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Research Article

Cost of arterioveinous fistula at the Douala General Hospital: A Cameroon-based cross-sectional study

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Abstract

Background: Cost is a major limiting factor for dialysis in low-income countries. The objective of our study was to determine the economic cost of creating an arteriovenous fistula (AVF) for hemodialysis at the Douala General Hospital (DGH).

Material and methods: We conducted a descriptive cross-sectional study including patients undergoing AVF creation at the DGH from January to April 2020. Costs were calculated using a bottom-up approach. The direct cost was composed of the sum of the cost of medical consultation, additional paraclinical tests, drugs, disposables, hotel services, food, transport and medical and nursing care. The indirect cost was calculated as the sum of the costs related to the temporary incapacity to work and the additional expenses of the families. The cost of temporary work incapacity was calculated according to human capital theory. The economic cost was the sum of the direct cost and the indirect cost. The costs were expressed as a mean with standard deviation. The calculated costs were expressed in US Dollars. Statistical

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significance was considered as $p < 0.05$.

Results: A total of 44 patients were included of which 29/44 (65.9%) were male. The mean age of the study population was 49.1 ± 14.7 years. The median monthly income was $172 and only 6.8% of patients had health insurance. The average direct cost per patient was $327.3 ± $212.7, with hospitalization costs accounting for 59.6% of that cost. The average indirect cost per patient was $64.5 ± $50.3. The largest proportion of these costs was due to lost productivity related to temporary work disability (45.7%). The average economic cost per patient was $391.9 ± $219.5. Direct costs accounted for 83.54% of the economic cost. Re-operation ($p = 0.039$), age ($p < 0.01$) and number of hospitalization days ($p < 0.01$) significantly affected the cost

Conclusion: The cost of creating an AVF for hemodialysis was high and represented more than 2 times the median monthly income of patients and was mainly due to hospitalization costs. Therefore, there is a need to implement strategies to reduce the financial burden of arteriovenous fistula creation in our setting.

Introduction

Haemodialysis is the most widely used kidney replacement therapy in the world [1]. It is a very expensive procedure, accounting for 1.4%, 2% and 2.5% of health care expenditure in France, Japan, and Korea respectively [2-5]. To achieve this procedure, vascular access (VA) such as Arteriovenous fistula, (AVF), (native (NAVF), prosthetic (PAVF), or graft (AVG)) and central venous catheters (CVC) is mandatory [6].

In the USA, the cost of establishing an AVF was $792.7 and $573.8 for an AVG and a NAVF respectively [7] compared to $160.7 for a CVC [8]. In Europe, this cost was $526.5 for a native AVF, $1594.7 for an AVG and $1276.3 for CVC [9,10].

In India, the cost ranged from $160 to $320 for NAVF, around $480 for AVG, and from $160 to $320 for CVC [11]. Agaba, et al. in Nigeria estimated the cost of a CVC at $26.7 [12]. Sadio Y, et al. in Mali estimated the average cost of creating an AVF at $68.8 (extremes $60.2 and $129) [13].

In Cameroon, chronic kidney disease (CKD) is common with an estimated prevalence of 10-13.2% [14,15]. Among these patients, 53,1% are referred in the end-stage renal disease (ESRD) [16,17]. A study conducted by Halle, et al. in 2017 estimated the overall cost of hemodialysis in Cameroon at $13740.7 per year per patient [18]. Furthermore, the patient himself supported 30% of this cost, i.e. $4162.9, which was expensive considering that only 9% of hemodialysis patients have health insurance [18]. The cost of creating VA for hemodialysis in Cameroon varies from one health facility to another (in practice between $344 and $430.1) despite a flat rate set by the public authorities. In particular, at the Douala General Hospital (DGH) where a flat rate of $344 is set. The study by Halle, et al. had shown that most patients started hemodialysis on a CVC, largely because this procedure is cheaper as compared to AVF creation. We, therefore, aimed to evaluate the real cost of creating an AVF in Douala General Hospital and then analyze the factors influencing it [18].

Methods

Study design, setting and participants

We carried out a cross-sectional study on the cost of creating an AVF at the DGH, over a period of 04 months from January 01 to April 30, 2020. The DGH is a tertiary care facility in the Cameroon health pyramid and the main referral hospital for patients with kidney disease in the Littoral region. About 12 arteriovenous fistulas are performed in the surgery department of this hospital each month.

All patients with stage 5 CKD in the process of creating an AVF for dialysis at the DGH and consenting to the study were included in the study. We excluded all patients with incomplete cost records.

Socio-demographic and clinical data were prospectively recorded in all patients.

Economic approach and cost analysis

We used the bottom-up approach for the cost calculation. In this approach, all the expenses generated and relating to each patient were collected individually by means of a questionnaire based on interviews done before and during their hospitalization as well as their clinical records and invoices. In this study, a non-comparative cost analysis was used, and this analysis was based on the perspective of the patient and society.

- The direct cost was estimated from the sum of the cost of consultations, drugs, laboratory tests, medical and surgical nursing acts, hospitalization costs, food and transport: Direct cost = Cost of diagnosis (cost of the medical consultation + cost of additional biological examinations) + Cost of the surgery (addition of the cost of analgesics, antibiotics, monetary evaluation of the time taken by the staff for the surgery itself and the cost of other drugs and consumables) + Cost of hotel services (addition of intra-hospital accommodation and food costs) + Cost of nursing care.
- The indirect cost was estimated from the losses linked to the temporary incapacity for work and the additional expenses of the nurses (transport, food, communication costs): Indirect cost = Cost of the temporary incapacity for work (duration of disability x Daily income) + Additional family expenses (addition of nutrition costs, travel costs, communication credit).
- Economic cost or total cost of creating an arteriovenous fistula = Direct cost + Indirect cost. The costs were expressed in $(USD), code for United States Dollar.

Statistical analysis

Data were analyzed by descriptive statistical methods using SPSS (Statistical Package of Social Sciences) software, version 20.0. The quantitative variables were expressed as a mean with their standard deviation, the median, and the interquartile range used when the distributions were asymmetrical. Qualitative variables were expressed as a percentage. Statistical significance was considered as $p < 0.05$.

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Results

Sociodemographic characteristics

A total of 44 patients were included. The mean age (SD) was 49.1 (14.7) years. The majority, 29.5% (13/44) were self-employed. The median monthly income of patients was $172 (interquartile range; [127.5 – 344] $) 40.9% (18/44) of patients had no income and only 6.8% (3/44) had health insurance. (Table 1).

Comorbidities and localization of AVF

Hypertension in 84.09% (37/44) patients and diabetes in 34.09% (15/44) were the most common comorbidities. More than half (56.82%) of the AFVs created were of left radiocephalic localization. The left brachiobasilic localization was the second most common localization with 13.6%. (Table 2).

Economic cost

Direct medical costs: The mean direct medical cost per patient was $179.7 ± $207.5. The median direct medical cost was $147.3 (interquartile range; $[138.2 - 159.1]). Drug costs accounted for the largest proportion (35.8%) of this cost and procedure costs for the smallest proportion (8.1%) (Table 3a).

Table 1 : Sociodemographic characteristics.

VARIABLE	n	%
Sex Women Men	15 29	34,1 65,9
Age (years) Mean (SD) 15-30 31-50 51-70 >=70	49,1(14,72) 8 15 18 3	/ / 18,2 34,1 40,9 6,8
Professional status Student Private sector Public official Independent Retired Unemploye	2 4 5 13 10 10	4,5 9,1 11,4 29,5 22,7 22,8
Monthly income salary (USD) Mean (SD) Median IQR No salary 62.4 – 86 86 – 172 172 – 258 258 – 344 344- 430 430 – 516 >516	297.2 (359.1) 172 127.5– 344 18 1 6 3 6 3 2 5	/ / / / 40,9 2,2 13,6 6,8 13,6 6,8 4,6 11,4
Health Insurance Yes No	3 41	6,8 93,2
Funding method Family Spouse One self Othe	34 2 6 2	77,3 4,6 13,6 4,6

SD:*standard deviation; Min: Minimum; Max: Maximum; USD: United States Dollar (USD); IQR: Interquartile Range.*

Table 2: Localization of AVF.

VARIABLE	N	%
Left Cubito-Cubital	1	2.3
Right Radiocéphalic	1	2.3
Right Brachiobasilic	3	6.8
Right Brachiocephalic	4	9.1
Left Brachiocephalic	4	9.1
Left Brachiobasilic	6	13.6
Left Radiocephalic	25	56.8

Nonmedical direct costs

The mean non-medical direct cost per patient was 149.9 ± 61.7 USD. The median non-medical direct cost was 132.7 USD (interquartile range; [126.6 - 146.6] USD) and the majority of the non-medical direct cost expenditure came from hospitalization costs accounting for 89.3 ± 41. The majority (59.6%) of the direct non-medical cost expenditure resulted from hospital fees and amounted to 89.3 ± 41.2 USD, while communications fees were the lowest expenditure, costing 4.2 ± 5.2 USD (2.78%). (Table 3b).

Total direct costs

The mean total direct cost per patient was 332.9 ± 216.2 USD. The median total direct cost was 332.9 ± 216.2 USD (Interquartile range [266.3 – 304.1] USD) The vast majority (54.9%) of this cost, i.e. 182.7 ± 211 USD, came from the direct medical cost. with expenses related to hospitalization costs accounting for more than a quarter (26.8%) of this cost (Table 3c).

Indirect cost

The mean total indirect cost per patient was 65.6 (51.2) USD. The loss of productivity due to temporary incapacity for work accounted for the largest proportion (45.7%) of the indirect cost, i.e. 30 ± 37 USD (Table 4).

Economic cost or Real cost

The mean economic cost per patient was 395 (221.3) USD. The median economic cost was 333 USD (Interquartile range; The direct cost accounting for (83.5%) i.e. 330 ± 214.3 USD and the indirect cost accounting for (16.5%) i.e. 65 ± 50.7 USD (Table 5).

Multivariate analysis of factors influencing the cost

Re-operation (p = 0.039), age (p < 0.01) and number of hospitalization days (p<0.01) significantly affected the cost (Table 6).

Discussion

The aim of this study was to determine the real economic cost of creating an AVF at the DGH. We found that the mean

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economic cost per patient was 395 (221.3) USD. The median economic cost was 333 USD (Interquartile range); The direct cost accounted for (83.5%) i.e. 330 ± 214.3 USD and the indirect cost accounted for (16.5%) i.e. 65 ± 50.7 USD.

Socio-demographic and clinical characteristics of patients

As suggested by many authors, ESRD is a burden that primarily affects young adult males who constitute the "active population" [14-17]. The most represented comorbidities in our study were hypertension and diabetes, as in Sadio, et al. in Mali with 89.8% and 9.1% respectively [13]. In Portugal, Luis, et al. in Portugal in 2013 diabetes represented 46% of the population on dialysis [19]. These results are in line with all previous studies putting these 2 co-morbidities as the main cause of end-stage renal failure in our context [14-17]. Our findings also emphasize the need to undertake preventive actions to tackle risk factors associated with these two diseases. Moreover, as usual in our setting, this population was poor, underemployed with very few having health insurance. In fact, our population was in a more precarious social situation compared to that of Kaze, et al. [20]. Indeed, nearly half of the patients (40.9%) had a monthly income of < 62.9 USD, which is the minimum salary in Cameroon versus 17.3% found in the Kaze, et al. study [21]. This could be due to the fact that in our study population, all the patients were at stage 5 of the kidney disease and therefore already had a general condition that did not allow them to work for the most part, in contrast to Kaze, et al. who had also included patients from the less severe stage. Furthermore, in 47.72% of cases, it was the family who financed the care, and only 6 (13.64%) patients took care of themselves.

Only 3 patients (6.82%) had health insurance. This comes close to the observation made by Kaze, et al. in Yaoundé and by Halle, et al. in Douala who found a rate of insured patients of 10% and 9.1% respectively [20,18].

Cost analysis

The mean direct medical cost per patient was almost three times that observed in Mali and mainly due to drugs [13]. This difference can be explained by the fact that they only took into account the cost of drugs, surgical consumables and the operating procedure, on the other hand, we included the cost of consultations, the cost of paraclinical examinations, the cost of the medical act, the cost of drugs and the cost of consumables in the calculation of this cost.

The average total direct cost per patient was lower than that described in several studies in Western countries [10,9,18].

Table 3a: Direct medical costs.

VARIABLE	Mean [SD] (USD)	Median (USD)	Min – Max (USD)	%
Consultations costs	36.1 [0]	36.1	36.1 – 36.1	20,1
Paraclinics exams costs	32.8 [12.2]	29.1	12.9 – 77.4	18,3
Medical procedure costs	14.6 [3.9]	13.6	6.8 – 27	8,1
Medications' costs	64.3 [208.5]	45.2	15.6 – 1414.4	35,8
Disposables' costs	31.9 [7.8]	30.4	26.2 – 78.8	17,7
Total direct medical costs	179.7 [179.7]	107.5	105.4 – 1519.3	100

SD: *standard deviation; Min: Minimum; Max: Maximum; USD: United States Dollar (USD).*

Tableau 3b: Non medical direct cost.

VARIABLE	Mean [SD] (USD)	Median (USD)	Min – Max (USD)	%
Hospitalization cost	89.5 [41.3]	78.6	26.3 – 210	59,6
Food cost	42.2 [10.9]	42	15.7 – 78.7	28,1
Transport cost	14.3 [30.3]	7	0 – 157.5	9,6
Communications costs	2 386.36 [2 981.38]	2.6	0 – 26.2	2,8
Total	150.2 [61.9]	133	46.4 – 325.3	100

SD: *Standard Deviation; Min: Minimum; Max: Maximum; USD: United States Dollar (USD)*

Table 3c: Total direct cost.

VARIABLE	Mean [SD] (USD)	Median (USD)	Min – Max	%
Nonmedical direct cost	150.1 [61.8]	133	46.3 – 325.3	45,1
Medical direct cost	182.7 [211]	149.8	107.2 – 1545.4	54,9
Total direct costs	333 [216.3]	285	185.6 – 1668	100

SD: *Standard deviation; Min: Minimum; Max: Maximum; USD: United States Dollar (USD).*

Table 4: Indirect cost.

VARIABLE	Mean [SD] (USD)	Median (USD)	Min – Max en USD	%
The loss of productivity due to temporary incapacity for work	30 [36.9]	17.4	7 – 227.4	45,7
Additional Family Expenses				
• Food	9.1 [5.6]	7.9	0 – 26.2	13,8
• Transport	6.1 [5.6]	5.2	0 – 35	9,3
• Communication	2.9 [2.5]	2.6	0 – 8.7	4,4
• Total	18 [11.1]	16.3	0 – 60.7	27,5
Loss of productivity due to family sick guards	17 [11.9]	12.9	0 – 60.7	26,1
Cost of hiring a housekeeper	0.4 [1.9]	0	0 – 10.4	0,6
Total indirect cost	60 [50.7]	52.1	10.4 – 320.8	100

SD: *Standard deviation; Min: Minimum; Max: Maximum; USD: United States Dollar (USD).*

Table 5: Economic cost or real cost.

VARIABLE	Mean [SD] (USD)	Median (USD)	Min – Max USD	%
Direct cost	330 [214.4]	282.5	183.9 – 1653.1	83.54
Indirect cost	65.8 [50.7]	52.1	10.4 – 320.8	16.46
Economic cost	395 [221.3]	329.9	212.7 – 1663.6	100

SD: *Standard Deviation; Min: Minimum; Max: Maximum; USD: United States Dollar.*

Table 6: Multivariate analysis of factors influencing the cost.

VARIABLE	Standardized coefficient	P value	CI (95%)	
			Minimum	Maximum
Age (en années)	22.11	<0.01	5.58	38.63
Re-operation	3.026	0.039	0.59	5.45
Number of hospitalization days	33.463	<0.01	8.45	58.47

IC: *Confidence interval.*

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Indeed, Aitken in the USA and Shakarchi in the United Kingdom found a mean direct medical cost of 572 USD, 643.04 USD and 1732.3 USD respectively [10, 9, 18]. This difference can be explained by factors related to the health system, the standard of living and the characteristics of the patients included in the various studies.

The indirect cost, resulting from the loss of productivity due to the absence of the patient in his place of work, the additional expenses of the families, the loss of productivity of the nurse and the cost of the possible hiring of a housekeeper were higher than the minimum wage in Cameroon confirming the burden of this pathology, enhancing the economic impact of this disease.

The overall mean economic cost of creating AFVs for hemodialysis per patient was 394.89 (221.2) USD. For comparison, the annual gross domestic product (GDP) per capita in Cameroon for the year 2018 was 1563.9 USD [21]. Also, this average overall cost represented 5.3 times the minimum salary in Cameroon. The direct cost accounting for the major part (83.54%) of this cost, the social impact on patients and their families was indisputable.

The influence of the length of hospitalization on the economic cost suggests that short-term or even day hospital interventions should be encouraged. At the same time, a better selection of patients, a judicious choice of the operating site and a smart operating technique could reduce the risk of reoperation in this precarious social environment.

Study Limitations

The monocentric nature of the present study limits the generalizability of our results. The lack of characterization of the "intangible" costs that enter into the evaluation of the economic cost of a condition and defined as the distress and pain felt by the patient and others. These effects linked to the loss of well-being are real, but the main difficulty lies in the quantitative estimation or even the monetary evaluation of these effects.

Despite these limitations, this study provides the first estimates of the true economic cost of creating an AVF for hemodialysis in Cameroon and sub-Saharan Africa.

Conclusion

The creation of the AVF is a heavy burden for Cameroonian patients who in our work were mostly young, hypertensive, diabetic, without insurance and without income. Shortening the duration of hospitalization and improving the results of surgery could reduce this burden.

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