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The Economic Burden of Visceral Leishmaniasis in Sudan: An Assessment of Provider and Household Costs

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Abstract. Visceral leishmaniasis (VL) is a neglected parasitic disease that is fatal if left untreated and is endemic in eastern Sudan. We estimated the direct and indirect costs of treatment of VL from the perspective of the provider and the household at three public hospitals in Gedaref State. The median total cost for one VL episode was estimated to be US$450. Despite the free provision of VL drugs at public hospitals, households bore 53% of the total cost of VL with one episode of VL representing 40% of the annual household income. More than 75% of households incurred catastrophic out-of-pocket expenditures. The length of treatment of 30 days led to important costs for both health providers and households. Alternative treatment regimens that reduce the duration of treatment are urgently needed.

INTRODUCTION

Visceral leishmaniasis (VL) is a neglected parasitic disease endemic in many parts of East Africa, in particular in eastern Sudan with important foci also found in South Sudan, Ethiopia, Kenya, and Uganda. VL is caused by *Leishmania donovani* and transmitted to humans through the bite of a female phlebotomine sand fly. The disease, also known as kala-azar, is systemic and results in the death of the infected individual if treatment is not provided in time. Signs and symptoms of VL include prolonged fever, fatigue and weakness, anemia, and enlarged lymph nodes, spleen, and liver.[1]

The public health importance of VL in East Africa is undervalued not least because of the limited knowledge on the disease burden, including the socio-economic aspects of the disease. In the Indian subcontinent (India, Nepal, and Bangladesh) studies examining the financial and economic burden of VL have led to a better understanding of the impact and the financial consequences of VL illness at the individual and household level.[2–4] Other tropical neglected diseases, in particular the helminthic infections, have been successful in garnering international attention and funding by showing the low cost of control interventions and their cost effectiveness. However, to date, no studies on the costs of VL illness, either from the household or the health care provider perspective, have been carried out in East Africa. Better cost data would allow the use of economic evaluation as a tool to inform policy decisions and could help to make the case for increased investment and resource allocation in VL control policies and programs.

Therefore, we carried out a costing study on VL in Gedaref State in eastern Sudan. The aim of this study was to estimate both the cost of providing VL diagnosis and treatment services (i.e., health care provider perspective) and the cost to patients and their family to access these services (i.e., household perspective).

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MATERIALS AND METHODS

This study is part of a research project on the cost effectiveness of treatment alternatives for VL in Sudan initiated by the Leishmaniasis East Africa Platform (LEAP) and the Drugs for Neglected Diseases Initiative (DND*i*).

Study sites. The study was conducted in Gedaref State, Sudan† between October 2009 and May 2011. Gedaref State is located in eastern Sudan bordering Ethiopia and had an estimated population of 1.35 million in 2008, representing 3.4% of the Sudanese population.[5] Agriculture is the main economic activity in the State with main products including sorghum, sesame, millet, and peanuts. Gedaref State is the main VL-endemic area in the country and recently experienced an important increase in the number of reported VL cases (deaths) from 2,792 (109) in 2006 to 5,050 (142) in 2010 (Gedaref State Ministry of Health, unpublished data). However, because many people do not have access to health services, the true incidence and mortality of VL are probably much higher[6]; it is estimated that about 20,000 VL cases occur annually in Sudan. The number of cases is expected to rise because of migration into endemic areas, climate change, human immunodeficiency virus (HIV)/VL co-infection, and the overall lack of efforts to control the disease.[7]

The public health care system in Sudan is organized across three levels: the Federal Ministry of Health (FMOH), the State Ministries of Health (SMOH), and the district level. The delivery of health care also follows a three-tiered structure. Primary health care units are the lowest tier followed by health centers and then rural/community hospitals.[8] The National Malaria, Schistosomiasis and Leishmaniasis Administration (NMSLA) of the FMOH is responsible for VL control activities in Sudan. Currently, VL control activities consist only of passive case detection and treatment at rural/community hospitals. Because of the low level of human and financial resources, VL treatment services are often provided in collaboration with private-not-for-profit partners, either through existing health facilities (e.g., Kassab Hospital supported by

†Sudan here refers to North Sudan and excludes the Republic of South Sudan that became an independent State in 2011.

the Institute of Endemic Diseases [IEND] and DND*i*) or by establishing independent health facilities (e.g., Um-el-Kher Hospital used to be operated by Médecins sans Frontières [MSF] and now by the Ministry of Health). Although there are no routine VL prevention activities, MSF has been involved in the distribution of bed nets in endemic areas since 1995.[9,10]

We purposefully selected three health facilities in Gedaref State as study sites: a public rural hospital located in Doka, the State's second largest city; a rural hospital in Kassab and a hospital in Bazora town. The hospital in Doka, funded by the Ministry of Health (MoH), is the largest of the three facilities and has a capacity of 82 beds. It is a referral hospital providing a wide range of medical services including surgery and obstetrical services. Kassab Hospital has a capacity of 68 beds and receives funding from both the MoH and DND*i*. This hospital, located between Doka and the State capital Gedaref, mainly provides VL treatment services. Both Doka and Kassab Hospitals cover the area between Rahad and Atbara Rivers together with other rural hospitals in the same area. Bazora Hospital is the smallest of the three facilities with a capacity of 51 beds and covers the Rahad River Basin area. It is operated by the MoH and also receives funds from the World Health Organization.

Current VL case management in Sudan. Sodium stibogluconate (SSG), a pentavalent antimony compound, is the first-line treatment of VL in Sudan[11] and is administered intramuscularly on a daily basis for 30 days at a dosage of 20 mg/kg/day. Although widespread resistance to SSG has been reported in the Indian subcontinent,[12,13] the drug is still effective in Sudan with a cure rate of 92%[14–16] but has numerous side effects including nausea, diarrhea, muscle pains, arrhythmia, and pancreatitis. Other treatment options are currently being evaluated.[17] Diagnosis of VL is made with either the rK39 rapid diagnostic dipstick test, the direct agglutination test (DAT) and/or microscopic confirmation of the parasite in lymph node or bone marrow aspirate.[18,19] Both diagnosis and treatment of VL are provided free of charge at public facilities. Other medical and non-medical costs (registration fee, laboratory investigations, food) need to be paid out-of-pocket by the patient. All patients diagnosed with VL are admitted for the full duration of treatment to ensure 100% adherence and to monitor for side effects because patients are usually high risk presenting with severe anemia and malnutrition.[20]

Costing methodology. The costs of VL were assessed from the perspective of the health care provider and the household. Each perspective involved a different methodology and data collection process described in more detail below (Table 1).

Costs from the provider perspective. The aim of the analysis from the providers' perspective was to estimate the cost of inpatient care at the health facilities included in the study to provide VL treatment of one episode of VL. We only considered the cost of inpatient care because patients are hospitalized for the full duration of treatment and are not managed on an outpatient basis. Because of data constraints we faced at the health facilities, we estimated the medical costs of VL care (drugs, diagnosis, medical supplies, and laboratory investigations) separately from the cost of hospitalization by combining step-down cost accounting with an ingredients approach. These methods have been frequently used in similar studies in Africa (e.g., References 21–23). Cost estimations represented economic costs whereby all goods and services were valued including voluntary labor and donated or subsidized goods and services[24]; all data were collected for the year 2008.

Table 1

Overview of costing methods used to estimate the unit cost of visceral leishmaniasis (VL) care and household costs in Sudan (2010) for one VL episode

	Perspective			
	Provider		Household	
Costs included	Direct medical costs of VL treatment (drugs, laboratory tests)*	Other recurrent and capital costs	Direct medical (registration, drugs, laboratory. test) and non-medical costs (food, transportation*	Indirect costs, i.e. productive time losses
Estimation method	Ingredient approach	Step-down costing	–	Human capital method
Data sources	Review of 250 medical records of VL patients†	Health facility records and primary data collection	Questionnaire‡	Questionnaire‡
Intermediary outcome	Median medical cost per patient (a)	"Hotel" unit cost per inpatient day (b)	Median out-of-pocket expenditures on VL services (c)	Median loss of income to the patient and family members caring for the patient (d)
Final outcome	(a) + [(b) × ALOS§] = Median cost of VL care per VL episode		(b) + (d) = Median cost incurred by households per VL episode	
	Median cost per episode of VL			

*Medical goods and services charged to patients were excluded to avoid double counting with the analysis from the household perspective.
†Detailed medical records were only available at Kassab Hospital. Calculations on direct medical costs of VL treatment were only done at this hospital and assumed to be the same for the other two hospitals.
‡Data from the household perspective was collected from Kassab and Bazora Hospitals. There were no patients attending Doka Hospital at the time of the study caused by a shortage of SSG.
§ALOS = average length of stay.

The medical cost of VL care was calculated using the *ingredients approach*, whereby the quantity of inputs used were multiplied by their price, with data obtained from a random retrospective sample of 250 medical records of patients that attended Kassab Hospital in 2008. We retrieved information on demographic characteristics, the date of admission and discharge, and the amount of SSG, laboratory investigations, and medical supplies patients received. This estimation was only done at Kassab Hospital for lack of sufficiently detailed medical records at the other two facilities. The price of generic SSG (Albert David, India) was US$ 8.25 per 30 mL vial of 100 mg/mL.[25] The unit costs of VL diagnosis and other laboratory investigations were also estimated using an ingredients approach by observing resource use at the laboratory of Kassab Hospital. The prices of medical and laboratory supplies and equipment were obtained from specialized suppliers in Khartoum. All items paid for by the patient were excluded from this analysis to avoid double counting with the data collected from the household perspective.

The *step-down costing* was used to allocate recurrent non-medical and capital costs and calculate the unit cost per inpatient day. This unit cost corresponded to the World Health Organization (WHO) definition of a "hotel" unit cost, which excluded the medical costs of VL care estimated with the ingredients approach described previously.[26] At each facility, information on *recurrent expenditures* were obtained from the financial records and consisted of aggregated data on administration costs (printing, stationary), vehicle running costs (fuel, maintenance), maintenance of buildings, utilities (electricity and water), etc. Personnel costs were not included in the financial statements and were estimated by compiling a list by department/unit of all staff by type and grade with their monthly salary and allowances. Staff that worked on a voluntary basis or were paid by external partners were given the same salary as personnel of the same type and grade according to government salary scales.

Capital costs included buildings, equipment, vehicles, and furniture. An inventory list of equipments and furniture and the size of buildings was established for all departments/units. Capital items were valued at replacement cost: the price of equipment, furniture and vehicles was obtained from local suppliers (market prices), whereas the replacement cost of buildings was based on the rental price per square meter of office space in the area. Capital costs were annualized using a discount rate of 10%, which is the rate mostly used for project appraisals in Africa. A discount rate of 0% (i.e. straight-line depreciation) and standard rates of 3% and 5%[27,28] were used in the sensitivity analysis. We assumed a lifespan of 30 years for buildings, 10 years for equipment and furniture, and 5 years for vehicles.

The *step-down costing* was applied as described by Conteh and Walker[29] using an adapted version of the WHO-CHOICE‡ CostIt software package for estimating hospital unit costs. Briefly described, the various departments/units at each health facility were divided into direct and indirect cost centers. Direct costs centers provided services directly to the patient (e.g., outpatient unit or wards), whereas indirect cost centers provided general services that are necessary to run a hospital, but were not directly related to patient care such as the administration or maintenance department. The final (direct) cost center of interest to this study was the inpatient ward (all wards were grouped together).§ In a first step, we allocated costs directly to the inpatient ward when resource usage could be identified. This was for instance the case with personnel costs whereby medical staff were assigned a proportion of their time (and thus cost) to the inpatient ward based on interviews with the staff. Other costs that could not be assigned directly to the inpatient ward were allocated on the basis of criteria reflecting service use including floor space (for costs of maintenance, cleaning, and utilities) and number of staff (for the administration costs).

Once all costs had been assigned to the inpatient ward, a unit cost per inpatient day was calculated by dividing the total cost of the inpatient ward with the total number of inpatient bed-days. Information about the number of inpatient bed-days at each facility was not readily available and was estimated by multiplying the number of admissions with the average length of stay (ALOS). The number of admissions of VL and non-VL patients was retrieved from the statistical records. The ALOS of VL patients was 30 days and obtained from the same sample of 250 medical records described previously. The ALOS of non-VL patients was estimated by taking a random sample of 120 medical records at each facility and recording the date of admission and date of discharge.¶ The ALOS for non-VL patients ranged from 2 days at Kassab to 3.5 days at Doka Hospital.

The median total cost of VL care from the provider perspective was obtained by multiplying the unit cost per inpatient day with the ALOS for a VL patient and adding to this figure the medical costs per VL patient obtained with the ingredients approach.

Costs from the household perspective. Costs from the household perspective, included direct and indirect costs. These were collected with a hospital exit survey using a pre-tested structured questionnaire. A total of 75 patients were interviewed at Kassab Hospital ($N = 45$) and Bazora hospital ($N = 30$) between December 2010 and May 2011. At the time of the survey there were no patients attending Doka Hospital because of a shortage of SSG at the hospital. The interviews were conducted in Arabic by a medical doctor with extensive experience in VL diagnosis and treatment (one of the authors, AA).

The monetary expenditures by patients and their family to access and receive VL services were recorded separately for all health care providers that were visited. Respondents were asked about all direct medical costs they incurred such as expenditure on registration fees, drugs, laboratory investigations, and medical supplies at each provider. The survey also included questions on non-medical costs including the cost of transportation to and from the various health providers and food costs incurred while traveling to a health provider and during hospitalization at the treatment facility.

Indirect costs represented the loss of productive time of patients and family members taking care of the patient caused by VL illness. Patients and their caretakers were asked about

‡World Health Organization, Choosing Interventions that are Cost Effective (WHO-CHOICE): http://www.who.int/choice/toolkit/cost_it/en/index.html.

§None of the health facilities had disease-specific wards but were differentiated by gender and age (male, female and pediatric ward).

¶ At Kassab, all medical records of non-VL patients were consulted.

the number of days they were unable to engage in productive activities, and this was multiplied by a median daily income to obtain the indirect cost of a VL episode. Most patients and caretakers that contributed to the household income combined subsistence farming with casual labor during the off-season when there was no field work. To estimate the median daily income (and household income in general), the survey collected data on the economic activities of all household members, the number of months these activities were done, and the daily or monthly income in the case of casual labor. For subsistence farming, information was collected on the annual production of each produce, which was valued with local market prices and divided by the number of agriculturally active household members. Data were also gathered on the income from sales of animals and animal products (e.g., milk) and remittances from family members. Farming activities were done on average 6 months per year, whereas the rest of the year consisted of casual labor usually in construction (e.g., brick making) or the collection and sale of wood.

The direct and indirect costs were added together to obtain the median total cost of an episode of VL from the perspective of the household. The costs of VL were considered catastrophic if they exceeded 10% of the annual household income.[30,31]

Data analysis. The data were entered into Excel (Microsoft Corp., Redmond, WA) and analyzed with Excel and STATA v10.1 (Stata Corp., College Station, TX). Cost data collected before 2010 were inflated using the consumer price index[32] to the year 2010. All cost data are presented in US$ whereby US$1 = SDP 2.64 (2010).

RESULTS

Costs from the provider perspective. Table 2 shows the median cost of VL case management per patient from the provider perspective and activity data for each of the three health facilities. The total cost includes both the "hotel" and the medical component.

There were marked differences in the median total cost per patient between facilities ranging from US$117 at Bazora, US$155 at Kassab, and US$366 at Doka Hospital. The medical cost of VL represented 13%, 30%, and 38% of total costs at Doka, Kassab, and Bazora, respectively. The median medical cost was US$45 (interquartile range [IQR] US$28–75) per patient with the cost of SSG representing 91% of medical costs. The large variation between facilities in the total cost per patient was caused by the difference in the (hotel) unit cost per inpatient day. Although the unit cost per inpatient day was similar at Bazora and Kassab Hospitals (US$2.5 and US$3.8, respectively), it was nearly three times higher at Doka Hospital compared with Kassab (US$11/inpatient day).

Varying the discount rate between 0% and 10% did not have much impact on the cost per inpatient day. At Bazora Hospital, where capital costs as a proportion of total hospital costs were the largest (23% versus 12% at Kassab and 11% at Doka), the unit cost per inpatient day changed from US$2.1 (0% discount rate) to US$2.5 (10% discount rate).

Costs from the household perspective. *Patient and household characteristics.* A total of 75 patients attending Kassab (N = 45) and Bazora Hospital (N = 30) were interviewed; we did not interview any patients at Doka Hospital because of a shortage of VL drugs at the time of the study. The cost data from the household perspective collected from Kassab and Bazora Hospitals were combined in the analysis (Tables 3 and 4). Site-specific household cost data are provided in Appendix 1.

The majority of patients were males (68.0%) and young with 60% of patients of < 15 years of age corresponding to the age profile of other studies showing the epidemic in East Africa is concentrated amount the young. The median age of the sample was 13 (range 3–40); female patients were younger than males (median 7.5 [range 2–34] versus 13 [range 2–40]; $P < 0.05$). Overall the level of education was low. Among patients 6 years of age and above (N = 61), 29 (47.5%) had not received any formal education (including Koranic schools). Only three patients had completed primary school. There were major differences in the level of education between males and females whereby male patients were more likely to have received some primary education ($P < 0.01$). The median household size was six members.

Twenty-nine per cent of patients were economically active (N = 22), mainly engaged in subsistence farming (N = 13; 59.1%) and daily labor (N = 7; 31.9%). Two patients were formally employed. Of those engaged in farming, seven patients were working as casual laborers during the off-season (defined as secondary occupation). The median annual income of working patients was US$471 (IQR US$244–1,049).

Subsistence farming was the principal economic activity for 80% of households (N = 60). A median of two different crops were cultivated by the same household (IQR 2–3; range 1–4); sorghum was the most common crop, followed by sesame, millet, and peanuts. Although 40% of households reported owning livestock, either sheep, goats, and/or cattle, the headcount was low and only 47% of these households sold livestock over the past year (N = 14) contributing to 6% of their household income. About 19% of households reported receiving remittances, nearly all from outside Sudan (92.9%). The median amount of remittances received was US$378

Table 2
Activity statistics and unit costs by health facility

	Kassab Hospital	Doka Hospital	Bazora Hospital
Area covered	Between Rahad and Atbara Rivers	Between Rahad and Atbara Rivers	Rahad River Basin
Beds	68	82	51
Admissions VL (non-VL)	805 (95)	102 (3,049)	580 (1,198)
In-patient days VL (non-VL)	24,150 (187)	3,060 (10,641)	17,400 (3,810)
Total in-patient days	*24,337*	*13,701*	*21,210*
Average length-of-stay VL (non-VL)*	30 (2)	30 (3.5)	30 (3)
Bed occupancy rate	111%	46%	114%
Median cost per patient (IQR) (US$)	154 (137–186)	366 (349–399)	117 (100–147)

*The ALOS was estimated from a random sample of medical records of visceral leishmaniasis (VL) and non-VL patients.

TABLE 3
Mean/median cost per provider visited during the health seeking phase prior to admission (US$ 2010)

Health provider	n	Mean	(SD)	Median	(IQR)
Traditional healer	3	10.2	(9.2)	10.2	(3.7–16.7)
Chemist	2	8.7	(4.5)	8.7	(5.6–11.9)
Village health worker	37	14.6	(19.8)	9.3	(4.5–16.0)
Public health center	22	33.3	(44.7)	15.3	(10.0–42.8)
Public hospital	30	56.8	(73.8)	24.2	(12.1–55.8)
Private doctor	26	90.7	(125.4)	51.2	(32.7–101.2)
Private laboratory	13	27.9	(16.8)	26.0	(17.9–34.2)
Total cost per person	75	60.8	(103.5)	33.1	(9.3–73.3)

Note: All data presented in this table was calculated using data collected at two hospitals (Kassab and Bazora). Household costs by facility are provided in Supplemental Appendix Table A.1.

per year (IQR US$114–454). Including all sources of income, the median annual household income was US$1,116 (IQR US$744–1,818) and the median annual per capita income was US$208 (IQR US$140–341).

Direct costs at health providers before admission. Before admission for treatment at Kassab or Bazora Hospitals, patients had visited on average three other health providers (IQR 2–4). A public provider—either a village health worker (43%), a health center (20%), or a hospital (25%)—was most often the first choice of provider mainly because of their proximity to the patients' home, whereas the remainder of patients visited either a chemist (3%) or a private general practitioner (9%). Because there are few private (formal) health providers in rural areas, < 10% of households had initially visited a private provider. In subsequent visits, households consulted a private general practitioner more frequently (24% of households had consulted a private general practitioner after the first provider) or a public hospital until eventually all patients consulted were referred to either Kassab or Bazora Hospitals and admitted for treatment.

Households incurred a median total cost of US$33 during the health-seeking phase (IQR US$9–73) (Table 3) and this included expenses on consultation (US$1), drugs (US$14), laboratory investigations (US$3), and transportation (US$1) (Table 4). Households paid the most at private formal providers (US$51), twice as much as at public hospitals (US$24) ($P < 0.01$), of which 94% were direct medical costs for consultation, drugs, and diagnosis/laboratory investigations. Households that visited private laboratories were usually referred by a previous provider to be tested for VL.

Direct costs at the treatment facility. The combined direct medical and non-medical costs by households for Kassab and Bazora Hospital are presented in Table 4. All interviewed patients were treated with SSG; our study confirmed that SSG was provided free of charge to patients in these two facilities. Very few laboratory investigations were done once the patient was admitted. The median direct medical cost was US$14 (IQR US$10–22). Over 85% of costs were non-medical, mainly food costs (median US$112) caused by the long stay at the hospital (median 30 days). The food costs were for the patient, caretaker(s), and other accompanying relatives. All patients were accompanied by at least one adult caretaker, usually the mother, and one or two young children that stayed with the patient at the hospital for the full duration of treatment. The median direct cost of VL care at the treatment facility was US$148 (IQR US$128–184).

Indirect costs of VL. Sixteen out of 22 patients (73%) reported they were unable to carry out either their primary or secondary occupation because of VL illness, which resulted in an income loss. The median number of workdays lost was 51 days (IQR 44–63). The median loss of income for working patients was US$101 (IQR US$62–233), whereas the average loss of income across all patients was US$41 (SD US$135). Among adult caretakers, 20 reported an income loss (out of 99 caretakers), with a median loss of 39 working days (IQR 31–58) because they had to take care of the patient. The median loss of income to caretakers was US$95 (IQR US$45–179). The average income loss across all attendants, both working and non-working was US$44 (SD US$85).

Total costs of a VL episode. The median total cost for one VL episode was US$450 (IQR US$387–544) (Table 5). The median cost of VL case management across the three health facilities was US$211 (IQR US$197–244). The median direct expenditure by households, including the health-seeking phase and the costs incurred at the treatment facility, was US$185 (IQR US$158–240), whereas the median income loss (i.e., indirect costs) was US$22 (IQR US$0–113.9). Overall, households bore 53% of the total cost of VL and public health facilities 47%. Direct costs, in particular non-medical costs, were the main cost driver from the perspective of the household representing nearly 86% of the median household cost, whereas indirect costs represented 14% of this cost. The median annual household income was estimated to be US$1,116. The economic burden of VL to households,

TABLE 4
Mean/median direct costs of visceral leishmaniasis (VL) care during the health-seeking and treatment phase (US$ 2010)

	Health-seeking phase				Admission and treatment			
	Mean	(SD)	Median	(IQR)	Mean	(SD)	Median	(IQR)
Direct medical costs								
Consultation	6.6	(13.0)	1.1	(0.0–6.0)	3.3	(1.7)	3.7	(1.1–4.8)
Ancillary drugs	26.0	(47.7)	13.8	(6.7–37.2)	11.1	(10.0)	7.4	(4.3–15.6)
Laboratory investigations	13.2	(24.9)	3.3	(0.0–16.7)	4.1	(7.0)	1.9	(0.2–4.1)
Total direct medical costs	45.9	(78.4)	24.2	(9.3-54.0)	18.5	(14.9)	14.0	(9.9–22.3)
Direct non-medical costs								
Transportation	7.5	(14.7)	1.1	(0.0–7.4)	6.5	(10.1)	2.6	(0.7–8.9)
Food	6.5	(19.9)	0.0	(0.0–4.8)	121.5	(44.5)	111.6	(111.6–141.4)
Other	1.0	(4.4)	0.0	(0.0–0.2)	5.0	(4.1)	4.5	(2.0–6.9)
Total direct non-medical costs	15.0	(31.1)	2.6	(0.0–18.6)	133	(46.0)	126.5	(113.9–157.8)
Total direct costs	60.8	(103.5)	33.1	(9.3–73.3)	151.5	(49.1)	148.5	(128.2–184.2)

Note: All data presented in this table was calculated using data collected at two hospitals (Kassab and Bazora). Household costs by facility are provided in Supplemental Appendix Tables A.2 and A.3.

Table 5
Summary of direct and indirect costs for one visceral leishmaniasis (VL) episode (US$ 2010)

	Mean	(SD)	Median	(IQR)
Direct costs				
Household*	212.4	(122.8)	185.1	(158.5–240.2)
Provider†	220.3	(31.4)	211.1	(197.3–243.9)
Indirect costs	118.8	(181.9)	22.3	(0–113.9)
Total cost				
Household	297.1	(250.4)	238.4	(171.8–333.2)
Household + provider	508.2	(250.3)	450.0	(386.9–544.3)
Median costs as a % of:				
Annual household income	23%			
Annual per capita income	122%			

*Health-seeking and treatment facility costs; calculated using the mean/median data from two hospitals (Kassab and Bazora) because no patients attended Doka Hospital at the time of the study.
†Calculated using the average hotel unit cost of US$5.74 across the three hospitals.

including direct and indirect costs, was equal to 23% of the median annual household income.

DISCUSSION

This is the first study to provide a comprehensive set of estimates on the cost and economic burden of VL in Sudan and East Africa in general. We collected data from both the provider and the household perspective. Data on provider costs were collected from three health facilities in Gedaref State; direct costs to access treatment and indirect costs of VL illness from the perspective of the household were collected using a structured exit questionnaire with 75 patients in two of these facilities.

The median total cost per episode of VL was estimated to be US$450. Over 75% of households incurred catastrophic out-of-pocket expenditures (defined as expenditures exceeding 10% of annual median income) when considering only direct costs, whereas 83% of households exceeded this threshold when also including indirect costs. These findings concur with studies that were carried out in the Indian subcontinent (Nepal, India, and Bangladesh), which also found a huge economic burden of VL illness for households.[2,4,33–35] There were however some differences with regard to the distribution of costs. Indirect cost as a proportion of the total household cost was smaller in Sudan, mainly linked with a different age profile. In our study we found that 60% of patients were below the age of 15, although in Bangladesh, for instance, it was 47%[3]; these differences are consistent with the demographic profile of VL across countries reported by Harhay and others.[36] Because patients were younger in Sudan, fewer reported earning an income. For instance, we found that 29% of patients were economically active and generating an income to the household compared with 36% in Nepal (Uranw and others, unpublished data) and 42% in India.[2]

In terms of the provider costs, the cost of hospitalization (which did not include the medical costs of VL) was the main cost driver and varied between 62% and 87% of the total provider cost at Bazora and Doka Hospitals, respectively. We observed large differences in the unit cost per inpatient day across the three facilities. There are several factors that explain the higher unit cost per inpatient day at Doka Hospital. From the cost side, because Doka Hospital is a secondary level referral facility, it has more skilled health staff resulting in higher personnel costs. For instance the ratio of medical doctors working at Doka compared with Bazora Hospital was 5:1. The capital costs were also higher compared with the other two health facilities. However, the factor that influenced the unit cost most was the workload at each hospital, and in particular the number of VL patients. Because most costs are fixed (including personnel costs on the short and medium term) and do not vary with the number of inpatients at the hospital, the fewer the inpatients, the higher the unit cost per inpatient day. A total of 1,487 patients were admitted for VL treatment in the three study facilities in 2008, with important differences in case load across facilities. Overall, the bed occupancy|| rate at Doka Hospital was low (46%), whereas in Kassab and Bazora it exceeded 100% (on average, there were not sufficient beds to accommodate all patients). Doka Hospital admitted the least VL patients in 2008 as a result of frequent shortages of SSG. These patients were then referred to Kassab Hospital, located ~50 kms away. The number of VL patients at Bazora Hospital was high because the hospital covers a very large area (the Rahad River Basin) with important transmission of VL.

Our estimates were also lower than the WHO-CHOICE hotel unit cost estimates for Sudan (i.e., US$13.5 inflation-adjusted for a secondary-level hospital at 80% occupancy rate).[26] The variation in unit costs between facilities in this study was caused by differences in the cost structure of the health facilities, but especially by the patient load because we observed a low occupancy rate at Doka Hospital (46%) and rates exceeding full occupancy at Kassab and Bazora. During the time of the study, most VL patients who attended Doka Hospital were referred to Kassab Hospital because of a shortage in SSG drugs. Given these logistical problems the unit costs of hospitalization should be interpreted with care and not considered as an indicator of efficient resource usage. As Hansen and others[21] noted in a study on the hospital costs of HIV/acquired immunodeficiency syndrome (AIDS) care, low unit costs may also indicate insufficient resources at these health facilities. Although an evaluation of optimal resource usage for VL care and other services was not within the scope of this study, there were clear indications that for example the hospital in Bazora was under-staffed compared with its patient load.

A limitation to our study was that we did not capture the seasonal pattern of costs. Although this is less relevant for provider costs that were based on data for a complete financial year, the household survey was carried out half-way through the dry season, which takes place approximately from November to April. This may have had an impact on the health-seeking behavior of households and transportation costs. Because health facilities are more accessible during the dry season, patients are likely to present faster to a health facility and transportation costs will be lower. For example, Gerstl and others[37] in a study examining the accessibility of VL treatment centers in Gedaref State found that transportation costs were two to three times higher during the rainy season. In addition, the time of the survey may also have had an impact on the opportunity cost of time lost caused by VL illness and treatment. Patients involved in subsistence farming reported they were not working at the time of the survey

||The bed occupancy rate was calculated as the number of inpatient days in a year divided by the number of beds × 365.

because it was the off-season. As such, we may have underestimated the indirect cost of VL illness for those patients that did not have a secondary occupation.

Second, data on costs were based on actual consumption of resources with the major cost elements (medical costs and personnel) obtained through micro-costing. However, the hospital records on activity statistics were poor and the unit costs per inpatient day are particularly sensitive to inaccurate activity data. Information on the number of admissions for both VL and non-VL patients were available at each facility, but the average length of stay needed to be extrapolated from a random sample of medical records. Although the average length of stay for VL patients is no doubt close to 30 days because of the duration of the drug regimen, there was more uncertainty regarding the ALOS of non-VL patients.

Finally, we were not able to obtain data for all cost categories at each hospital included in the study. From the provider perspective, detailed information from medical records to estimate the direct medical costs was only available at Kassab Hospital. Data from the household perspective were collected from Kassab and Bazora Hospitals and not Doka Hospital because there were no patients attending the latter facility at the time of the study as a result of a shortage of SSG. Given the limitations in data availability and because the aim of the study was to estimate the cost of providing and accessing VL diagnosis and treatment services, rather than making comparisons across facilities (in terms of e.g., efficiency or access), results were presented in terms of the mean/median across the three facilities. This is the first study of its kind for VL carried out in Sudan (and eastern Africa in general). We hope that in the future, cost data on VL diagnosis and treatment will be more readily available to support on-going control efforts in the country.

In the absence of a vaccine and preventive interventions, the diagnosis and treatment of VL is currently the main control strategy available in Sudan. We showed VL diagnosis and treatment to be expensive not only to the public health sector but also to the households compared with their income. Policies are therefore needed that reduce this cost to both providers and households. A common determinant of costs for both perspectives was the length of treatment. The current first line treatment is SSG and patients are admitted for the full duration of treatment of 30 days to ensure adherence to treatment and monitor for possible side-effects. In recent years there have been a number of therapeutic innovations that open the door to treatment alternatives with shorter duration. These treatment alternatives would not only reduce the cost of hospitalization from the provider perspective but also the substantial food costs patients and caretakers incur. One of the alternatives is a combination of SSG and paromomycin for 17 days[15] that showed an acceptable safety and efficacy profile in a recent randomized-controlled trial[16]; this treatment is in fact now being rolled out in Gedaref state. Other alternatives include combinations of an oral drug miltefosine with either SSG or liposomal amphotericin B[17] that may reduce treatment to 10 days (for the latter combination) or a multi-dose regimen of liposomal Amphotericin B for 10 days.[38] Liposomal Amphotericin B (AmBisome) is already registered in Sudan and used as second-line treatment but is not considered as first line because of its very high cost despite preferential pricing agreements between the WHO and its manufacturer Gilead Sciences (US$270 for total dose of 21 mg/kg for a 35 kg patient). However, a donation by Gilead to treat 50,000 patients opens new perspectives for using AmBisome as the first-line treatment in East Africa.[39]

The cost data that we presented here will facilitate the use of cost-effectiveness analysis to compare the various treatment alternatives presently available or in the near future for Sudan. This study highlighted the importance of including the household perspective in such analysis because VL caused catastrophic health expenditure in almost all households despite drugs and diagnostics being free. In the absence of effective prevention, the best way to alleviate this burden is through a treatment regimen with shorter duration. The article is hopefully the first in a series of studies investigating the behavioral and socio-economic aspects of VL and its control. Until we are able to close this knowledge gap, there will be little interest from the government and the international community to actively engage in the control of VL in Sudan and East Africa in general.

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