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Economic study of dialysis using the cost-procedure clinical protocol-adjusted method

A. Rodríguez-Carmona[1], A. Castro[2], M. Pérez Fontán[1*] and M. Mojón[1]

Nephrology Department[1] and Management Control and Internal Auditing Department[2]. Juan Canalejo Hospital (La Coruña) and Medicine Department*. Health Sciences Institute. University of La Coruña.

SUMMARY

Studies analyzing the economic cost of dialysis therapy have raised a considerable interest in the nephrologic community, both inside and outside our country. The objective of the present study was to approach this question from a different point of view, by applying the cost-per-procedure method, according to clinical protocol, to all the routine clinical procedures in our dialysis unit (both Hemodialysis and Peritoneal Dialysis). We analyzed 68 routine protocols (42 for Hemodialysis and 26 for peritoneal Dialysis), carrying out a pormenorized study of all the components of the economic cost of each procedure (personnel, laboratory, surgical and sanitary material, drugs and other concepts). We calculated the final cost of all these procedures after individualizing the different components of the economic spends, with the informatic support of the management department of our center, and in coordination with the data bases of the Pharmacy and General Supplies units. Although the initial implementation of this method is tedious, it subsequently allows to analyze the global cost of therapy in the Unit, as also the cost of certain subsets, or even particular patients, in a simple and flexible way. Moreover, the system is easy to update, as clinical protocols undergo changes or the economic cost of individual components vary. Finally, this method is a useful tool at the time of comparing the cost of clinical procedures in diferent centres, according to their varying clinical protocols, economic spends and clinical results.

Key words: ***Economic cost. Procedure. Hemodialysis. Peritoneal Dialysis.***

ESTUDIO ECONÓMICO DE DIÁLISIS POR EL MÉTODO DE COSTE POR PROCEDIMIENTO AJUSTADO A PROTOCOLO CLÍNICO

RESUMEN

El estudio de costes de diálisis ha generado un importante interés entre los nefrólogos suscitando estudios comparativos entre las diferentes modalidades dentro[1,2] y fuera de nuestro país[3-5]. El objetivo del presente trabajo es describir el método de análisis de coste por procedimiento ajustado a protocolo clínico de todos los protocolos realizados en nuestra Unidad de Diálisis (hemodiálisis y diálisis peritoneal). Analizamos un total de 68 protocolos realizados de manera rutinaria en nuestra Uni-

Correspondence: Ana Rodríguez Carmona
Servicio de Nefrología
Hospital Juan Canalejo
Xubias, 84
15006 A Coruña
E-mail: arodtor@canalejo.org

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dad (42 en Hemodiálisis y 26 en Diálisis Peritoneal) con estudio pormenorizado de todos los componentes del coste (personal, laboratorio, material quirúrgico y sanitario, fármacos y otros conceptos). Tras la descripción de los diferentes componentes del coste y mediante un trabajo informático del área de gestión (conectada a los servicios de Farmacia y Compras de Suministros) se calcularon los costes de cada uno de los procedimientos. Este método, laborioso en su implantación inicial, genera posteriormente, de forma sencilla, la posibilidad de estudio de los costes globales de la Unidad y de cada enfermo en particular. Asimismo, resulta fácilmente actualizable según cambien los protocolos y los costes de cada uno de los componentes del mismo. Por otro lado, resulta una herramienta clave para comparar los costes entre los diferentes hospitales según los protocolos y resultados de cada uno. Palabras clave: análisis de coste, procedimiento ajustado a protocolo clínico, Hemodiálisis, Diálisis Peritoneal.

Palabras clave: ***Coste por procedimiento. Protocolo clínico. Hemodiálisis. Diálisis peritoneal.***

INTRODUCTION

Renal replacement therapy (RRT) by means of dialysis consumes important health care resources and this has been an issue of increasing interest from the nephrologic community worldwide. A result of this interest has been the publication of a number of papers analyzing the costs of the dialytic procedure, and usually comparing the different dialysis modalities among them and among different countries.[1,2,3,4,5] Several indicators suggest that the number of patients on RRT worldwide will still increase during the years to come (approximately at a 4% annual rate)[6,7] which will keep or even increase the interest on the economic study of the cost of these therapies.

If all costs of the different procedures needed for each dialysis modality were structurally differentiated (based on the clinical protocols put in practice at each unit), we would be able to achieve the desirable goal of being able to compare the costs from different areas or hospitals. In 1996, our Center presented an economic study comparing the costs of hospital-based hemodialysis (HHD) with those of the two ambulatory peritoneal dialysis (PD) modalities, manual (CAPD) and automated (APD). This study[1] showed that at our setting home-based modalities were cheaper, which is in agreement with previous experiences in other areas.[3] Computerizing the Management Area of our Hospital currently allows us accurately calculating the cost of each process and updating it yearly with no need of restarting all the procedure. Based on that, we have reviewed the cost analysis comparing the different RRT modalities by using the cost-per-procedure method, which allows calculating in detail the general expenses for each one of the basic processes compounding the initial and maintenance therapy of patients on HD and PD.

POPULATION AND METHOD

A total of 42 procedures in HD and 26 in PD were identified. For each one of them, seven basic cost types were calculated:

1. *Personnel:* time spent on each procedure by all the personnel implicated in its preparation and performance.
2. *Laboratory and other testing:* blood analysis required for each protocol, imaging, and electrocardiography.
3. *Surgical material:* gloves, clothes, masks, gowns, dressings, scalpel, syringes, first aid kits or material used for catheter placement, dialysis lines, priming bags, material used lavage and formolization of hemodialysis machines and sterilization of the material used.
4. *Medical material:* permanent peritoneal catheter, catheter prolonger, titanium connector, peritoneal catheter plug, central catheter kit, dialyzer, shaving machine, gauzes, compresses, suture material, needles and intravenous lines, sterile or non-sterile tubes, hemoculture containers, nail brush, glycemia strips, residues container.
5. *Drugs:* antibiotics, anesthetics, fluids, heparin, urokinase, dialysis concentrates for HD, disinfectants, intravenous iron preparations, erythropoietic agents, medications used for intra-dialysis complications, enemas, oral medications used before catheter placement, PD fluids.

Table I. Coste per clinical protocol-based procedure in Peritoneal Dialysis

	Lab.	Diag.	Personnel	Medical equipment	Drugs	Other items	Total
Catheter placement	220.81	0.00	89	418.25	25.79	956.83	1,710.68
Catheter care*	0.00	0.00	12.24	2.04	0.69	10.77	25.74
Catheter outlet care**	0.00	0.00	4.62	1.06	0.04	1.42	7.14
Obstructed catheter	0.00	8.62	41.64	3.66	82.24	27.86	164.02
Simple exchange	0.00	0.00	6.00	1.61	3.63	0.37	11.61
Appropriateness	22.72	0.00	12.45	0.00	0.00	0.00	35.17
Prolonger change	0.00	0.00	15.24	42.18	0.37	29.07	86.86
PET	29.9	0.00	39.6	2.03	3.63	2.22	77.38
Simple follow-up visit	6.24	0.00	32.7	1.12	0.00	7.51	47.57
Staph. aureus screening	129.28	0.00	11.90	1.79	2.98	7.25	153.20

The figures are expressed in euros. Abbreviations: Lab.: laboratory. Diag.: Diagnostic tests. PET: Standard 4-hour peritoneal equilibrium test.
* Occlusive dressing after placement of the permanent peritoneal catheter.
** Daily care at the hospital.

6. *Other concepts:* hospitalization days, hours of staying at the dialysis room, cleansing of the dialysis Unit, hours of dialysis monitoring device functioning, consumption of osmotized water and energy, food, time of operating room use, transportation used by the patient to come to the dialysis unit.
7. *Indirect costs:* general and structural (estimated as 12% of total direct costs).

Each per-procedure cost analysis has been standardized based on current clinical protocols used at our Unit; in some cases modifications have been introduced during performing the study.

Laboratory costs have been calculated individually and in detail for each determination, including costs of reactives, maintenance, and redemption of laboratory machines, local costs, and personnel costs. For imaging tests and other tests we have applied similar methodology including direct material consumption, redemption of devices used, space and personnel. Personnel costs are estimated based on the cost per hour (including bonuses) for each category (the system allows including the cost of each personnel member in particular, by using a code). Both the Pharmacy and the Procurement Departments of our Hospital have access to databases that allow imputing current costs to each drug or medical/surgical material).

The cost study for each procedure was the result of a detailed analysis carried out by health care personnel (physicians, nurses, and assistants) of all the material and time required to carry out that particular procedure and of the comprehensive work done by the Management Department by identifying and quantifying required costs. Every procedure has been reviewed at least 5 times, from both the clinical perspective and from the management perspectives.

Excell® software has been used for calculation of the cost for each procedure. The Management and Internal Audit Department of the Juan Canalejo Hospital has spreadsheets remotely connected with the Pharmacy and Procurement Departments so that the cost can be directly calculated after knowing the clinical protocol and the codes for the different products used. Besides, this proceeding allows automatic updating that is done at least once a year.

The Juan Canalejo University Hospital assists a basic health care area of 468,000 population. However, the Galician Health Care Service (SERGAS) has not available hierarchical nephrology assistance with RRT capability in the Ferrol area so that health care assistance from that area for PD patients, emergencies and HD intercurrences is covered by our Center; thus, total nephrologic assistance is 717,826 population. The personnel comprising the PD Unit includes two physicians, four nurses (three in the morning shift and one in the afternoon shift), one clinical assistant in the morning shift for attending hospitalized patients, the outpatient clinic, trainings, home visits, and dialysis-related emergencies. The HD Unit comprises two specialized physicians, 19 nurses, and 13 assistants, which take care of HD sessions at the Units of Chronic Patients, Acute Patients, and Isolated Patients

Table II. Cost per clinical protocol-based procedure in Peritoneal Dialysis

	Laboratory	Personnel	Medical equipment	Drugs	Other	Total
Outlet infection	22.01	10.40	3.18	22.11	1.48	73.09
Peritonitis CAPD	111.21	60.30	23.87	37.00	0.00	232.38
Peritonitis APD	111.21	60.30	23.87	48.50	0.00	243.88
Treatment adjustment Peritonitis	143.48	80.16	23.49	59.05	83.50	392.68
Catheter withdrawal	55.38	89.00	47.94	24.44	1,232.58	1,537.21

The figures are expressed in euros. Abbreviations: CAPD: Manual peritoneal dialysis. APD: Automatic peritoneal dialysis.

(including those done at other hospital areas); thus, patients attending the Chronic Patients Unit for their usual sessions, acute patients and emergency HD patients are attended by the HD Unit.

Hospitalized patients from the Chronic Patients Unit from our Hospital, as well as other satellite units (from our Health Care Area and the Ferrol area) are also dialyzed at our Acute Patients Unit. Besides, there is one supervisor nurse for all the Dialysis Unit (HD and PD), one clerk for all the Dialysis Unit (working half-part time) and one attendant and one cleaner during the entire morning shift, shared with the Hospitalization Unit.

With this personnel, 60 patients on average are assisted at our Chronic HD Unit, the emergencies occurring in approximately 240 HD patients at satellite units, and 95 PD patients on average, as well as patients with CRF not included in RRT program but with acute deterioration of renal function, chronic patients on RRT admitted to the hospital, and patients with acute renal failure requiring RRT.

RESULTS

The procedures which cost was studied for PD were:

1. Peritoneal catheter placement.
2. Post-placement care
3. Peritoneal catheter withdrawal.
4. Care of the peritoneal catheter outlet.
5. Management of obstructed peritoneal catheter.
6. PD appropriateness.
7. Four types of regular follow-up visits: simple, appropriateness, semestral, and annual.
8. Exchange of the peritoneal catheter prolonger.
9. Peritoneal equilibrium test (PET).
10. Simple exchange
11. Management of *Staphylococcus aureus* carriers.
12. Not complicated catheter outlet infection or infection with peritoneal catheter withdrawal.
13. Peritonitis therapy (for manual PD and automated PD), adjustment of peritonitis therapy.
14. Manual PD training: at a hotel for patients, both hospitalized and outpatient.
15. Automated PD training: at a hotel for patients, both hospitalized and outpatient.
16. Home visit.

Tables 1, 2 and 3 show the results of detailed cost analysis for these procedures for every item. Table 4 shows all the components for each item comprised peritoneal catheter placement (because of the high percentage of patients from rural areas and the geographical characteristics of our region, this procedure is done with the patient admitted to the hospital).

The cost per hospitalization day was given by the Hospital Management Department, updated for the Nephrology Department for the year 2005 (by GRD). In the present study, only procedures performed at the hospital are presented so that domiciliary costs have not been applied (e.g., therapy with erythropoietic factors).

The term "semestral follow-up visit" includes a more complete laboratory work-up than the one performed at simple follow-up visits. The annual follow-up visit includes, besides, chest X-ray, bone scan, and electrocardiogram. The costs for these two follow-up visits are obtained by adding 38.03 euros (semestral) and 177.54 euros (annual) to the cost of the simple visit.

For HD, the following costs were calculated:

1. Central temporary catheter placement, at the femoral, jugular and subclavian veins.
2. Permanent catheter placement at the jugular vein.
3. Management of permanent catheter obstruction.
4. Creation of internal arterial-venous fistula: radial-cephalic, humeral-cephalic (with and

Table III. Cost per clinical protocol-based procedure in Peritoneal Dialysis. Cost per day of education

	Personnel	Medical equipment	Drugs	Other	Total
Manual ambulatory	51.00	11.88	18.73	7.14	88.75
Manual hotel	51.00	11.88	18.72	63.59	145.20
Manual hospitalized	51.00	11.88	18.72	535.39	705.75
Automatic ambulatory	88.77	46.69	11.78	17.52	174.76
Automatic hotel	88.77	46.69	11.78	83.38	240.62
Automatic hospitalized	88.77	46.69	11.78	325.66	482.90
Home visit	74.40	0.00	0.00	34.40	108.80

The figures are expressed in euros. A laboratory work-up costing 29.72 euros must be added to the total cost for education in automatic peritoneal dialysis.

without surfacing of the basilic vein), placement of a vascular prosthesis.
5. Complication during the HD session (hypotension, cramps, nausea and vomiting, chest pain, cardiorespiratory arrest, dialyzer breakdown, system clotting, venous rupture, and change of monitoring device).
6. HD session at the Chronic Patients Unit (membranes 1, 2, 3 and 4).
7. HD session at the Acute Patients Unit through a provisional line (membranes 1 and 2), with 2-4 hours duration.
8. HD session at the Acute Patients Unit through an internal fistula (membranes 1 and 2), with 2-4 hours duration.
9. HD session in Isolation regimen (including the Isolated Patients Unit or Intensive Care, Reanimation, or Burnt Patients Units) through provisional lines (membranes 1 and 2), with 2-4 hours duration.
10. HD session in Isolation regimen (including the Isolated Patients Unit or Intensive Care, Reanimation, or Burnt Patients Units) through internal fistula (membranes 1 and 2), with 2-4 hours duration.
11. Estimation of dialysis appropriateness.
12. Regular ambulatory follow-up: simple, four-monthly, and annual.

The data for each HD procedure are shown in detail for item costs in Tables 5-8. The cost of jugular catheter placement is shown in detail in Table 9. The cost per hospitalization day has not been imputed to the cost of creation of a permanent vascular access since most of them were performed in an ambulatory manner (externalization of access creation).

In order to analyze the real cost of complications taking place during HD session, all HD sessions done at our Department during a random three-month period were reviewed recording their frequency and therapeutic measures applied in each case (Graph 1).

HD membranes used are designated as 1, 2, 3, and 4, according to:

- Membrane 1: Polyamide
- Membrane 2: Poly-methyl-methacrylate
- Membrane 3: AN69 at biofiltration regimen with bicarbonate solution reposition
- Membrane 4: AN69 at hemofiltration regimen, with dialysis being done with concentrated fluid but without acetate or bicarbonate, and with infusion of bicarbonate solution (AFB, Hospal®)

All HD sessions were done with bicarbonate bath, with the exception of membrane 4, as it has been specified.

The main difference between HD sessions administered at the Chronic Patients, Acute Patients and Isolated Patients Units is personnel requirement (4 patients per nurse and 8 patients per nurse assistant at the Chronic Patients Unit; 3 patients per nurse and per nurse assistant at the Acute Patients Unit; and one nurse per patient at the Isolated Patients Unit). The term «isolated patients» includes both HD sessions performed on isolated patients within our Unit due to infectious causes and HD sessions performed outside our Unit (Reanimation, Intensive Care, and Burnt Patients Unit). Dialysis procedures with membrane types 3 and 4 are only performed at the Chronic Patients Unit, whereas at the Acute Patients and Isolated Patients Units polyamide and polysulfone dialyzers (membranes 1 and 2, respectively) are used.

In order to take into account the cost of erythropoietic factors, their use has been averaged for each dialysis membrane type. Currently, patients at our Dialysis Unit attend the hospital by shared health

Table IV. Cost of placement of permanent peritoneal catheter

Catheter placement in dialysis

PATIENT	STANDAD				HISTORY		DATE		
Type of study/reference	**Code**	**Amount**	**Price**	**Cost**	**Type of study/reference**	**Code**	**Amount**	**Price**	**Cost**
LABORATORY					**OTHER TEST AND IMAGING**				
Pre-surgical profile-LURG	690	1.00	14.6600	14.66 €					
Blood count (Post)-LURG	661	2.00	1.7800	3.56 €					
Biochemistry (Post)-LURG	665	1.00	4.4600	4.46 €					
Previous analysis	660	1.00	198.1300	198.13 €					
TOTAL				**220.81 €**					
OTHER ITEMS	**Code**	**Amount**	**Price**						
Days of average staying at Nephr.	GRD 316	4.00	308.1400	1,232.60 €					
TOTAL				**1,232.60 €**					
PERSONNEL	**PT**	**minutes**	**cost/min**			**PT**	**minutes**	**cost/min**	
Physician	5004	120.00	0.5200	62.40 €	Nurse	6002	60.00	0.3100	18.60 €
					Nurse assistant	6502	40.00	0.2000	8.00 €
TOTAL				**62.40 €**					
SURGICAL EQUIPMENT	**Code**	**Amount**	**Price**						**36.60 €**
Surgical cap	840200	2.00	0.0500	0.10 €	*Sterilization of surgical material*				0.00 €
Masks	830100	4.00	0.0600	0.24 €	Surgical box Nephr. Catheter placement		50.00	0.1100	5.40 €
Sterile gloves	820800	2.00	0.4200	0.84 €	Separators		50.00	0.1100	5.40 €
Serum kit	530600	2.00	0.2700	0.54 €	Trocar		50.00	0.1100	5.40 €
Scalpel	670400	1.00	0.1000	0.10 €	Rigid guide		50.00	0.1100	5.40 €
Surgical sterile dressings	810200	2.00	0.7200	1.44 €	Bowl		50.00	0.1100	5.40 €
Surgical sterile clothing	850200	8.00	0.2900	2.32 €	Surgical brushes		50.00	0.1100	5.40 €
TOTAL				**5.58 €**					**32.40 €**
MEDICAL MAT. AND ANEST.	**Code**	**Amount**	**Price**		**DRUGS**	**Code**	**Amount**	**Price**	
Material					*Medication*				
Big transparent dressing	011700	1.00	0.7000	0.70 €	Heparin 1% vial	628669	2.00	0.5400	1.08 €
Abbocath n.º 22	240600	1.00	0.3500	0.35 €	Atropine 1 mg	635649	1.00	0.0900	0.09 €
Sterile gauzes	030410	100.00	0.0100	1.00 €	Hibitane for disinfection	4739	1.00	0.0000	0.00 €
Sterile compresses w/o contrast	030200	120.00	0.1300	15.60 €	Betadine 125 mL flask	997437	0.50	0.7500	0.37 €
Vicril-Dexon 2/0 C-16/GL-12	730500	0.13	84.9200	10.62 €	Cephazolin 2 g	64450	2.00	1.6800	3.35 €
Silk Straight needle	754300	1.00	29.3500	29.35 €	Tobramycin 100 mg	625129	4.00	0.6700	2.69 €
5 mL syringe	510400	1.00	0.0200	0.02 €	Minurin C/10 Amp.	673665	7.00	1.8200	12.72 €
10 mL syringe	510100	3.00	0.0400	0.12 €	Diazepam 10 mg	626382	1.00	0.0400	0.04 €
SC needle	610300	1.00	0.0100	0.01 €	Soapy enema Cassen	683649	1.00	1.8300	1.83 €
IM needle	610500	1.00	0.0100	0.01 €	Bicarbonate 8.4% 10-mL	11908	1.00	0.3300	0.33 €
IV needle	610600	1.00	0.0100	0.01 €					
Disposable shaver	AL1175	1.00	0.0900	0.09 €					
Swan Thenckoff Cath.	D16030	1.00	120.9600	120.96 €	*Fluids*				
Plug disconnection equipment	D13100	1.00	1.1400	1.14 €	Scandicam 2% 10 mL	651823	3.00	0.4500	1.34 €
Titanium cath. Adapter	SPC4129	1.00	195.9500	195.95 €	Normal saline 250 mL Viaflex	640417	2.00	0.9700	1.94 €
Prolonger p/Sis.	D16010	1.00	36.9000	36.90 €					
				0.00 €	*Blood*				
				0.00 €	HCH RBC SAG-Manitol	500002	1.00	66.2700	66.27 €
TOTAL				**412.67 €**					**92.06 €**
Laboratory				**220.81 €**	**Direct costs**				**2,052.77 €**
Other tests and imaging				**0.00 €**					
Personnel				**89.00 €**					
Medical material and anesthesia				**418.25 €**					
Medications, fluids, and blood				**92.06 €**					
Other concepts				**1,232.58 €**					

Table V. Cost per clinical protocol-based procedure in hemodialysis. Vascular access

	Lab.	Diag.	Personnel	Medical equipment	Drugs	Other	Total
Jugular catheter	0.00	18.40	30.90	122.57	7.54	1.28	180.69
Femoral catheter	0.00	0.00	30.90	146.21	7.54	1.28	185.92
Subclavian catheter	0.00	18.40	30.90	146.25	7.54	1.28	204.37
Permanent catheter	0.00	18.40	46.35	513.16	7.76	1.71	587.37
Catheter clearance	0.00	0.00	45.90	12.82	10.00	2.56	71.30
IAVF-simple	14.11	0.00	41.00	47.76	11.49	6.59	120.96
IAVF with surfacing	14.12	0.00	84.65	72.71	5.85	75.60	252.92
Prosthetic IAVF	14.12	0.00	125.15	701.65	15.39	79.99	936.29

The figures are expressed in euros. Abbreviations: Lab.: Laboratory. Diag.: Diagnostic tests. IAVF: internal arterial-venous fistula.

care transportation (10 cases) or by own means. In this case, patients have the right to a reimbursement of 0.12 euros per kilometer, provided that they do not belong to the Coruña municipality.

Patients managed at the Chronic Hemodialysis Unit of our Hospital are submitted to a simple follow-up visit every 45-60 days; to a four-monthly visit including complete liver biochemistry, iron kinetics, viral serology, nutritional markers, PTH, and dialysis appropriateness (Kt/V); and annual, including the former plus electrocardiogram and complete bone scan. The costs for these follow-up visits are shown in Table 6.

The annual treatment cost for a particular patient on a particular dialysis modality may be estimated by adding partial costs of that patient or of an average patient. For patients on peritoneal dialysis, the daily domiciliary costs and the cost of required erythropoietic factors should be added to the costs shown in this study.

By analyzing the data shown in the different tables, the cost greatly varies depending on whether the period of dialysis onset is included or it is a patient on a stable program because of the high cost of procedures such as creation of a definitive access for dialysis, education, dialysis sessions through temporary accesses, or the need for hospitalization, among others.

DISCUSSION

The greater and greater complexity of the different procedures performed with RRT, as well as of patients that nephrologists take care of, makes necessary focusing the cost analysis of the different dialysis modalities from a different perspective than the one being used so far. In hospital management, the concept of cost per procedure (considering as such every hospitalization episode a patient may have)[8] has been created based on the American system of Medicare reimbursement that applies a code for each hospitalization episode (GRD- group related diseases-).[9,10] Each code is weighted against the unit (the average price of all procedures performed

Table VI. Cost per clinical protocol-based procedure in hemodialysis. Hemodialysis session at the Chronic Patients Unit

	Lab.	Diag.	Personnel	Medical equipment	Drugs	Other	Total
HD - Membrane 1	0.09	0.00	44.24	40.61	25.64	19.38	130.99
HD - Membrane 2	0.09	0.00	44.24	64.96	25.64	28.39	164.65
HD - Membrane 3	0.09	0.00	47.79	76.35	18.77	27.32	170.34
HD - Membrane 4	0.09	0.00	47.79	96.08	5.98	27.52	177.48
Rev. simple	9.53	0.00	9.13	0.00	0.00	5.99	24.66
4-monthly FUV	230.64	0.00	12.55	0.00	0.00	5.99	249.19
Annual FUV	280.46	30.89	17.75	0.00	0.00	5.99	335.10
Appropriateness	2.56	0.00	3.42	0.00	0.00	0.00	5.99

The figures are expressed in euros. Abbreviations: Lab.: Laboratory. Diag.: Diagnostic tests. FUV: follow-up visit. HD: Hemodialysis session.

Table VII. Cost per clinical protocol-based procedure in hemodialysis. Hemodialysis session at the Acute Patients Units

	Laboratory	Personnel	Medical equipment	Drugs	Other	Total
Membrane 1 2 hours Temporary catheter	0.09	59.80	39.53	4.33	9.08	112.83
Membrane 1 4 hours Temporary catheter	0.09	73.46	39.53	4.33	13.59	131.00
Membrane 2 2 hours Temporary catheter	0.09	59.80	75.40	4.33	9.08	148.70
Membrane 2 4 hours Temporary catheter	0.09	73.46	74.79	4.33	13.59	166.26
Membrane 1 2 hours IAVF	0.09	54.70	40.61	33.84	10.68	139.94
Membrane 1 4 hours IAVF	0.09	66.76	40.61	33.84	15.12	156.04
Membrane 2 2 hours IAVF	0.09	54.7	64.94	33.84	10.77	164.36
Membrane 2 4 hours IAVF	0.09	66.36	64.94	33.84	12.69	180.95

The figures are expressed in euros.

during the preceding year). In our country, this system is used to calculate the cost per hospitalization episode, but there are no studies analyzing all the procedures performed at a Dialysis Unit.

On the other hand, in order to know the cost per hospitalization (per procedure) it is necessary to know the cost of every intermediate activity unit[11] (what is called in the present study as cost per procedure). That is to say, in nephrology, accurate costs for dialysis or for ancillary procedures are not been currently assessed when calculating the costs per procedure.

From this perspective, costs study at dialysis units becomes especially complex: there are ambulatory procedures (usual sessions at the Chronic Patients Unit, follow-up visits at the Dialysis Unit –for both HD and PD–, management of peritoneal catheter outlet infections, peritonitis, etc.); procedures done on hospitalized patients (HD sessions, PD exchanges, etc.), and procedures done at the patients' home (home visits). Besides, the same procedure may be done with the patient being hospitalized or outpatient, depending on the clinical status (HD sessions, infections management, creation of the temporary vascular access, etc.).

Currently there is a trend towards individualized management by clinical areas in the different Spanish health care systems.[12] This management is impossible without knowing the cost of the activities usually performed in each area, for both being able to set up budgets (prospective payment per procedures) and comparing the same procedures (adjusted to clinical protocol) performed at different hospitals. This makes cost comparison easier and allows assessing its relationship with clinical outcomes (cost-benefit).

Calculating the cost for each clinical procedure demands a big initial effort that is later compensated since all further modifications of clinical protocols and annual updates are relatively simple and may be automatically done in many cases. This does not mean, of course, that the annual cost of a therapy for

Table VIII. Cost per clinical protocol-based procedure in hemodialysis. Hemodialysis session in individualized regimen

	Laboratory	Personnel	Medical equipment	Drugs	Other	Total
Membrane 1 2 hours Temporary catheter	0.09	68.87	39.53	5.73	15.69	129.93
Membrane 2 2 hours Temporary catheter	0.09	68.87	63.86	5.73	15.69	154.27
Membrane 1 4 hours Temporary catheter	0.09	101.21	39.53	5.73	20.13	166.72
Membrane 2 4 hours Temporary catheter	0.09	101.21	63.86	5.73	20.13	191.11
Membrane 1 2 hours IAVF	0.09	63.77	40.04	8.25	15.69	128.48
Membrane 1 4 hours IAVF	0.09	96.11	40.65	8.25	20.15	165.26
Membrane 2 2 hours IAVF	0.09	63.77	64.99	8.25	15.69	152.81
Membrane 2 4 hours IAVF	0.09	98.11	64.99	8.25	20.19	191.66

The figures are expressed in euros.

a patient is automatic, but it is relatively simple since it is just an addition of standardized procedures. Besides, this method also allows calculating the cost for the average patient. Finally, this method is interesting for the analysis of a problem relatively complex such as the cost of the initial phases of RRT (creation of the permanent access, education, etc.). This is the most expensive phase of RRT so that any method allowing for its optimization from a mixed point of view, clinical and financial, seems very useful.

The different economical studies on RRT done in our country have consistently shown that real costs do not correlate with those officially published (Official Estate Bulletin or the bulletins of the Autonomies). This disagreement may only be solved by means of the joint effort from clinicians (standardization of the procedures required for an activity) and managers (cost analysis of these procedures), which would allow health care managers optimizing simultaneously quality and costs of health care assistance provided in our hospitals.

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Table IX. Cost of placement of temporary internal jugular line for hemodialysis

Jugular line - Hemodialysis									
PATIENT	**STANDARD**				**HISTORY**		**DATE**		
Type of study/reference	**Code**	**Amount**	**Price**	**Cost**	**Type of study/reference**	**Code**	**Amount**	**Price**	**Cost**
LABORATORY					**OTHER TEST AND IMAGING**				
				0.00 €	Chest X-Ray	70501	1.00	18.40000 €	18.40 €
				0.00 €					0.00 €
				0.00 €					
				0.00 €					0.00 €
TOTAL				**0.00 €**					**18.40 €**
OTHER ITEMS	**Códe**	**Amount**	**Price**						
Hour of staying at Hem. room (w/o machine)		0.75	1.71000 €	1.28 €					
TOTAL				**1.28 €**					**0.00 €**
PERSONNEL	**PT**	**minutes**	**cost/min**			**PT**	**minutes**	**cost/min**	
Physician	5004	30.00	0.52000 €	15.60 €	Nurse	6002	30.00	0.31000 €	9.30 €
				0.00 €	Nurse assistant	6502	30.00	0.20000 €	6.00 €
				0.00 €					0.00 €
TOTAL				**15.60 €**					**15.30 €**
SURGICAL EQUIPMENT	**Code**	**Amount**	**Price**						
Sterile gloves	820800	2.00	0.41500 €	0.83 €	*Sterilization of surgical material*				0.00 €
Masks	830100	4.00	0.05830 €	0.23 €	Sterile bowl		50.00	027000 €	13.50 €
Non-sterile gloves	821300	2.00	0.00410 €	0.01 €					0.00 €
Sterile gauzes	030410	60.00	0.01130 €	0.68 €					0.00 €
Surgical sterile dressings	850200	6.00	0.29040 €	1.74 €					0.00 €
Surgical sterile clothing	810200	3.00	0.73260 €	2.20 €					0.00 €
Scalpel	670400	1.00	0.09720 €	0.10 €					
Surgical caps	840200	2.00	0.04620 €	0.09 €					
TOTAL				**5.88 €**					**13.50 €**
MEDICAL MAT. AND ANEST.	**Code**	**Amount**	**Price**		**DRUGS**	**Code**	**Amount**	**Price**	
Material					*Medication*				
Silk Straigh needle	754300	1.00	29.50000 €	29.50 €	Heparin 1% vial	628669	1.00	0.53800 €	0.54 €
Big transparent dressing	011700	1.00	0.70110 €	0.70 €	Heparin 5% vial	628677	1.00	1.06000 €	1.06 €
Sterile compresses w/o contrast	030200	48.00	0.12950 €	6.22 €	Bicarbonate 8.4% 10 mL	11908	1.00	0.34980 €	0.35 €
10 mL syringe	510100	3.00	0.03800 €	0.11 €	Betadine 125-mL flask	997437	0.50	0.74700 €	0.37 €
IM needle	610600	1.00	0.01220 €	0.01 €	Clorhexidine 2% 1,000 mL	20057	1.00	3.24460 €	3.24 €
IV needle	610500	1.00	0.01220 €	0.01 €					0.00 €
Disposable shaver	AL1175	1.00	0.09040 €	0.09 €					0.00 €
Normal nail brush	AL1020	1.00	0.80890 €	0.81 €					0.00 €
Jugular catheter kit 11.5 x 150	D11100	1.00	65.73990 €	65.74 €					0.00 €
				0.00 €					0.00 €
				0.00 €					0.00 €
				0.00 €					0.00 €
				0.00 €	*Fluids*				0.00 €
				0.00 €	Normal saline 1,000 mL Viaflex	610865	1.00	1.29900 €	1.30 €
				0.00 €	Scandicam 2% 10 mL	615823	1.50	0.44700 €	0.67 €
				0.00 €					0.00 €
				0.00 €	*Blood*				0.00 €
				0.00 €					0.00 €
TOTAL				**103.19 €**					**7.54 €**
Laboratory				**0.00 €**	**Direct costs**				**180.69 €**
Other tests and imaging				**18.40 €**					
Personnel				**30.90 €**					
Medical material and anesthesia				**122.57 €**					
Medications, fluids, and blood				**7.54 €**					
Other concepts				**1.28 €**					

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