per patient year (€): mean (10th–90th percentile)	Proportion (%) of costs per patient year
Dialysis procedure	30 029 (29 100–30 894)	54.8
Hospitalization		
Total	7761 (0–14 361)	14.2
Including		
Hospitalization due to shunt or catheter implementation or revision	7159 (0–13 727)	
Outpatient care outside the dialysis centre		
Total	724 (115–1724)	1.3
Including outpatient care due to		
Laboratory services	425 (114–716)	
Surgery due to shunt or catheter implementation	231 (0–48)	
Medication		
Total	12 074 (2677–22 356)	22.0
Antianaemia drugs	10 622 (1434–21 556)	
Phosphate-binding drugs	499 (0–1332)	
Vitamin D3	203 (0–390)	
Cinacalcet	330 (0–1134)	
Antihypertensive drugs	354 (0–813)	
Urokinase	66 (0–0)	
Transportation costs to and from our dialysis centre	4170 (0–7482)	7.6
Total cost 2006	54 777 (36 476–72 685)	100

Table 5. Association between dialysis-related costs and sex, age, duration of ESRD, diabetes and observed dialysis time in 2006

	Relative cost differences (%) (95% CI ^a)
	Total dialysis-related costs
Sex (male versus female)	0.96 (0.91–1.01)
Age (change per 10 years) ^b	1.03 (1.01–1.05)*
ESRD duration (change per 3 years) ^b	0.99 (0.98–1.01)
Diabetes (yes versus no)	1.04 (0.98–1.10)
Time of dialysis in 2006 (i.e. observation time) (change per 30 days) ^b	1.12 (1.11–1.13)*

^aResults from generalized linear regression with log-link function * $P < 0.05$.

^bAge, ESRD duration and time of dialysis in 2006 are included as continuous variables in the model. However, for better interpretation, we present the relative changes per 10 years, 3 years or 30 days.

14% of the per-patient-year costs, with shunt or catheter implementation or revision as the most frequent reasons. The largest part of the costs for outpatient care provided outside of our dialysis centre was caused by surgery due to shunt or catheter implementation. Again, the mean costs here may be larger than the 90th percentile in case only a few patients with high values are affected.

Overall, cost differences between men and women or between patients aged younger than 65 years and older were particularly pronounced in regard to hospitalization and transportation. Women caused higher mean hospitalization costs than men (10 610 versus 5341 Euros) and higher mean transportation costs (4632 versus 3776 Euros). Patients aged 65 years or older caused higher mean hospitalization costs than patients aged younger than 65 years (9038 versus 4815 Euros) and higher mean transportation costs (4909 versus 2472 Euros).

Cost predictors

The results from the generalized linear regression models are presented in Table 5. Besides time on dialysis in 2006, which is equivalent to the observation time, only age was significantly associated with costs, with increasing costs associated with increasing age. No significant associations were found for sex, presence of diabetes and dialysis duration. Also dialysis strategy (PD or HD) was not significantly associated (data not shown).

Discussion

Study findings

For the first time, we present the costs of dialysis in 2006 in a defined region in Germany on the basis of patient-level data from a population-based sample. Incidences and prevalence in our study region were highly comparable with the German data of the nationwide QUASI Niere Documentation (point prevalence as of 31 December 2006: 808 per million; incidence in 2006, 213 per million

[9]). Also our distribution of the causes of ESRD is were highly comparable with German nationwide data.

As expected, the largest part of costs was caused by the dialysis procedures (55%). However, other dialysis-related healthcare utilizations had a surprisingly high cost impact, accounting for nearly half of all dialysis-related costs. We found a significant association between dialysis-related direct costs and age but not for sex, dialysis strategy, ESRD duration and diabetes. Age may be significantly related due to higher dialysis reimbursement fees for older patients. Interestingly, diabetes is not significantly associated with dialysis cost. Also, dialysis reimbursement fees are higher for diabetic patients; however, they are only 10 Euros for the majority of individuals aged 59 years or older. Furthermore, we assessed only dialysis-related costs and did not consider costs caused by other reasons, for example, hospitalization due to diabetic complications [14]. Not surprisingly, the observation time, that is the time on dialysis during 2006, was also significantly associated with costs.

Comparison with other studies

Comparisons with other studies are difficult because of largely differing study designs and denominators. In many studies, economic evaluations were performed from the perspective of healthcare purchasers, based on expenditures and not on reimbursement, but in other studies the perspective was not clear. Generally, studies from different countries are difficult to compare because of differences in patient management and in health care reimbursement systems.

In Germany, routinely collected administrative data on costs for dialysis are lacking. We found only two studies that estimated dialysis costs. Kleophas and Reichel [12] estimated the cost per dialysis patient for the year 2002. For their cost estimates, they did not assess patient-specific data, however, but used routine data from ad hoc expert conferences and from several studies investigating resource utilization of dialysis patients. Data of the dialysis patient population were collected from the QUASI Niere documentation. The mean total cost per patient year was 53 613 Euros in 2002, with 62.5% accounting for the dialysis procedures, +AH413% for hospitalization, 9% for erythropoietin, 7.5% for other medication and 8.5% for non-dialysis physician services. Thus, in spite of comparable costs per patient year as in our study, the methods for assessing health care utilization differed largely (no patient-specific assessment, inclusion of hospitalization and medication not related to dialysis and missing reimbursement fees for patient transportation). That may be the reason for the differences in the cost distribution in both studies: the proportion of costs for dialysis was higher in 2002 compared with our calculated costs in 2006, although the dialysis fee was lower in 2006 than in 2002. This may be in part due to higher costs accompanying dialysis in 2006. In particular, we found a higher percentage of medication costs.

A second study that estimated costs in ESRD patients in 1999 was performed by Nebel [11]. They based their analysis on 250 patients from one center. They found costs per

patient to be between +AH430 000 and 43 000 Euros, including costs unrelated to dialysis treatment. However, the approach was not dialysis specific, and healthcare organization and financing changed greatly in the past 10 years.

Limitations

Our study has several limitations. First, we based our analysis on the population of a small region in Germany. However, incidence, prevalence and patient characteristics with respect to age distribution and cause for ESRD were comparable with the ESRD population in the entire country. There are, however, some differences in regard to dialysis treatments between our study region and the entire country: within the study region, all dialysis is offered only in our outpatient facility, not in hospitals. In the case of hospitalization, however, dialysis treatment is still performed by our dialysis center. Hospital-based dialysis services are reimbursed per dialysis procedure, not by flat rates. Those rates are usually higher than the rates applying for outpatient facilities. However, only +AH410% of the dialysis patients in Germany receive dialysis treatments in hospitals [9]. Furthermore, the proportion of patients on PD in our study centre is higher (+AH411%) than the proportion of PD patients in the whole country (+AH44%) because our study centre encourages patients to choose PD. However, the costs are quite comparable: the costs for HD (2600 Euros), PD catheter implementation (3200 Euros) and shunt implementation (3500 Euros) differ, but the weekly flat rates are the same for HD and PD. The proportion of patients with shunts in our study population was lower (+AH470%) as described for Germany in 2002/2003 (+AH485%) [16], which may be due to the higher proportion of PD patients in our study population. However, costs for shunt or catheter implementation occur only for incident patients in 2006; therefore, cost bias should be negligible.

The most important limitation of our study is the definition of dialysis-related costs. The best way to estimate excess cost that can be attributed to ESRD is to evaluate patients with and without ESRD and to estimate the relative cost increase, e.g. by using data from the statutory health insurance. However, we had the opportunity to evaluate a regionally defined complete sample of patients on dialysis, and to assess individual health care resource usage and costs, leading to valid cost calculations. Performing a similar detailed assessment of health care usage and related costs was not possible for a control group without ESRD in our study region.

Conclusion

For the first time, we present costs of dialysis in Germany from the perspective of the statutory health insurance, based on patient-level data in a population-based sample. We found the mean total cost to be +AH455 000 Euros per patient year in 2006. We found no significant associations between dialysis-related direct costs and age, sex, ESRD duration and diabetes. Only time on dialysis in the study

year and age were significantly associated. This finding may be explained by the fact that age is considered through higher dialysis reimbursement fees since older patients cause higher accompanying costs. The largest part of costs was caused by the dialysis procedures themselves; however, additional dialysis-specific health care utilization had a surprisingly high-cost impact as well.

Acknowledgments. The German Diabetes Centre is institutionally funded by the German Ministry of Health and the Northrhine Westphalian Ministry of Education and Science. We thank the Nieren-und Hochdruckforschung e.V. Mettmann foundation for their unrestricted grant. We also thank Silke Haidekker, PhD, ELS, for reviewing the manuscript and her assistance in revising the English language.

Conflict of interest statement. All authors state that they have nothing to declare.

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Received for publication: 17.7.09; Accepted in revised form: 16.11.09