University of Groningen

Maternal death reviews at a rural hospital in Malawi

Vink, Naomi M.; de Jonge, Hendrik C. C.; Ter Haar, Reynier; Chizimba, Ellen M.; Stekelenburg, Jelle

Published in:
International journal of gynecology & obstetrics

DOI:
[10.1016/j.ijgo.2012.07.028](https://doi.org/10.1016/j.ijgo.2012.07.028)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2013

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Vink, N. M., de Jonge, H. C. C., Ter Haar, R., Chizimba, E. M., & Stekelenburg, J. (2013). Maternal death reviews at a rural hospital in Malawi. *International journal of gynecology & obstetrics*, 120(1), 74-77. <https://doi.org/10.1016/j.ijgo.2012.07.028>

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

CLINICAL ARTICLE

Maternal death reviews at a rural hospital in Malawi

Naomi M. Vink ^{a,*}, Hendrik C.C. de Jonge ^b, Reynier Ter Haar ^c, Ellen M. Chizimba ^c, Jelle Stekelenburg ^d^a Department of Gynecology and Obstetrics, Maasstad Ziekenhuis, Rotterdam, Netherlands^b Public Health Department, Erasmus Medisch Centrum, Rotterdam, Netherlands^c Nkhoma Church of Central Africa Presbyterian Hospital, Nkhoma, Malawi^d Department of Gynecology and Obstetrics, Medisch Centrum Leeuwarden, Leeuwarden, Netherlands

ARTICLE INFO

Article history:

Received 6 February 2012

Received in revised form 16 July 2012

Accepted 9 October 2012

Keywords:

Maternal death

Meningitis

Pregnancy

Three-delays model

ABSTRACT

Objective: To analyze maternal deaths at Nkhoma Church of Central Africa Presbyterian (CCAP) Hospital and identify factors causing delays in care. **Methods:** Maternal death audits are performed after every maternal death at Nkhoma CCAP Hospital. Information regarding the care provided at the health facility, the referral process, and any delays in the community was collected by an audit team using a structured approach. Data from August 2007 to September 2011 were analyzed retrospectively. **Results:** In total, 61 maternal deaths occurred during the study period, of which 58 were analyzed. Most deaths were categorized as indirect ($n = 34$ [58.6%]). Non-pregnancy-related infections were the leading cause of indirect death ($n = 22$), with meningitis the most common ($n = 13$). Most patients experienced a delay in seeking care ($n = 37$ [63.8%]), a transport delay ($n = 43$ [74.1%]), or a delay in receiving adequate care ($n = 34$ [58.6%]). **Conclusion:** Most maternal deaths had indirect causes and were associated with delays in all phases. An audit makes clear which part of the referral chain needs to be strengthened. Nkhoma CCAP Hospital has taken steps to address all phases of delay.

© 2012 International Federation of Gynecology and Obstetrics. Published by Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Millennium Development Goal 5 is to reduce by three-quarters the maternal mortality ratio (MMR) by 2015. The incidence of maternal mortality is highest in low-income countries [1]. In 2008, an analysis of MMR was carried out in 181 countries; it showed that Malawi had an MMR of 1140 per 100 000 live births, which was one of the highest in the world [2]. However, in the same year, WHO reported an MMR of 510 per 100 000 live births in Malawi [3].

The 4 major causes of maternal death in low-income countries are postpartum hemorrhage, sepsis, hypertensive disorders, and complications of abortion [4]. In a 2009 study in central Malawi, Kongnyuy et al. [5] identified postpartum hemorrhage (25.6%), postpartum sepsis (16.3%), and HIV/AIDS (16.3%) as major causes of maternal death.

Causes of maternal death can be divided into direct and indirect etiologies. Direct causes are those that result from obstetric complications (pregnancy, labor, and the puerperium); interventions; omissions or incorrect treatment; or a sequence of events caused by any of the above. Indirect obstetric deaths are those that result from a pre-existing disease or one that develops during pregnancy; such diseases do not have direct obstetric causes but they are made worse by pregnancy [6]. Kongnyuy et al. [5] observed that 65% of maternal

deaths in Malawi were attributable to direct obstetric causes, with 35% attributable to indirect causes [5].

Another method for understanding a maternal death is the 3-delays model, in which 3 phases of delay can be distinguished: delay in the decision to seek care (phase 1 delay); delay in arrival at a health facility (phase 2 delay); and delay in the provision of adequate care (phase 3 delay) [7].

Analyzing the causes of maternal death can help health policy makers to adjust programs and interventions and can help clinicians to improve the quality of care within health institutions [1]. A maternal death review is an in-depth qualitative investigation of the causes of and circumstances surrounding maternal deaths at a health facility [8].

The aim of the present study was to determine the causes of the maternal deaths at Nkhoma Church of Central Africa Presbyterian (CCAP) Hospital, Malawi, between August 2007 and September 2011 and to identify factors causing delay, in order to formulate recommendations to reduce maternal morbidity and mortality.

2. Materials and methods

Nkhoma CCAP Hospital is a district hospital with a catchment area of 60 000 people and a capacity of 220 beds. It provides reproductive health services, including family-planning services, prenatal clinic, and comprehensive emergency obstetric care services [9]. Approximately 200 deliveries take place per month at the study hospital, of which 16% are cesarean deliveries. Most patients are seen 3 times prenatally, starting in their second trimester. An HIV test is performed

* Corresponding author at: Maasstadziekenhuis, Postbus 9100, 3007 AC Rotterdam, Netherlands.

E-mail address: naomivink@gmail.com (N.M. Vink).

at the first visit, and hemoglobin and malaria smears are carried out on clinical suspicion of anemia or malaria, respectively. All patients routinely receive intermittent preventive therapy for malaria (sulfadoxine/pyrimethamine) during pregnancy and/or treatment if malaria has been diagnosed. Approximately 5% of the prenatal population is HIV positive. HIV-positive patients receive a daily dose of co-trimoxazole to prevent infections and malaria; intermittent preventive therapy is not needed in these patients. The incidence of sickle-cell disease in Malawi is very low.

Nkhoma CCAP Hospital has a blood transfusion service; blood for transfusion is collected from volunteers or provided by the Malawian Blood Transfusion Services. Blood stocks regularly run out.

When there is clinical suspicion of meningitis, cerebrospinal fluid (CSF) can be analyzed in the laboratory. White and red blood cells are counted via microscopy, and there are resources for Gram staining, Ziehl–Neelsen staining for tuberculosis, and India ink staining for cryptococcal infection. Cultures and assessments of CSF glucose or protein are not available.

Ten health centers around Nkhoma refer their patients to Nkhoma CCAP Hospital. These health centers provide basic emergency obstetric care services [9]. The number of deliveries at the health centers ranges from 20 to 150 per month. Transport for referring patients is a problem for most health centers; 5 have their own (motorcycle) ambulances but maintenance and fuel shortages limit availability. Nkhoma CCAP Hospital has 2 ambulances; when an ambulance is needed, the caregiver at the relevant health center must contact the hospital via their mobile phone. Three health centers are connected to Nkhoma by tarmac road; 7 are connected by dirt roads, which are difficult to pass during the rainy season.

In the past, women were encouraged to give birth in their villages, attended by traditional birth attendants (TBAs)—who have extensive experience assisting deliveries, but no training or instruments. For that reason, a government policy (which is still ongoing) to discourage attendance at birth by TBAs was implemented in 2008. In 2010, the percentage of deliveries conducted by TBAs in Malawi was 14% [10].

In Malawi, all maternal deaths must be reported to the District Health Officer. Every maternal death at Nkhoma CCAP Hospital is reviewed by a team of clinical and nursing staff. The audit team collects information about the care provided at the facility and visits the family to obtain information regarding the referral process and any delays in the community. Subsequently, the case is presented to all clinical and nursing staff for discussion during a morning report. A specific “maternal death review form,” which contains details regarding the causes of and the factors contributing to the death, together with a summary of the visit to the family, is sent to the District Health Officer.

For the present study, all maternal death review forms from August 1, 2007, to August 31, 2011, were analyzed retrospectively (by N.M.V.). The phases of delay were recorded; if a patient was referred prenatally or postnatally by a TBA, the case was labeled as having a phase 1 delay. Causes of deaths were grouped into direct and indirect categories (by N.M.V.). Ambiguous cases were discussed among the authors before a final decision was taken.

3. Results

In total, 61 maternal deaths occurred and were reviewed. Three cases were excluded: 2 involving women who died in their village before seeking any type of health care; and 1 for which all notes were lost before analysis. Thus, 58 cases were analyzed.

The mean age of the women was 28 years (range, 14–43 years) (Table 1). Median parity was 3, with a maximum of 9 deliveries. Three patients died in the first trimester of pregnancy, 16 in the second trimester, and 39 in the third trimester. In total, 34 deaths occurred in the postpartum period, 4 were intrapartum, 17 were prenatal, and 3 were associated with complications of abortion or molar pregnancy.

Table 1
Characteristics of the maternal deaths (n = 58).

Characteristic	No. (%)
Age, y	
<20	5 (8.6)
20–29	20 (34.5)
30–39	25 (43.1)
>40	3 (5.2)
Unknown	5 (8.6)
Parity	
1	6 (10.3)
2–4	33 (56.9)
>5	16 (27.6)
Missing data	3 (5.2)
Gestational age, wk	
1–14	3 (5.2)
15–28	16 (27.6)
29–42	39 (67.2)
Condition on admission	
Stable	20 (34.5)
Critically ill	33 (56.9)
Death on arrival	5 (8.6)
Referral status	
Not referred	27 (46.6)
Referred from a health center	27 (46.6)
Referred from a traditional birth attendant	3 (5.2)
Referred from other	1 (1.7)
HIV status	
Positive	12 (20.7)
Negative	28 (48.3)
Missing	18 (31.0)
Condition at time of death	
Prenatal	17 (29.3)
Intrapartum	4 (6.9)
Postpartum	34 (58.6)
Complications of abortions and molar pregnancies (<24 weeks pregnant)	3 (5.2)
Interval between initiation of care seeking and death, h	
≤24	24 (41.4)
25–48	10 (17.2)
49–120	6 (10.3)
≥120	18 (31.0)

Thirty-three patients were admitted to the hospital while critically ill; 20 were admitted in stable condition; and 5 died before arrival at the hospital. For the 53 admitted patients, the median length of hospital stay was 2 days. Twenty-four patients died within the first 24 hours after seeking care (at a health center or at the hospital). Twenty-seven women were not referred, and 27 were referred from one of the health centers. Twelve women were HIV positive, and 18 patients did not undergo an HIV test owing to stock problems with the test kits in 2007 and 2008.

Indirect causes of maternal death were found in 34 (58.6%) cases (Table 2). The most common indirect cause was non-pregnancy-related infection (n = 22). In these 22 cases, 13 deaths were due to meningitis; 3 were due to pneumonia; 2 were due to AIDS; 2 were due to sepsis (1 probable case of pneumonia and 1 case of malaria); and 2 involved patients who presented with fever, neck stiffness, headache, or convulsions and who died before lumbar puncture was performed (classified as unconfirmed meningitis or cerebral malaria). Other causes of indirect death were severe anemia (n = 7) and pre-existing disease (n = 5), including cirrhosis and cardiac disease. Of the 12 HIV-positive women, 10 were classified as belonging to the non-pregnancy-related infection group.

There were direct causes of maternal death in 23 (39.7%) patients. There were 5 cases of postpartum hemorrhage; 4 cases of hypertensive disorders (including eclampsia and HELLP syndrome); 1 case of postpartum sepsis; 4 cases of uterine rupture (2 involving a previous scar, 1 involving obstructed labor in a primigravida, and 1 involving a grand multipara); 2 cases involving complications of abortion; 2 cases

Table 2
Causes of maternal death (n = 58).

Primary cause of death	No. (%)	No. HIV positive (n = 12)
Indirect obstetric deaths	34 (58.6)	12
Non-pregnancy-related infections	22 (34.4)	10
Meningitis	13 (22.4)	5
Pneumonia	3 (5.2)	2
AIDS	2 (3.4)	2
Unconfirmed meningitis or cerebral malaria	2 (3.4)	1
General sepsis	2 (3.4)	0
Anemia	7 (12.1)	1
Pre-existing disease	5 (8.6)	1
Cardiac disease	1 (1.7)	0
Direct obstetric deaths	23 (39.7)	0
Postpartum hemorrhage	5 (8.6)	0
Hypertensive disorder	4 (6.9)	0
Uterine rupture	4 (6.9)	0
Anemia	3 (5.2)	0
Complications of abortion or molar pregnancy	3 (5.2)	0
Complications of anesthesia	2 (3.4)	0
Postpartum sepsis	1 (1.7)	0
Pulmonary embolism	1 (1.7)	0
Unclassified	1 (1.7)	0

involving complications of anesthesia; 1 case of pulmonary embolism; and 1 case involving molar pregnancy.

Severe anemia was classified as a hemoglobin level below 7 g/dL. Seven patients had a long history of anemia, or anemia in early pregnancy; their deaths were categorized as indirect. Three patients had severe anemia and complications during or shortly after labor;

their deaths were categorized as direct. Five of the 10 patients with anemia had a hemoglobin level below 4 g/dL, even after several blood transfusions. All patients received intermittent preventive therapy for malaria during pregnancy and/or malaria treatment during admission.

There was 1 postpartum death after history taking at the outpatient department, before a physical examination was carried out. In this case, it was unclear whether the death was indirect or direct.

In 4 of the 13 confirmed meningitis cases, specific bacteria could be detected in the CSF on Gram staining. In 7 cases, only elevated white blood cells were found, leading to a diagnosis of bacterial meningitis. Cryptococcal meningitis and tuberculous meningitis were likely in 2 cases based on clinical criteria, with normal results on CSF examination. One patient with a diagnosis of bacterial meningitis also had malaria (3+ malaria smear), which might have contributed to her death. Patient characteristics and laboratory results, including HIV status, of these 13 patients are provided in Table 3.

Delays in seeking care occurred in 37 (63.8%) cases; in 10 of these cases, the women visited a TBA before attending a health center or the hospital. Transport delays occurred in 43 (74.1%) cases; the longest phase 2 delay was almost 10 hours. Delays in the provision of adequate care occurred in 34 (58.6%) cases; in 21 of these cases, health worker factors were the leading contributors to death. The major health worker factors were incomplete initial assessment (n = 8) and incomplete treatment (n = 4). In 6 of the 8 patients with an incomplete initial assessment, a differential diagnosis of meningitis was not made when the patient attended the health facility. In these cases, lumbar puncture was performed many hours after presentation. In 13 of the cases involving a phase 3 delay, logistical factors—the most important of which were lack of blood (n = 5)

Table 3
Patient characteristics and laboratory results for meningitis cases (n = 13).

Case No.	Gestational age, wk	Outcome of infant	Clinical features	Malaria smear ^a	HIV status	Lumbar puncture results	Conclusion
1	37	Alive	Convulsions, headache	1+	Positive	Cloudy GS: diplococci	Meningococcal or pneumococcal meningitis
2	18	IUD	Headache, neck stiffness, fever	1+	Unknown	Cloudy GS: Gram-positive diplococci	Pneumococcal meningitis
3	30	NND	Convulsions, confusion	1+	Positive	Normal	Cryptococcal or bacterial meningitis
4	28	Alive	Severe headache (reduced after lumbar puncture), fever	Unknown	Unknown	Normal	Cryptococcal meningitis likely
5	40	NND	Long period of confusion, fever	Unknown	Positive	Straw-like color Results lost	Tuberculous meningitis likely
6	24	IUD	Convulsions	1+	Negative	High pressure of CSF WBC: very high	Bacterial meningitis
7	34	Fresh SB	Neck stiffness, fever	Negative	Negative	Cloudy WBC: 18 000 per mm ³ ; 85% neutrophils, 15% lymphocytes	Bacterial meningitis
8	20	IUD	Neck stiffness, fever	Unknown	Negative	Cloudy WBC: 80 000 per mm ³ ; 80% neutrophils, 20% lymphocytes India ink and ZN negative	Bacterial meningitis
9	38	Alive	Neck stiffness	1+	Positive	Cloudy Results lost	Bacterial meningitis
10	22	IUD	Headache, neck stiffness, fever	1+	Negative	Cloudy WBC: 12 000 per mm ³ ; 80% neutrophils, 20% lymphocytes	Bacterial meningitis
11	34	IUD	Convulsions, fever, neck stiffness, unconsciousness	3+	Negative	Cloudy WBC: 8000 per mm ³ ; 90% neutrophils India ink and ZN negative	Bacterial meningitis
12	28	IUD	Headache	Unknown	Negative	Cloudy WBC: > 1000 per mm ³ India ink and ZN negative GS: diplococci	Meningococcal or pneumococcal meningitis
13	16	IUD	Headache	Negative	Positive	Cloudy WBC: 10 000 per mm ³ ; 90% neutrophils, 10% lymphocytes GS: Gram-negative diplococci	Meningococcal meningitis

Abbreviations: CSF, cerebrospinal fluid; GA, gestational age; GS, Gram stain; IUD, intrauterine death; LP, lumbar puncture; NND, neonatal death; SB, stillbirth; ZN, Ziehl–Neelsen stain.

^a 1+ signifies 1–10 parasites per 100 thick-film fields; 3+ signifies 1–10 parasites per single thick-film field [20].

and lack of laboratory facilities ($n = 4$)—were the leading contributors to death.

4. Discussion

There were direct causes of maternal death in 39.7% of the cases analyzed, which is low compared with the rates observed in other studies [4,5]. A possible explanation for this lower frequency is the introduction at the study hospital of a postpartum sepsis protocol, a postpartum hemorrhage protocol, and several Advanced Life Support in Obstetrics trainings for clinical and nursing staff from 2008 to 2010. As other studies have shown [1,11], it is possible to reduce the number of direct deaths by providing more training and guidelines. It should be noted that, in the context of high rates of staff turnover in Malawi, this is a significant challenge [12].

The percentage of HIV-positive women among the cases analyzed is much higher than in the prenatal population (20.7% versus 5%). In HIV-endemic areas, non-pregnancy-related infections are an important cause of maternal death [13]. Of the 12 HIV-positive patients in the present study, 10 died of non-pregnancy-related infections. Most did not begin antiretroviral treatment or started it a few weeks before they died. In 2009–2010, the national protocol in Malawi was to start antiretroviral treatment for HIV-positive pregnant women at week 28 of pregnancy for prevention of mother-to-child transmission (PMTCT). However, to prevent decreased immunity of the mother during pregnancy, it may be better to start such treatment earlier, even before pregnancy. The PMTCT protocol in Malawi has recently changed; pregnant women can now begin antiretroviral treatment as soon as they are found to be HIV positive [14].

We are aware of the fact that anemia is not a diagnosis in itself; there is always an underlying condition that causes anemia. However, to enable causes of death to be divided into underlying, immediate, and contributing factors, patients would need to attend the hospital at the beginning of their illness. In low-income countries, patients often present late and in critical condition, when it is difficult to elucidate the underlying and contributing factors of mortality. More diagnostic facilities are also needed. To investigate the underlying cause of anemia in the present study, only a thick blood smear for malaria and, occasionally, microscopy (depending on the laboratory staff) could be performed to differentiate among microcytic, normocytic, and macrocytic anemia. Nutritional deficiencies could not be tested for, and bone marrow biopsies could not be performed. Therefore, it was decided that anemia would be used as a cause of death, which is consistent with the practices of WHO and other authorities [4,5].

Bacterial meningitis during pregnancy is a rare but serious condition. Adriani et al. [15] reported maternal death in 24% of pregnant women with meningitis [15]. At Nkhoma CCAP Hospital, meningitis was the cause of more than one-fifth of the maternal deaths analyzed. This is a high proportion compared with those reported in other case series from Sub-Saharan Africa; none of the 43 maternal deaths in central Malawi assessed by Kongnyuy et al. [5] was caused by meningitis. A study of 17 maternal deaths in Uganda showed that 2 were due to meningitis. Both patients were HIV positive [16]. Menéndez et al. [17] performed autopsies following 139 maternal deaths in Mozambique and found pyogenic meningitis in 7% of cases. Major diagnostic errors had been made in 40% of the deaths, with a high rate of false-negative diagnoses of infectious diseases [17,18].

The diagnosis of bacterial meningitis in the present maternal death review was made on clinical grounds: fever; headache; neck stiffness; coma; and/or convulsions, often in combination with a cloudy lumbar puncture. A positive Gram stain result was detected in only 4 of 13 patients (Table 3). Most patients had received antibiotics—either at a health center or at the hospital—before lumbar puncture, which could explain the low rate of positive Gram stains.

Maternal mortality remains a serious risk for pregnant women in Malawi and other Sub-Saharan countries [2]. Maternal death audits

are a constructive way of learning from such deaths in the context of the facility and the community [19]. The audits indicate which part of the referral chain needs to be strengthened. Nkhoma CCAP Hospital has established women's groups and bicycle ambulance committees in the communities to address phase 1 delays, and motorcycle ambulances and a radio system at health centers to address phase 2 delays. The hospital will maintain in-service training for emergency obstetric care and will continue presenting the maternal deaths to all clinical and nursing staff. A protocol for meningitis during pregnancy has also been developed. Since November 2011, pneumococcal vaccination has become standard in the Expanded Program for Immunization for children less than 1 year of age. We recommend the maternal death review as a tool to improve maternal health care in health facilities.

Conflict of interest

The authors have no conflicts of interest.

References

- [1] Cross S, Bell JS, Graham WJ. What you count is what you target: the implications of maternal death classification for tracking progress towards reducing maternal mortality in developing countries. *Bull World Health Organ* 2010;88(2):147–53.
- [2] Hogan MC, Foreman KJ, Naghavi M, Ahn SY, Wang M, Makela SM, et al. Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards Millennium Development Goal 5. *Lancet* 2010;375(9726):1609–23.
- [3] World Health Organization, UNICEF, UNFPA, World Bank. Trends in Maternal Mortality: 1990 to 2008. http://whqlibdoc.who.int/publications/2010/9789241500265_eng.pdf. Published 2010.
- [4] Khan KS, Wojdyla D, Say L, Gülmezoglu AM, Van Look PF. WHO analysis of causes of maternal death: a systematic review. *Lancet* 2006;367(9516):1066–74.
- [5] Kongnyuy EJ, Mlava G, van den Broek N. Facility-based maternal death review in three districts in the central region of Malawi: an analysis of causes and characteristics of maternal deaths. *Womens Health Issues* 2009;19(1):14–20.
- [6] World Health Organization. ICD-10: International Statistical Classification of Diseases and Related Health Problems: Tenth Revision, Second Edition. http://www.who.int/classifications/icd/ICD-10_2nd_ed_volume2.pdf. Published 2004.
- [7] Thaddeus S, Maine D. Too far to walk: maternal mortality in context. *Soc Sci Med* 1994;38(8):1091–110.
- [8] World Health Organization. Beyond the Numbers: Reviewing Maternal Deaths and Complications to Make Pregnancy Safer. http://www.ino.searo.who.int/LinkFiles/Reproductive_health_Beyond_the_numbers.pdf. Published 2004.
- [9] Maine D, Bailey P, Lobis S, Fortney J. Monitoring Emergency Obstetric Care: a Handbook. http://www.unfpa.org/webdav/site/global/shared/documents/publications/2009/obstetric_monitoring.pdf. Published 2009.
- [10] National Statistical Office, Community Health Sciences Unit. Malawi Demographic and Health Survey 2010. <http://www.measuredhs.com/pubs/pdf/pr4/pr4.pdf>. Published February 2011.
- [11] Nyamtema AS, Pemba SK, Mbaruku G, Rutasha FD, van Roosmalen J. Tanzanian lessons in using non-physician clinicians to scale up comprehensive emergency obstetric care in remote and rural areas. *Hum Resour Health* 2011;9:28.
- [12] Médecins Sans Frontières. Help Wanted. Confronting the health care worker crisis to expand access to HIV/AIDS treatment: MSF experience in southern Africa. http://www.doctorswithoutborders.org/publications/reports/2007/healthcare_worker_report_05-2007.pdf. Published May 2007.
- [13] Bicego G, Boerma JT, Ronsmans C. The effect of AIDS on maternal mortality in Malawi and Zimbabwe. *AIDS* 2002;16(7):1078–81.
- [14] Ministry of Health, Malawi. Clinical Management of HIV in Children and Adults. Published 2011. <http://www.hivunitmohmw.org/uploads/Main/Malawi%20Integrated%20Guidelines%20for%20Clinical%20Management%20of%20HIV%202011%20First%20Edition.pdf>.
- [15] Adriani KS, Brouwer MC, van der Ende A, van de Beek D. Bacterial meningitis in pregnancy: report of six cases and review of the literature. *Clin Microbiol Infect* 2012;18(4):345–51.
- [16] Somigliana E, Sabino A, Schrettenbrunner C, Nkurunziza R, Okello E, Manenti F. A comprehensive and integrated project to improve reproductive health at Oyam district, northern Uganda: insights from maternal death review at the district hospital. *Arch Gynecol Obstet* 2011;283(3):645–9.
- [17] Menéndez C, Romagosa C, Ismail MR, Carrilho C, Saute F, Osman N, et al. An autopsy study of maternal mortality in Mozambique: the contribution of infectious diseases. *PLoS Med* 2008;5(2):e44.
- [18] Ordi J, Ismail MR, Carrilho C, Romagosa C, Osman N, Machungo F, et al. Clinico-pathological discrepancies in the diagnosis of causes of maternal death in sub-Saharan Africa: retrospective analysis. *PLoS Med* 2009;6(2):e1000036.
- [19] van den Akker T, van Rhenen J, Mwagomba B, Lommerse K, Vinkhumbi S, van Roosmalen J. Reduction of severe acute maternal morbidity and maternal mortality in Thyolo District, Malawi: the impact of obstetric audit. *PLoS One* 2011;6(6):e20776.
- [20] World Health Organization. Basic Malaria Microscopy: Part I. Learner's Guide. Geneva: World Health Organization; 1991.