ORIGINAL ARTICLE

Cost estimate of chronic hemodialysis in Kinshasa, the Democratic Republic of the Congo: A prospective study in two centers

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ABSTRACT

Background: The number of patients on dialysis has significantly increased worldwide. However, prospective studies estimating the cost of hemodialysis (HD) in sub-Saharan Africa remain scarce. The present study aimed to evaluate the direct cost of treating end stage renal disease. Determinants of additional direct cost were also assessed.

Methods: This study is an analytical, prospective study of cost performed at two HD centers in Kinshasa for a period of 3 months among HD patients enrolled consecutively. The cost analyzed includes only expenditures: consultation, HD session, drugs, comorbidities, laboratory tests, and imaging. Transportation, patient hospitalization, and indirect costs are not taken into account. The determinants of the additional direct cost of HD are identified by multivariate logistic regression analysis. $P < 0.05$ is the level of statistical significance.

Findings: The average quarterly direct cost of chronic HD in United States Dollars (US$) is $7070 (~US$28,280 annual cost) at a rate of US$287 per patient per HD session. This cost includes the HD session (US$237) and medicine (US$33) costs, which account for 82.5% and 11.3% of the direct costs, respectively. The presence of at least 4 comorbidities (OR adjusted 4.3, 95% CI [1.23–14.95], $P = 0.022$) and infection (adjusted OR 4.56, 95% CI [1.05–19.85], $P = 0.043$) emerged as independent determinants of additional direct cost.

Conclusion: The direct cost of HD is very high in Kinshasa, where more than 80% of Congolese people live on less than US$1.25 a day.

Keywords: Direct cost, hemodialysis, quarterly follow-up, Kinshasa, economic evaluation

INTRODUCTION

End-stage renal disease (ESRD) is a major public health problem because of increased incidence and prevalence worldwide, high risk of cardiovascular mortality in chronic kidney disease (CKD), and the very high cost of renal replacement therapy (RRT).[1–4] The prevalence of ESRD patients on dialysis is 1010 per million inhabitants (pmi) in the European Union (U-E), 1100 pmi in the United States, and more than 1400 pmi in Japan.[5–8] It ranges from

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400 to 760 pmi in the Maghreb and less than 100 pmi in Sub-Saharan Africa (SSA).[9,10] The annual ESRD patient incidence in most North African countries is estimated to be 74–200 pmp, ranging from 98 to 198 pmp per year in registries from developed countries.[6,8,10,11]

This ESRD patient number has increased and reached epidemic proportions, and only few countries have strong economies that can meet the need.

ESRD constitutes a heavy burden on communities worldwide due to the high cost of RRT.[12] Between 2014 and 2015, Medicare fee-for-service spending for beneficiaries with ESRD rose by 2.4% in United States of America dollars (USD) from 33.1 billion to 33.9 billion in the United States, accounting for almost 7.1% of all Medicare paid claims costs.[13] In Europe, ESRD absorbed approximately 2% of the health care budget patients constituting less than 0.1% of the population.[14]This treatment cost depends on the method used (hemodialysis (HD) vs. peritoneal dialysis) and complications and events during treatment sessions.[15] It is estimated at an average annual cost in Euros (€) of 50,000 per patient per year and €81,500 per patient per year, respectively, for peritoneal dialysis and HD in central Europe.[16]

In SSA, CKD diagnosis usually occurs late in advanced stages requiring urgent RRT management.[1] The consequences are huge and in addition to trauma related to lack of preparation for treatment initiation. Complications installed during the disease's silent phase severely burden patients' future and treatment cost. In this part of the world, most patients finance their treatment from their own resources or with the assistance of their family members or through the help of employers.[17,18] It is slowly starting to be subsidized by the state at varying proportions in many countries such as Cameroon, Kenya, Sudan, and others.[18]

In the Democratic Republic of the Congo (DRC), a low-income country with a gross domestic product per capita of US$271 and annual health expenditures of US $15 per capita,[19] CKD prevalence is 12.4% in Kinshasa, and 0.2% have ESRD.[20] In a more recent analysis of financing of health care in DRC, direct payment (particularly fee-for-service payment) is the most common mode, constituting a real barrier to care accessibility.[21]The absence of health insurance and state subsidy means that the high cost of RRT is always entirely supported by the patient and/or his/her family or employer. The accessibility of dialysis in Kinshasa is estimated to be 12%.[22] Hence, most patients with ESRD in DRC die without receiving appropriate treatment. In this regard, HD cost evaluation, one of the rapidly expanding RRT methods in the DRC, is essential for advocacy and rational policy development in health care financing. The present work intends to end information deficits on the cost of management of chronic HD and provides useful information to clinicians and policy makers to elaborate a policy.

MATERIELS AND METHODS

Design, period, and setting

In this analytical, prospective study, incident and prevalent patients on maintenance HD consecutively enrolled, between January 1, 2013 and December 31, 2013, were followed during one quarter (3 months). Incident patient was defined as any patient who started HD during this study. Prevalent patient was any patient who started HD before this survey. The Ngaliema Medical Center (NMC) and Afia Medical Center (AMC) HD private centers provided the framework. These centers were chosen because they were the only functional HD centers in Kinshasa at this time. All centers were equipped with Fresenius 4008B, 4008s, and 5008s dialysis machines, used consumables produced by the manufacturers and did not practice dialyzer reuse. Monitoring of pre-dialysis biochemical and hematological parameters was performed monthly in hospital HD patients. In these units, patients underwent 2 or 3 dialysis sessions of 4 hours per week. Epoetin β was the erythropoietin stimulant agent used to maintain hemoglobin within the recommended range, and the frequency of administration was 2 or 3 times a week. Carbonate calcium and calcium channel blockers were the main phosphate binder and antihypertensive drug used, respectively.

Cost methodology and data collection

Data and costs were obtained from patient interviews, medical records, bills, hospital price lists, and hospital procurement departments. Socio-demographic and clinical baseline data included age, sex, educational level, occupation and care funding source, ESRD primary cause (chronic glomerulonephritis, hypertension, diabetes, polycystic kidney disease, etc.), comorbidities associated with ESRD (history of stroke and ischemic transient stroke, disorders rhythm, heart failure, coronary heart disease, cirrhosis, viral hepatitis, HIV, diabetes, hypertension, respiratory failure, etc.), vascular access, and ESRD complications at the beginning of follow-up (encephalopathy, pericarditis, hypervolemia, acidosis, anemia, hypocalcemia, etc.).

Direct costs included only direct medical costs (first consultation fees for incident patients in HD, setting up vascular access fees, dialysis session fees, consumables and investment cost, drugs (treatment of complications

and ESRD comorbidities, HD treatment complications and events in session), outpatient consultation fees, laboratory, and imaging tests. Vitamin D supplements, erythropoiesis stimulating agents, and phosphate binders were also considered. During the HD session, the costs of the occurrence of the following events recorded were assessed: infection (intravenous antibiotic), hypotension, muscle cramps, dyspnea, parenteral nutrition, and intravenous analgesics. Direct nonmedical costs (transport, feeding, water, and electricity) were not taken into account. The average quarterly direct cost of HD per patient and direct cost per HD session were evaluated. The calculation was based on the cost of each component of the various expenditures. The average expenditure cost per item was estimated. Observations of HD sessions were assessed based on the number of HD sessions performed in 3 months of the follow-up.

Operational definitions

We used the following definitions in the present study:

- Secured financing was defined as financing provided by a company or public treasury or health insurance.
- Unsecured financing was out-of-pocket form the patient's own resources and/or family resources.
- Low socio-economic status referred to individuals who have little income or were unemployed.
- An event in an HD session was any symptom or clinical sign during an HD session and reported on the meeting sheet. The initial pathology was pathology at ESRD origin.
- A clot of the circuit was coagulation (total or partial) of the extracorporeal circulation circuit requiring HD session interruption.
- Hypertension peak during a session was any increase in blood pressure during an HD session that required the use of a parenteral or oral antihypertensive drug.
- Hypotension was a drop in blood pressure during an HD session requiring vascular filling.
- Infection was any condition that required antibiotics during or outside HD sessions.

Statistical analyses

Qualitative data are presented as absolute and relative frequency (%). Quantitative data are presented as the mean ± SD with their extremes. Pearson chi-square and Fisher's exact tests were used to compare qualitative variable proportions as appropriated. Averages of normally distributed continuous variables were compared using Student's *t* tests and ANOVAs. Mann–Whitney U tests and Wilcoxon and Kruskall–Wallis tests were used for continuous variables with asymmetric distributions to compare group means and categories. We used logistic regression analysis to search the determinants of additional quarterly direct costs of HD. Odds ratio (OR) and confidence interval (CI) were also obtained. Statistical significance was set at $P < 0.05$. Statistical analyses were performed using statistical software SPSS version 20.

Table 1 Baseline characteristics of the study population

Variables	N	All Group (N = 92)	Male n = 70	Female n = 22	P
Age, (years),	92	51.9 ± 12.8	52.2 ± 12.1	51.1 ± 15.1	0.7190
Ag > 60 years, n (%)	27	27 (29.4)	20 (28.5)	7 (31.8)	
Profession, n (%)	92				
Private employee	47	47 (51.1)	42 (60.0)	5 (22.7)	<0.0001
Public employee	17	17 (18.5)	14 (20.0)	3 (13.6)	
Unemployed	17	17 (18.5)	5 (7.1)	12 (54.5)	
Independent	6	6 (6.5)	6 (8.6)	0 (0.0)	
Student	5	5 (5.4)	3 (4.3)	2 (9.1)	
Level of formal education, n (%)	92				
University	53	53 (61.6)	47 (73.8)	5 (23.8)	<0.0001
Secondary	24	24 (27.9)	13 (20.0)	11 (52.4)	
Primary	9	9 (10.5)	4 (6.2)	5 (23.8)	
Dialysis centers, n (%)	92				0.5180
NMC	56	56 (60.9)	43 (61.4)	13 (59.1)	
AMC	36	36 (39.1)	27 (36.6)	9 (40.9)	

Data are expressed as mean ± SD, absolute (n) and relative frequency (in percent). Abbreviations: AMC = Afia Medical Center; NMC = Ngaliema Medical Center.

Table 2 The distribution of the average quarterly direct cost of HD-related care

	Average quarterly direct cost (US$)	
	∑ (%)	× ± SD
All variables	650,432 (100)	7069.9 ± 2571.8
Consultations fee	970 (0.2)	23.1 ± 2.5
Vascular access	13,860 (2.1)	277.2 ± 134.4
dialysis session fee	536,310 (82.5)	5829.5 ± 2090.6
Medications	73,820 (11.3)	802.4 ± 508.1
Laboratory tests	22,282 (3.4)	242.2 ± 125.2
Imaging	3155 (0.5)	60.6 ± 57.4

Data are expressed as mean ± SD, absolute (n) and relative frequency (in percent).

Ethical considerations

Written informed consent was obtained from all participants before enrolment. The study protocol was approved by the Public Health Department of the University of Kinshasa Institutional Review Board.

RESULTS

Sample characteristics

As shown in Table 1, 92 ESRD patients were included, 49 (53.3%) prevalent and 43 (46.7%) incident patients. Their mean age was 51.9 ± 12.8 years, and 70 (76.1%) were males. The majority of our patients had a low socio-economic level with more than 25% without income. Only 5.4% had health insurance.

Estimation of the quarterly direct costs of HD-related care

The distribution of the average quarterly direct cost by different variables is listed in Table 2. The total average quarterly direct cost of HD-related care per patient was US$7069.9 ± 2571.8 (~US$28,280 annual cost). The average direct cost for each HD session that includes costs of the session, medications, laboratories, and imaging was US$287. It includes the HD session (US$237) and drug (US$33) costs, which account for 82.5% and 11.3% of the direct costs, respectively. The consultation fee for the first session was considered only for incident patients. The average cost of consultations was US $23.1 ± 2.5. Tables 3 and 4 show the cost categories for vascular access procedures, HD complications, comorbidities, and medications. The average cost of catheter placement was US$277.2 ± 134.9. In fact, some differences exist between temporary catheters and permanent catheters (US$265 vs. 900), with the latter being relatively more expensive. The temporary catheter accounted for 93% of the financial burden of catheters. The average

Table 3 Direct cost categories for vascular access and dialysis complications

	Average quarterly direct cost (US$)			
	All group ∑ (%) × ± SD	Incident ∑ (%) × ± SD	Prevalent ∑ (%) × ± SD	P
Vascular access	13.860 (100)	11.760 (84.8)	2.100 (15.2)	0.633
	277.2 ± 134.4	273.5 ± 104.2	300 ± 266.1	
Temporary catheter	12.960 (93.5)	11.760 (90.7)	23.1 ± 2.5	0.095
	264.5 ± 100.9	273.5 ± 104.2	200 ± 31.0	
Permanent catheter	900 (6.5)	0	900 (100)	-
	900	0	900	
AVF	0 (0)	0	0	-
HD complications	7.842 (100)	4.201 (53.6)	3.641 (46.4)	0.4930
	126.5 ± 166.9	127.3 ± 167.7	125.6 ± 168.9	
Infections	7.090 (90.4)	3.657 (51.6)	3.433 (48.4)	0.3614
	322.3 ± 103.1	332.4 ± 92.3	312.1 ± 116.5	
Hypotension	351 (4.5)	170 (48.4)	181 (51.6)	0.3614
	3.9 ± 11.1	11.4 ± 7.6	28.8 ± 14.1	
Hypertension	127 (1.6)	115 (90.6)	12 (9.4)	<0.0001
	9.8 ± 11.6	12.8 ± 13.0	2.9 ± 1.6	
Other complications	274 (3.5)	259 (94.5)	15 (5.5)	0.6442
	35.4 ± 20.0	11.9 ± 3.8	11.5 ± 4.4	

Data are expressed as mean ± SD, absolute (n) and relative frequency (in percent).
Abbreviations: AVF = artério-venous fistula; HD = hemodialysis.

Table 4 Direct cost categories for ESRD and comorbidities medications

	Average quarterly direct cost (US$)			
	All group ∑ (%) × ± SD	Male ∑ (%) × ± SD	Female ∑ (%) × ± SD	P
ESRD drugs	49.227 (100)	37854 (76.9)	11.373 (23.1)	0.7670
	547 ± 444.2	556.7 ± 443.7	300 ± 266.1	
Anemia drugs	42.462 (86.3)	32.631 (77)	9.831 (23)	0.9890
	471.8 ± 434.3	479.9 ± 437.7	446.9 ± 432.9	
Phosphocalcic drugs	3.700 (8.7)	2.843 (76.8)	857 (23.2)	0.2840
	68.5 ± 27.6	71.1 ± 31.2	900	
Other drugs	3.065 (5)	2.380 (77.6)	685 (22.4)	0.7335
	422.4 ± 431.5	431.1 ± 431	394.9 ± 442.2	
Comorbidities drugs	16759 (100)	12957 (77.3)	3802 (22.7)	0.5655
	199.5 ± 179.8	202.5 ± 193.4	190.1 ± 130.7	
Antihypertensive	11878 (70.9)	8883 (74.8)	2995 (25.2)	0.5098
	154.3 ± 85.8	148.1 ± 77.3	176.2 ± 111.1	
Antidiabetic	2719 (16.2)	2430 (89.4)	289 (10.6)	0.3658
	136 ± 231.4	151.9 ± 254.5	72.3 ± 91.2	
Antithrombotic	1260 (7.5)	1005 (79.8)	256 (20.2)	0.7699
	24.2 ± 32.9	26.4 ± 38.4	18.3 ± 4.0	
Other medications	908 (5.4)	644 (70.9)	264 (29.1)	0.8447
	34.9 ± 28.0	35.8 ± 30.3	32.9 ± 23.9	

Data are expressed as mean ± SD, absolute (n) and relative frequency (in percent).
Abbreviation: ESRD = end stage renal disease.

total quarterly cost of drugs was US$802.4 ± 508.1. The cost of ESRD drug complications accounted for 66.7% of the total drugs cost. We did not find significant difference in the average quarterly cost of each category of drugs. The treatment of anemia accounted for 86.3% of the total spent for drug complications of ESRD and 57.5% of the total amount spent for all drugs, with an average quarterly cost of US$471.8 ± 434.3. No significant differences were found comparing each category of drug treatment with ESRD complications. The largest proportion (90.4%) of the amount spent on drugs occurring during the HD session was due to the management of infections (average cost of US$322.3 ± 103.1). Compared with prevalent patients, the financial cost of treating blood pressure spikes in incident patients was significantly higher (US$12.8 vs. US$2.9, P<0.0001). Hypertension accounted for 70.9% of the total expenditure on co-morbidities with an average cost of US $154.3 ± 85.8. We did not find significant differences in each component of the treatment of comorbidities by sex. The strength of association between the different parameters and the high cost of HD (corresponding to an average quarterly cost of HD higher than US$7070) was found with a logistic regression analysis. In the univariate model, infection, hypertensive peak and 4 or more comorbidities increased additional by 4 (unadjusted OR 3.56, 95% CI [1.29–9.77], P < 0.014), 3 (unadjusted OR 2.92, 95% CI [1.22–6.98], P < 0.016) and 3 (unadjusted OR

Table 5 Additional cost predictors in chronic hemodialysis by multivariate logic regression analysis

Variables	OR (IC95%)	P	Adjusted OR (IC95%)	P
Infection				
No	1	0.014	1	0.043
Yes	3.56 (1.29–9.77)		4.56 (1.05–19.85)	
Comorbidities				
<4	1	0.016	1	0.022
≥4	2.86 (1.22–6.73)		4.29 (1.23–14.95)	
Hypertension				
No	1	0.016	1	0.056
Yes	2.92 (1.22–6.98)		0.308 (0.092–1.032)	

2.86, 95% CI [1.22–6.73], $P < 0.016$), respectively. In the multivariate analysis (Table 5), the strength of associations found in the univariate analysis persisted only for infection and the number (at least 4) of comorbidities, which emerged as independent determinants of additional costs of HD-related care and multiplied the risk by 5 and 4, respectively.

DISCUSSION

This study is the first study to report the direct cost of HD-related care in the DRC. The total quarterly direct cost of HD-related care was US$650,432 with an average of US$7070 per patient, and 83% of this amount represented HD session cost (average HD session cost is US $237), 11% drug cost (US$33), and 3.4% laboratory tests (US$10). Therefore, the total HD session direct cost was US$287.

Although it is difficult to compare analyses carried out at different centers (cost evaluation depends on a variety of factors), the mean annual expenditure per patient on HD-related care in US$ is 28,280 in Kinshasa, which is significantly higher than that reported in Cameroon (U $13,581),[23] Morocco (US$12,000),[11] lran (US$11,549)[24] and India (US$4821)[25] but similar to the annual cost reported in Brazil (US$28,570)[26] and Tanzania (US$27,440).[27] This annual expense per Congolese HD patient is, however, relatively lower than the HD cost from other countries (€81,500 in France,[16] US$68,000 in the USA[13] and US$46,332 in Saudi Arabia[28]). This discrepancy in the direct cost of HD-related care may due to differences between countries in state subsidies, health coverage, HD adherence, current drugs prescribed (EPO, iron, calcimimetic, etc.), laboratory and imaging examinations, annual per capita income, imported consumables cost and cost of services related to local labor costs.[14] In the DRC, only a minority of patients received financial support for their dialysis, explaining why less than 10% of patients are on maintenance HD;[29] the remaining die without receiving appropriate treatment.

The sources of funding of direct costs of HD in this study were assistance from family members (45.7%) and employers (40.2%) without HD expenditures from the government. However, most people living in this country live on less than US$1.2 per day. In this context, out-of-pocket payments for HD treatment and care often trap poor households in cycles of catastrophic expenditure.

The financial burden of drugs in Kinshasa (12%) is similar to that reported in Iran by Arefzadeh et al.,[24] but it is far less important than the 53% estimated in Greece by Kaitelidou et al.[30] Additionally, it is very difficult to compare studies in terms of drug costs because health policies differ widely between countries. Indeed, in some countries, only generic drugs are reimbursable, whereas in others, all drugs regardless of the generic quality or specialty are reimbursed. The cost of generic drugs is significantly cheaper compared to specialty drugs, producing a significant difference in cost.

In the present study, the management of infection and at least four comorbidities emerged as the primary independent determinants of additional HD costs.

Indeed, infection treatment accounts for 90% of the financial burden of the cost of drug complications and events during HD sessions. This cost was most often from infection treatment with very expensive anti-staphylococcal agents complicating the temporary catheter (most tunneled catheters, which are less frequently complicated by infections, could significantly reduce cost).[31] This cost assumes that patients are referred early.

A high number of comorbidities increase the cost of HD because of the additive cost of their management. However, this direct cost is likely to be less because of the proportion of diabetic patients in this study (30%), which was significantly lower than developed countries where diabetes is the leading cause of ESRD.[3,32] This difference could substantially impact the direct cost of treatment. The lack of data in the literature did not allow comparison with other studies, particularly in SSA. We believe that early management of patients with CKD would help reduce the number of comorbidities, especially cardiovascular diseases.[33]

CKD and the ESRD extent in the DRC as demonstrated by previous studies[20,27] and cause a very heavy economic burden in this country's health sector. Thus, it is imperative to find appropriate strategies for SSA countries by implementing universal health coverage. Several approaches exist to reduce direct HD costs, especially in developing countries such as the DRC, including subsidizing treatment and consumable exemptions or local production (obeying standards). In the long run, the most important factor to lessen overall annual cost is reducing the number of ESRD patients. With this option, heath care funding should focus on CKD risk factors and early detection and prevention. Another alternative is the development of living donors for renal transplantation.

The present study has some weaknesses related to the nature of data. Indeed, some direct cost expenditure items (hospitalization and transport) and indirect costs were not taken into account. In addition, the recording of events during HD sessions was sometimes handled by the nursing staff in the absence of the main researcher.

Despite these limitations, this study provides, for the first time, the quarterly direct cost of HD-related care in

Congolese ESRD patients. It provides a comprehensive cost calculation that included not only the cost of dialysis treatment but also additive treatments (comorbidities, medication use and complications).The results will help health care planners develop strategies to improve financial access to health care for these patients.

In conclusion, the direct cost of HD-related care that was estimated in this present study is very expansive for the majority of Congolese ESRD patients deprived of any form of health coverage. In this context, it is necessary to change health policy to improve the accessibility of patient care through universal health coverage (shifting from fee-for-service payment to a subsidized, flat-rate payment). A vast national program of early detection and prevention of CKD would be useful and cost-effective.

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AUTHOR CONTRIBUTIONS

PPI and EKS designed the study, acquired, analyzed and interpreted data, and drafted and revised the manuscript. YMN, FBL, YME, JRM, VMM, JBB, FNK, and NMN analyzed and interpreted data and revised the manuscript. All authors read and approved the final manuscript.

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