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Original Article

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Variability in quality of care among dialysis units in western Switzerland

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Abstract

Background. Quality indicators for dialysis care vary across countries and regions, but regional variability across centres has received little attention. We analysed variations in quality indicators among dialysis facilities in western Switzerland to identify opportunities for improving care for patients with end-stage kidney disease.

Methods. A cross-sectional study of 617 dialysis patients treated at 19 facilities examined the distribution of indicators of quality of care addressing: adequacy of dialysis (Kt/V $\geq$1.2 for haemodialysis, Kt/V $\geq$2 for peritoneal dialysis), anaemia control (haemoglobin $\geq$110 g/l), calcium and phosphate control (product $\leq$4.4 mmol^2/l^2), adequate nutrition (serum albumin >35 g/l), hypertension control (predialysis blood pressure <140/90 mmHg) and type of vascular access. Centre quality targets were the following: achievement of quality criteria for 80% of their patients, except 85% for anaemia control and 60% for arterio-venous fistulae.

Results. Most centres fulfilled quality targets for dialysis adequacy, but substantial variations existed among centres (haemodialysis, 76%, range 36–100; peritoneal dialysis, 76%, range 33–100). Results were similar for anaemia (77%, range 35–100), calcium $\times$ phosphate product (69%, range 29–92), albumin (63%, range 26–95), hypertension control (33%, range 13–54) and arterio-venous fistula (61%, range 49–92). The between-centre variability was significantly greater than would be expected by chance, for all indicators. Dialysis facilities with >40 patients better fulfilled quality targets than university-based centres. Adjustment for patient characteristics did not modify these results.

Conclusions. Substantial variations in quality indicators existed between dialysis centres in western Switzerland, which could not be attributed to different centre policies, or to differences in available measures of patient case mix. These findings indicate opportunities for improvement in dialysis practice which may translate into improved clinical outcomes.

Keywords: dialysis; end-stage renal failure; quality assessment; quality of care

Introduction

The quality of care provided to dialysis patients is under increasing scrutiny. Since the 1990s, dialysis practice guidelines have been developed and disseminated, both in the USA [1,2] and in Europe [3,4], and systematic measurements of clinical performance, relying on indicators such as levels of Kt/V, haematocrit and serum albumin, have been implemented. These indicators have gained acceptance both because they reflect the quality of relevant health care processes (i.e. amount of dialysis, treatment of anaemia, nutrition level) and because they correlate with patient mortality and morbidity [5–7].

Earlier studies have revealed striking regional differences in the distributions of such indicators, both across dialysis networks in the USA [8] and among countries in international comparisons [9]. The differences are not fully explained by patient characteristics, suggesting variations in the quality of

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care. However, studies that focus on regional or national averages fail to capture possible differences in quality indicators between dialysis centres within a given region. Between-centre variations in quality of care have received only limited attention so far. In particular, a recent study has shown that the implementation of a quality improvement programme reduces between-centre variability in quality indicators [10]. Understanding between-centre variability in clinical performance is important for the identification of best practices in dialysis care.

The aim of the present study was to compare quality of care indicators between dialysis facilities in an area—western Switzerland—where access to health care is virtually unrestricted, and where the population is culturally and ethnically homogenous. Furthermore, we adjusted these comparisons for patient characteristics, in order to clarify whether patient case mix could explain part of the observed differences in quality indicators.

Subjects and methods

Setting

Western Switzerland has a population of ~1.7 million inhabitants. The prevalence of dialysis treatment for end-stage renal disease (ESRD) is between 329 and 476 per million inhabitants [11]. Twenty-one dialysis units (18 in the French-speaking area and three in the German-speaking area) treat patients with ESRD. Three units are privately owned, 16 are in the public sector and two belong to tertiary care hospitals.

Study design

A cross-sectional evaluation of all patients with end-stage renal failure (ESRF) on all forms of chronic dialysis was performed in March 2001 for the 18 French-speaking centres and in June 2001 for the three German speaking-centres. Two months prior to the study, a resource guidebook was provided to the centres, containing selected internationally recognized guidelines and recommendations on dialysis quantity and modalities, anaemia, nutritional status, calcium and phosphate metabolism and vascular access [3,12–15]. A multidisciplinary team of the University Hospitals in Geneva and Lausanne led this project. Participation of all dialysis centres was voluntary. The project was approved by the research ethics committees of the Universities of Lausanne and Geneva.

Data collection

We collected patient-level data by means of a questionnaire, completed by the centre team based on each patient's medical and nursing records, and centre-level data using a questionnaire, completed by the medical director and head nurse. In addition, patients filled in a self-report questionnaire regarding their satisfaction with their care and health status, the results of which will be reported elsewhere.

Patient-level data

Quality criteria were defined for individual patients in six domains of clinical care:

1. Dialysis adequacy: for haemodialysis patients, the Kt/V was calculated using the single pool Daugirdas II method, based on post-dialysis plasma samples drawn after slowing the blood pump to 50 ml/min for 2 min; a sp (single pool) Kt/V $\geq$1.2 was considered adequate. For peritoneal dialysis patients, weekly Kt/V and creatinine clearances were determined according to classical kinetic modelling of peritoneal transport, and a weekly Kt/V $\geq$2 was considered adequate.
2. Appropriate anaemia management: assessed by achieved levels of haemoglobin or haematocrit. A haemoglobin $\geq$110 g/l or a haematocrit $\geq$33% were considered adequate. When several measures were recorded during the past month, the average was used for the determination.
3. Calcium and phosphate metabolism: assessed by the calcium $\times$ phosphate product. A value of $\leq 4.4\ \text{mmol}^2/\text{l}^2$ was considered to be adequate using pre-dialysis serum calcium and phosphorus levels.
4. Nutrition: assessed by the serum albumin. A level >35 g/l was considered to be a criterion of good nutrition.
5. Vascular access: defined by the the presence of a native arterio-venous fistula, a synthetic graft or a catheter. Dialysis via a native arterio-venous fistula was considered optimal.
6. Hypertension was defined as a mean pre-dialysis blood pressure over 1 week of >140/90 mmHg.

To better understand the aetiology of possible deviations from the recommended criteria for some of the quality indicators, we also recorded the mean dose of recombinant human erythropoietin per week and its mode of administration, measurements of ferritin and transferrin saturation, levels of serum alkaline phosphatase and serum intact parathormone (PTH), use of phosphate binders and vitamin D, the body mass index, and the date of creation and type of vascular access (arterio-venous fistula, graft, tunnelled and non-tunnelled catheters).

Finally, we also requested for each patient descriptive and clinical data: age, gender, time on renal replacement therapy, current dialysis modality, pre-dialysis nephrologist referral, placement on waiting list for transplantation, cause of renal failure and presence of medical conditions that allow computation of the modified Charlson co-morbidity index. This index gives a score of 1 for all forms of coronary artery disease as well as congestive heart failure, peripheral vascular and cerebrovascular diseases, dementia, chronic pulmonary disease, connective tissue disorder, peptic ulcer disease, mild liver disease and diabetes. Hemiplegia, diabetes with organ damage, any tumour, leukaemia and lymphoma received a score of 2. Moderate or severe liver disease were scored 3, and AIDS or metastatic solid tumour were scored 6. We added 2 for ESRF and 1 for each decade >40 years of age. This index was recently validated for predicting outcomes and costs in dialysis patients [16].

Centre-level data

Centre-level data were obtained by averaging values across all patients treated by each centre. Percentages of patients

Table 1. Standards for routine clinical practices and implementation in 21 dialysis centres in western Switzerland, 2001 (Chateau d'Oex and Néphrologie Pédiatrique CHUV centres are included in this analysis)

Routine practices	Frequency suggested according to [4], [9], [12], [13], [15]	Centres with criteria fulfilled
Dialysis adequacy		
Haemodialysis: Kt/V measurement	Monthly	14/21
Peritoneal dialysis: measurement of weekly Kt/V and creatinine clearance	Every 4 months	1/9
Anaemia management		
Haemoglobin and/or haematocrit measurement	Monthly	21/21
Iron stores measurement	Every 3 months	21/21
Prevention of hyperparathyroidism		
Calcium measurement	Monthly	19/21
Phosphate measurement	Monthly	19/21
PTH measurement	Every 6 months	16/21
Nutritional assessment		
Serum albumin measurement	Monthly	5/21
Nutritional assessment by at least two methods	Every 6 months	10/21
Vascular access monitoring		
Physical examination	Weekly	11/21
Fistula/graft flow monitoring	Every 2 months	5/21
Blood pressure control		
Blood pressure measurement	At each session	21/21

expected to fulfil a quality criterion (quality targets) were derived from Canadian and European guidelines for anaemia management (85%) and native fistula prevalence (60%). They were set arbitrarily to 80% for dialysis adequacy, calcium and phosphate metabolism, and nutrition.

Furthermore, we obtained a description of each centre for routine clinical practices such as target dose of delivered dialysis, anaemia treatment, calcium/phosphorus management policies, vascular access monitoring and blood pressure control (Table 1).

Patient census, medical staffing and nursing workload were recorded as well as the main interventions for each quality indicator (mean erythropoietin dose for anaemia correction, dietitian support for albumin and control of $Ca \times P$ product, dialysis duration and fistula prevalence for dialysis adequacy (Table 2). Centres were also classified into three categories: University-based centres, centres with $\geq$40 patients and centres with <40 patients.

Data analysis

For dichotomous patient-level variables, such as whether a patient fulfils a given quality criterion, we report centre-level proportions in the total patient population, as well as the mean proportion in each centre, and the mean and SD of centre means. The centre means and SDs were weighted in proportion to the centre census size. For continuous variables, we report the mean and SD, or quantiles (25th, 50th and 75th) for skewed distributions.

We used logistic regression modelling to determine if patient characteristics influenced between-centre comparisons. The dependent variable was the fulfilment of each quality of care criterion, and the regression coefficients for each centre were adjusted for patient age, gender, duration of dialysis and Charlson co-morbidity index. We derived the adjusted proportions of patients who fulfilled each quality criterion from these models. Then, we computed a Pearson correlation coefficient between the unadjusted and the adjusted proportions. To take into account intra-centre characteristics, we performed an analysis that considered each centre as a cluster of observations using a generalized estimating equation. This procedure estimates SEs that are corrected for lack of independence between observations.

All data analyses were performed using SPSS for Windows (version 11.0, Chicago, IL) and Stata (version 8.2; College Station, TX).

Results

Data collection

Data were obtained from all 21 centres in western Switzerland. Demographic, clinical and laboratory information was recorded by centre nurses and nephrologists for all 617 patients dialysed in March (French-speaking centres) and June 2001 (German-speaking centres). Data from two centres treating only one patient at the time of the survey (Château d'Oex and Division de Néphrologie Pédiatrique, CHUV Lausanne) were aggregated to those of the CHUV Lausanne for the purpose of analysis. Retrieval of data for individual patients took between 25 and 45 min per patient. Patient questionnaires were verified for missing or improbable data (30% of the questionnaires), which were subsequently added or rectified.

Centre characteristics

Centres treated a median of 23 haemodialysis patients (range 6–75), and were equipped with a median of 10 dialysis beds (range 3–26, total 190). There were two University-based centres which treated 158 patients in total, five centres with $\geq$40 patients which treated 238 patients and 12 centres with <40 patients which treated 221 patients. In the nine units performing peritoneal dialysis, a median of six peritoneal dialysis patients (2–23, total 64) were treated per centre. Median nursing workload was 54 dialysis sessions/nurse/month (range 33–68).

Median medical staffing was 0.5 physician/10 patients (range 0.1–1.1) (Table 2).

All units had reverse osmosis-based, water preparation systems, and all implemented mixed (heat and chemical) disinfection procedures of the water treatment system. Routine measures for infection prevention (vascular access care, patient isolation and vaccination procedures) were comparable among the centres, but routine vaccination against pneumococcus was implemented in only nine centres. Only one centre had a dialyser reuse policy. The target dose of delivered dialysis (sp Kt/V) was $\geq$1.2 for 17 centres, $\geq$1.4 for three centres (one centre did not specify a target dose)

Table 2. Centres' human resources and main parameters of intervention for each quality indicator

Patients (n) by centres	Staffing		Absence of anemia (Hb ≥ 110)		Albumin > 35g/L[1] and Ca × P < 4.4 mmol^2/L^2			Dialysis adequacy (KT/V > 1.2)			BP controlled (mean BP < 140/90)		Fulfilled criteria
	Physician/ 10 patients	Dialysis/ nurse/mo	(%)	Mean ePo Dose (IU/kg/wk)	(%)[1]	(%)[2]	Dietitian Support (%)	(%)	Dialysis time (mn/session)	Fistula (%)	(%)	Classes of anti-hypertensives	
57	0.5	33	89	127 ± 92	81	75	51	82	238 ± 14	61	41	1.4 ± 1.4	4
6	0.8	48	100	166 ± 101	67	67	66	67	240 ± 0	83	17	1.3 ± 0.8	2
27	0.2	60	81	143 ± 111	26	65	19	91	230 ± 24	67	35	1.48 ± 1.2	2
46	0.2	68	83	107 ± 85	89	63	4	83	185 ± 12	54	31	0.78 ± 0.9	2
89	0.5	57	74	134 ± 118	66	70	24	74	199 ± 21	65	26	1.20 ± 1.3	1
50	0.6	45	88	128 ± 89	90	73	32	90	225 ± 17	58	40	1.93 ± 1.1	3
69	1.1	54	74	175 ± 129	30	59	42	58	220 ± 26	49	52	1.56 ± 1.3	0
17	0.7	50	35	79 ± 31	76	59	47	76	189 ± 36	71	12	2.38 ± 1.1	1
14	0.1	52	79	109 ± 76	79	29	7	71	201 ± 27	64	21	1.91 ± 1.2	1
40	0.3	37	85	174 ± 137	95	70	65	70	245 ± 31	74	31	1.43 ± 1.1	3
10	0.2	49	90	107 ± 87	70	90	0	70	203 ± 28	50	50	1.43 ± 1.0	2
20	0.6	59	40	157 ± 116	35	86	45	75	208 ± 28	60	60	2.31 ± 1.4	2
26	0.3	55	81	85 ± 52	38	92	8	96	282 ± 93	58	54	1.64 ± 1.1	2
27	0.1	56	59	111 ± 63	56	85	11	78	219 ± 28	54	39	2.00 ± 1.1	1
45	0.8	58	82	107 ± 76	71	69	4	78	228 ± 34	62	39	1.34 ± 1.2	1
22	0.5	46	41	298 ± 202	5	50	50	36	210 ± 26	77	64	1.64 ± 0.9	1
18	0.2	65	94	127 ± 66	35	67	6	56	191 ± 20	39	39	1.46 ± 1.1	1
15	0.9	41	80	101 ± 52	40	53	100	93	240 ± 0	92	38	0.33 ± 0.5	2
19	0.3	67	89	102 ± 129	78	76	37	95	100 ± 18	53	24	1.17 ± 1.1	2

and/or URR ≥65% in all units. All centres treated anaemia with erythropoietin (subcutaneously in 94% of the patients) and intravenous iron, with a target haemoglobin of 110 g/l in 15 centres and 100 g/l in four centres (two centres did not specify a target dose). Iron stores were considered adequate when the ferritin level was >200 IU/l in 13 centres. All centres aimed to maintain serum phosphorus levels below 2 mmol/l and calcium levels between 2.25 and 2.50 mmol/l, with the help of phosphate binders and vitamin D. Aluminium salts were not used routinely. As no specific guidelines on blood pressure control in dialysis patients were available at the time of the study, hypertension control was characterized as a pre-dialysis blood pressure of <140/90 mmHg according to JNC VI.

Patients characteristics

Almost all patients (98%) were Caucasian, a slight majority was male, and the mean age was 64 years (Table 3). Hypertensive nephropathy was the leading cause of ESRD, and vascular disease was the most prevalent co-morbid condition. Diabetes was diagnosed as the main cause of ESRD in 15% of our patients but, when included as a co-morbidity factor, was present in nearly one-third of them. The mean modified Charlson index was 7.6 (SD 3.1).

Two out of five patients were referred late for dialysis (late referral was defined as <1 month prior to implementing dialysis) (Table 3). Most patients were treated by haemodialysis, and the median duration of renal replacement therapy was 3 years. The mean haemodialysis duration was 218 min/session.

Table 3. Demographic characteristics of dialysed patients in western Switzerland (March 2001)

No. of patients	617
Age (years, mean ± SD)	63.7 ± 15
Patients >70 years old (%)	39.9
Male gender (%)	62
Late referral (%)	37.8
Causes of renal failure (%)	
Hypertensive nephropathy	31
Diabetes (unique diagnosis)	15
Glomerulonephritis	15
Interstitial nephritis	14
Polycystic kidney disease	11
Others	16
Smokers (%)	21
Physical disability (%)	17
Cerebrovascular disease/coronary heart disease/peripheral vascular disease (%)	53
Cancer (%)	14
Diabetes (%)	28
Body mass index between 20 and 25 (%)	48
Body mass index <20 (%)	14
Modified Charlson's co-morbidity index (mean ± SD)	7.6 ± 3.1
Patients on the waiting list for transplantation (%)	21
Patients hospitalized in the previous 3 months (%)	36

Quality of care indicators

For all six indicators, the majority of patients satisfied the individual quality criteria, with proportions ranging from 61% (arterio-venous fistula) to 77% (for anaemia control), save for control of hypertension which was only 33% (Table 4). However, the conformity rate varied considerably across centres (Figure 1). This variation was statistically significant for all indicators (all $P < 0.001$). Less than half of the dialysis centres fulfilled each of the centre quality targets (Table 4). Overall, no centre fulfilled all six centre quality targets, one (5%) fulfilled four targets, three (16%) fulfilled three targets, nine (47%) fulfilled two targets, five (26%) fulfilled one target and one (5%) centre fulfilled none.

Case mix

Fulfilment of individual quality criteria varied little with patient characteristics (Table 5). Older patients and women had a higher calcium × phosphate product than younger patients and men. Women also had fewer native arterio-venous fistulae. Patients with the highest co-morbidity score were more anaemic and those with a duration of dialysis >2 years were more adequately dialysed but more likely to have low albumin levels. Blood pressure control was inadequate in >66% of our patients and was inversely correlated with the Charlson score for co-morbidities.

Table 4. Overall results of indicators of quality for patients and centres in western Switzerland (March 2001)

Criterion	Mean (SD, range)	Individual target for quality criterion	Proportion of patients fulfilling target	Centre quality target	Mean (SD, range) of weighted centre means	No. of centres fulfilling target
Kt/V (HD patients)	1.37 (0.3, 0.4–4.28)	≥1.2	400/529 (75.6%)	≥80% of patients	75.6 (9.0, 36–100)	8/19
Kt/V (PD patients)	12.48 (0.8, 1.5–6.2)	≥2.0	42/55 (76.4%)	≥80% of patients	76.4 (13.7, 33–100)	6/9
Haemoglobin or haematocrit	119 (12.5, 73–151) or 35.9 (3.7, 21–46)	≥110 mg/dl or ≥33%	473/617 (76.7%)	≥85% of patients	76.7 (7.7, 35–100)	6/19
Calcium × phosphate product	3.9 (1.1, 0.7–8.7)	≤4.4 $mmol^2/l^2$	420/610 (68.9%)	≥80% of patients	68.9 (5.5,29–92)	4/19
Albumin	36.1 (5.9, 13–72)	≥35 g/l	386/610 (63.3%)	≥80% of patients	63.3 (9.0, 26–95)	4/19
Native AVF prevalence	–	Prevalent	336/553 (60.8%)	≥60% of patients	60.8 (5.6, 49–92)	9/19
Blood pressure control	145/77 (21/12, 70–220/37–114)	≤140/90	201/617 (32.6%)	≥80% of patients	32.6 (9.0, 13–54)	0/19

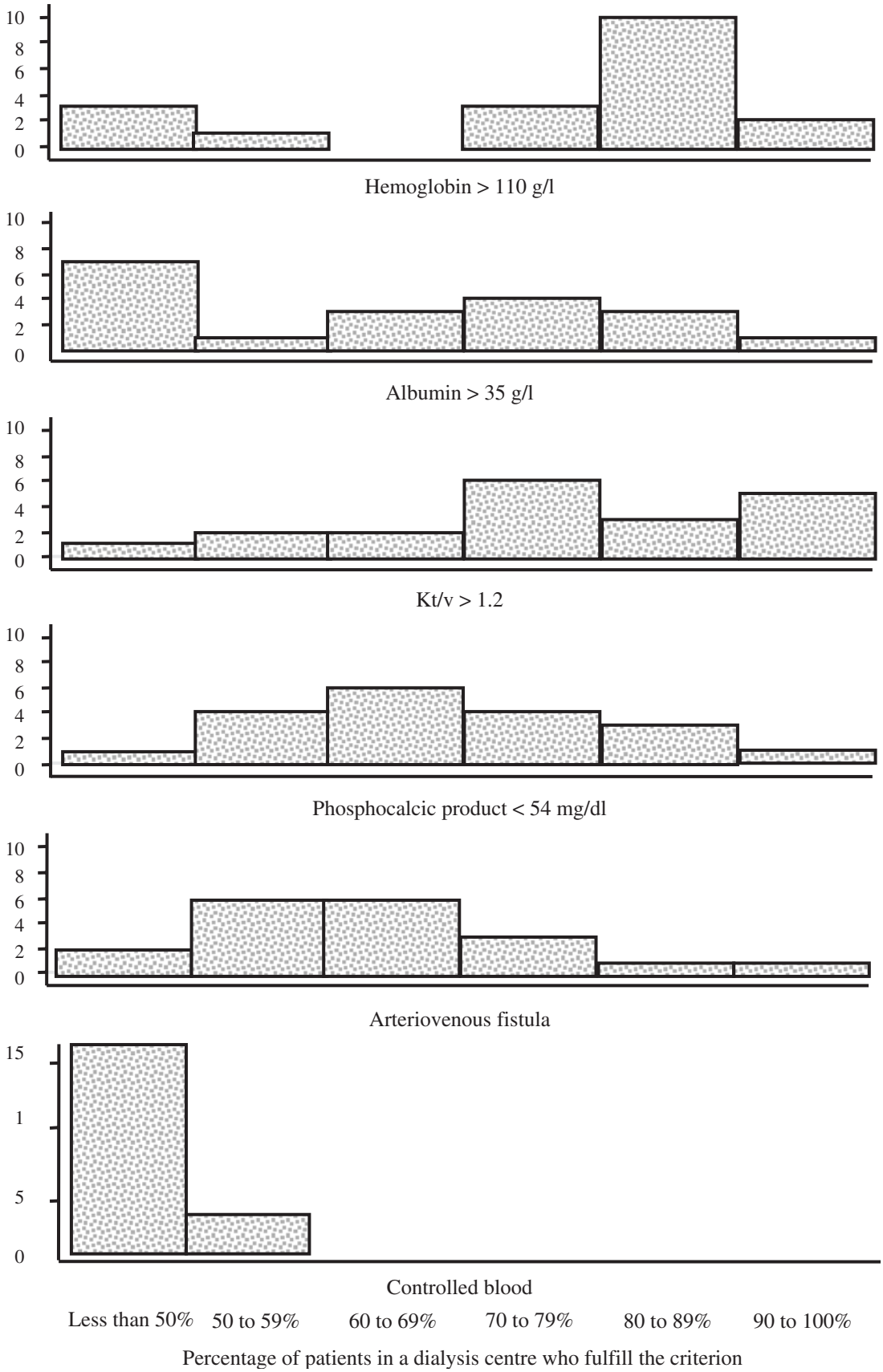

Fig. 1. Distribution of the centres by adjusted prevalence of conformity with indicators of quality for the six domains of clinical care in the 19 dialysis centres of western Switzerland.

Table 5. Conformity to quality criteria according to patient characteristics (patient age, gender, co-morbidity score and duration of renal replacement therapy) and size of dialysis facility

	Dialysis adequacy, *n* (%)	Absence of anaemia, *n* (%)	Albumin >35 g/l, *n* (%)	C × P product ≤4.4 mmol^2/l^2, *n* (%)	AV fistula (HD patients), *n* (%)	Controlled blood pressure, *n* (%)
Age (*n*)	$P=0.61$	$P=0.66$	$P=0.30$	$P=0.03$[a]	$P=0.56$	$P=0.06$
<55 (149)	104 (74.3)	115 (77.2)	95 (64.4)	93 (63.3)	81 (64.8)	49 (32.8)
56–65 (140)	99 (75.0)	106 (75.7)	89 (64.0)	97 (69.8)	73 (57.5)	58 (41.4)
66–75 (176)	129 (76.8)	134 (76.1)	105 (60.7)	114 (65.5)	102 (63.4)	49 (27.8)
≥75 (152)	110 (76.4)	118 (76.6)	90 (59.6)	116 (77.3)	80 (58.0)	45 (29.8)
Gender (*n*)	$P<0.002$[b]	$P=0.27$	$P=0.22$	$P=0.02$[c]	$P=0.04$[d]	P = 0.66
Males (384)	257 (70.6)	300 (78.3)	242 (64.0)	105 (27.6)	223 (64.1)	128 (33.3)
Females (233)	185 (84.1)	173 (74.3)	137 (59.1)	85 (37)	113 (55.1)	73 (31.3)
Charlson score (*n*)	$P=0.25$	$P=0.009$[e]	$P=0.52$	$P=0.06$	$P=0.16$	$P=0.005$[f]
2–5 patients (151)	106 (74.7)	119 (78.8)	99 (66.0)	97 (65.1)	85 (65.9)	61 (40.4)
6–7 patients (157)	120 (79.7)	131 (83.4)	95 (61.3)	106 (68.0)	93 (65.0)	59 (37.6)
8–9 patients (152)	112 (78.3)	117 (77.0)	94 (63.5)	98 (64.9)	75 (54.7)	41 (26.9)
≥10 patients (157)	104 (70.3)	106 (67.5)	91 (58.0)	119 (77.3)	83 (57.6)	40 (25.5)
RRT duration (*n*)	$P<0.001$[g]	$P=0.79$	$P=0.01$[h]	$P=0.16$	$P=0.96$	$P=0.15$
1–2 years (165)	89 (57.8)	128 (77.6)	77 (47.5)	124 (76.6)	83 (60.1)	53 (32.1)
3–4 years (185)	143 (80.8)	139 (75.1)	57 (30.1)	117 (63.6)	102 (61.1)	66 (35.7)
5–8 years (142)	111 (83.5)	107 (75.4)	49 (35.0)	100 (71.4)	81 (61.4)	42 (29.6)
≥9 years (125)	99 (82.5)	99 (79.2)	48 (38.7)	79 (64.8)	70 (60.3)	40 (32.0)
Size (*n*, range)	$P<0.005$[i]	$P<0.001$[i]	$P<0.001$[i]	$P<0.55$	$P<0.59$	$P<0.23$
University (158, 69–89)	96 (66.2)	115 (72.8)	77 (50)	102 (65.4)	73 (57)	43 (27.2)
>40 patients (238, 40–57)	191 (80.9)	204 (85.7)	201 (84.8)	166 (70.3)	128 (61.2)	80 (33.6)
<40 patients (221, 6–27)	155 (76.3)	154 (69.7)	101 (46.1)	152 (69.7)	135 (62.5)	78 (35.2)

All *P*-values are calculated using the score test for trend of odds.
[a]Older patients have a lower C × P product.
[b]Female patients have a better dialysis adequacy.
[c]Male patients have a lower C × P product.
[d]Female patients have fewer native AVFs.
[e]Patients with the highest Charlson score were more anaemic.
[f]Blood pressure control was associated with a smaller Charlson score.
[g]Short duration of RRT was associated with less dialysis adequacy.
[h]Short duration of RRT was associated with a higher albumin level.
[i]Absence of anaemia, normoalbuminaemia and dialysis adequacy were associated with non-university-based facilities treating ≥40 patients.

We computed adjusted centre conformity rates for the six indicators, adjusting for age, gender, modified Charlson index, duration of renal replacement therapy and size of facilities. Among the 19 centres, the correlation coefficients between unadjusted and adjusted conformity rates for the five indicators were between 0.98 and 1.00, suggesting that adjustment was unnecessary.

Differences in the prevalence for three indicators (absence of anaemia, albumin and Kt/V) were found between larger (>40 patients) dialysis units *vs* smaller units and university-based dialysis units (Table 5).

Using university-based dialysis units as the reference group, odds ratios for absence of anaemia were 2.2 [95% confidence interval (CI) 1.1–4.5] in the >40 patients dialysis units and 0.8 (95% CI 0.4–1.5) in the <40 patients dialysis units. For normoalbuminaemia, odds ratios were 6.4 (95% CI 1.9–22.1) in the >40 patients dialysis facilities and 1.0 (95% CI 0.4–2.9) in the <40 patients dialysis units.

For dialysis adequacy, odds ratios were 2.1 (95% CI 1.0–4.6) in the >40 patients dialysis facilities and 1.6 (95% CI 0.8–3.2) in the <40 patients dialysis units.

Discussion

The main finding from this study was that quality of care indicators varied considerably among haemodialysis units of western Switzerland, even though the aggregate findings for the region demonstrated facility-level characteristics only modestly below pre-defined targets. The variability in quality indicators contrasts with the rather homogeneous treatment and management policies reported by the centres. Centres had similar approaches to the measurement of dialysis quantity, anaemia evaluation, and calcium and phosphate metabolism. Assessment of nutritional status was, however, not performed according to published recommendations in most dialysis units. Though effective interventions differed between centres, there was no obvious correlation with the results of target indicators.

Several patient characteristics were associated with the achievement of quality criteria. In particular, men were more likely than women to have an arteriovenous fistula, and healthier patients were less likely to be anaemic. Patients with the briefest duration of

ESRD in our population were less likely to suffer from hypoalbuminaemia, which is in agreement with a previously published observation [17]. Adjustment for patient characteristics changed centre-level results very little. This suggests that the dialysed population in the participating centres is similar, and that in this particular instance, adjustment for patient case mix is not necessary for meaningful between-centre comparisons. We found that centres having >40 patients scored better than university-based centres in terms of dialysis adequacy, absence of anaemia and normoalbuminaemia. These better results probably reflect the increased prevalence of incident patients in the university-based dialysis centres. The differences between centres with >40 patients and smaller centres is more difficult to explain since neither centre policies nor patient characteristics appear to explain this variation. In particular, the great variability in human resources among the centres did not correlate with the variation observed in quality of care indicators (Table 2). The availability of the nephrologist may play a role since in the larger centres the medical staff are more important. Another possible explanation is that the patient characteristics included in our adjustment models failed to include important determinants of quality indicators, and that better adjustment models would have decreased residual inter-centre variability. However, it is unclear to us what these hidden confounding variables might be. An alternative explanation could be that centre policies as reported do not truly reflect how care is delivered to patients in daily practice, and that these clinical practices vary from one centre to another despite stated policies being globally the same. Furthermore, differences in family support or income may also contribute to the variation in the achievement of quality criteria. Unfortunately, we did not obtain this information in our study. Other explanations have to be found for the well-known hurdles to translate guidelines into clinical practice, i.e. resources availability, physician behaviour, etc.

Generally, the results observed in the western Swiss centres matched those observed elsewhere. Dialysis adequacy in our patients (both haemodialysis and peritoneal dialysis 76%) was midway between the levels observed in the USA (haemodialysis 86%, peritoneal dialysis 69%) and The Netherlands (haemodialysis 59%) [18,19]. Our patients were slightly older than their US counterparts, but the proportion of patients with a functional arterio-venous fistula is considerably higher than in the USA. We believe that adequacy of dialysis should improve in our region as nephrologists become more aware of the recommended threshold for the Kt/V.

Anaemia management in our patients nearly reached the target identified by the European Best Practice Guideline (EBPG) 5 (target of >11 g/dl for ≥85% of the population) [3,20]. Two factors may have contributed to this finding. First, European guidelines on anaemia treatment were published in 1999, well before our study was conducted, and anaemia treatment in haemodialysed patients has received much attention in the interim. Secondly, most facilities in our area also participated in the European Survey on Anaemia Management (ESAM) study in the 1990s. Understandably, most of our nephrologists were fully aware of the haemoglobin target of 110–120 g/l in this population.

Calcium and phosphate metabolism as well as the nutritional status of our patients were areas with the largest opportunity for improvement. One-third of our patients had an elevated serum calcium × phosphate product. Similar results have been reported in Italy [21]. These parameters have been linked to an increased risk of cardiovascular mortality, and lowering their levels in dialysed patients is crucial. However, mild phosphate and calcium disturbances are often asymptomatic, and aggressive use of phosphate binders and active vitamin D sterols to treat secondary hyperparathyroidism and hyperphosphataemia is commonly hampered by the risk of hypercalcaemia.

Hypo-albuminaemia was observed in 37% of our patients, well above the 20% found in a French cooperative study [17]. Although serum albumin was shown to predict mortality in dialysis patients, it is also related to factors other than nutrition, such as liver disease and inflammatory states. It also has to be mentioned that the nephelometric method which gives lower results was used in almost all units. Nevertheless, the absence of a nutritional assessment by two methods in nearly 80% of the patients and absence of widespread nutritional support indicate a deficiency in care. Indeed, a dietitian was available only part-time in most of the facilities, which may explain the fairly low standard of nutritional care in our patients.

Concerning vascular access, our results (61% patients with an arterio-venous fistula) are midway between European (80%) and American (24%) results reported by the Dialysis Outcomes and Practice Patterns (DOPPS) survey [22]. Fistula prevalence varied considerably among centres in our area, ranging from 49 to 92% of the patients. This probably reflects local habits or availability of surgeons dedicated to arterio-venous fistula surgery, but may also reflect a lack of implementation of guidelines in some centres. Blood pressure seems adequately controlled in only one-third of our patients. Moreover, cardioprotective medications such as angiotensin-converting enzyme inhibitors (ACEIs)/angiotensin II receptor blockers and β-blockers were given only to one in three patients in our dialysed population (Table 6). As these medications have been proven to reduce the elevated cardiovascular mortality in these patients, their use should be more widespread in dialysis patients.

Globally, the majority of the participating centres (15 out of 19) achieved only two or fewer of the six quality targets, and none achieved all six. Therefore, there is still room for improvement. We believe that development and systematic implementation of

Table 6. Treatment characteristics of dialysed patients in western Switzerland (March 2001)

Haemodialysis/peritoneal dialysis patients	553/64
Renal replacement therapy duration (years, median and interquartile range)	3 (1–6.5)
Haemodialysis time (min, mean and SD)	218 (37)
Biocompatible (synthetic) dialyser membranes (%)	90
Continuous ambulatory peritoneal dialysis/automated peritoneal dialysis patients	34/30
RhuEpo use (%)	90
Subcutaneous/intravenous use of RhuEpo (%)	95/5
Nutritional assessment by $\geq$2 methods [12] (%)	21
Nutritional support in hypoalbuminaemic patients [12] (%)	14
Vitamin D use (%)	50
Calcium-based phosphate binders (%)	85
Aluminium salts (%)	17
Use of ACE inhibitors/angiotensin II antagonists (%)	35
Use of β-blockers (%)	26
Temporary catheters use among incident (last 3 months) patients (%)	24
Permanent tunnelled catheter use (%)	13

validated practice guidelines will eventually lead to a global improvement in health care for dialysis patients in western Switzerland.

Our study has several strengths and limitations. The cross-sectional design does not afford a prospective assessment of quality of care, and may not be as effective as periodic monitoring of quality indicators at stimulating improvement projects in treatment facilities [23,24]. On the other hand, enrolment of every patient on dialysis, as opposed to a sample, ensured that even the smallest units felt themselves to be partners of the project, and avoided opportunities for patient selection bias. Nevertheless, facility-level results based on small numbers of observations are imprecise, e.g. if eight out of 10 patients meet the quality criterion, the exact confidence interval on the adequacy proportion is 43–97%, if 24 of 30 patients meet the criterion, the interval shrinks to 61–92%, and if 80 of 100 do, the interval is 71–87%. This lack of precision limits the utility of the feedback given to individual centres. Implementation of guidelines provided only 2 months prior to the study may have been difficult for some dialysis facilities. Finally, the usefulness of evaluation of quality of care is markedly reduced if it is not followed by a continuous quality improvement programme within dialysis facilities [25]. This would necessitate implementation of an educational programme across the public and private dialysis treatment sectors, demonstrating providers' strong commitment to evidence-based guidelines and enhancing their capacity to measure quality of care and to act on observed deficiencies [25]. A randomized controlled trial has shown that an intervention focused on dialysis adequacy and tailored to overcome specific barriers, such as shortened treatment time, use of catheters and insufficient prescribed dialysis dose, can be successful over a 6 month period [26].

In conclusion, we described substantial variations in six quality indicators among dialysis facilities of western Switzerland. We could not attribute these variations to discordant treatment policies, nor to differences in patient case mix. Better standardization and repeated evaluation of treatment goals and processes, according to recognized clinical practice guidelines, with the help of a national registry for dialysis patients, would be likely to reduce the variability we observed, and potentially improve the quality of care.

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