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Adult and paediatric mortality patterns in a referral hospital in Liberia 1 year after the end of the war

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Summary The aim of this study was to describe and analyse hospital mortality patterns after the Liberian war. Data were collected retrospectively from January to July 2005 in a referral hospital in Monrovia, Liberia. The overall fatality rate was 17.2% (438/2543) of medical admissions. One-third of deaths occurred in the first 24 h. The adult fatality rate was 23.3% (241/1034). Non-infectious diseases accounted for 56% of the adult deaths. The main causes of death were meningitis (16%), stroke (14%) and heart failure (10%). Associated fatality rates were 48%, 54% and 31% respectively. The paediatric fatality rate was 13.1% (197/1509). Infectious diseases caused 66% of paediatric deaths. In infants <1 month old, the fatality rate was 18% and main causes of death were neonatal sepsis (47%), respiratory distress (24%) and prematurity (18%). The main causes of death in infants ≥1 month old were respiratory infections (27%), malaria (23%) and severe malnutrition (16%). Associated fatality rates were 12%, 10% and 19%. Fatality rates were similar to those found in other sub-Saharan countries without a previous conflict. Early deaths could decrease through recognition and early referral of severe cases from health centres to the hospital and through assessment and priority treatment of these patients at arrival.

1. Introduction

In August 2003, after 14 years of civil war in Liberia, a peace agreement was signed between the parties in conflict. The war left a devastated country and around half a million displaced persons out of a 3.2 million population. The government health system had collapsed and health needs were basic. The average life expectancy had decreased from 55 years in 1980, to 48 in 2000 and 42 in 2004 (Liberia Core Health Indicators; http://www.who.int). In the year 2000, the under-five mortality rate was 194 out of 1000 live births, which ranked Liberia as 43rd of the 46 African countries.[1] Also in the year 2000, full vaccination coverage for children aged ≤1 year was 28%.[2]

One year after the end of the war, approximately 1.3 million people were living without running water, electricity or a sanitation system in Monrovia, the capital of Liberia. The health situation of the population was precarious and health care services scant. During the violent fighting that took

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place in Monrovia, over the summer of 2003, an emergency hospital had been set up by the French branch of the non-governmental organization Médecins Sans Frontières (MSF-F) in their offices in the town centre. Once the conflict had ended, the organization rebuilt a former school building, and a new hospital called Mamba Point Hospital was opened in these grounds in November 2003.

There are few published studies of the mortality pattern in Liberia[3–5], and there are no recent data available from during or after the civil war. Likewise, only limited literature is available about mortality patterns after wars in Africa.[6–9] The aim of this study was to describe and analyse the causes of death in adult and paediatric patients in a referral hospital in Monrovia 1 year after the end of the war.

2. Methods

This is a descriptive and retrospective study carried out from January to July 2005 in the medical and paediatric wards of Mamba Point Hospital, Monrovia, Liberia. A comparative and retrospective cohort study has been used for the analysis of meningitis cases.

2.1. Study site

Mamba Point Hospital is a referral hospital for emergencies and severe medical cases in Monrovia. It has 147 beds divided in four departments: medical ward (25 beds), paediatric ward (51 beds), surgical ward (35 beds) and obstetric ward (36 beds). Patients <15 years of age were hospitalized in the paediatric ward and patients over this age in the medical ward. Sick newborn children born in the hospital were hospitalized in the paediatric ward. Admissions were done through the emergency department (12 observation beds). Due to the limited number of beds in the hospital, severely ill patients and those who could benefit more from hospitalization were given priority admission.

The hospital was fully administered by MSF-F and was staffed by 181 medical personnel including doctors, physician assistants, nurses and nursing auxilliaries. In the medical ward, paediatric ward and emergency room, two or three doctors, six physician assistants, nine nurses and seven nursing auxilliaries worked during the day shift. At night, one doctor, four physician assistants, five nurses and four nursing auxilliaries were on duty. All medical equipment and drugs were provided by MSF. Medical materials and drugs were supplied regularly.

2.2. Data collection and analysis

Patients' files, laboratory and hospital registers were reviewed for data collection. For the general analysis the following data were collected: age, date of admission, date of discharge, diagnosis and outcome. For analysis of the meningitis and malaria cases, the following additional data were collected: clinical status, lumbar puncture performance, laboratory results, treatment, date and time of the beginning of treatment, and duration of treatment. In 28 meningitis cases (13 adults, 15 children) the information available in the files was incomplete and therefore these cases were excluded from the meningitis analysis.

A portable X-ray machine was available in the daytime, and a basic laboratory functioned 24 h a day. The following laboratory tests were performed: haemoglobin level through colorimetric analysis (Lovibond), manual white cell count and differentiation (thin blood film stained with Giemsa); urine and stool direct examination; cerebrospinal fluid (CSF) analysis; gram stain; urine strip test (glucose, proteins, pH, density, keton, blood, nitrites, leucocytes). The Paracheck rapid test was used for the diagnosis of falciparum malaria. A thin blood film was performed in suspected cases with a negative rapid test, and in order to determine parasitaemia. The CSF analysis included cell count and differentiation, Pandy test (protein estimation), gram stain, and Slidex meningitis-kit 5 rapid test. The latter test is able to detect *Neisseria menigitidis* groups A, B, C, *Haemophilus influenzae*, *Streptoccocus pneumoniae* and *Escherichia coli* K1. The sensitivity of the test ranges between 75% and 94% depending on the microorganism. White cell count was considered abnormal when the result was higher than 5 cells μl^{-1}.

Diagnosis was based mainly on clinical data and was confirmed by laboratory tests whenever possible. The case definitions used for the main diseases diagnosed were the following:

Anaemia and severe anaemia: haemoglobin lower than 11 g/dl and 5 g/dl respectively.
Chronic pulmonary disease: includes clinical suspicion of chronic conditions such as asthma, chronic bronchitis or emphysema.
Heart failure: clinical suspicion established by the presence of dyspnoea, orthopnoea, crackles in the chest auscultation, signs of acute pulmonary oedema (left ventricular failure), or/and peripheral pitting oedema, hepatomegaly, ascites, high pulsations in the jugular venous system (right ventricular failure).
Hepatic disease: clinical signs of hepatitis, hepatic failure or cirrhosis.
Intoxication: clinical suspicion of toxicity induced by any substance including therapeutic drugs, herbs and traditional treatments.
Malaria: clinical suspicion established by presence of fever and always confirmed with positive rapid test for *Plasmodium falciparum* or the presence of *Plasmodium* in the blood film.
Severe malaria: malaria cases fulfilling WHO criteria for severe malaria.
Meningitis: clinical suspicion established by the presence of fever, severe headache, convulsions, signs of meningeal irritation or conscience impairment. Lumbar puncture was attempted in all suspected cases.
Neonatal tetanus: progressive onset of trismus and generalized rigidity of muscles in the first 3 weeks of life.
Neurological disease: includes non-infectious conditions affecting the central or peripheral neurological system such as epilepsy, motor or sensory deficits of unknown origin.
Renal failure: clinical signs of acute oliguria or anuria without urethral obstruction.
Severe malnutrition: weight/height ratio lower than 70% of the median weight of a non-malnourished child of the

same height, or mid upper arm circumference in children of 6—59 months lower than 11 cm.
Stroke: clinical suspicion established by the sudden onset of characteristic neurological deficit (hemiplegia, aphasia, hemianopia, limb ataxia).
Suspected AIDS: clinical suspicion according to WHO criteria. A diagnostic test was offered to all suspected cases (both adult and children) through pre-test counselling. The blood samples were sent for analysis to the laboratory of Mother Pattern College in Monrovia where screening and confirmatory rapid tests were performed. Post-test counselling was offered to all the cases. The counselling was done keeping strict confidentiality measures by a trained social worker.

Severe malaria cases were always treated with i.v. artemether followed by oral amodiaquine whenever possible. Meningitis cases were treated mainly with ceftriaxone (2—4 g/d) and in some specific cases with chloramphenicol (4—6 g/d). HIV-positive patients were referred to the Catholic Hospital for HIV care and antiretroviral treatment. Malnourished children were treated following a protocol which included a progressive increase in the quantity of therapeutic milk (F-75, F-100) and therapeutic food (Plumpy Nut, BP-5), albendazole, folic acid, iron, vitamin A, treatment of dehydration, malaria, and other infections. Severely malnourished patients were only admitted to Mamba Point Hospital when they were severely ill or when presenting a medical complication requiring hospitalization. The other severely malnourished cases were referred from the emergency room to a therapeutic feeding centre situated in town and supported by MSF-Holland.

Morbidity and mortality data from medical and paediatric departments of the main hospitals in Monrovia were personally communicated to the authors. These data were collected from the hospital registers from January to July 2005. The data are not part of the study group but have been used for comparison with those found in Mamba Point Hospital. The data were available from Redemption Hospital (governmental hospital supported by MSF-Belgium, 185 beds), Benson Hospital (hospital supported by MSF-Spain and Switzerland, 88 beds), JFK Hospital (governmental hospital, around 85 beds in use but capacity of 375 beds before the war) and ELWA Hospital (private hospital, 40 beds). It was not possible to obtain medical information from the remaining hospital, the St. Joseph Catholic Hospital.

For statistical analysis the χ^2 test was used for comparisons among qualitative variables. Relationships were considered statistically significant when $P < 0.05$.

3. Results

From January to July 2005, 5137 patients were admitted to Mamba Point Hospital and 538 died (10.5%). Of the total hospitalizations, 2543 (49.5%) were admitted to the medical and paediatric wards and 438 (81.4%) of the total deaths occurred in these two departments. The overall fatality rate of the medical admissions was 17.2%. Forty-one adults and 13 children died in the emergency room before admission.

3.1. Medical ward

During the period analysed, 1034 patients were hospitalized and 241 (23.3%) died in this department. The average duration of hospital stay was 5 d. Thirty-two percent of deaths occurred in the first 24 h after admission, with the remaining deaths taking place an average of 5 d after admission. The average age of the deceased patients was 38 years.

Of the 1034 hospitalized patients, 465 (45%) were diagnosed with an infectious disease, 529 (51%) with a non-infectious disease, and in 40 (4%) an accurate diagnosis could not be established. Among the 241 deaths, the cause was infectious disease in 92 (38%) patients, non-infectious disease in 134 (56%) patients and in 15 (6%) patients the cause could not be established. The fatality rate for infectious diseases (19.7%; 92 deaths/465 cases) was lower ($P = 0.04$) than for non-infectious diseases (25.3%; 134 deaths/529 cases).

Table 1 shows the morbidity, proportion of deaths and case-fatality rate (CFR) in the medical ward. The main causes of death were meningitis, stroke and heart failure. Respiratory infection was the main cause of hospitalization but not the most frequent cause of death due to the low fatality rate. Less common diseases such as hepatic disease or AIDS were frequent causes of death because of their high fatality rate.

Considering infectious and non-infectious diseases separately, 80% of deaths caused by infectious diseases were caused by meningitis, AIDS, sepsis and respiratory infections. Meningitis was by itself the cause of 42% of deaths due to infectious diseases whereas suspected AIDS was responsible for 13% of deaths. Cardiovascular diseases caused half of deaths due to non-infectious diseases: 25% stroke, 18% heart failure and 10% severe hypertension. No cases of ischaemic heart disease were found.

3.2. Paediatric ward

From January to July 2005, 1509 patients were hospitalized in this department and 197 (13.1%) died. The average length of hospital stay was 6 d. Thirty-five percent of deaths occurred in the first 24 h after admission. After this 24 h, death occurred at an average of 3 d after admission.

The fatality rate was higher in the younger children, with 85% of the fatal cases occurring in children aged <5 years. The difference in fatality rate was statistically significant ($P = 0.02$) when comparing the group of children <1 month old (18%) and the group of children aged 5—14 years (10%). The high proportion of infants aged <1 month admitted to the department was due to the fact that they were born in Mamba Point Hospital, which was a referral centre for pregnancies at risk and complicated deliveries.

Among the hospitalized children, 1189 (79%) were diagnosed with an infectious disease, 229 (15%) with a non-infectious disease, and in 91 (6%) an accurate diagnosis could not be established. Of the 197 deaths, the cause was an infectious disease in 130 (66%) children, a non-infectious disease in 66 (34%) children and the cause could not be determined for 1 (0.5%) child. The fatality rate for infectious diseases (18.6%; 197 deaths/1189 cases) was lower ($P < 0.01$) than for non-infectious diseases (28.8%; 66 deaths/229 cases).

Table 1 Morbidity, proportion of deaths and case-fatality rate (CFR) of patients hospitalized in the medical ward in Mamba Point Hospital, Monrovia, Liberia (January—July 2005)

	Deaths *n* (%)	Patients *n* (%)	CFR %
Meningitis	39 (16)	81 (8)	48
Stroke	34 (14)	63 (6)	54
Heart failure	24 (10)	78 (8)	31
Hepatic disease	14 (6)	28 (3)	50
Severe hypertension	13 (5)	74 (7)	18
Sepsis	12 (5)	20 (2)	60
Suspected AIDS	12 (5)	31 (3)	39
Respiratory infection	11 (5)	107 (10)	10
Anaemia	8 (3)	44 (4)	18
Suspected tuberculosis	7 (3)	46 (4)	19
Neurological disease	7 (3)	18 (2)	37
Tetanus	6 (3)	16 (2)	38
Peptic disease	6 (3)	41 (4)	15
Diabetes	5 (2)	36 (4)	14
Malaria	4 (2)	54 (5)	7
Renal failure	4 (2)	10 (1)	40
Chronic pulmonary disease	4 (2)	27 (3)	15
Intoxication	4 (2)	20 (2)	20
Gynaecological disease	3 (2)	11 (1)	27
Trauma	2 (1)	14 (1)	14
Pyelonephritis	—	10 (1)	—
Malignancy	—	9 (1)	—
Unknown diagnosis	7 (3)	9 (1)	78
Other diagnosis	15 (6)	106 (10)	14
Total	241 (100)	1034 (100)	23

Overall, the main causes of death in the paediatric population were respiratory infections, 21.8% (43/197); malaria, 18.3% (36/197); and severe malnutrition, 12.7% (25/197). Together, they were responsible for half of the deaths in this department. The first three causes of morbidity added up to more than half of the causes of hospitalization: respiratory infections, 23.4% (353/1 509); malaria, 23.1% (348/1509); and neonatal sepsis, 9.2% (138/1509). No paediatric AIDS case was diagnosed.

Among the 216 infants <1 month old, the causes of death were neonatal sepsis, 18 (47.4% of deaths) cases; neonatal respiratory distress, 9 (23.7%) cases; prematurity, 7 (18.4%) cases; neonatal tetanus, 3 (7.9%) cases; and malformation, 1 (2.6%) case. The CFR of these conditions was neonatal sepsis, 12.9%; neonatal respiratory distress, 30.1%; prematurity, 77.8%; neonatal tetanus, 37.5%; and malformation, 14.3%.

Table 2 shows the proportion of deaths and the CFR according to age for the 1293 children ≥1 month old. For the children aged 1—59 months, respiratory infections, malaria and severe malnutrition were responsible for more than 70% of deaths. In the group aged ≥5 years, malaria, tetanus and trauma were the main causes of death.

3.3. Meningitis cases

Ninety-two (68 adults, 24 children) of 108 meningitis cases hospitalized between January and July 2005 were analysed. The average age was 36 years in adults, 10 years in children aged ≥5 years, and 13 months in children aged <5 years. The overall outcome was 45 (49%) deaths, 43 (47%) discharged, and 4 (4%) transferred to another centre or discharged against medical advice. Thirty-eight of 68 (55.9%) of the adult meningitis cases studied died, while 7 (29.2%) paediatric deaths were registered among the 24 children with meningitis. The fatality rate in adults was twice that in children ($P = 0.02$).

In 70 cases (76%) a lumbar puncture was performed successfully. A microorganism was identified in 42 cases (60% of CSF analysed). The fatality rate in the cases in which a microorganism was identified was 57.1% (24/42), and in the cases in which no microorganism was identified was 35.7% (10/28). This difference was not statistically significant [odds ratio (OR) = 2.4, $P = 0.08$]. The fatality rate in the cases in which the lumbar puncture was not successfully performed was 50.0% (11/22).

Table 3 shows the number of deaths and fatality rate according to the CSF analysis result. The fatality rate for those cases in which only an increase in the number of white cells was found in the analysis was lower than the cases in which also a pathogen was found (OR = 0.25, $P = 0.05$). The time of administration of the first antibiotic dose was analysed in 29 cases (all deceased): only in a third of the patients (9 cases, 31%) was the first antibiotic dose administered within the first hour after arrival in the hospital while in 20 (69%) cases the first antibiotic dose was administered more than 1 h after arrival (an average of 4 h after arrival).

Table 2 Proportion of deaths and case-fatality rate (CFR) according to age group in hospitalized children ≥1 month old in the paediatric ward of Mamba Point Hospital, Monrovia, Liberia (January—July 2005)

	1—59 months	5—14 years	Total		
	Deaths *n* (%)	Deaths *n* (%)	Deaths *n*	Cases *n*	CFR %
Respiratory infection	42 (31)	1 (5)	43	353	12
Malaria	32 (23)	4 (18)	36	349	10
Severe malnutrition	25 (18)	—	25	129	19
Meningitis	8 (6)	1 (5)	9	39	23
Sepsis	7 (5)	2 (9)	9	15	60
Surgical case	4 (3)	2 (9)	6	11	55
Diarrhoea	4 (3)	—	4	97	4
Trauma	1 (1)	3 (14)	4	54	7
Heart disease	1 (1)	2 (9)	3	4	75
Tetanus	—	3 (14)	3	6	50
Others	13 (10)	4 (18)	17	236	7
Total	137 (100)	22 (100)	159	1293	12

Table 3 Number of deaths and case-fatality rate (CFR) according to the cerebrospinal fluid analysis result in the meningitis cases hospitalized in Mamba Point Hospital, Monrovia, Liberia (January—July 2005)

	Adults			Children		
	Deaths *n*	Cases *n* (%)	CFR %	Deaths *n*	Cases *n* (%)	CFR %
Neisseria meningitidis	5	10 (21)	50	1	2 (10)	50
Streptococcus pneumoniae	12	18 (37)	67	3	7 (33)	43
Haemophilus influenzae	—	—	—	1	3 (14)	33
Gram+ve bacillus	2	2 (4)	100	—	—	
Abnormal increase of white cells	3	8 (16)	38	—	4 (19)	0
Abnormal increase of red cells	2	5 (8)	40	—	—	
No abnormality	4	6 (10)	67	1	5 (24)	20
Total	28	49 (100)	57	6	21 (100)	30

Laboratory results were as follows: 229 CSF samples were analysed, 148 (65%) were normal and 81 (35%) had at least one abnormal finding. Among the abnormal findings, 21 (26%) cases had an abnormally high white cell count (>5 μl^{-1}) and the test for protein detection was positive, but rapid test and gram stain were negative. In 60 (74%) cases the rapid test or the gram stain were positive: in 29 cases both were positive, in 17 the rapid test was positive and the gram stain negative, and in two cases the rapid test was negative and the gram stain positive. In 12 cases the gram stain was positive and the rapid test was not performed or not interpretable.

3.4. Malaria cases

Among the 54 malaria cases diagnosed in adults, 19 cases met criteria for severe malaria. The fatality rate of the hospitalized malaria cases was 7.4% (4 deaths/54 cases), but the fatality rate of severe malaria was 21.1% (4 deaths/19 cases). Of the 19 severe cases, 14 (73.7%) had neurological impairment, and 5 (26.3%) cases had severe anaemia. The fatality rate of the severe malaria cases with neurological impairment and of those with severe anaemia was similar: 21% (3 deaths/14 cases) and 20% (1 death/5 cases) respectively. Two of the deceased adult patients with severe malaria had a negative rapid test and a positive blood film.

Among the paediatric patients, 349 cases of malaria were hospitalized and 314 met severity criteria. The fatality rate of the hospitalized cases was 10.3% (36 deaths/349 cases), but the fatality rate in the severe malaria cases was 11.5% (36 deaths/314 cases). In 29 deceased patients the criteria for severity were the following: 11 (38%) had respiratory distress, 8 (28%) neurological impairment, 7 (24%) severe anaemia, and 7 (24%) prostration. In four cases more than one alteration was present.

From January to July 2005, 11 046 rapid tests for detection of *P. falciparum* were performed, and 2493 (22.6%) were positive. Seven hundred and sixty-one blood films to search for *Plasmodium* were performed. In 11 (1.4%) cases the rapid test was negative and the blood film positive.

4. Discussion

There are no data available on mortality or morbidity before the war in Liberia. The high fatality rate observed in this study is probably due to the actual situation in Liberia where the deficient living conditions, the nutritional status after a long-term war and a health system breakdown cause a

very high proportion of severely ill patients among those admitted to hospitals.[6] Often, the severe clinical status upon admission is also caused by delays in seeking medical attention, since two-thirds of the Liberians initially seek care from traditional healers, and they use modern medicine only when the traditional treatment has been unsuccessful.[2] In Mamba Point Hospital many patients were severely ill upon arrival. The hospital received almost half of the transfers done by the ambulance system in Monrovia and a high proportion of deaths occurred in the emergency room or in the first 24 h after admission. The global care provided on arrival was relatively good: sufficient medical staff, no shortage of drugs, and the laboratory available 24 h a day.

4.1. Medical ward

Similar fatality rates have been found in other African hospitals: 25% in Nigeria[10], 20% in South Africa[11] and 18% in Malawi.[12] In Monrovia, Mamba Point, Redemption and ELWA Hospitals had similar medical resources and case mix. Redemption Hospital (27 adult medical beds, 280 admissions per month) had a lower fatality rate, 15%, and ELWA (20 adult medical beds, 55 admissions per month) had a similar fatality rate, 23%, to Mamba Point Hospital. The different fatality rate observed in Redemption Hospital may be explained by its less strict criteria for admission of severe patients.

The substandard living conditions in the city of Monrovia (lack of water and sanitation system, lack of electricity, overcrowded homes) could explain the higher proportion of infectious diseases in this study compared to other countries: 38% in Uganda[13], 22% in South Africa[14] and 31% in other African hospitals.[15]

The morbidity and mortality patterns were similar to those found in other hospitals in Monrovia and in Africa. Pneumonia, tuberculosis and AIDS were as frequent causes of admission in Monrovia as in Zimbabwe,[16] South Africa[14] and Malawi.[17] Cardiovascular diseases, meningitis, pneumonia and AIDS were the most frequent causes of adult death in Redemption and ELWA Hospitals, as well as in other African countries.[15] However, it seems that the impact of AIDS on the hospital fatality pattern is still not as important as in countries with a high prevalence of HIV infection. The proportion of AIDS cases in Mamba Point Hospital (3%) was similar to the proportion found in other hospitals in Monrovia: 1% and 3% of the adult admissions in Redemption and ELWA Hospitals respectively. The important stigma of AIDS in Liberia and the refusal of the diagnostic test by some patients might have caused some under-diagnosis in the hospitals. In Blantyre, Malawi, where the estimated prevalence of HIV infection in the population is 30%, tuberculosis and AIDS accounted for almost half of the deaths in the medical ward.[18] In Liberia the estimated prevalence of HIV infection in the population is 8.2%[1], and in this study tuberculosis and AIDS only accounted for 8% of the deaths in the medical ward.

This study shows the considerable burden of non-infectious diseases on adult fatality in sub-Saharan countries. In other hospitals in Monrovia cardiovascular diseases accounted for 16—24% of the admissions. In Liberia, Ghana, Nigeria and Burkina Faso cardiovascular diseases also accounted for a high proportion of the medical admissions: between 16 and 37%.[19—22] The CFR in these hospitals, 20—29%, was similar to that found in Mamba Point Hospital. In West African countries, stroke contributed to 11—17% of the deaths with a fatality rate of 34—69%.[23—25] While heart failure is the most common heart disease, ischaemic heart disease is extremely rare in sub-Saharan countries.[14,17,19,22] Toxicity of traditional medicinal herbs may have played an important role in some of the liver and renal failures leading to death, but it was impossible to ascertain this aetiology.

4.2. Paediatric ward

In all Monrovia hospitals the paediatric fatality rates were similar: 11%, 14% and 17% in Redemption, ELWA and Benson Hospitals respectively. In other African hospitals the paediatric fatality rate is variable: 10% in Nigeria,[26] 15% in Burkina Faso,[27] 18% in Zimbabwe[28] and 21% in Mali.[29] In many African hospitals, early deaths accounted for an important proportion of the fatal cases reflecting the severity of the cases at admission.[26,28,30,31] The delay on consultation of sick patients undoubtedly contributes to the severity of their condition. Only half of the fatal cases observed in a hospital in Togo came during the first or second day of their illness.[32]

It is well known that the most vulnerable children are those <5 years old and the fatality rate decreased with older age. In Mali, the fatality rate decreased perceptibly from 29% in children <1 year old, to 14% in children 1—4 years old and 10% in children >4 years old.[29] In Kenya, the fatality rate in children <3 months old was 18% but reached 34% in those younger than 7 d.[33] The neonatal fatality rate, including the fatality rate of premature infants, was similar to that found in a special care baby unit in Tanzania.[31]

Infectious diseases, some of them preventable, are still the main cause of morbidity and mortality among African children.[6,29,30,34] The morbidity and mortality patterns were very similar in the other hospitals in Monrovia and in other African hospitals.[15,26,29,30] The proportion of admissions for meningitis was similar in Mamba Point and in a Kenyan hospital: 3% and 2% respectively.[35] The main difference was the higher proportion of diarrhoea in other hospitals: 21% of the admissions with an associated CFR of 11% in Zimbabwe[28] and 20% of the admissions in Mali[29] In Mamba Point Hospital, diarrhoea was common, but it was associated with other major diseases and only the main diagnosis was considered in the analysis. It is remarkable that, as in other hospitals in Monrovia, no paediatric cases of AIDS were diagnosed. The stigma and refusal of the test might have led to some under-diagnosis.

The proportion of severe malnutrition in a post-conflict context is similar to other hospitals in Africa; this is probably due to two factors. First, during the siege of Monrovia in 2003 there was an increase in the number of malnutrition cases due to the lack of food. A number of organisations distributed food and opened therapeutic feeding centres and once the siege was over the recuperation of the population was quite fast. Second, only severely malnourished children with medical complications requiring

hospitalization were admitted to Mamba Point Hospital. The second factor probably also contributed to a higher CFR.

4.3. Meningitis cases

Meningitis was a more frequent cause of morbidity in Mamba Point Hospital than in other hospitals in Monrovia: 2% of the admissions in Redemption, ELWA and Benson Hospitals, and none in JFK Hospital. A higher suspicion of meningitis and the referral of very sick patients from smaller facilities to Mamba Point Hospital might explain this finding. However, the adult and paediatric CFRs were similar in all the hospitals. In other African hospitals the meningitis fatality rate is variable: 20% in Mali[29], 24% in Egypt[36], 33% in Zimbabwe[28], 37% in Ghana[37], 38% in Uganda[13], 40% in Malawi[38], 42% in Nigeria[39] and 51% in Tanzania[40].

The fatality rate of pneumoccocical meningitis in children in African hospitals is variable but not very different to the one in Mamba Point Hospital: 55% in Gambia[41] and 59% in Niger.[42] During the meningoccocical epidemics in Nigeria[43] in 1996 and in Ethiopia[44] in 2001, the lethality was 10%. However in hospitalized children, this figure is higher: 18% in Niger[42] and 23% in Egypt.[36]

Ceftriaxone has been validated for the treatment of meningitis in several studies due to the high pathogen sensitivity to this antibiotic.[36,39] Even though the time between the first symptoms and arrival to the hospital could be a major prognostic factor,[40] the delay in the administration of the first dose of antibiotic probably also contributed to the meningitis fatality rate.

In one-third of the CSF-positive results the rapid test and the gram stain were discordant. These findings support the need to perform both tests in all suspected cases. Antibiotic treatment before admission and the sensitivity of the rapid test could be the cause of this discrepancy.

4.4. Malaria cases

Admissions for severe malaria in adults were rare in Mamba Point Hospital. The confirmation of all suspected cases with a rapid test has probably avoided over-diagnosis, common in facilities where these tests are not available. Only a quarter of the suspected malaria cases were confirmed with a positive rapid test, which could mean that, without the test, more than 8000 suspected patients would have been over-diagnosed and treated for malaria. However, malaria cases with a very high or a very low parasitaemia might have a negative rapid test result.

The high malaria fatality rate in adults in an area of high transmission throughout the year,[45–48] might be explained by the fact that only the severely sick patients were admitted. Unconsciousness has been identified as one of the main prognostic indicators of a high fatality rate in adults.[49] The fatality rate in children was similar to that described by other authors.[29,50–52] Respiratory distress is a predictive factor of high mortality in children.[53,54] Severe malaria is sometimes indistinguishable from sepsis[55] or meningitis.[56] Some authors have suggested that a lumbar puncture should be performed systematically in case of convulsions in children.[37]

5. Conclusions

Although the lack of pre-war data make difficult to establish conclusions on the effect of the war in Liberia, 1 year after the end of the war, the fatality rates at Mamba Point Hospital are not different to those found in other African hospitals.

In sub-Saharan countries, non-infectious diseases and in particular cardiovascular diseases, such as hypertension, heart failure and stroke, account for a considerable proportion of hospital morbidity and mortality among adults.

The high fatality rates in both adults and children seem linked to an early mortality in the hospital. Training of health centre staff to recognize and refer severe cases at an early stage to the hospital would reduce the delay in the treatment. Recommendations to improve care in the emergency room are: to assess and give priority treatment to the very sick patients on arrival and without delay, to speed up the laboratory results in order to give adequate treatment as soon as possible, to ensure the presence of senior staff and to match the staffing with the hourly workload.

Authors' contributions: HH and BV designed the study; HH collected the data and carried out the analysis; HH and EP carried out the interpretation; HH drafted the manuscript. All authors read and approved the final manuscript. HH is guarantor of the paper.

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