See editorial comment on page 256

Multicentre study of haemodialysis costs

E. Parra Moncasi[1], M.D. Arenas Jiménez[2], M. Alonso[3], M.F. Martínez[4], A. Gámen Pardo[1], P. Rebollo[5], T. Ortega Montoliú[6], T. Martínez Terrer[7], F. Álvarez-Ude[8], Grupo de Gestión de la Calidad de la Sociedad Española de Nefrología

[1] Nephrology Department. Reina Sofía University Hospital. Tudela, Navarra, Spain
[2] Nephrology Department. Perpetuo Socorro Hospital. Alicante, Spain
[3] Nephrology Department. Valle del Nalón Hospital. Langreo, Asturias, Spain
[4] Nephrology Department. Casa de la Salud Hospital. Valencia, Spain
[5] BAP Health Outcomes Research. Oviedo, Asturias, Spain
[6] Biohealth Research Office Oviedo, Asturias, Spain
[7] Biostatistics Unit. University of Zaragoza, Spain
[8] Nephrology Department. General Hospital of Segovia, Spain

Nefrologia 2011;31(3):299-307
doi:10.3265/Nefrologia.pre2011.Apr.10813

ABSTRACT

Background: Previous studies to determine the cost of haemodialysis (HD) in Spain have significant limitations: they are outdated or used indirect methods. There is also a lack of analysis performed simultaneously on Public centres (PC), with direct HD services, and partially state-subsidised centres (SC). This is an important issue since the two systems coexist in Spain. **Objectives:** To estimate the cost of HD replacement therapy for chronic renal failure in several centres. **Methods:** This is a prospective and publicly-funded study, which estimates the costs for 2008 using a cost accounting system with specific allocation criteria. We collected demographic and comorbidity data for each centre. **Results:** Six centres participated, two PC and four SC. There were no significant differences between centres in terms of patient demographics, time on haemodialysis and the Charlson comorbidity index. The total cost per patient per year ranged between €46 254 and €33 130. The cost per patient per year (excluding vascular access and hospital admission) for PC was €42 547 and €39 289 and for SC €32 872, €29 786, €35 461 and €35 294 (23% more in PC than SC). Costs related to staff/patient/year and consumables/patient/year were 67% and 83% respectively, higher for PC than SC. The highest percentage cost was for staff (average 30.9%), which showed significant variability between centres, both in absolute numbers (staff cost per patient per year between €18 151 and €8504) and as a percentage (between 42.6 % and 25.4%). **Conclusions:** Cost variability exists among different HD centres, and this can be attributed primarily to staff and consumables costs, which is higher for PC than SC.

Keywords: Cost. Hemodialysis. Dialysis. Renal failure.

Correspondence: E. Parra Moncasi
Servicio de Nefrología.
Hospital Reina Sofía.
Ctra. de Tarazona, km 3. 31500 Tudela. Navarra. Spain.
eparramo@cfnavarra.es

Estudio multicéntrico de costes en hemodiálisis

RESUMEN

Antecedentes: *Los estudios realizados en España para determinar el coste de la hemodiálisis (HD) presentan importantes limitaciones; son antiguos o utilizan metodologías indirectas. Además, carecemos de análisis realizados simultáneamente en centros públicos (CP), con prestación directa del servicio de HD, y centros concertados (CC) con la Administración.* ***Objetivos:*** *Estimar el coste efectivo del tratamiento sustitutivo de la función renal con HD en la enfermedad renal crónica terminal en diversos centros.* ***Métodos:*** *Estudio prospectivo, financiado con fondos públicos, que estima el coste de 2008 mediante un sistema de contabilidad analítica que explicita los criterios de imputación. Se recoge información demográfica y de comorbilidad de cada centro.* ***Resultados:*** *Participaron seis centros, dos CP y cuatro CC. No hubo diferencias significativas en-*

tre los diferentes centros en cuanto a los datos demográficos de los pacientes, el tiempo en HD y el índice de comorbilidad de Charlson. El coste/paciente/año osciló entre los 46.254 y los 33.130 €. El coste/paciente/año (excluyendo hospitalización y acceso vascular) de los CP fue de 42.547 € y 39.289 € y los de los CC de 32.872 €, 29.786 €, 35.461 € y 35.294 € (23% superior en CP respecto a los CC). Los costes de personal/paciente/año y fungible/paciente/año fueron un 67% y un 83%, respectivamente, superiores en los CP respecto a los CC. El porcentaje de costes más elevado fue el de personal (media de 30,9%), que mostró una importante variabilidad entre centros, tanto en cifras absolutas (coste personal/paciente/año entre 18.151 y 8.504 €) como porcentuales (entre 42,6 y 25,4%). ***Conclusiones:*** *Existe una importante variabilidad de coste entre diferentes centros de HD, y ésta puede atribuirse fundamentalmente al coste de personal y fungible, que es superior en los CP respecto a los CC.*

Palabras clave: *Coste. Hemodiálisis. Diálisis. Insuficiencia renal.*

INTRODUCTION

The clinical and economic consequences of chronic renal failure with haemodialysis (HD) certainly represent a social repercussion. In Spain, there are more than 19 000 patients undergoing HD,[1] and its cost represents approximately 1% of the health system's expenditure. However, the volume of patients only represents 0.043% of the population.[2] More information is therefore needed so that we can improve our knowledge of the costs associated with this treatment as a premise to ensure its sustainability.

The studies that have been conducted to determine the actual cost of HD (even though they only provide an estimate) have several limitations. The first is that some are very outdated (before 1999[3-5]), which is a considerable limitation, given that different factors suggest that costs have risen in recent years. 1. Technologic factors: costs may increase as procedures needing more costly material and consumables are used, such as haemodiafiltration, acetate-free biofiltration (AFB) and online HD. 2. Human factors: staff demand is increased because the comorbidity of the patients is greater or techniques are used more often than usual. 3. Pharmacological factors: erythropoietin, darbepoetin, intravenous iron, binders, paricalcitol, calcimimetics and others.

Another limitation of some of the previous costs studies is that they use indirect methodologies, calculating costs using clinical protocols,[6] or "price" assessments taken from Spanish official gazettes, which do not necessarily correspond with actual treatment costs.[7,8] Furthermore, in Spain, public centres (PC) and partially-state subsided centres (SC) both exist, meaning that "centre ownership" is very relevant. As far as we are aware, this variable has yet to be studied. Furthermore, we have not found any cost studies on renal replacement therapy with HD, analysing actual costs.

This study aims to estimate the effective costs of renal replacement therapy with HD for end-stage renal disease, using a single methodology in several PC and SC centres.

METHOD

We conducted a prospective and descriptive study, in the context of the *Estudio de Evaluación Global de Centros de Diálisis* (study on the overall evaluation of dialysis centres) by the Quality Management Group from the Spanish Society of Nephrology. This study is aimed to evaluate HD centres, assessing clinical outcomes, patient satisfaction, health-related quality of life, and costs. In this article, we shall only present the cost assessment results.

During the first half of 2007, we created an Excel accounting database which recorded the most HD-relevant financial items and specific allocation criteria for all the centres.

In October 2007, we sent an email to all centres that usually collaborate with the Quality Management Group formally inviting them to participate in the study. We included all centres that voluntarily and explicitly accepted the invitation. The accounting department from each centre participated in the study, choosing an individual to analyse the financial data (hereinafter financial researcher). This person was then given the accounting database to collect the financial data, filling it out prospectively during the financial year of 2008.

The centres' costs were calculated using a cost accounting system, which included the same items and allocation criteria for all centres, so that we could compare several centres. If a given centre was not able to provide cost data for an item according to the pre-defined allocation criterion, an alternative, second one was created so that the data could be recorded.

We used the following items and allocation criteria for the financial analysis:

Staff

Effective cost for staff was collected with respect to the time dedicated to HD. Time for non-HD-related activities

carried out by staff was not considered (hospital admission, check-ups, night shift, emergency department, peritoneal dialysis, acute patients). All staff costs were included (pay, social security contributions, personal income tax, replacement staff, among others). Each centre's financial researcher calculated the time assigned to HD, and the financial value was provided by the accounting or human resources department.

Consumables

Cost was measured in accordance with the monthly computer record for the actual store outputs to the HD unit throughout 2008. Consumables included dialysers, arterial and venous lines, needles, syringes, gloves, dressings, among others.

Inpatient pharmacy

Analysis was performed using the monthly computer record of actual pharmacy outputs to the HD unit throughout 2008. Inpatient pharmacy included: erythropoiesis-stimulating agents, heparins, HD dialysate, saline, cinacalcet, antibiotics, fibrinolytic agents, among others.

Outpatient pharmacy

Using each centre's electronic clinical records, the total number of outpatient drugs consumed (number of pills) during a whole week in 2008 was recorded. The public retail price (PRP) for that year was considered using a table with reference price per pill. The figure was then extrapolated to the whole year.

Laboratory

Laboratory expenses were calculated by considering the annual number of tests requested by the dialysis unit multiplied by the average test cost for 2008, taken from the centre's cost accounting system.

Diagnostic imaging

Included average cost per test, calculated using the centre's cost accounting system. Fistulography was not included.

Transport

Price of transport was in accordance with the contracted company's tariff. When the company's tariff was not available, the tariff published on the Spanish official gazette was used.

Management

Included the head doctor or nurse, supervisors, admission and reception staff, and other intermediary positions, in proportion to time dedicated to the HD unit. It also included indirect costs that have an impact on the HD unit management, i.e. the building structure, (considering a 30-year depreciation period) and equipment (10-year depreciation period), calculated using the cost accounting system.

Maintenance

When equipment maintenance was performed by the HD monitor or consumables supplier, the company provided data, separating the percentage that corresponded to each item, and each partial cost was allocated to the relevant section (consumables, health care equipment or maintenance). If there was an additional external maintenance service, the invoice was accounted for (including the material). If in any of the cases above there was also an internal service, the proportional period of time and material used in the unit were taken into account, as well as the costs outlined in the cost accounting system.

Health care equipment

When financed by the consumables supplier, each item was separated in the same way as in the maintenance section. When owned by the centre, a depreciation period of 30 000 hours for monitors and 10 years for a water treatment system were considered. If the health care equipment was leased, its annual cost was considered. Costs associated with dialysis monitors and water treatment systems are also considered.

Cleaning

This is in accordance with the invoice issued to the HD unit, or the proportion of surface area that the HD unit covers with regard to the rest of the centre.

Food

Calculated according to the invoice issued to the HD unit.

Laundry

Depending on the number of kilograms sent to the laundry during a week, extrapolated to the whole year, and applying price per kilo for the external service.

Other centre costs

Including electricity, water, telephone (in proportion to the unit's surface) and waste (in proportion to the number of containers used in one week, considering the price that the waste company charges, extrapolating the cost to the whole year). Other costs included: computing, stationary, water sample transport and other transport, services, quality, safety, anatomical pathology, library, preventative medicine, risk prevention, communication, security, common areas, legal consultancy, and medicinal gases. All were considered and allocated using the centre's cost accounting system.

Costs for admissions and performing vascular access were calculated using an estimation based on the authors' previous cost studies, and weighted by each centre's activity.[9]

The number of patients in each centre was calculated on a monthly basis: a patient who was in the unit for four weeks was recorded as 1, three weeks as 0.75, two weeks as 0.5 and one week as 0.25. Then, the results for each centre were extrapolated to calculate the annual figure. The demographic and comorbidity characteristics were also prospectively collected for each patient.

Alternate-day HD, daily HD, AFB, biofiltration and online HD were considered as special techniques.

To verify the homogeneity of the patient sample from each centre, its distribution was checked. The Kruskal-Wallis test was applied for quantitative variables, and the chi-square test used for qualitative variables.

RESULTS

Six centres participated in the study: two were public (PC) and provided direct HD services, and the other four were partially state-subsidised (SC). The two PC (1-2) were dialysis units integrated within regional hospitals, two of the SC (3-4) were also integrated within hospitals and the other two SC (5-6) dialysis units were separate from the main centre building.

Table 1 shows the demographic and comorbidity characteristics for each centre. There were no statistically significant differences between the centres with regards patient age, time on HD, and Charlson comorbidity index. There were more men than women in all centres, which is usual in the HD population, as we have found in the regional and national records.

The cost results per centre and the distribution of percentage costs per item are included in Table 2. The highest percentage cost was staff in all centres (30.9%), but there was significant variability between the centres (42.6% in centre 1 and 25.4% in centre 5). Other important costs were: pharmacy at 27.3% (inpatient 13.3%; outpatient 14.0%), consumables (17.5%), transport (8.1%) and management (4.5%). The rest of the percentage costs were less than 2.5%.

The average daily cost for hospital stay was estimated at €498, vascular access at €2649 (autologous or prosthetic fistula), and placing a catheter at €1380. This was then

Table 1. Demographic and comorbidity characteristics of the centres

Demographics, morbidity/centres	1	2	3	4	5	6	P
Age in years (SD)	67.73 (13.88)	68.38 (13.09)	68.0 (14.20)	66.87 (15.03)	64.31 (14.64)	67.8 (15.28)	0.632[a]
Sex							
Men (%)	25 (61.0%)	22 (59.5%)	37 (69.8%)	89 (65.4%)	34 (63.0%)	27 (65.9%)	
Women (%)	16 (39.0%)	15 (40.5%)	16 (30.2%)	47 (34.6%)	20 (37.0%)	14 (34.1%)	0.952[b]
Months on HD (SD)	47.59 (41.23)	43.70 (40.43)	43.37 (39.81)	50.93 (63.11)	50.00 (52.34)	57.32 (59.39)	0.91[a]
Charlson Index (SD)	7.78 (3.25)	7.68 (2.4)	7.11 (2.06)	7.84 (2.86)	7.55 (3.09)	7.21 (3.02)	0.694[a]

[a] Kruskal-Wallis test; [b]Chi-square

SD: Standard deviation; HD: haemodialysis.

Table 2. Type of centres and their costs. Items listed with percentages of the total

CENTRE	1	2	3	4	5	6	Mean	Mean 1-2	Mean 3 to 6
- **Type**[a]	P	P	S	S	S	S	P	S	P and S
- **Total annual cost (€)**	1587 993	1202 251	1544 967	4986 131	1414 910	984 705			
- **Item (percentage)**	%	%	%	%	%	%	%	%	%
- **Staff**	42.6	32.1	28.9	28.5	25.4	28.1	37.3	27.7	30.9
- Doctor	7.8	5.2	7.8	4.9	7.2	14.0	6.5	8.5	7.8
- Nursing	24.5	18.9	17.4	15.4	14.5	9.3	21.7	14.1	16.7
- N. auxiliary	9.4	7.3	2.7	7.9	3.2	4.0	8.4	4.5	5.8
- Other health care staff (porters and others)	1.0	0.7	-	-	-	-	0.8	-	0.3
- Administrative staff (if necessary)	-	-	0.9	0.3	0.6	0.9	-	0.7	0.5
- **Consumables and pharmacy**	37.1	49.5	43.0	47.5	46.9	44.5	43.3	45.5	44.7
- Consumables	16.7	28.2	21.8	13.5	11.4	13.2	22.4	15.0	17.5
- Inpatient Pharmacy	12.1	11.6	10.3	17.7	16.0	12.4	11.8	14.1	13.3
- Outpatient pharmacy	8.4	9.7	10.9	16.2	19.5	19.0	9.0	16.4	14.0
- **Diagnostic tests**	3.1	1.3	0.6	3.4	2.8	2.8	2.2	2.4	2.3
- Laboratory	3.0	0.9	0.4	3.2	2.6	2.7	2.0	2.2	2.1
- Diagnostic imaging	0.1	0.4	0.2	0.2	0.2	0.1	0.2	0.2	0.2
- **Other costs**	17.1	17.1	27.5	20.6	24.9	24.6	17.1	24.4	22.0
- Transport	4.8	5.2	14.1	7.7	8.2	8.6	5.0	9.7	8.1
- Management	4.8	1.6	3.7	6.3	5.2	5.3	3.2	5.1	4.5
- Maintenance	1.4	3.1	1.3	0.8	1.8	2.1	2.3	1.5	1.7
- Health care equipment	1.1	1.4	0.5	1.0	1.8	2.2	1.3	1.4	1.3
- Waste	0.1	1.7	0.7	0.5	0.4	0.5	0.9	0.5	0.6
- Cleaning	1.1	1.4	3.3	1.0	0.9	1.4	1.2	1.7	1.5
- Food	1.8	0.2	-	0.9	2.4	2.0	1.0	1.3	1.2
- Laundry	1.3	1.5	0.8	0.5	0.4	0.4	1.4	0.6	0.8
- Others	0.7	1.0	3.1	2.0	3.7	2.0	0.9	2.7	2.1

P: public centre with direct services; S: partially state-subsidised centre; %: percentage of the total cost.

weighted by the number of stays and accesses performed by the unit.

The cost per patient, per HD session and other items are shown in Table 3. The six centres' average cost for a HD session was €201 and the average cost per patient/year was €33 479, not including hospital admission or vascular access. The total average cost per patient/year (including hospital admission and vascular access) was €40 136, ranging between €46 254 and €33 130. The cost/patient/year for PC was €42 547 and €39 289 and it was €32 872, €29 786, €35 461 and €35 294 for the SC.

Cost/patient/year (without considering hospital admission or vascular access) ranged between €42 574 (centre 1) and €29 786 (centre 4). The greatest difference was found for the staff cost/patient/year in the same centres, being €18 151 and €8504, respectively. Cost variability for other items was:

1. Consumable cost/patient/year: between €11 065 and €4029.
2. Inpatient pharmacy/patient/year: between €5665 and €3376.
3. Outpatient pharmacy/patient/year: between €6923 and €3564.
4. Diagnostic tests cost/patient/year: between €195 and €1332.
5. Other costs/patient/year (transport, management, maintenance, equipment, waste, cleaning, food and laundry): between €6734 and €9055.

Several parameters were retrospectively analysed in order to explain why there were differences in staff costs: number of sessions/staff member/12 hours (nephrologist, nurse and

Table 3. Cost of the centres for haemodialysis, hospital admission and vascular access

Centre	1	2	3	4	5	6	Mean P (1-2)	Mean S (3-6)	Variation PS (%)	Total/ Average
- Type	P	P	S	S	S	S	P	S		
- Average no. of patients	37.3	30.6	47.0	167.4	39.9	27.9				350.1
- No. of patients with special HD	2	2	1	29.7	0.6	0.4				
Haemodialysis										
- No. sessions	5890	4932	7495	28 170	6925	4847				58 259
- Cost/HD session	270	244	206	177	204	203	257	198	30	201
- Total cost/patient/year[a]	42 574	39 289	32 872	29 786	35 461	35 294	40 931	33 353	23	33 479
- Staff cost/patient/year	18 151	12 594	9 490	8 504	9 009	9 922	15 373	9 231	67	11 278
- Consumable cost/patient/year	7112	11 065	7179	4029	4037	4645	9089	4972	83	15 975
- Inpatient pharmacy cost/patient/year	5131	4554	3376	5267	5665	4367	4843	4669	4	4727
- Outpatient pharmacy cost/patient/year	3564	3811	3576	4840	6923	6709	3688	5512	-33	4904
- Diagnostic test cost/patient/year	1332	530	195	1000	1001	973	931	792	18	838
- Other costs/patient/year[a]	7284	6734	9055	6146	8826	8678	7009	8176	-14	7787
Hospital admissions										
- No. of hospital stays	235	268	292	888	295	259	252	434		2237
- Stays/patient/year	6.3	8.8	6.2	5.3	7.4	9.3	7.5	7.0	7	7.2
- Hospital admissions cost	117 030	133 464	145 416	442 224	146 910	128 982	125 247	215 883		185 671
- Cost/hospital admission/patient/year	3138	4362	3094	2642	3682	4623	3750	3510	7	3590
Vascular access										
- No. of fistulas (autologous or prosthetic)	4	6	7	34	8	6	5	14		
- No. of catheters (temporary or permanent)	7	7	8	20	4	1	7	8		
- Vascular access cost	20 256	25 554	29 583	117 666	26 712	17 274	22 905	47 809		
- Access cost/patient/year	543	835	629	703	669	619	689	655	5	667
Total cost										
- Total cost/patient/year[b]	46 254	44 486	36 595	33 130	39 813	40 536	45 370	37 519	21	40 136

P: public centre with direct services; S: partially state-subsidised centre; [a]does not include hospital admission or vascular access; [b]includes haemodialysis, hospital admission and vascular access.

nursing auxiliary), the staff cost in accordance to professional level, and the hours worked per year in each centre (Table 4).

DISCUSSION

Our study revealed that the cost associated with renal replacement therapy with HD ranged between €4630 per patient per year. We understand that this is the first study conducted this decade, which estimates the actual costs of this therapy in different centres, simultaneously and using similar methodology. We therefore believe that the data provided here is more precise and up-to-date than that of previous studies.

To compare the results from this study with those conducted in the 1990s, we would have to update the prices in accordance with the Spanish consumer price index (CPI).[10] Using the prices given in 1994 and converting them to the 2008 equivalent, they ranged between €64 935/patient/year in the Juan Canalejo Hospital and €34 339 /patient/year in the *Consorcio* Hospitalario de Sabadell in the same year.[3] As can be observed, the costs in our study are almost the same as the costs found in the previous studies, having updated the CPI. The data show that costs do not seem to have increased above the CPI during the past decade, despite technological and pharmacological sophistication and more intensive use of human resources. This statement should however be interpreted with caution, as the

Table 4. Theoretical and effective patient ratios per staff member, staff costs, working hours per centre

Centre	1	2	3	4	5	6	Mean P (1-2)	Mean S (3-6)
Theoretical ratio								
No. of patients/doctor	NR	32	NR	40	40	40		
No. of patients/nurse	3	4	4	5	5	5	3.5	4.75
No. of patients/n. auxiliary	5	8	12	10	10	10	6.5	10.5
Effective ratio								
Sessions/doctor/12 h	22.5	20.0	29.7	36.4	30.9	26.7	21.3	30.9
Sessions/nurse/12 h	5.1	8.0	7.4	10.4	10.3	10.7	6.6	9.7
Sessions/n. auxiliary/12 h	8.2	16.0	24.8	14.6	15.4	17.8	12.1	18.1
Staff cost (€)								
Doctor	57 486	62 073	60 492	97 780	78 158	98 154	59 780	83 646
Nursing	38 665	22 776	33 588	40 324	40 937	36 693	30 721	37 885
N. auxiliary	26 179	17 290	21 120	28 289	22 370	24 533	21 735	24 078
Working hours								
Hours worked /year	1560	1510	1780	1826	1826	1826	1535	1815
Staff cost/h (€)								
Doctor	36.9	41.1	34.0	53.5	42.8	53.8	39.0	46.0
Nursing	24.8	15.1	18.9	22.1	22.4	20.1	19.9	20.9
N. auxiliary	16.8	11.5	11.9	15.5	12.3	13.4	14.1	13.3

Sessions/doctor/12 h: number of sessions assisted per doctor in 12 hours; Sessions/nurse/12 h: number of sessions assisted per nurse in 12 hours; Sessions/nursing auxiliary/12 h: number of sessions assisted per nursing auxiliary in 12 hours; NR: not reported

comparison has not been made between the same centres, which may have had different initial situations. Furthermore, it seems that special techniques are not highly used in the centres studied.

Other more recent studies, which have the previously mentioned limitations, calculate costs using indirect methodologies, based on clinical protocols[6] or official gazette tariffs.[7,8] The estimated HD cost was €43 234/patient/year and €47 000/patient/year (including hospital admission cost) in two recent studies that used the second methodology. As such, these figures are in the higher part of the range that we obtained.

HD department outsourcing has stereotypically been considered as a good way of keeping therapy costs minimal, although no definite proof of such has been presented and it has even been questioned.[3] We did not consider hospital admission and vascular access costs to be directly related to the dialysis unit, we therefore excluded them so that we could compare the costs between the different centres. Furthermore, as will be explained in the study limitations, assessing these costs is very complex and the method used has a low discriminatory power. In our study, all centres encountered a similar degree of difficulty in performing analysis, although, even considering the study limitations, the results seem to indicate that the costs tend to be higher in PC than SC.

This difference is mainly associated with costs for staff and consumables, rather than other therapy-related costs. Therefore, the results from our study can be considered to support the stereotype mentioned above. However, we should point out that an overall evaluation of centres must analyse the clinical outcome variables, patient satisfaction and health-related quality of life in order to answer difficult questions such as: What is the optimum price? what is the best possible result? or how much is too much?

We decided to perform a retrospective analysis in order to explain why there was a variation in staff costs among the different types of centres. The difference between PC and SC staff costs is surprising. However, it does generally even out when adjusted to the number of hours worked annually (staff cost per hour), except for PC doctors, which is still remarkably lower. However, the difference that we consider most significant between PC and SC seems to mainly be organisational, and lies in the theoretical patient/staff ratio, and especially the effective patient/staff ratio (number of sessions/staff member/12 hours). We believe that the latter item better represents

the actual patient/staff ratio in the dialysis centre. We think that both ratios, due to organisational or structural reasons, do not necessarily have to coincide with one another. In general, the annual staff cost was generally higher for SC but since the number of hours worked annually was also more, the hourly cost levelled out. However, considering the number of HD sessions performed per staff member and per time period, considerably fewer HD sessions were performed in PC than in SC. This data suggests that SC more efficiently optimise their human resources. However, finding the difficult equilibrium between working conditions and efficiency should take into account a third variable, which as we have mentioned above, is the results obtained.

PC have a higher patient/consumable/year cost than SC. Theoretically, PC would have a competitive advantage over SC as they are able to buy in larger quantities. However, the SC overcame this advantage by having the incentive to prevent financial losses or generate profits. The overall result was that SC had more efficient purchasing management. There were differences in food costs because the content administered to the patients varied among the centres. Differences for other items (management, cleaning, transport, etc.) are not as easily explained and may be due to various causes. In any case, apart from transport and management, the differences were quantitatively lower. The fact that centre 4 had the lowest costs per patient and the highest number of patients may be explained by an economy of scale phenomena, favouring a more efficient use of resources in the centres after a given patient volume is achieved. However, we are still lacking information on the optimum centre size with regard to financial and clinical perspectives.

Our study has had several limitations. Firstly, a small number of centres participated in the study, which are not necessarily representative of all centres. Despite this, as far as we are aware, our study has included the most centres in Spain. Secondly, the exact same items could not be used in all cases, given that some centres were able to easily adapt to certain item criteria, but it was not feasible in others. However, the items that were not recorded in the same way, in general, represented relatively small costs, and affected items such as electricity, water and others. A third limitation is that costs for consumables, equipment and maintenance were not very clear given as they are interrelated and overlap one another. As such, it is possible to analyse the total of all three costs, but it is sometimes difficult to separate it into the three items. Lastly, we understand that using average estimated costs to calculate hospital admission and vascular accesses is a severe limitation for identifying differences between centres, although they are useful for calculating overall HD costs. This is a limitation because it tends to even out the costs, which is why we only used them to assess overall costs, but not to estimate each centre's costs. Furthermore, implementing an ad hoc hospital cost system for each centre exceeds our study's capabilities.

An outstanding article was recently published in the *Revista de Nefrología*[8] which discussed quality and sustainability of renal replacement treatment. Dr. Arrieta economically assessed this treatment, and correctly reported that the object of his study was not to make cost savings. We can add to this point, conferring that the main objective of cost studies is to simply find out what the costs are, and help distinguish which are appropriate and which are unnecessary. This is essential to guarantee that the appropriate costs are funded, and secondly, ensure treatment sustainability.

We understand that we must make an effort to standardise the manner that results are presented in cost studies on renal replacement therapy, so that they can be compared between centres. As such, they should include the items relevant to the main production factors, and which are recognised by nephrologists and other dialysis unit staff, specifying at least the following: staff, consumables, inpatient and outpatient pharmacy, laboratory, radiology, transport, maintenance, equipment, cleaning, food, hospital admission and management.

To conclude, our study, even considering its limitations, seems to indicate that there is an important variation in the costs among different HD centres. This variability is mainly due to staff and consumables costs, which tend to be higher in PC offering direct HD services than in the SC.

Acknowledgements

We would like to thank a number of people associated with the centres' dialysis units and financial management departments. Without these people, our study would not have been possible: Araceli Vidal, Francisca Hernández Cobo, Carmen Blanco Suárez, Luis Pérez Puyo, José Ángel González Herranz and Luis Robledo Díaz.

REFERENCES

1. Informe 2006 de diálisis y trasplante renal en España. Registro Español de Enfermos Renales. Nefrologia 2009;29(6):525-33.
2. Organisation for Economic Co-operation and Development. Consultado Sept 2010.Available at: http://www.oecd.org/home/
3. Lamas J, Alonso M, Saavedra J, García-Trío G, Rionda M, Ameijeiras M. Costes de la diálisis crónica en un hospital público: mitos y realidades. Nefrologia 2001;3:283-94.
4. Burgos R, Martín Martín J, López del Amo MP, Arellano J, Pérez C, Pozo F. Importancia del método de estimación de costes en diálisis y trasplante renal. Nefrologia 2001;Supl 4:86-90.
5. Martín Hernández R. Análisis de los costes en nefrología: situación actual y perspectivas de futuro. Nefrologia 1998;18(6):40-51.
6. Rodríguez-Carmona A, Castro A, Pérez Fontán M, Mojón M. Estudio económico de diálisis por el método de coste por procedimiento ajustado a protocolo clínico. Nefrologia 2007;27(3):359-69.
7. Lorenzo V, Perestelo L, Barroso M, Torres A, Nazco J. Economic evaluation of haemodialysis. Analysis of cost components based on patient-specific data. Nefrologia 2010;30(4):403-12.
8. Arrieta J. Evaluación económica del tratamiento sustitutivo renal (hemodiálisis, diálisis peritoneal y trasplante renal) en España. Nefrologia Suplemento Extraordinario 2010;1(1):56-62.
9. Ortega T, Ortega F, Díaz-Corte C, Rebollo P, Baltar JM, Álvarez-Grande J. The timely construction of arteriovenous fistulae: a key to reducing morbidity and mortality and to improving cost management. Nephrol Dial Transplant 2005;20:598-603.
10. Instituto Nacional de Estadística. Consultado Sept 2010. Available at: http://www.ine.es/

Sent for review: 24 Jan. 2011 | Accepted: 7 Apr. 2011