Perioperative mortality: Analysis of 3 years of operative data across 7 general surgical projects of Médecins Sans Frontières in Democratic Republic of Congo, Central African Republic, and South Sudan

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Background. *The African continent has the greatest burden of surgical disability-adjusted life years, yet the least is known about operative care here. This analysis describes the surgical patients admitted to 7 hospitals supported by the Médécins Sans Frontières (MSF) over 3 years in 3 conflict-affected countries—Eastern Democratic Republic of Congo, Central African Republic, and South Sudan.*
Methods. *A standardized operative data collection tool was used for routine collection of operative inpatient data between 2011 and 2013 at 7 MSF surgical facilities. Surgical records of 14,482 patients were analyzed to describe surgical epidemiology, major procedures, and perioperative mortality. The perioperative mortality rate (POMR) was calculated within 2 days of admission (POMR2) and within 30 days from admission (POMR30). The POMR is used as a marker of quality of operative care.*
Results. *Caesarean delivery was the most common major procedure performed and had a POMR30 of 5.28 per 1,000 admissions. The overall inpatient mortality was 19.67 per 1,000 admissions. Children had greater POMR than adults for the same procedure types (47.97 vs 15.89 deaths per 1,000 admissions,* $P < .001$*); 85.1% of all major procedures were emergency procedures and between 3 and 30% of admissions were related to violence. After adjustment, perioperative death was associated with emergency surgery, violence, and age younger than 15 years.*
Conclusion. *POMRs varied by age group and type of major procedure performed. Collecting surgical data is achievable and can inform future planning and support for national surgical programs. More information is needed on operative outcomes in adults and children in low-resource settings to improve quality and access to care. (Surgery 2016;159:1269-78.)*

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Operative care is a key component of global health. Although surgical conditions account for an estimated 11% of the global burden of disease, approximately 2 billion of the world population lacks access to basic surgical care.[1-3] The African continent has the greatest burden of disability-

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adjusted life years at 38 per 1,000 people, yet little is known about basic general operative care in Africa.[4] Where the burden of untreated operative disease is known in sub-Saharan Africa, it is vast and underestimated.[5] Approximately 288 million people are living with a surgically treatable condition, and a potential 5.6 million deaths could be avoided by access to operative care each year.[3] In validated, cluster, randomized, cross-sectional countrywide surveys in Sierra Leone, Rwanda, and Nepal, it was estimated that a quarter of respondents had a surgically treatable condition and that a quarter of household deaths might have been avoided with access to safe operative care.[3,6] Basic procedures, such as Caesarean delivery and hernia repairs, are underprovided, and surgery remains inequitably distributed amongst the poorest populations.[2,7,8]

Until recently, global surgery has remained a relatively neglected area of public health in low-resourced settings. Increased research into infrastructure, access, cost, resources, and safety of operative and perioperative care have aided the global health community to better understand the barriers that limit surgical care in Africa. The inclusion of basic surgery in the Disease Control Priorities for Developing Countries and support from The World Health Organization (WHO) and the Lancet Commission on Global Surgery have fuelled interest, support, and collaboration on operative care for low-income countries,[9-11] but many obstacles remain to expanding surgical care in Africa, particularly in the crisis of human resources that is being addressed in large part by nonphysician providers.[12,13] Operative care in the poorest countries of Africa often goes undocumented, and it is important to disseminate and share knowledge to aid planning of future interventions and support. This knowledge is particularly relevant, given the vast projections for increasing surgical burden across Africa by 2030, carried mostly by enormous increases in trauma and surgical care for noncommunicable diseases.[1]

Médecins Sans Frontières (MSF) has been providing operative care in low-resource settings since its inception in 1971. Operative care has remained a key focus for the organization, and MSF has been a strong advocate for access to basic affordable emergency medical care.[14] Recent studies have quantified the burden of surgical conditions in several areas such as trauma, burn care, pediatric care, surgery for infections, and Caesarean deliveries.[15-20] WHO recommends the provision of basic emergency surgical care for injuries and trauma and obstetric and reproductive surgical conditions; nonemergency care for hernia repairs and some congenital anomalies should be available at the district health services level.[11] Humanitarian surgical outcomes are important, because they can assist in planning future medical aid and provide knowledge of the surgical epidemiology for populations who otherwise have no or inadequate access to safe surgical care.

MSF has been present in the Democratic Republic of Congo (DRC) since 1981, in South Sudan since 1983, and in the Central African Republic (CAR) since 1996. All countries have been affected by chronic violence and political instability with resultant population displacement and collapse of national health systems. The three countries are among the lowest when ranked according to Human Development Index, and in 2013 all three countries were considered "failed states."[21,22]

A perioperative mortality rate (POMR) has been proposed as a credible indicator of access to and safety of operative and perioperative care.[23] The most common definition for POMR according to WHO is death after surgery and anesthesia within 2 time periods: the first point on the day of surgery (including death in the operating theatre) and the second point either before discharge from hospital or within 30 days of operation, whichever is sooner.[24,25] Collection of operative data can be difficult in low-resourced settings because of major limitations of the health information systems. POMR is a widely reproducible measure that does not require complex operative data. POMR can overcome some of the variations in data collection so that benchmarking and comparison can assist in improving operative safety.

To contribute to the available evidence on surgical epidemiology in 3 conflict affected countries in Africa, we described the surgical activities and POMRs in 7 MSF-supported hospitals in the DRC, CAR, and South Sudan between 2011 and 2013.

METHODS

Study sites. The 7 surgical hospitals included in this analysis were located in eastern DRC (Mweso, Kimbi, Baraka, and Shamwana), northern CAR (Boguila), and South Sudan (Leer and Nasir) (Fig).

These 7 projects were located similarly in challenging environments in sub-Saharan Africa, subject to frequent outbreaks of violence, and served a largely unknown catchment population. All operative projects were run as a part of other health care programs and were staffed largely by national surgical staff with varying levels of training, except at both sites in South Sudan and Mweso (DRC) where the surgeons were expatriates. Anesthetic providers were trained nurses. All care was provided free of charge to the patient.

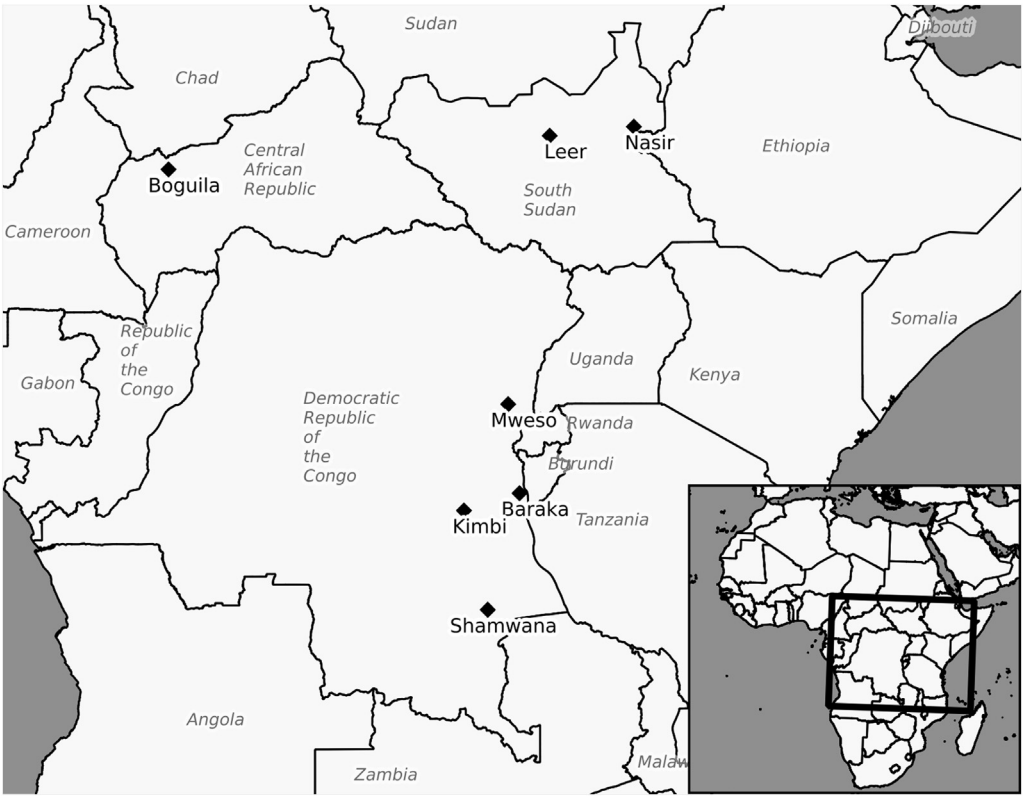

Fig. Map of Central Africa showing relative locations of 7 MSF projects in CAR, South Sudan, and DRC.

Data collection. A standardized surgical data collection tool in Excel was used to collect individual patient data on surgical inpatients admitted to MSF facilities from January 1, 2011 to December 31, 2013. The tool collects information on the sex, age, primary procedure undergone by the patient, number of procedures, duration of admission, urgency of operation, type of anesthetic, type of exit from hospital and any resulting complications. If a patient undergoes more than one operation during their hospital stay, the first and main procedure is recorded and information on the additional operations is not recorded in the database systematically. The attending surgeon recorded data postoperatively or after exit (discharge, death, default) of the patient.

Definitions. Data were collected according to MSF-Amsterdam surgical definitions. A surgical inpatient was anyone who underwent an operation (including obstetric) or who was managed by the surgical team. A child was considered to be anyone younger than 15 years of age. Major operations were defined as any intervention requiring general or spinal anesthesia regardless of complexity. The number of major operations was counted by the number of episodes of anesthesia that a patient underwent. A minor procedure was any procedure not under general or spinal anesthesia. Each project independently defined specific surgery types as "options," which were grouped under the title of "project specific options" and usually included nonoperative management of trauma, burns, wounds, abscess drainage, and head injuries. Defaulting patients were those who left hospital but were not discharged. Violence-related injuries were only those considered resulting from intentional violence. Surgery (operative intervention) was categorized into emergency surgery (immediately life-threatening), surgery of infection and neglect (imperative but not urgent), and elective surgery. Elective surgery could include procedures that followed an initial emergency such as skin grafting for burns, because this would be recorded as the first operation during a subsequent admission.

Data analysis. Data on surgical inpatients were collated in July 2014 and distinguished by hospital site and year. Frequencies and proportions were used to describe patient demographics. Non-normally distributed variables such as age were described with medians, and interquartile ranges (IQRs) and nonparametric tests for differences

between groups. Tests for differences in proportions were performed using chi-square or Fisher exact tests. The inpatient POMR was calculated by dividing the number of deaths occurring in patients who had undergone a major operation by the number of patients undergoing at least one major operation during the same period (ie, admissions in that period). We calculated 2 POMRs: within 2 days after admission (POMR2) and up to 30 days after admission (POMR30). If a patient underwent more than 1 major operation, the subsequent operations did not contribute to the POMR; this was because our data set did not contain detailed operative data on subsequent operations during each admission. We calculated the crude POMR2 and POMR30 and specific rates by age group, sex, country of intervention, and type of operation stratified by sex (as the type of procedures varied between males and females).

Unadjusted risk ratios (with respective 95% confidence intervals [95%CI] and p values) were calculated using poisson regression to determine risk factors for POMR2 and POMR3. We also constructed 2 logistic multivariate regression models to understand the risk of death within 2 time periods: 1) 2 days after admission (as the bulk of reported perioperative mortality was in this time period), and 2) between 2 and 30 days after admission. In these models, we calculated strength of association between age group, urgency of intervention, violence-related injury, and primary operation and death by calculating adjusted odds ratios (ORs), their respective 95% CI, and *P* values. For these multivariate logistic regression models, we only included operative procedures that were common to male and female inpatients (orthopedic operation, laparotomy, hernia repair, and other operative interventions). Analysis was performed using STATA (version 13.1, College Station, TX).

Ethical approval. This study was exempted from MSF Ethical Review Board revision, because it pertains to a retrospective review of anonymous data collected for routine medical activity monitoring. Ethical approval was granted from the Ethics Committee of the London School of Hygiene and Tropical Medicine Masters Project.

RESULTS

Over 3 years from January 2011 to December 2013, a total of 14,482 patients were admitted to MSF-supported facilities in DRC, CAR, and South Sudan as surgical inpatients. Of these, 9 patient files were excluded because of the absence of any usable data. From 2011 to 2013, the number of surgical inpatients increased overall from 4,134 patients to 4,920 in 2012 and 5,428 in 2013. The projects in DRC represented the majority of surgical activities during this time (70.5% of total). For completeness, 48 patients who were admitted before January 2011 but were discharged during 2011 remained in the data set. For 10,570 (72.9%) inpatients, we had complete data referring to details of surgical interventions undergone, anesthesia received, minor/major procedures, whether the intervention was an emergency, whether the injury was violence-related, and the outcomes of the patient.

General description. Between 2011 and 2013, more women (57.5%) than men were admitted to the surgical projects described. In South Sudan, however, 37% of surgical inpatients were women. The adult median age was 28 years (IQR 21–37) and 5 years for children (IQR 2–10). Children composed 17.8% of the total cohort, but this proportion varied according to site. Both South Sudan projects admitted more children (25.7% Nasir, 33.2% Leer) than other projects ($P = .001$). For whom the information was available ($n = 13{,}663$), 11.8% of the reason for admission was related to violence; however, the proportion of violence-related admissions varied between sites ($P < .001$); 27.9% of all surgical admissions were violence-related in South Sudan compared with 7.0% in DRC and 3.4% in CAR (Table I). More men ($n = 1{,}302$) were admitted with violence-related injuries compared with women ($n = 311$, $P < .001$) (Table I). Overall, 74.1% of all operative admissions were emergencies, 9.2% were for imperative but not immediately life-threatening indications, and 16.7% were elective.

Operative procedures and outcomes. At least 1 major operation was performed on 63.5% ($n = 9{,}203$) of surgical inpatients (Table I). A further 8% ($n = 1{,}147$) had at least 1 minor procedure, and 26% ($n = 3{,}768$) had no procedure but were treated as a surgical inpatient. The most commonly performed surgery was a Caesarean delivery ($n = 4{,}646$, 32.4%) (Table II). Caesarean deliveries represented more than half of all operative procedures performed at Baraka (56%), Kimbi (55%), and Mweso (52%) (DRC). "Other surgical procedures" represented the second most common procedure and included soft-tissue injuries, debridement, and nonabdominal trauma. The majority (85.1%) of operative procedures were conducted as emergency interventions. The majority (53.4%) of all orthopedic procedures were related to violence, as was a large proportion of

Table I. Surgical inpatient admissions to MSF facilities, 2011–2013

	DRC				*CAR*	*South Sudan*	
	Baraka (N = *3,450*)	*Kimbi* (N = *1,401*)	*Shamwana* (N = *598*)	*Mweso* (N = *4,759*)	*Boguila* (N = *715*)	*Nasir* (N = *1,767*)	*Leer* (N = *1,792*)
Patient characteristics	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Female	2,484 (72)	841 (60)	371 (62)	2,903 (61)	408 (57)	618 (35)	699 (39)
<15 y	483 (14)	196 (14)	42 (7)	714 (15)	72 (10)	495 (28)	591 (33)
Violence-related	104 (3)	84 (6)	24 (4)	476 (10)	21 (3)	530 (30)	448 (25)
At least 1 major operation	2,171 (63)	668 (48)	525 (88)	3,328 (70)	658 (92)	1,042 (59)	811 (48)

CAR, Central African Republic; *DRC*, Democratic Republic of Congo; *MSF*, Médecins Sans Frontières.

"other surgical procedures" (24.7%). Most major procedures were conducted under general anesthesia, but the majority of hernia repairs and other gynecologic procedures were conducted under spinal anesthesia (Table II).

Overall, 13,255 (93.9%) of surgical inpatients had the type of exit from MSF facilities recorded; 294 died (2.1%), 275 defaulted (2.0%), and 290 (2.0%) were transferred to another facility. Of the 294 reported deaths, 175 (59.5%) occurred within the first 2 days after admission.

POMR in patients with major operations. In the complete cohort, 9,203 patients underwent a major operation during the study period, of which 187 died (2.03%); 181 deaths occurred within 30 days of admission to the surgical program (POMR30 = 19.67, 95% CI 17.00–22.75, per 1,000 admissions) and 101 deaths occurred within two days after admission (POMR2 = 10.97, 95%CI: 9.03–13.34, per 1,000 admissions), irrespective of operative procedure type (Tables III and IV). In 2011 the POMR was 19.10 per 1,000 admissions (95% CI 14.44–25.28), in 2012 it was 22.52 (95% CI 17.82–28.47), and in 2013 it was 17.56 (95% CI 13.69–22.53); there was little evidence of difference between years ($P = .35$).

The POMR2 and POMR30 were significantly greater in children, in male patients, in South Sudan compared with DRC, in emergency operations and in interventions for violence-related injuries (Tables III and IV). In female patients, hysterectomies were associated with a significantly greater risk of perioperative mortality compared with orthopedic interventions (RR = 15.38 and RR = 20.52 in POMR2 and POMR30, respectively). In male patients, laparotomies were associated with a significantly greater risk of perioperative mortality compared with orthopedic interventions (RR = 14.25 and RR = 16.75 in POMR2 and POMR30, respectively) (Tables III and IV).

In the adjusted risk factor analysis, being younger, having an emergency operation, having a violence-related injury, and undergoing a laparotomy remained markedly associated with death within 2 days after admission (Table V). For deaths that occurred after 2 days and up to 30 days after admission, being younger than 15 years of age and undergoing a laparotomy remained significantly associated with death, and undergoing an emergency operation showed a trend toward association with death ($P = .06$) (Table V).

DISCUSSION

Despite limited resources, more than 14,000 patients have accessed surgical care during a 3-year period across the 7 surgical projects and more than 9,200 patients underwent at least one major operation. The surgical facilities reported on here functioned within extremely challenging environments, where patients and staff also were subject to frequent security threats. Despite this, only a small proportion of all patients required operations for a problem related to violence. This finding is similar to other reports of MSF surgical activities and confirms the need for basic general and obstetric surgical services at the district hospital level.[26-29]

Collecting operative data in humanitarian emergencies is difficult for multiple reasons, some of which include the lack of consistent means of patient identification, documentation of inpatient events (particularly when disrupted by local violence), and almost no opportunity for follow-up.[30,31] Our findings along with other similar operative publications show that collection of operative data from humanitarian interventions and other low-resourced surgical projects is possible and that these findings can give a valuable insight into quality aspects of resource-poor surgical care and the attendant populations that use those services.[8,17,18,29,32-34] In these 3 African countries, there is very little information regarding local

Table II. Description of operative activities at Seven MSF facilities between 2011 and 2013, CAR, South Sudan, and DRC (N = 10,570)*

	Caesarean	*Laparotomy*	*Hernia repair*	*Orthopedic*	*Other gynecologic*	*Hysterectomy*	*Other operation*	*Project-specific options*
Total operations	4,646	1,202	929	593	120	23	3,032	25
Median age, y	23	28	40	27	28	36	24	25
Emergency operation, *n* (%)	4,613 (99.3%)	1,085 (90.3%)	525 (56.5%)	444 (74.8%)	48 (40.0%)	18 (78.3%)	1,719 (56.7%)	15 (59.6%)
Major operation, *n* (%)	4,646 (100%)	1,197 (99.6%)	891 (95.9%)	591 (99.6%)	111 (92.5%)	23 (100%)	1,959 (64.6%)	2 (7.9%)
Anesthetic type, major operation, *n* (%)								
General	3,187 (68.6%)	1,072 (89.6%)	404 (45.3%)	511 (86.4%)	30 (25.2%)	16 (69.6%)	1,575 (80.4%)	1 (50.0%)
Spinal	1,459 (31.4%)	125 (10.4%)	487 (54.7%)	80 (13.6%)	81 (74.8%)	7 (30.4%)	384 (19.6%)	1 (50.0%)
Relation to violence *n* (%)	5 (1.0%)	114 (9.5%)	6 (0.6%)	317 (53.4%)	3 (2.5%)	0 (0.0%)	745 (24.7%)	3 (13.6%)

*Incomplete data for 3,921 patients.
CAR, Central African Republic; *DRC*, Democratic Republic of Congo; *MSF*, Médecins Sans Frontières.

operative care. By sharing these surgical data, we hope to encourage other surgical providers to collect and publish operative outcomes, particularly from low-resourced settings.

There are few other reports of pediatric POMR in low-resourced settings. Operative care when disaggregated by age provides the global health community insights into ways of targeting improvements to care.[34] In our data, children aged younger than 15 years had greater POMRs compared with adults. This observed difference might be explained by variations potentially in underlying pathology, malnutrition, or more severe presentations in this age group, as well as variations in surgical skills of surgery providers. This demonstrates the need to view pediatric surgical cases as a particularly vulnerable group in surgical programs.

A high proportion of the interventions conducted in South Sudan, CAR, and DRC between 2011 and 2013 were for emergency indications. In other MSF studies of surgical mortality, emergency operations were associated with greater mortality (OR 20.1, P = .004) along with projects in conflict settings (OR 4.6, P = .001); this outcome also was reflected in our POMR calculations.[32] There was a marked risk of death for women undergoing hysterectomy and laparotomies compared with those undergoing other procedures and laparotomy. This observation has been confirmed by another MSF in a study that identified associations between operative mortality and abdominal operations (OR 3.4, P = .003) and hysterectomy (OR 12.3, P = .001).[32]

Broadly, Caesarean delivery accounts for approximately one third of all surgical activities in low-resourced settings.[29,35] In the hospitals reported on here that were less affected by violence, Caesarean delivery accounted for more than half of all operations, but this proportion was markedly less in South Sudan, where the burden of violent injuries was greater. One factor affecting our POMR was that half of all major operations were Caesarean delivery, which were almost entirely emergency operations but had a relatively low POMR. In our adjusted analysis, exclusion of female-only operatives procedures found emergency operations were associated with perioperative mortality. Support should be directed at enabling safe and low-cost emergency surgical and obstetric care to be accessible in all settings.

There are several limitations to our results. As stated previously, data collection was a challenge in these settings, reflected in the high proportion of missing data (27%) within our dataset. The

Table III. Unadjusted analysis for risk factors associated with 2-day perioperative mortality (POMR2), CAR, South Sudan, and DRC, 2011–2013

Characteristic	*Procedures*	*Deaths*	*Rate (95% CI)*	*RR (95% CI)*	P *value*
Crude rate		101	10.97 (9.03–13.34)		
Age group					
<15 yr	1,084	27	24.91 (17.08–36.32)	Ref	<.001
≥15 yr	8,119	71	9.11 (7.26–11.45)	0.37 (0.24–0.57)	
Sex					
Female	6,341	47	7.41 (5.57–9.87)	Ref	<.001
Male	2,862	54	18.87 (14.45–24.64)	2.55 (1.72–3.76)	
Country					
South Sudan	1,853	33	17.81 (12.66–25.05)	Ref	.003
DRC	6,692	58	8.67 (6.70–11.21)	0.49 (0.32–0.75)	
CAR	658	10	15.20 (8.18–28.25)	0.85 (0.42–1.73)	
Emergency operation					
No	1,400	5	3.57 (1.49–8.58)	Ref	.007
Yes	7,803	96	12.30 (10.07–15.03)	3.44 (1.40–8.46)	
Violence-related					
No	8,337	75	9.00 (7.17–11.28)	Ref	<.001
Yes	863	26	30.13 (20.51–44.25)	3.35 (2.14–5.23)	
Type of operation only in female patients					
Orthopedic	118	1	8.47 (1.19–60.16)	Ref	<.001
Laparotomy	708	23	32.49 (21.59–48.89)	3.83 (0.52–28.38)	
Caesarean delivery	4,549	15	3.30 (1.99–5.47)	0.39 (0.05–2.95)	
Hysterectomy	23	3	130.43 (42.07–404.42)	15.38 (1.60–147.87)	
Other	695	5	7.19 (3.00–17.28)	0.85 (0.10–7.27)	
Type of operation only in male patients					
Orthopedic	354	2	5.65 (1.41–22.59)	Ref	<.001
Laparotomy	472	38	80.51 (58.58–1.10E+02)	14.25 (3.44–59.08)	
Hernia repair	739	2	2.71 (0.68–10.82)	0.48 (0.07–3.40)	
Other	1,293	12	9.28 (5.27–16.34)	1.64 (0.37–7.34)	

CAR, Central African Republic; *CI*, confidence interval; *DRC*, Democratic Republic of Congo; *RR*, risk ratio.

missing data may have underestimated overall POMRs and, therefore, led to a bias of the unadjusted and adjusted estimates of risk. Also, these calculated POMRs may be context-specific and, thus, cannot be extrapolated outside MSF-run and MSF-supported low-resourced surgical settings in these countries. As the surgical care provided in MSF hospitals is free to the end user, this approach might generate augmented epidemiology because financial barriers to surgical access may be overcome. End-user cost is a major determinant of accessing surgical care in low and middle income countries.[36]

The POMR reported here only includes the first operation that the patient underwent during each admission. Therefore, patients could be "counted" twice if they returned after an emergency operation for an elective procedure and could distort potentially the surgical demographics; however, this possibility was a small number of patients (2%, data not shown) and is unlikely to change the POMR significantly.

The majority of deaths occurred within 48 hours after admission, which reflects the emergent, life-threatening injuries and pathology addressed by these facilities. Deaths within 30 days that occurred outside of hospital either after discharge or in "defaulters" who left hospital before discharge were unknown and could have contributed to an underestimate of our POMRs.

An unexpected finding in our operative epidemiology was the greater rates of children and men in South Sudan compared with DRC and CAR hospitals. A greater proportion of women were admitted to the hospitals that performed the greatest number of Caesarean delivery. This observation may be because of cultural differences among women, particularly in relation to attitudes toward childbirth in hospital. Other factors to explain this include greater levels of violence that limited hospital access; however, this does not explain the greater proportion of children seen in South Sudan. Categorizing a complex process such as an operation into only 8 types of operation

Table IV. Unadjusted analysis for risk factors associated with 30-day perioperative mortality (POMR30), CAR, South Sudan, and DRC, 2011–2013

Characteristic	*Procedures*	*Deaths*	*Rate (95% CI)*	*RR (95% CI)*	P *value*
Crude rate		181	19.67 (17.00–22.75)		
Age group					
<15 yr	1,084	52	47.97 (36.55–62.95)	Ref	.001
≥15 yr	8,119	129	15.89 (13.37–18.88)	0.33 (0.24–0.46)	
Sex					
Female	6,341	84	13.25 (10.70–16.40)	Ref	<.001
Male	2,862	97	33.89 (27.78–41.36)	2.56 (1.91–3.43)	
Country					
South Sudan	1,853	49	26.44 (19.99–34.99)	Ref	.03
DRC	6,692	116	17.33 (14.45–20.79)	0.66 (0.47–0.92)	
CAR	658	16	24.32 (14.90–39.69)	0.92 (0.52–1.62)	
Emergency operation					
No	1,400	12	8.57 (4.87–15.09)	Ref	.001
Yes	7,803	169	21.66 (18.63–25.18)	2.53 (4.87–15.09)	
Violence-related					
No	8,337	147	17.63 (15.00–20.73)	Ref	.001
Yes	863	34	39.40 (28.15–55.14)	2.23 (1.54–3.24)	
Type of operation only in female patients					
Orthopedic	118	1	8.47 (1.19–60.16)	Ref	.001
Laparotomy	708	43	60.73 (45.04–81.89)	7.16 (0.99–51.97)	
Caesarean section	4,549	24	5.28 (3.54–7.87)	0.62 (0.08–4.60)	
Hysterectomy	23	4	173.91 (65.27–463.38)	20.52 (2.30–183.49)	
Other	695	12	17.27 (9.81–30.40)	2.04 (0.27–15.65)	
Type of operation only in male patients					
Orthopedic	354	3	8.47 (2.73–26.28)	Ref	.001
Laparotomy	472	67	141.95 (111.72–180.35)	16.75 (5.27–53.25)	
Hernia repair	739	4	5.41 (2.03–14.42)	0.64 (0.14–2.85)	
Other	1,293	23	17.79 (11.82–26.77)	2.10 (0.63–6.99)	

CAR, Central African Republic; *CI*, confidence interval; *DRC*, Democratic Republic of Congo; *RR*, risk ratio.

Table V. Adjusted analysis of risk factors for death within 2 days of admission and between 2 and 30 days after admission, CAR, South Sudan, and DRC, 2011–2013

		Death within first 2 d of admission			*Death between 2 and 30 d after admission*		
Characteristic	*Procedures*	*Deaths*	*OR (95% CI)*	P *value*	*Deaths*	*OR (95% CI)*	P *value*
Age group							
<15 y	1,084	27	Ref		25	Ref	
≥15 y	8,119	74	0.39 (0.24–0.64)	<.001	55	0.40 (0.24–0.67)	.001
Emergency operation							
No	1,400	5	Ref		7	Ref	
Yes	7,803	96	2.76 (1.08–7.03)	.03	73	2.17 (0.96–4.93)	.06
Violence-related							
No	8,337	75	Ref		72	Ref	
Yes	863	26	3.50 (2.07–5.91)	<.001	8	0.91 (0.42–1.98)	.81
Type of operation							
Orthopedic	472	3	Ref		1	Ref	
Laparotomy	1,180	61	15.62 (4.67–52.23)		49	20.40 (2.72–152.90)	
Hernia repair	884	2	1.02 (0.16–6.42)	<.001	2	1.24 (0.11–14.19)	<.001
Other	1,988	17	1.92 (0.55–6.66)		18	4.01 (0.53–30.52)	

CAR, Central African Republic; *CI*, confidence interval; *DRC*, Democratic Republic of Congo; *OR*, odds ratio.

naturally requires a compromise in the specificity of each type. Categories of operative procedures require a broad group, such as "other surgical procedures" to encompass a range of procedures that "specialty" surgery categories do not. In contrast, the *International Classification of Diseases*,

Revision 10, includes more than 71,000 procedure codes.[37] Agreed-on surgical definitions for understanding low-resourced surgical care are needed urgently but disputed widely.[38] Still, our methods of data collection can provide more complex information about operative care and patients compared with surgical facilities that aggregate patient data over time intervals. It should be noted that as a result of this analysis, MSF-Operational Centre Amsterdam has reviewed its methods of collection of surgical data.

In conclusion, we support the use of a simple POMR for surgical humanitarian projects and other surgical services in low-resourced settings which delineates death within 48 hours of operation and within 1 month of operating or inpatient admission, whichever is first. The POMR provides a starting point for bench marking of surgical indicators that can help to target areas for improvement.[39] When comparing the quality of care of projects, specific factors influencing mortality, such as violence and epidemics, need to be taken into account for adjustment to local risks. Increased investment by governments and global health agencies in affordable emergency surgical care is necessary, particularly as the cost-effectiveness of basic surgical care continues to be proven and understood by the global health community.[39,40,41]

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