

Direct cost of management and clinical profile of severe malaria in Paediatric Hospital of Mbujimayi; Congo DR

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Research

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Abstract

Background: Leading cause of morbidity and mortality of the Congolese child, malaria especially severe is so much a source of economic losses, both direct (related to curative treatment or prevention) and indirect (due to absenteeism or the decrease of productivity), non-negligible for Mbuji-Mayi's population whose majority lives below the poverty line.

Methods: This prospective study related to the direct cost of in-hospital hold in charge of severe malaria among children of 6 to 59 months, as well as the factors influencing it, was undertaken from July 01, 2012 to June 30, 2013 in the Provincial Hospital Dipumba. Consultation, laboratory tests, medication and hospitalization were the components of the direct cost. EPI Info and SPSS software were used to analyse data.

Results: Severe malaria accounted for 70.9% of admissions (534 of 753). The subject was generally male (55.1%), under 3 years of age (28.6 ± 17.5 months), having received no correct anti-malarial treatment before admission (81.5%), brought urgently in serious condition (95.5%), subjected to a low rate of laboratory tests (4.8 ± 1.6) and treated mainly with quinine infusion (93.25%). Recovery amounted to 79.2% against 7.3% of deaths most often early. The majority of affected households (81.5%) were very poor as earning less than \$ 30/month. The mean direct cost of the hold in charge of a severe malaria episode rose to US \$ 38.6 ± 11.2 (range US \$ 8.5-79.94) of which 74% were bound to medication, 11% to consultation, 8% to hospitalization and 7% to laboratory tests. Age, quality of treatment before admission, severity at admission, severe anaemia and disease outcome were the factors influencing this direct cost.

Conclusion: Malaria is a costly disease in relation to the standard of living of our population and severe malaria is the main reason for hospitalization among children aged 6 to 59 months. It is necessary to reinforce management capabilities of cases correctly and early so much at home that in hospital and to streamline medical prescriptions in order to reduce costs led by malaria.

Background

First disease in the world, malaria threatens 3.3 billion people who are the half of humanity. In 2010, it caused 216 million clinical episodes and 655,000 deaths [1, 2]. About 91% of these deaths occurred in Africa and overall 86% of all deaths were children [1, 2]. It is in Democratic Republic of the Congo (DRC) the first endemic disease and the leading cause of child morbidity and mortality [3]. Congolese children under 5 years run on average 8–10 malaria episodes per child per year including an episode of severe malaria [3, 4]. Approximately 150,000 to 250,000 children under 5 die each year from malaria, which corresponds to 25–30% of all deaths in paediatric patients [3, 5].

Malaria is a disease of poverty and cause of poverty. It imposes significant costs on all individuals and governments. Costs imposed on individuals and households relate to expenditure for the purchase of curative DTC drugs both at home and in a health care institution; expenses for transport to the point of care; lost working days; absenteeism from school; expenses for preventive measures; funeral expenses in

the event of death. According to the League against malaria, an affected family would only harvest 40% of its agricultural production, due to the days of work lost. For governments, this concerns spending on health policy strategies; medicines and health equipment; community interventions against malaria; the fall in productivity due to absenteeism at work; and loss of opportunities for economic and tourist progress. The direct cost, for example, has been estimated to be at least US \$ 12 billion per year [1, 2].

The socio-economic impact of malaria in the Afro-tropical region is all the more deleterious as other endemic diseases such as tuberculosis and HIV are rife there and as the pauperization of populations is increasing. Direct costs of malaria in relation to care, prevention and drugs are felt by populations, public authorities, private companies and non-governmental organizations. Absenteeism from work and school, high infant mortality, reduced purchasing power and educational difficulties have negative consequences on the socio-economic development of states. The WHO has even calculated that Africa's GDP (Gross Domestic Product) would exceed its current level by 115 billion euros, or an additional 32%, if malaria had been eliminated 35 years ago. In terms of the fight, UNICEF estimates that the average annual cost of antimalarial programs in each African country would amount to around 345,000 euros, or, for a country of 5 million inhabitants, less than seven cents euros per capita [5, 6].

Populations located in malarious zones live mostly in poverty, the new drugs, much more effective but more expensive than the old ones, are often beyond their financial possibilities. In the Democratic Republic of Congo (DRC), the majority of population practices agriculture. Some live exclusively by hunting, fishing, gathering and ranching. The Gross National product (GNP) is less than 100 USD / year / capita, which places the country among those with the lowest incomes of the continent. Indeed, if we consider absenteeism at school (49 days out of the 225 in a school year) and at workplaces (10 days per episode of severe malaria in a child) as well as the high cost of healthcare of a child suffering from severe malaria (estimated at US \$ 95 per episode by Mulumba and co-authors in 2005), it is easy to understand that malaria is one of the factors of poverty in this population.

If any illness is a source of both direct economic losses (due to expenses related to treatment or prevention) and indirect (due to absenteeism, lower productivity) [6], hold in charge of malaria especially of severe cases induced significant costs for population including that of Mbujimayi whose majority live below the poverty line. In Kinshasa (DRC), the cost of the support of a child with uncomplicated and severe malaria is respectively estimated to \$ 11.4 and \$ 95 USD [3]. But there is no previous data available on this matter concerning the City of Mbujimayi.

It is therefore necessary to assess the situation; hence this present study had been undertaken in Mbujimayi to determine the clinical profile of severe malaria among children aged 6 to 59 months admitted in paediatrics and the direct cost of the in-hospital hold in charge of an episode and the factors influencing it.

Methods

Study site, nature and period

General Hospital Dipumba had been chosen as study site. This provincial referral hospital and university clinics is located in Kanshi commune within the city of Mbujimayi (or Mbuji-Mayi) in Eastern Kasai province in the Congo DR (DRC). According to the report of the provincial division of Interior on population Census of Eastern Kasai (January 2012), Mbujimayi city had about 3,209,629 inhabitants. This survey was conducted in paediatrics department of Dipumba hospital. This department had a capacity of about 73 beds subdivided in intensive care unit and different hospital wards. The drugstore or pharmacy called "Pharmacie de l'hôpital" located in front of Dipumba hospital was chosen as reference for drug prices.

This prospective study of cases involving the support of severe malaria was conducted in children admitted in paediatrics during the period from July 01, 2012 to June 30, 2013.

Sample

A comprehensive recruitment of all severe malaria cases was carried out among children admitted during the investigation period. For case definition, WHO 2000 criteria of severe *Plasmodium falciparum* malaria [7] were used including clinical findings (prostration, impaired consciousness or coma, acidotic breathing, multiple convulsions, circulatory collapse, pulmonary oedema, abnormal bleeding, jaundice, macroscopic hemoglobinuria) and laboratory findings (severe anaemia, hypoglycaemia, acidosis, hyperlactatemia, Hyperparasitaemia, Renal Impairment). Were included in this study all children aged from 6 to 59 months with *Plasmodium falciparum* asexual parasitaemia and at least one of the complications criteria above mentioned. Patients were excluded if parent or guardian refused to give clear consent.

During our investigation, 753 children aged 6 to 59 months were admitted for observation and hospitalization in intensive care unit and wards of the paediatric department of Provincial Hospital Dipumba. Among them, 534 cases of severe malaria meeting our selection criteria were identified and constituted our study sample.

Patient assessment

All selected patients benefited from physicians or interns a full clinical examination including medical history, physical examination and laboratory tests leading to therapeutic approach for support with a medical record. Cases were first monitored in intensive care unit then in hospital room. If improvement, after a final clinical assessment, patients were discharged and parents or guardians were asked to bring the child to the hospital for follow up seven days or a week after discharge to assess their clinical status.

Cost estimation

For an economist, cost relates to the sacrifice (of benefits) made when a resource is allocated to a given consumption. For us, cost is the monetary value of resources spent on treating a malaria episode. Financial costs reflect the unit cost of an intervention and necessary resources for its delivery according to actual expenses incurred. While economic costs capture the opportunity cost of all resources used to deliver an intervention, whether or not they incur a financial expenditure. Thus cost of health care includes monetary cost and non-monetary cost or, in other words, direct cost (due to expenditure related to

treatment or prevention) and indirect cost (due to absenteeism, decreased productivity). The direct cost covers individual and public expenditure for the prevention and treatment of the disease. According to Professor Lututala M, direct costs are primary costs that a patient is required to bear, namely the costs relating to consultation, laboratory, drugs, hospitalization, transport, catering, laundry ... It is therefore all costs directly linked to the administration of care [6, 8]. Pricing uses the concept of tariff which is defined as regulations fixing the amount of fee paid by a private user of a service.

This study estimated the direct cost of managing inpatient child with severe malaria what corresponds to the sum spent for the hold in charge. It accounted of Cost of consultation, Cost of laboratory tests {thick smear of blood's patient and rapid diagnosis test (RDT), haemoglobin and haematocrit, glycaemia, blood-Rhesus typing, white blood cells count and typing, erythrocyte sedimentation rate, lumbar puncture, Compatibility, HIV testing, etc.}, Cost of medication including specific treatment or anti-malarials (Quinine, Artesunate or Artemether and ACT), adjuvant treatment or complication managing (antipyretics, antiemetic, anticonvulsant, cerebral oxygenators, iron, vitamins, transfusions, etc.) and nursing, and Cost of hospitalization.

For consultation, hospitalization, laboratory tests and nursing fees, recommended tariffs of the relevant hospital were applied. For drugs, price noted on the payment receipt was considered. If receipt was unavailable, price of the chosen referral drugstore's retail price was considered as the majority of patient' guardians bought drugs around the hospital. Expenses related to different components of the direct cost were included in analysis only if they were paid. Every unpaid price scale fixing was not accounted for direct cost.

Additional treatments and diagnostic costs related to co-morbidity (other diseases) were not considered in the analysis. Costs related to transportation, catering and others have not been included in our definition of direct cost. Indirect cost of malaria includes loss of productivity or income associated with illness or death. It can be expressed in terms of the cost of lost working days or absenteeism and the value of unpaid work done at home by men and women. In the event of death, the indirect cost includes the expected future income of the deceased. This cost, which was not the subject of our study, is difficult to assess [6, 8].

The Congolese franc (Fc) was used with the reference currency US dollar (US \$ or USD) at the exchange rate of Fc 900 for US \$1, which was the average rate of the national bank of DRC during the investigation period. According to the Socioeconomic state, households had been categorized in 3 socioeconomic levels: High (rich) if spending at least US \$1/person/day; Medium (stable poor) if spending about US \$0.5–0.99/person/day and Low (unstable poor and very poor) if spending less than US \$0.5/person/day or earning less than \$30/household/month.

Data collections and statistical analysis

Elements related to the studied variables (socio-economic, clinical and biological) were collected using a pre-established survey sheet. Collected data was entered, cleaned and validated using EPI Info v.6.04d (Centres for Disease Control and Prevention, Atlanta, GA) and analysed using SPSS for Windows (version

12.0, SPSS Inc., Chicago, IL). Descriptive statistics were used to compute the frequencies, proportions, means and standard deviation (SD), and confidence intervals. If normal distribution, means were compared using Anova test. If not normal distribution, medians were computed and compared using Kruskal-Wallis test. P values < 0.05 were considered statistically significant.

Ethical approval and consent to participate

Ethical clearance for this study was obtained from the Ethics Committee of the Mbujimayi School of Medicine, University of Mbujimayi with a research recommendation letter which was received and approved by Clinical Direction of Dipumba Hospital before data collection. Case data have been considered in this study only after the informed consent of the parent or guardian of the child.

Results

Characteristics of household and guardians

Table 1 Characteristics of households and child guardians

Characteristics	n (%)
Number of people per household (mean and SD)	7.2±6.5
Number of under 5 years per household (mean and SD)	2.2±1.1
Socioeconomic level ^a	
Low	435 (81.5)
Medium	78 (14.6)
High	21 (3.9)
Sex of child guardians	
Male/Female	44 (8.2)/490 (91.8)
Age of child guardians	
Mean (years and SD)	25.2±11.1
Education of child guardians ^b	
Any	51 (9.6)
Primary school	342 (64)
High school	75 (14)
University	66 (12.4)

Data are summarized as number (%), mean with standard deviation [mean ± SD]. ^a Socioeconomic state of households was categorized in 3 levels: High if spending US \$ 1/person/day or more, Medium if spending about US \$ 0.5-0.99/person/day and Low if spending less than US \$ 0.5/person/day or less than \$ 30/month/household. ^b Education level was considered following the highest degree earned by guardian.

The table 1 shows economic characteristic of household concerned by child severe malaria, whose records was sampled for this study. The average number of people per household was 7.2 with 2.2 subjects under five years old. More than ¾ of households or 81.5% lived below the poverty line as earning less than \$30 a month/household or spending less than \$0.5/person/day while 14.6% were stable poor and only 3.9% were rich. Overall child guardians were female (90.7% of cases), young adult (mean of 25.2±11.1 years) with low education level as almost three quarter (73.6%) of them had not achieved high school.

Clinical assessment

Table 2 Characteristics of children admitted for severe malaria

Characteristics (N= 534)	n (%)
Records reviewed (Among 753 admissions in paediatrics)	534 (70.9)
Sex	
Male/Female	294 (55.1)/240 (44.9)
Age	
Mean age (months and SD)	28.6 ±17.5
6-11 months	105 (19.7)
12-23 months	102 (19.1)
24-35 months	96 (18)
36-47 months	66 (12.4)
48-59 months	165 (30.9)
Weight	
Mean body weight (kg and SD)	11.9±9.1
Admission modality	
Emergency entry	510 (95.5)
Outpatient entry	24 (4.5)
Quality of treatment before admission ^a	
Untreated	243 (45.5)
Poorly treated	192 (36)
Treatment failure	99 (18.5)
Most observed criteria ^b	
Prostration	438 (82)
Severe anaemia	249 (46.6)
Acidotic breathing	249 (46.6)
Multiple convulsions	195 (36.5)
Hyperparasitaemia	165 (30.5)
Hypoglycaemia	108 (20.2)
Impaired consciousness (coma)	108 (20.2)
Circulatory collapse	107 (20)
Number of laboratory tests per patient	
Mean and SD	4.8±1.6
Co-morbidly	
Present/Absent	214 (40)/320 (60)
Antimalarial in intensive care unit	
Parenteral Quinine (prescribed/performed)	528 (98.9)/498 (93.2)
Parenteral Artemether (prescribed/performed)	27 (5.1)/12 (2.2)
Outcome	
Recovering	423 (79.2)
Death	39 (7.3)
Abscond	72 (13.5)
Outpatient attendance after discharge (N=423)	204 (48.2)
Hospitalization duration	
Mean duration (days and SD)	3.3±2.1
0-2 days	204 (38.2)
3-5 days	258 (48.3)
6-8 days	63 (11.8)
9-11 days	9 (1.7)

Data are summarized as number (%) or mean with standard deviation [mean ± SD]. ^a Quality of treatment received at home or in a healthcare facility was appreciated according to the national guidelines in DR Congo. ^b According to WHO

criteria of severe Plasmodium falciparum malaria. ° The interval of 3-5 days was the most represented (48.3%).

Among 753 children aged 6 to 59 months who were admitted for observation and hospitalization in paediatrics of Dipumba hospital, there were 534 cases of severe malaria either an overall frequency of 70.9% (Table 2). Males were more represented with 55.1% versus 44.9% for females. Mean age of study population was 28.6 ± 17.5 months ranging from 6 and 59 months. Predominance was noted in tranche of 48-59 months (30.9% of patients) followed by the groups of 6-11 months (19.7%), 12-23 months (19.1%) then 24-35 months (18%). Subjects from 6 to 35 months, under 3 years, therefore represented more than half of the cases (56.8%). Mean body weight was 11.9 ± 9.1 Kg.

Almost all children (95.5%) were brought to emergency with life threatening as more than the half of them was considered as medium and high severity cases at admission! A total of 243 children (45.5%) had not received before admission any anti-malarial treatment following national guidelines (National Malaria Control Programme or NMCP) of DRC while 192 (36%) were undertreated with an anti-malarial drug and 99 (18.5%) were classified as treatment failure category (Table 2). The average number of laboratory tests performed per patient was 4.8 ± 1.6 ranging from 2–9.

Among clinical features, prostration (82%), acidotic breathing (46.6%), multiple convulsions (46.6%), Impaired consciousness (20.2%) and circulatory collapse (20.04%) were most observed. Severe anaemia (46.6%), Hyperparasitaemia (30.9%), hypoglycaemia (20.2%) were the most laboratory findings (Table 2). Co-morbidities were present in 40% of cases.

Parenteral quinine was the most performed anti-malarial treatment (93.25%) in intensive care unit against artemether injection which was performed at 2.2%. Severe anaemia management was the most performed adjuvant treatment (240 of 249).

More than $\frac{3}{4}$ of patients (79.2%) had a favourable issue but only 48.2% of them were present at outpatient appointment (follow up) after discharge according to instructions given to parents or guardians. Overall 72 cases (13.5%) were absconded and 39 children (7.3%) died in the hospital. The mean length of in-hospital stay was 3.3 ± 2.1 days (range 0-10 days). Predominance was observed in the interval of 3-5 days (48.3%).

Hospitalization duration was longer in case of treatment failure than poor treatment (5.2 ± 2.3 days versus 3.3 ± 1.6 days, $P < 0.001$) (Figure a), in case of recovering than death (3.7 ± 2.1 days versus 1.4 ± 1.8 days, $P < 0,001$) (Table 3).

Table 3 Factors influencing the evolution (death in particular)

Parameters	Evolution		P-value
	Recovery and Abscond	Death	
	n (%) ^a	n (%) ^a	
Anaemia			0.029
No	267 (53.94)	18 (46.15)	
Yes	228 (46.06)	21 (53.85)	
Total (N=534)	495	39	
Coma			0.015
No	408 (82.42)	18 (46.15)	
Yes	87 (17.58)	21 (53.85)	
Total (N=534)	495	39	
Severity at admission^b			0.04
Low	245 (49.5)	12 (30.77)	
Medium and high	250 (50.5)	27 (69.23)	
Total (N=534)	495	39	
Hospitalization (days)	Recovery/ Abscond	Death	<0.001
Duration ^c	3.7±2.1 / 3.5±2	1.4±1.8	

^a Data are summarized as number (%). ^b Severity was determined using WHO criteria of severe malaria as following: low if 2-3 criteria were present, medium if 4-5 and high if 5 or more. ^c The duration is summarized as mean with standard deviation [mean ± SD].

Death was significantly in association with high severity of the case at admission ($P=0.04$), with coma ($P=0.015$) and with severe anaemia ($P=0.029$) and short length of hospitalisation ($P<0.001$) (Table 3).

Direct cost of the hold in charge

Table 4 Direct cost of the in-hospital hold in charge of one episode of child severe malaria

Components	Cost		%
	US \$±SD	(Range)	
Consultation	4.12±0.73	(0.77-4.27)	11
Laboratory tests	2.76±1.18	(1-8.72)	7
Medication ^a	28.53±11.69	(1.61-57.55)	74
Hospitalization	3.19±2.4	(0-15.55)	8
Total	38.6±11.82	(8.5-79.94)	100

Data are summarized as number (%) or mean with standard deviation [mean ± SD]. ^a Cost of medication includes cost of specific treatment, adjuvant treatment and nursing or services.

The average direct cost of managing a severe malaria episode in-hospital was US \$38.6±11.82 ranging from \$8.5-\$79.94 with \$40.56 as median (Table 4). This was equivalent to Fc 34,740±10,636 (Congolese franc) per patient with a median of Fc 36,500 (range Fc 7,650-Fc 67,450). Table 4 shows that 74% of the mean direct cost was due to medication, 11% to consultation, 8% to hospitalization and 7% to laboratory tests.

The cost of medication was due in 63% to adjuvant treatment, in 31% to specific treatment and in 6% to nursing (Figure b). The average cost of adjuvant treatment per episode was \$ 18.03±8.01 and the mean specific treatment cost was \$ 8.85±3.23. From the mean Direct Cost of \$ 38.60 for an episode of severe

malaria we could deduce that about 47% of the direct cost was devoted to adjuvant treatment and only 23% to specific treatment. Severe anaemia management, especially transfusion, had been reported to be responsible of the high adjuvant treatment cost (240 children transfused on 249 with severe anaemia).

Table 5 Direct cost depending on entrance modality, sex and age

Parameters	Direct cost (USD)	P-value ^a
Emergency entry		0.33
Yes	34.67±8.5	
No (outpatient entry)	38.79±13.5	
Sex		0.709
Male	38.61±12.7	
Female	37.46±9.13	
Age (months)		0.017
6-16	39.22±11.95	
17-27	31.18±11.19	
28-38	40.43±13.52	
39-49	34.45±11.4	
50-59	41.57±10.26	

Data are summarized as mean with standard deviation [SD]. ^a Homogeneity of distribution was determined using Bartlett's test. Anova test was used to compare means in normal distributions. P values <0.05 were considerate statistically significant.

Table 5 shows that the mean direct cost increased significantly with child's age ($P=0.017$) as it was highest in children aged 50–59 months. Sex was not significantly associated with direct cost ($P=0.709$). There was no significant difference in costs between cases admitted through direct emergency door and those through outpatient consultations ($P=0.33$). Mean direct cost in case of emergency entry was higher than outpatient entry, but not statistically significant.

Table 6 Factors influencing the direct cost

Parameters	Direct cost (USD)	P-value ^a
Treatment before admission		<0.001
No treatment	38.83 (9.5-63.11)	
Poor treatment	40.27(9.83-67.22)	
Treatment failure	44.11 (19.55-74.94)	
Severity at admission ^b		0.029
Low	38.2 (8.5-63.11)	
Medium	39.64 (9.5-74.94)	
High	45.18 (23.5-65.61)	
Coma		0.4
Absent	30.75 (19.55-65.61)	
Present	40.69 (8.5-74.94)	
Severe anaemia		<0.001
Absent	34.96 (8.5-74.38)	
Present	42.77 (8.5-74.94)	
Outcome		<0.001
Recovery	47.48 (9.77-74.94)	
Abscond	31.89 (9.5-43.55)	
Death	24.5 (8.5-65.61)	
Hospitalization (days)		<0.001
0-2	38.2 (8.5-63.11)	
3-5	39.64 (9.5-74.94)	
6-8	41.89 (19.55-67.22)	
9-11	45.18 (23.5-65.61)	
Socioeconomic level		0.46
Low	24.6 (8.5-65.61)	
Medium	32.8 (8.5-67.22)	
High	45.7 (22.55-74.94)	

Data are summarized as median with range. ^a Homogeneity of distribution was determined using Bartlett's test. Kruskal-Wallis test was used to compare medians. P values <0.05 were considered statistically significant. ^b Severity was determined using WHO criteria of severe malaria as following: low if 2-3 criteria were present, medium if 4-5 and high if 5 or more.

Quality of treatment before admission was significantly associated with direct cost ($P < 0.001$) because the direct cost was higher in case of poor treatment and treatment failure notion (respectively \$40.27 and \$44.11 as median) than in absence of treatment (Table 6). Median direct cost of lowest severity cases was significantly lower than highest severity cases (\$36.25 versus \$45.02, $P = 0.029$). Median Direct cost of those with severe anaemia was significantly higher than those without severe anaemia (\$42.77 versus \$34.96, $P < 0.001$). Recovering of case was significantly associated with a high direct cost (\$47.48 versus \$24.5 in case of death, $P < 0.001$). The table 6 shows also that association direct cost - coma was not statistically significant ($P = 0.4$) despite the higher cost children with coma. Direct cost increased significantly with the lengthening of hospitalization duration ($P < 0.001$). Direct cost of management was higher in case of high socioeconomic level household (median of \$45.7 versus \$24.6 in case of low socioeconomic level) but differences were not statistically significant ($P = 0.46$).

Discussion

This study showed the high density and the young age of population in this background, given an average number of 7 people per household with about 2 aged less than 5 years. The majority of affected households (81.5%) live below the poverty line (they were very poor or unstable poor as earning less than US \$ 30 a month). This could be explained by the financial crisis that is raging in the Congo DR in general and in the Eastern Kasai province in particular, especially as the main mining company of this area (Mining Society of Bakwanga or MIBA) has been bankrupt for several years. Our results corroborate literature that describes malaria as disease of poverty [1, 8, 9]. Literature adds that improving social and economic conditions reduces the burden of malaria [2, 5, 10, 11]. Local women literacy is demonstrated by the profile of child guardians who's generally a young female with low educational level. However, this rate shows that women's literacy tends to grow comparing to rates previously reported in the same area.

In this audit of paediatric admissions there was a high frequency of severe malaria (70.9% of admissions). This finding corroborates literature which states that malaria is the leading cause of morbidity and mortality of children under 5 years in Africa as they pay severe tribute of the disease [1-4, 8, 12]. In Central African Republic among subjects 6 months to 4 years observed rates were 89.35% in 1998 [13] and 42% in 2002 [14], in Congo-Brazza it rose to 57.6% in 2006 among children 1 to 5 years [15]. Difference could be related to restriction of inclusion criteria in these studies [13-15] and to case definition which was specific to each of them and over time [16].

In this hospital, children below 3 years (56.8% of cases) were most affected by severe malaria and males were most concerned (55.1% of cases). Similar results were observed in Saya District Hospital / Kenya [17] and in Cameroon [18].

Neglected uncomplicated malaria and poor quality of simple cases management, especially at home, seemed to be main causes of complications. In this study more than three quarters of admitted children were poorly or untreated before admission (81.5%). In addition, severity of case at admission was higher as almost all children (95.5%) were brought to emergency unit with life threatening. Some parents explained their belatedly arrival by behaviour to consult in hospital only in case of high severity after using (self) management of cases at home in order to avoid a bit of expensive costs related to in-hospital care. This situation needs community awareness with a great emphasis on prevention of malaria, correctly and promptly management of cases as well at home as in hospital.

The therapeutic memento of malaria in Africa [5] recommends for severe malaria management to make a minimum stock of 12 laboratory tests in general hospital and 16 in provincial or university hospital. In 2005, the minimum stock in Bonoua hospital was of 10 tests [19]. Laboratory investigations in this provincial hospital Dipumba are by far insufficient (mean of 4.8 ± 1.6 , ranging from 2–9). This situation can be linked first to frequent logistical problems including out-dated equipment, archaic methods, frequent blackout, lack or depletion of reagents; secondly to socioeconomic limits of households and third to a low rate of required tests in inpatient monitoring. Low frequency of co-morbidities can be linked to this low rate of performed laboratory tests.

Prostration, acidotic breathing, multiple convulsions, severe anaemia, hyperparasitaemia, hypoglycaemia, impaired consciousness and circulatory collapse were the most observed complications. Other literatures had mostly accused anaemia, neurological and hypoglycaemia [5, 13, 15, 18, 20]. However, difference is linked to revision in WHO criteria definition as some of these studies used ancient definition [16].

Parenteral quinine remains the most performed treatment in case of severe malaria in intensive care unit (93.25%). This attitude is consistent with literature which states that quinine is the ultimate molecule in case of complicated malaria [4, 5, 20] but not with currently national DRC guidelines on the treatment of severe malaria (2012) which strongly recommended injectable artesunate in preference to quinine or artemether as first-line treatment for severe malaria [21]. The major reason was the lateness in retraining and training healthcare givers on recently national guidelines updates.

Severe anaemia seemed to be a more redoubtable complication of malaria in this background as it was more frequent (46.6% of cases) and was significantly correlated with death ($P = 0.029$). The same situation was reported by Obonyo [17]. The death rate of 7.3% was significantly associated with high severity, coma, severe anaemia and lowest in-hospital stay. Similar rate (7.5%) was observed in Kenya [17]; lower rate (2%) in Cameroon [18] and higher rates elsewhere: 18% by Bobossi [13] and 26.3% by Moyon [15]. This shows that, generally, severe malaria management in this audit of paediatrics was effective. But after improvement there were unfortunately a bad attitude from parents and guardians, as only 48.2% of recovered cases attended the follow-up visit after discharge.

The mean length of hospitalization was 3.3 ± 2.1 days. It was longer in case of treatment failure than poor treatment, in case of recovering than death. Delayed duration of treatment after admission was frequent but not analysed in this study. The quickly death after admission (1.4 ± 1.8 days) can be linked to high severity of cases at admission and lateness of care when poor household didn't pay medicine promptly.

The direct cost of US $\$38.6 \pm 11.2$ (range $\$8.5$ - $\$79.94$) or even a little more in case of recovering ($\$40.83 \pm 10.95$) is a greater sum than the monthly income of the most households as 81.5% earned less than US $\$30$ a month of which the bulk expenditure is devoted to basic need which is food [3, 9]. As the majority of households live below the poverty line, these results show that direct cost of severe malaria management in hospital is high for developing countries. In addition, if a household has an average of 2.2 children under 5 years and that each one would on average an episode of severe malaria per year [4], thus each household will have to spend on average US $\$77.2$ per year for under five severe malaria management and even more (US $\$81.66$) for a good outcome of the disease. This is a serious economic burden for household; especially the latter shall assume all costs allocated to the hold in charge of the disease as system of health insurance is not yet operational in this community. These results corroborate literature that describes malaria as cause of poverty [1, 8, 9]. Studies previously conducted on malaria direct costs in this background are almost non-existent. This could be partly explained by the fact that the vast majority of countries affected by malaria have neither economic possibilities nor adequate technology to develop real research in medical field in their country. In the DRC, for example, the Gross National Product (GNP) is less than 100 USD / year / capita, which places the country among those with

the lowest incomes of the continent. A recent multicentre study in sub-Saharan Africa had given figures ranging between 12 and US \$ 75 [20]. A summary of 43 studies conducted over the past decade in Africa [8] revealed that the average cost of a severe malaria episode was US \$30.26 (range \$15.64 to \$137.87). These literatures are superimposed to results observed in paediatrics of Dipumba hospital.

The mean direct cost consisted essentially of medication (73.9%) which two third bounds to complications management of which severe anaemia management, especially transfusion, was responsible of the high adjuvant treatment cost. This study shows that the highest cost of severe malaria management is linked to complication. So avoiding worsening of the disease by reinforcing management capabilities of simple cases correctly and early and streamlining prescriptions can reduce the costs led by malaria.

In this study the direct cost increased with age ($P=0.017$). This could be explained by relation between dosage and weight which itself increases with age. Direct cost varied according to quality of managing before admission. This could be explained on the one hand, by the fact that in case of poor treatment and treatment failure patient who has been subjected to antimalarial drugs before will require better treatment and therefore more expensive, on the other hand because this type of patient often admitted in bad condition requires more and expensive intensive cares. The significant long duration of hospitalization observed in case of poor treatment and treatment failure (especially in intensive care unit) could also explain that. Direct cost varied according to severity of case at admission ($P=0.029$). High severity requires more intensive cares and more adjuvant treatments, more effective and therefore more expensive which are raising the cost of medication. In addition, high severity case will require more laboratory investigations which will be charged, and besides that severity will extend the length of in-hospital stay (especially in intensive care unit) which has also financial consequences. Severe anaemia increased the direct cost ($P<0.001$). High cost of blood transfusion in these settings, of other relayed adjuvant treatments and of multiple laboratory tests indispensable in case of anaemia could explain this higher cost. The direct cost was higher when the outcome was favourable (recovery) ($P<0.001$). This could be explained by relation between recovering and long in-hospital stay which will require more drugs, more cares and more laboratory tests therefore more expensive. New drugs, much more effective are more expensive than the old ones, and can also increase the cost of recovered cases as opposed to earlier deaths. Another reason was that death occurred quickly before administration of some expensive treatment / care and also because of absconded cases who escaped before payment. All of this shows that to fight an episode of severe childhood malaria, parents spend a lot on care, and sometimes they have to spend beyond their financial possibilities for a successful outcome.

Limitations

This study is not without limitations. Categorization of socioeconomic household level was very difficult because the majority of households had no specific monthly income and daily expenses were highly variable depending on the daily income. Another limitation was in determination of the severity of the case as certain laboratory tests were not carried out because of frequent logistical problems and financial

limits of household. Comparison of direct costs with other studies was not easy. In studies achieved elsewhere some medical services were free of charge and definitions of direct cost differed across studies and over time.

Conclusion

Severe malaria is the most cause of young children morbidity and mortality. In addition, it causes heavy economic losses on household. This study shows that severe malaria is the main reason for hospitalization among children aged 6 to 59 months and it is a costly disease in relation to the standard of living of Congolese peoples especially those of Mbuji-Mayi City. Adequate management of cases, most often late, is costly and even more expensive in case of recovery. Hence this study suggests that reinforcing management capabilities of uncomplicated cases correctly and promptly as well at home as in hospital and streamlining medical prescriptions will reduce the costs led by malaria.

Abbreviations

ACT: Artemisinin-based combination therapy; DRC: Democratic Republic of the Congo; Fc: Congolese Franc; HIV: Human Immunodeficiency Syndrome; NMCP: National Malaria Control Program; SD: Standard Deviation; US \$ or USD: United States dollar; RDT: Rapid diagnostic test; WHO: World Health Organization.

Declarations

Ethics approval and consent to participate

Ethical clearance for this study was obtained from the Ethics Committee of the Mbuji-Mayi School of Medicine, University of Mbuji-Mayi with a research recommendation letter which was received and approved by Clinical Direction of Dipumba Hospital before data collection.

Case data have been considered in this study only after the informed consent of the parent or guardian of the child.

Consent for publication

Not applicable

Availability of data and materials

The datasets during and/or analysed during the current study available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

OBM and TLB participated in the design of the analysis. OBM and EKT conducted the fieldwork and provided supervision throughout the duration of the study. OBM and EKT performed statistical analysis and TLB, (SBU), JCBM and GTD carried out interpretation of data. OBM and GTD wrote the manuscript and EKT, TLB, (SBU) and JCBM revised it critically. All authors read and approved the final manuscript.

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References

1. World Health Organization: World Malaria Report 2010. Geneva: World Health Organization;
2. CDC: Impact of malaria, Global Health-Division of Parasitic Diseases and Malaria, November 9, 2012.
3. Ministère de la Santé : Rapport d'Etat – Santé et Pauvreté, RDC, Avril 2004.
4. PNLP : Guide technique de formation en prévention et prise en charge du paludisme (Hôpital général de référence), Kinshasa : Ministère de la Santé, RDC ; 2010.
5. Eholie SP, Bissagnéné E, Girard PM. Mémento thérapeutique du paludisme en Afrique. 1^{ère} édition, Dion, IMEA, Paris ; 2008.
6. Martine A. Lutte contre le paludisme : Approche économique des obstacles à son contrôle (commentaires). Sciences sociales et Santé 2004, 22(4) :25–33.
7. World Health Organization. Severe falciparum malaria. Trans R Soc Trop Med Hyg 2000, 94(1):1–
8. White MT, Conteh L, Cibulskis R, Ghani AC. Costs and cost-effectiveness of malaria control interventions - a systematic review. Mal J. 2011; 10: 33

9. Chima RI, Goodman CA, Mills A. **The economic impact of malaria in Africa: a critical review of the evidence.** *Health Policy* 2003; **63**:17-36.
10. Rogier C, Henry MC, Trape JF. Evaluation épidémiologique du paludisme en zone d'endémie. *Med Trop* 2009 ; 69 :123-142.
11. Rogier C. Paludisme de l'enfant en zone d'endémie : épidémiologie, acquisition d'une immunité et stratégies de lutte. *Med Trop* 2004 ; 63 :449-464.
12. Sachs J, Malaney P. The economic and social burden of malaria. *Nature* 2002 ; 415 :680–
13. Bobossi SG, Ndoyo J, Mukeshimana T. Le paludisme grave à l'hôpital préfectoral de Bouar (Centrafrique). *Med Afr Noire* 2006 ; 53(4) :219-223.
14. Bobossi SG, Ndoyo J, Gaudeuille A. Les aspects actuels du paludisme grave de l'enfant en milieu hospitalier pédiatrique centrafricain. *Med Mal Infect* 2004 ; 34(2) :86-91.
15. Moyon G, Mbika CA, Kambourou J : Paludisme grave de l'enfant à Brazzaville. *Med Afr Noire* 2010 ; 55(2) :113-116.
16. Imbert P, Gérardin P, Rogier C, Brousse V. Pertinence des critères OMS 2000 du paludisme grave chez l'enfant non immun à Dakar, Sénégal. *Brill Soc Pahtol Exot* 2003 ; 96(3) :156-160.
17. Obonyo C, Vulule J, Akhwale WS, Grobbee DE. In-hospital morbidity and mortality due to severe malaria anemia in western Kenya. *Am J Trop Med Hyg* 2007; 6(1):23-28.
18. Forlack EA, Obama MT, Owono MB, Manga E. Direct cost of case managing following WHO guidelines in children hospitals of Cameroon. *Clinics Mother and Child Health* 2005; 2(1):253-256.
19. Couitchéée GLS, Niangue – Beugré, Oulaï SM. Evaluation des coûts directs de la prise en charge du paludisme grave de l'enfant à l'hôpital général de Bonoua, Côte d'Ivoire. *Arch de pédiatrie* 2005 ; 12(3) :330-332.
20. Lubell Y, Riewpaiboon A, Dondorp AM, von Seidlein L, et al. Cost-effectiveness of parenteral artesunate for treating children with severe malaria in sub-Saharan Africa. *Bull World Health Organ.* 2011; 89:504–
21. Directives nationales de traitement du paludisme en République Démocratique du Congo (Draft). Kinshasa : Ministère de la Santé ; 2012.

Figures

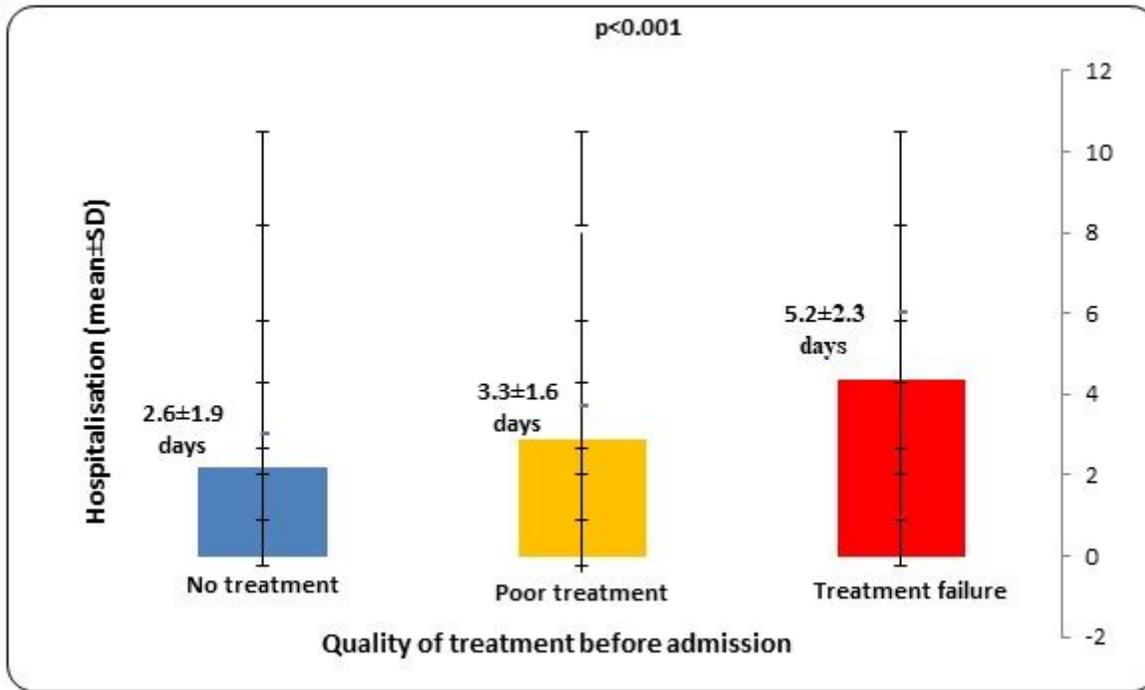


Figure 1

Figure a Hospitalization depending on quality of treatment before admission

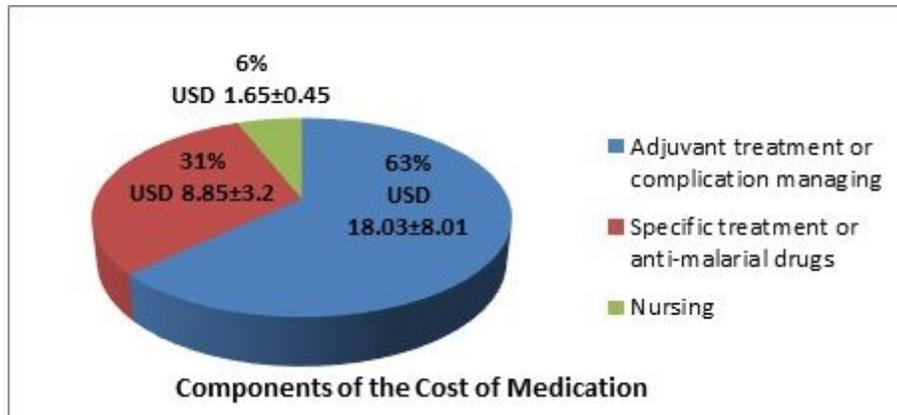


Figure 2

Figure b Components of the Cost of Medication