

Causes of pediatric mortality and case-fatality rates in eight Médecins Sans Frontières-supported hospitals in Africa

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Setting: Eight pediatric hospital in-patient wards in remote, rural and/or insecure areas in Africa.

Objectives: To describe, in children aged <5 years, 1) overall and individual mortality rates, 2) the 10 most common causes of mortality, and 3) their case-fatality rates.

Design: Retrospective analysis of routinely collected standardized program data for 2010.

Results: During 2010, 21 357 children aged <5 years were admitted and 1520 died, resulting in an overall in-patient mortality rate among under-fives of 7%. This remained the same after considering the three most common causes of mortality per hospital. One hospital with a neonatal unit showed a mortality rate of 14%. Of the 10 most common causes of mortality in the eight hospitals, severe malaria, acute lower respiratory tract infection and neonatal infection counted for about 77% of total deaths. Ranking the 10 most common causes of mortality according to case-fatality rates, septicemia, meningitis, low birth weight with pathology, neonatal infection and neonatal asphyxia were the most common (case-fatality rates 15–40%).

Conclusion: Despite widely different contexts, mortality rates for pediatric in-patients were consistently under 10%. To further reduce mortality, emphasis should be placed on treating sepsis and introducing implementable and/or adapted care packages for neonatal-related pathologies.

Child mortality is a world-wide concern, and more so in sub-Saharan Africa, as this region accounts for the highest child mortality rates among the 11 million child deaths per year.¹ These deaths often occur as a result of preventable or treatable diseases. Children aged <5 years are the most vulnerable for morbidity and mortality, and reducing these specific deaths by two thirds constitutes the Millennium Development Goal.²

Médecins Sans Frontières (MSF), a medical humanitarian organization, currently supports hospital pediatric care delivery in eight sub-Saharan African countries, using standardized treatment guidelines with a focus on treatable causes of child mortality. The contexts in which these hospitals operate vary widely: some are rural hospitals, others function as referral centers, while others serve in conflict zones. With no international goals for pediatric mortality available from the World Health Organization (WHO) or other important technical agencies, MSF has set an arbitrary goal for in-patient mortality of $\leq 10\%$ for children admitted to hospital.

In 2010, complete and standardized data on pediatric mortality were collected in all of MSF's eight hos-

pitals in sub-Saharan Africa. This provided the opportunity for a detailed study that would assess the performance of pediatric in-patient care in those hospitals, as a group and individually, and provide data that could improve care goals. In particular, documenting the most common mortalities and associated case-fatality rates for children aged <5 years would allow MSF to focus on those diseases at most need of attention.

The study will also add to the scarce literature on pediatric in-patient mortality in sub-Saharan Africa, as only a few reports on the topic could be found in the medical literature. One rural district hospital in Kenya reported an under-five in-patient mortality rate of 8%.³ This hospital was comparable to one of the MSF hospitals. Another study from Kenya of 14 first referral care district hospitals showed under-five in-patient mortality rates ranging from 4% to 15%.⁴ However, no information has been found in relation to hospital settings, especially those in insecure contexts where health care systems have collapsed and where MSF frequently works.

The aim of this study was to report on the causes of mortality and case-fatality rates for children aged <5 years in eight MSF-supported hospitals in Africa. Specific objectives were to determine: 1) the overall and individual mortality rates for the eight hospitals, 2) the 10 most common causes of mortality in all hospitals combined, and 3) the case-fatality rates for these diseases.

METHOD

Design

This was a retrospective analysis of routinely collected program data for the year 2010.

Settings

MSF supports hospital care in settings where in-patient care is not readily available or accessible due to insecurity or post-conflict where infrastructure has been destroyed by war.

This study was conducted in all eight public hospitals where MSF Operational Centre Brussels (OCB) was providing support, seven of which were located in sub-Saharan Africa and one in Northern Africa. Some hospitals were district hospitals serving a rural population, while others were in extremely remote areas and two were located in highly insecure environments. Three hospitals were entirely run by MSF staff and were under MSF's management, while the other five were Ministry of Health structures where MSF support was integrated at various levels.

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KEY WORDS

pediatric in-patient mortality; pediatric case-fatality rate; neonatal care; Africa; operational research

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TABLE 1 MSF hospitals included in the study

Hospital, country	Description	Location	Bed capacity
Dakoro, Niger	MoH general district referral hospital with a pediatric ward	Rural, remote South Niger where MSF, in addition, ran a large feeding program with in-patient capacity for severely malnourished children aged <5 years	236 beds with 164 pediatric beds, serving a <5 years population of 101 053
Guidam R, Niger	MoH general district referral hospital with a pediatric ward	Rural, remote South Niger where MSF, in addition, ran a large feeding program with in-patient capacity for severely malnourished children aged <5 years	177 beds with 68 pediatric beds, serving a <5 years population of 78 563
Lubutu, DRC	MSF general district referral hospital with a pediatric ward	Rural, remote North-East DRC where another international NGO offered medical care at health center level	111 beds with 27 pediatric beds, serving a population of ~100 000
Masisi, DRC	MoH general district referral hospital with a pediatric ward and neonatal unit	Rural, remote, insecure East DRC	152 beds with 55 pediatric beds and 10 beds for neonates, serving a population of ~377 000
Gondama, Sierra Leone	MSF gynecological/obstetric and pediatric district referral hospital A general MoH hospital provides all care for the general population of 600 000	Second largest city, capital of Bo district, central-south Sierra Leone	200 beds with 171 pediatric beds, with 64 beds allocated to severely malnourished children <15 years, serving a target population of ~300 000
East Imey, Ethiopia	MoH general referral health center serving the population of East and West Imey District, accounts for a population of 140 000 people	Very remote and chronically insecure rural South-East Ethiopia	8 beds, none specifically allocated for pediatrics
Guri El, Somalia	MoH general district referral hospital with a pediatric ward	In Galgadud region of war-torn Somalia	90 beds with 36 pediatric beds, serving a population of 330 000
Kaguro, North Sudan	MSF general referral health center Due to its high insecurity, it is hard to estimate its target population as people are extremely mobile. It is estimated to be between 50 000 and 100 000	Very remote, highly insecure Darfur region of Northern Sudan	Capacity 6–8 beds, none specifically allocated for pediatrics

MSF = Médecins Sans Frontières; MoH = Ministry of Health; DRC = Democratic Republic of Congo; NGO = non-governmental organization.

Two hospitals were extended health centers with limited in-patient capacity. The six general hospitals had a separate pediatric ward where children were admitted up to the age of 14 years; of these, one had a separate neonatology unit (Table 1).

Study population

The study population included all children aged <5 years who were admitted to the eight hospitals in 2010. Only children aged <5 years were selected as they are known to be the most vulnerable group, and records for this age group were consistently identifiable across all hospitals.

Variables, data collection and validation

The outcome variables were 1) mortality and 2) case-fatality rates for children aged <5 admitted to the eight hospitals. Mortalities were recorded in hospital in-patient registers as discharge outcomes; case-fatality rates were calculated based on these mortality outcomes and according to disease diagnoses.

Both disease diagnosis and mortality outcomes were assumed to be recorded according to standardized guidelines used by clinical staff trained in the utilization of these guidelines.

Data handling

The diagnostic and discharge data were entered into the in-patient registers of all eight hospitals by clinic staff. They were then collected by MSF-trained staff on a weekly basis and entered into the MSF in-patient department tool (IPD tool, Epicentre, Paris, France). This tool enhanced the standardization of diagnostic and discharge data across the different settings in which MSF worked. The data were then sent on a monthly basis to MSF-OCB head-

quarters. There was no independent validation of the data transferred from the registers to the headquarter summaries; however, the data were checked at headquarters level, and in case of significant inconsistencies, verification was requested from field staff.

For this study, mortality data were extracted from the IPD tool and entered into a new, especially designed Excel-based spreadsheet. Data were double-entered for reliability.

Analysis

Mortality rates were reported overall and for individual hospitals, and the 10 most common causes of mortality and their case-fatality rates were then calculated. No sample size was calculated because the whole study population across the eight hospitals was included.

Ethics approval

The study was approved by the Ethics Advisory Group of the International Union Against Tuberculosis and Lung Disease, Paris, France. The study met the Médecins Sans Frontières Ethics Review Board-approved criteria for analysis of routinely collected program data.

RESULTS

In 2010, in all eight hospitals, 21 357 children aged <5 years were admitted and 1520 died, resulting in an overall under-five in-patient mortality rate of 7% (Table 2).

Table 3 shows the main three causes of death in each individual hospital setting, stratified by geographic area. These three causes cover a total of 12 996 cases with a total of 956 deaths, giving a 7% mortality rate.

TABLE 2 Number of under-five admissions, deaths and mortality rates in eight African MSF-supported hospitals in 2010

Hospital, country	Total admissions <i>n</i>	Total deaths <i>n</i>	Hospital mortality rate %
Dakoro, Niger	3905	276	7
Guidam R, Niger	4976	315	6
Lubutu, DRC	920	29	3
Masisi, DRC	1325	117	9
Gondoma, Sierra Leone	7837	684	9
East Imey, Ethiopia	330	10	3
Guri El, Somalia	1721	72	4
Kaguro, North Sudan	343	17	5
Total	21 357	1520	7

MSF = Médecins Sans Frontières; DRC = Democratic Republic of Congo.

Despite the different hospital settings, there was little difference in the main causes of mortality. Acute lower respiratory tract infection (ALRTI) was the most common (6/8 hospitals), followed by severe malaria and neonatal infection (4/8 hospitals). Despite the fact that only one hospital had a neonatal unit, four hospitals recorded neonatal infections. Masisi hospital, Democratic Republic of Congo (DRC), the only hospital with a neonatal care unit, recorded three neonatal causes. It should be noted that in this hospital the neonatal infection case-fatality rate was low (5%) compared with the other three hospitals (20–30%).

The 10 most common causes of mortality, ranked according to absolute numbers for all eight hospitals combined, are shown in Table 4A. The first three ranked mortalities were severe malaria,

TABLE 3 The three most common causes of mortality for the eight hospitals individually, by absolute mortality

Hospital, country	Conditions	Cases <i>n</i>	Deaths <i>n</i>	Case-fatality rate %
Dakoro, Niger	Neonatal infection	166	39	24
	Severe malaria	840	37	4
	Anemia	576	33	6
Guidam R, Niger	Severe malaria	2 635	208	8
	ALRTI	942	21	2
	Neonatal infection	43	13	30
Lubutu, DRC	Malnutrition	351	18	5
	ALRTI	238	4	2
	Septicemia	8	5	63
Masisi, DRC	LBW with pathology	84	27	32
	Neonatal asphyxia	192	19	10
	Neonatal infection	98	5	5
Gondoma, Sierra Leone	Severe malaria	3 242	256	8
	ALRTI	1 504	135	9
	Neonatal infection	366	72	20
East Imey, Ethiopia	Malnutrition	54	3	6
	ALRTI	96	1	1
	Kala azar (visceral leishmaniasis)	4	1	25
Guri El, Somalia	ALRTI	888	24	3
	Malnutrition	298	22	7
	Non-bloody diarrhea	202	8	4
Kaguro, North Sudan	ALRTI	102	3	3
	Non-bloody diarrhea	58	1	2
	Severe malaria	9	1	11
Total		12 996	956	7

ALRTI = acute lower respiratory tract infection; DRC = Democratic Republic of Congo; LBW = low birth weight.

TABLE 4 The 10 most common causes of mortality in all eight hospitals combined

Number	Mortality	Cases <i>n</i>	Deaths <i>n</i>	Case-fatality rate %
A Absolute mortality				
1	Severe malaria	6839	505	7
2	ALRTI	4695	206	4
3	Neonatal infection	678	130	19
4	LBW with pathology	202	43	21
5	Malnutrition	718	48	7
6	Anemia	824	43	5
7	Neonatal asphyxia	266	40	15
8	Non-bloody diarrhea	1340	35	3
9	Meningitis	93	22	24
10	Septicemia	55	22	40
B Case-fatality rate				
1	Septicemia	55	22	40
2	Meningitis	93	22	24
3	LBW with pathology	202	43	21
4	Neonatal infection	678	130	19
5	Neonatal asphyxia	266	40	15
6	Severe malaria	6839	505	7
7	Malnutrition	718	48	7
8	Anemia	824	43	5
9	ALRTI	4695	206	4
10	Non-bloody diarrhea	1340	35	3

LBW = low birth weight; ALRTI = acute lower respiratory tract infection.

ALRTI and neonatal infection, amounting to about 77% (841/1094) of the most common deaths in total. These deaths did not include 287 deaths encoded as 'others', as no classification of these deaths was possible. The remaining 139 deaths are those due to the least common causes ($n = 111$) and those that were non-classified ($n = 28$) among the eight hospitals.

Table 4B shows the ranking of the 10 most common causes of mortality according to their case-fatality rates. The following conditions were most common: septicemia, meningitis, low birth weight (LBW) with pathology, neonatal infection and neonatal asphyxia. Case fatalities ranged from 15% to 40%.

Table 5 shows the mortality and case-fatality rates of the three main neonatal pathologies combined, if recorded at all, in the eight different hospitals. A total of 1134 neonates had been recorded, of which 211 had died, resulting in an overall neonatal mortality rate of 19%.

TABLE 5 Three main combined causes of neonatal admissions, deaths and case-fatality rates in eight African MSF-supported hospitals in 2010

Hospital, country	Total recorded admissions <i>n</i>	Total recorded deaths <i>n</i>	Case-fatality rate %
Dakoro, Niger	351	75	21
Guidam R, Niger	43	13	30
Lubutu, DRC	0	0	0
Masisi, DRC	374	51	14
East Imey, Ethiopia	0	0	0
Gondoma, Sierra Leone	366	72	20
Guri El, Somalia	0	0	0
Kaguro, North Sudan	0	0	0
Total	1134	211	19

MSF = Médecins Sans Frontières; DRC = Democratic Republic of Congo.

DISCUSSION

Despite large differences in context and type of hospital and some variations in cause of death, pediatric mortality in these eight MSF-supported hospitals was surprisingly consistent, with an overall rate of 7%. The rate was below the 10% goal set by MSF and no hospital exceeded this. It is difficult to know how to interpret these results, as there are no guidelines from the WHO or other technical agencies to indicate what might be an acceptable rate of mortality for pediatric in-patient care in these high-risk settings. The 10% goal selected by MSF was arbitrary, as when MSF took on neonatal care in addition to pediatric and adult care, it exceeded its previous goal of 5% for overall hospital mortality. However, given these results, the first reported in the literature, an overall mortality target of 10% would appear to be reasonable for other hospitals offering neonatal and pediatric in-patient care in similar settings. Naturally, this figure needs to be corroborated by other studies in other hospitals/contexts.

The overall positive results may be due to the standardization of treatment by MSF and the fact that the organization can mobilize resources (human, equipment and supplies) that permit an adequate standard of care. This is supported by a study from Guinea-Bissau in a national referral hospital showing that the introduction of standardized guidelines and financial incentives reduced mortality rates.⁵ Whether or not these hospitals would have fared as well under typical local government support is open to question.

Looking at the absolute numbers, deaths due to malaria, ALRTI, non-bloody diarrhea, malnutrition and anemia are high, but their case-fatality rates were under 10%. This suggests that the care provided for these diseases was of acceptable standard, although there are no published guidelines.

The five conditions with the highest case-fatality rates are septicemia, meningitis, LBW with pathology, neonatal infection and neonatal asphyxia. Three of these can be considered as 'infectious' or 'septic', and their case-fatality rates were approximately $\geq 20\%$, much worse than the overall average. This highlights an area where MSF can focus its attention on increasing effective care; reducing septic deaths would make a major contribution to lowering the overall mortality rate.

In addition, the three identified neonatal pathologies have a case-fatality rate of between 15% and 21%. Although slightly lower than described in the literature, where rates range between 23% and 28%, these pathologies are known to be associated with increased mortality.^{3,6} However, when looking only at the three main neonatal pathologies in the eight different hospitals, case-fatality rates range between 14% and 30%, whereas Masisi hospital (DRC), the only hospital with a neonatal unit, had the lowest case-fatality rate (14%). In the hospitals in Sierra Leone (20%) and Dakoro in Niger (21%), comparable case-fatality rates among admissions were significantly higher than in Masisi. This would suggest that a dedicated neonatal care unit could have a positive impact on neonatal survival rates. However, despite this and despite various calls for action,^{7,8} neonatal care still appears to be a neglected area for: 1) policy makers in African countries, although substantial efforts have been made in Malawi and Uganda;^{9,10} 2) donors;^{11,12} and 3) non-governmental organizations such as MSF (among the MSF hospitals only one offered special care for neonates). Low-cost and implementable or adaptable care packages have been proposed in the literature,^{12,13} suggesting that there should be no resource barriers for implementation.

The hospital in Lubutu, DRC, was the only hospital to record seven (clinical) acquired immune-deficiency syndrome cases, of

which one died. This is not surprising, as the human immunodeficiency virus (HIV) prevalence in the countries of the hospitals under study was low (0.7–1.2%), although seven of the eight hospitals were in sub-Saharan Africa. The only country showing a moderate prevalence rate was DRC (1–5%).¹⁴

The study had some strengths. All children aged <5 years who were admitted to the eight hospitals in 2010 were included in the study. All eight hospitals used the same standardized data collection tool (IPD tool), thereby minimizing any methodological bias, and all the extracted data from the IPD tool were double-entered into a new especially designed spreadsheet for reliability.

There were also some limitations. Although data were collected from the IPD tool, utilization of the standardized treatment guidelines and/or entry by the clinical staff into the in-patient register could not be validated during the study. The use of routinely collected data did not allow recorded diagnoses and/or discharge outcomes such as 'anemia' to be interpreted, nor did it provide HIV status for the children who died. Of the total number of deaths, 287 were encoded as 'others' and another 28 were not classified. As the nature of these 'others' and non-classified records could not be systematically identified, they were excluded from the analysis of the 10 most common causes of mortality and their case-fatality rates. This may have significantly altered the reported numbers of deaths and case-fatality rates.

Furthermore, as a tool for classifying diagnosis and mortality data in a standardized fashion across different contexts, the IPD tool did not allow neonates to be segregated among the under-five population, except where a separate neonatal unit existed or a clear diagnosis such as 'neonatal infection' was recorded. We were therefore unable to perform an in-depth analysis of the most common causes of mortality in this unique age group. It is possible that neonatal pathologies may have been under-recorded and/or misclassified.

CONCLUSION

This analysis of mortality for pediatric in-patients across widely different hospitals and contexts in Africa revealed a surprisingly consistent mortality rate of less than 10%. In the absence of any other published targets, we suggest that 10% could be used as a starting point. The study also suggests that to further reduce mortality, emphasis should be placed on treating sepsis and neonatal-related pathologies.

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Contexte : Huit services d'hospitalisation pédiatrique dans des zones rurales éloignées ou peu sûres d'Afrique.

Objectifs : Décrire chez les enfants âgés de <5 ans : 1) les taux globaux et individuels de mortalité et 2) les 10 causes les plus courantes de mortalité ainsi que les taux de létalité.

Schéma : Analyse rétrospective des données standardisées du programme recueillies en routine pendant l'année 2010.

Résultats : Au cours de l'année 2010, 21 357 enfants âgés de <5 ans ont été admis à l'hôpital et 1520 d'entre eux sont décédés, ce qui correspond à un taux de mortalité globale de 7% chez les patients hospitalisés âgés de <5 ans. Ce taux reste le même après avoir pris en considération les trois causes les plus courantes de mortalité par hôpital. Dans un hôpital comportant une unité néo-natale, le taux de mortalité a été de 14%. Parmi les 10 causes les plus communes de

mortalité dans les huit hôpitaux, une malaria grave, une infection aiguë du tractus respiratoire inférieur et une infection néonatale ont été responsables d'environ 77% de l'ensemble des décès. Si l'on classe en fonction des taux de létalité les 10 causes les plus courantes de mortalité, la septicémie, la méningite, un faible poids de naissance accompagné de manifestations pathologiques, l'infection néonatale et l'asphyxie néo-natale ont été les plus courantes (taux de létalité 15–40%).

Conclusion : En dépit de contextes largement différents, les taux de mortalité chez les patients pédiatriques hospitalisés se situent régulièrement en dessous de 10%. Afin de réduire davantage la mortalité, il faut insister sur le traitement de la septicémie et introduire des ensembles de soins réalisables et/ou adaptés pour les pathologies de la période néo-natale.

Marco de referencia: Ocho servicios de hospitalización pediátrica en zonas rurales, aisladas o inseguras en África.

Objetivos: Describir las tasas globales y específicas de mortalidad en los niños <5 años de edad y definir las 10 causas más frecuentes de muerte con su respectiva tasa de letalidad.

Método: Fue este un análisis retrospectivo de los datos recogidos de manera sistemática y normalizada en un programa en el 2010.

Resultados: Durante el año 2010, se hospitalizaron 21 357 niños <5 años de edad y 1520 fallecieron, lo cual representa una tasa de mortalidad intrahospitalaria global de 7% en este grupo de edad. Esta cifra permaneció estable cuando se consideraron las tres causas más frecuentes de mortalidad por hospitales. En un hospital dotado de unidad de recién nacidos, la tasa de mortalidad fue 14%. De las

10 causas más frecuentes de mortalidad en los ocho hospitales, el 77% correspondió a la malaria grave, la infección de las vías respiratorias inferiores y la infección neonatal. Al categorizar las principales 10 causas de muerte en función de su tasa de letalidad, las causas más frecuentes fueron la sepsis, la meningitis, los casos de bajo peso al nacer con alguna afección, la infección neonatal y la asfisia neonatal (tasa de letalidad 15–40%).

Conclusión: Pese a la gran diversidad de contextos, las tasas de mortalidad de los pacientes pediátricos hospitalizados fueron constantemente inferiores a 10%. A fin de disminuir aun más la mortalidad, se debe hacer hincapié en el tratamiento de la sepsis e introducir programas viables y adaptados de tratamiento de las afecciones neonatales.