

ORIGINAL RESEARCH ARTICLE

Components of Maternal Healthcare Delivery System Contributing to Maternal Deaths in Malawi: A Descriptive Cross-Sectional Study

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Abstract

In Malawi, it has been observed that some women are dying even when they reach a comprehensive emergency obstetric care facility where the quality is expected to be high and the maternal mortality low. The objective of this study was to describe shortcomings within the maternal healthcare delivery system that might have contributed to maternal deaths in the district of Lilongwe. Retrospectively, 14 maternal deaths that occurred between January 1, 2011 and June 30, 2011 were reviewed. Interviews were conducted with healthcare workers who provided care to the deceased women. Triangulated data from the respective medical charts and interview transcripts were analyzed using a directed approach to content analysis. Excerpts were categorized according to three main components of the maternal healthcare delivery system: skill birth attendant (SBA), enabling environment (EE) and referral system (RS). Most of the shortcomings identified were grouped under SBA. They included inadequate clinical workups and monitoring, missed and incorrect diagnoses, delayed or incorrect treatment, delayed referrals and transfers, patients not being stabilized before being referred and outright negligence. The SBA component should be investigated further. Interventions based on evidence from these investigations may have a positive impact on maternal mortality. (*Afr J Reprod Health 2014; 18[1]: 15-25*).

Keywords: maternal mortality; maternal death review; healthcare delivery system; skilled birth attendant; Malawi

Résumé

Au Malawi, il a été remarqué que certaines femmes meurent encore, même quand elles arrivent à un établissement de soins obstétricaux d'urgence complets où l'on s'attend à une qualité élevée et à une faible mortalité maternelle. L'objectif de cette étude était de décrire les lacunes dans le système de prestation de soins de santé maternelle qui aurait pu contribuer à la mortalité maternelle dans le district de Lilongwe. Rétrospectivement, 14 décès maternels survenus entre le 1er Janvier 2011 et le 30 Juin 2011 ont été examinés. Les entrevues ont été menées auprès de travailleurs de la santé qui dispensent des soins aux femmes décédées. Des données triangulées des dossiers médicaux respectifs et des transcriptions des entrevues ont été analysées à l'aide d'une approche dirigée à l'analyse de contenu. Des extraits ont été classés en fonction de trois principaux composants du système de prestation de soins de la santé maternelle: des accoucheuses compétentes (AC), un environnement favorable (EF) et le système de référence (SR). La plupart des lacunes identifiées ont été regroupées sous les CA. Ils comprenaient une croisière d'endurance et la surveillance clinique insuffisante, des diagnostics ratés ou mauvaise qualité, un traitement incorrect ou retardé, les orientations vers les spécialistes et les transferts différés, les patients n'étant pas stabilisés avant d'être orienté vers les spécialistes et la négligence pure et simple. La composante de CA devrait être examinée davantage. Les Interventions fondées sur des données de ces enquêtes peuvent avoir un impact positif sur la mortalité maternelle. (*Afr J Reprod Health 2014; 18[1]: 15-25*).

Mots-clés: mortalité maternelle, examen de la mortalité maternelle; système de prestation de soins de santé; accoucheuse qualifiée, Malawi

Introduction

Maternal mortality is a major health problem in Malawi, as the maternal mortality ratio is one of the highest in the world at 675 per 100,000 live

births¹. Since the late 1990s to date, the government of Malawi has ratified policies and strategies, and implemented several initiatives in response to the maternal mortality crisis. The 2009 National Sexual and Reproductive Rights Policy

states that all women shall have ready access to essential obstetric care, skilled attendance at childbirth, emergency obstetric care, postpartum care and effective referral and transport². The National Road Map outlines nine strategies for accelerating the reduction of maternal and neonatal mortality and morbidity, and serves as a guide for stakeholders to align with the government's efforts³. Supporting initiatives include the expansion of the Safe Motherhood Project with emphasis on increasing trainings in obstetric life-saving skills and maternal death audit sessions; human resources; infection prevention; providing information, education and communication materials; updating the nurse/midwife technicians' curricula to include basic emergency obstetric care signal functions; and upgrading hospitals, health centers and maternity units. Two new state of the art maternity facilities opened within a year of each other (the district referral hospital and the central region referral hospital in October 2009 and August 2010, respectively) in the capital city of Lilongwe. Despite these and other efforts, the maternal mortality ratio (MMR) has remained high.

Maternal deaths have been problematized as maternal healthcare delivery system failures^{4,5}, or as malfunctions, that warrant urgent remedial action. These malfunctions may be identified by juxtaposing the maternal deaths along the continuum of obstetric care. The juxtaposition serves as a critical first step to help unearth the underlying problems. It makes breakdowns and blockages within the maternal healthcare delivery system even more glaring and palpable, and helps direct efforts to areas needing further investigation.

Generally speaking, a health care system consists of organizations, people and actions whose primary intent is to promote, restore or maintain health⁶. Though it has several functions, the chief function of a health care system is service delivery⁷, which can be termed health care delivery system.

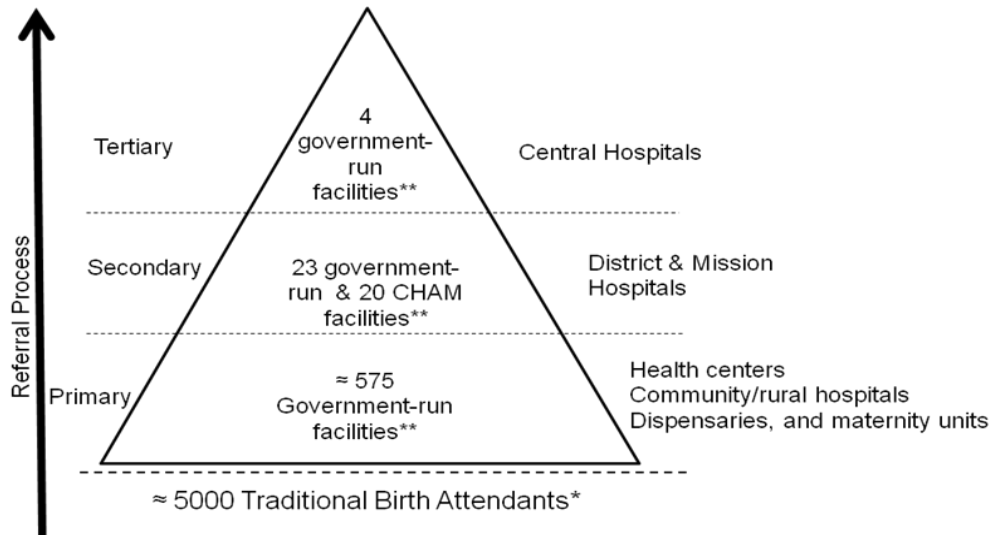
Throughout safe motherhood literature, three key components of a maternal healthcare delivery system have been emphasized repeatedly as being essential to saving lives and reducing maternal mortality: skilled birth attendants (SBA), an

enabling environment (EE) and a functioning referral system (RS)⁸⁻¹¹. SBA refers to a qualified and competent healthcare provider who provides care to a woman and her newborn during pregnancy, childbirth and immediately after birth¹². EE describes a context that provides a skilled birth attendant with the necessary backup support to perform routine deliveries to ensure that women with complications receive prompt emergency obstetric care¹³. It includes but is not limited to equipment, supplies, infrastructure, protocols, guidelines and supervision, RS indicates the desired movement from delivery care for normal labor at the primary level to basic and comprehensive emergency obstetric care for obstetric complications at the secondary and tertiary levels of care¹⁴.

In Malawi, including the district of Lilongwe, maternal healthcare is informally provided by traditional birth attendants. Formally it is provided by midwives, nurse-midwives, clinical officers, general medical doctors and gynecologists/obstetricians. The provision of healthcare occurs at three different levels (primary, secondary, and tertiary) linked by a referral system (Figure 1). Maternal healthcare is offered free of charge in government facilities. At the primary level, maternal healthcare is provided by nurse midwives. They typically manage normal deliveries, with the exception of a few facilities that conduct vacuum extraction. Most Christian Health Association of Malawi (CHAM) hospitals and district hospitals in the public sector provide emergency obstetric care (EmOC), which includes the administration of parenteral antibiotics, oxytocic drugs and anticonvulsants, as well as manual removal of the placenta, the removal of retained products, assisted vaginal delivery, surgery (cesarean sections) and blood transfusions. Facilities that provide the first six are called basic EmOC facilities, while others performing all eight signal functions are called comprehensive EmOC facilities. In the district of Lilongwe, there are five fully functioning basic EmOC facilities, compared to the recommended 19, and five fully functioning comprehensive EmOC facilities¹⁵. In a functioning district maternal healthcare delivery system, the quality of EmOC is expected to be high and maternal mortality is expected to be low¹⁶.

However, that is not always the case. This paper aims to describe some of the malfunctions related to the three key components of the maternal

healthcare delivery system that might have potentially contributed to some of the maternal deaths in the district of Lilongwe, Malawi.



*Bisika T (2008) The effectiveness of the TBA programme in reducing maternal mortality and morbidity in Malawi. *East Afr J Public Health* 5: 103-110.

** Ministry of Health (2011). Malawi: Health sector strategic plan 2011-2016. Draft III. Lilongwe, Malawi: Government of Malawi.

Figure 1. Maternal Healthcare Delivery System in Malawi

Methods

Study Design

A retrospective, cross-sectional, descriptive study design was used. Qualitative methods of content analysis and structured interviews were selected to conduct an in-depth investigation of the circumstances and events surrounding individual maternal death cases.

Study Setting

The district of Lilongwe is one of 28 districts in Malawi. It is situated in the central region of Malawi and shares its borders with Dedza, Salima, Dowa and Mchinji (Figure 2). It is divided into three localities: urban, semi urban and rural areas. Approximately 67% of the population lives in the rural and semi-urban areas and are subsistent farmers producing tobacco, maize,

ground nuts and rearing livestock. According to the 2008 population census, approximately 1.9 million persons resided in the district¹⁷. The predominant tribe is Chewa, with the matrilineal marriage system being more common. The main religions in the district are Christianity, Islam and the traditional religion known as Gulewankulu. The district of Lilongwe has one central region referral hospital, one district referral hospital, two community hospitals formally known as rural hospitals and 63 health centers. Thirty-six of the 63 health centers are government operated. The community hospitals and the health centers are under the responsibility of the Lilongwe district health officer (DHO) whilst the central region referral hospital has a different administration.

Knowing that many women with complications eventually reach a hospital, the study was based at the comprehensive EmOC district referral hospital in Lilongwe, Malawi, which serves non-paying patients and has an urban catchment area of

approximately 600,000 – 700,000 inhabitants (Table 1). In addition to providing maternal health care to its own case load, it receives referrals from 36 other health centers within the district. Complications that cannot be managed are referred to the central region referral hospital (tertiary level, Table 1). The maternity unit of the central region referral hospital primarily serves paying patients, but also receives referrals from the

mentioned district referral hospital, five CHAM hospitals within the district of Lilongwe and eight other district hospitals within the central region of Malawi. The district and central referral hospitals in Lilongwe share clinicians. On average, 15,000 babies are delivered annually, and the maternal death numbers are estimated to be one every other week, with a range between two to six per month.

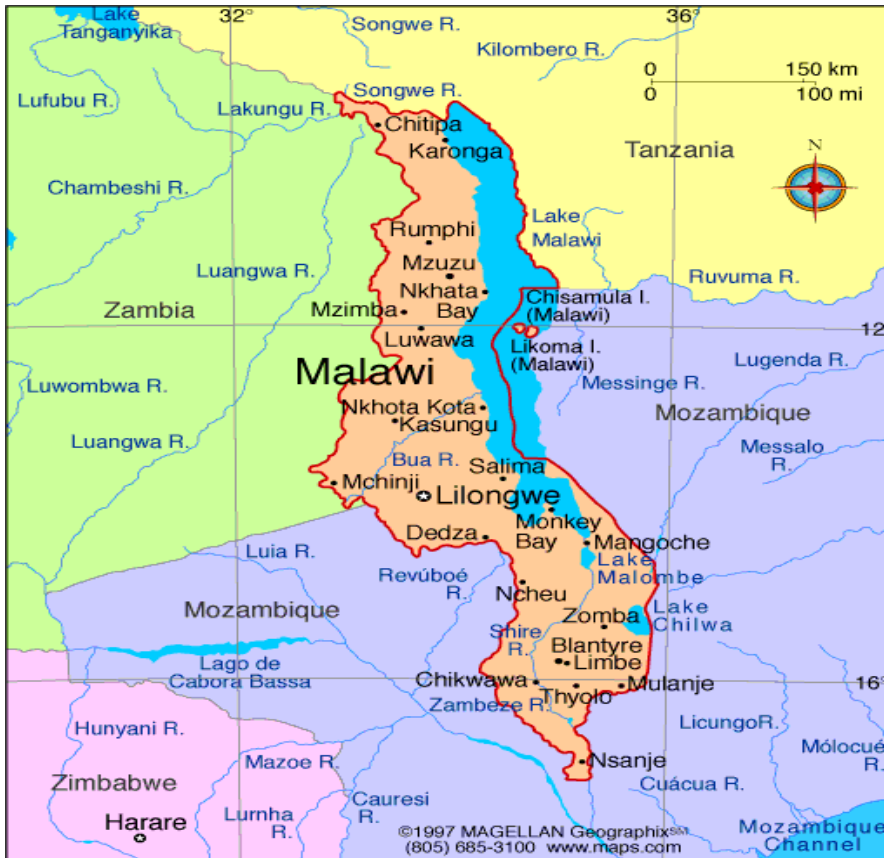


Figure 2. Map of Malawi

Study Sample

Maternal death cases that occurred between January 1, 2011 and June 30, 2011, and for whom we had access to medical charts, were included in the study. Some cases were referred to the central region referral hospital where they subsequently died. They were included in the sample to determine whether there were any deficiencies during the referral process. Maternal deaths cases that occurred prior to reaching the district referral

hospital were not included. A total of 14 maternal deaths were reviewed. Healthcare workers who provided care to the deceased patients were also included in the study (n=14). The district health officer, district nursing officer and the district safe motherhood coordinator were included as key informants. The sites were purposively selected because they were high-volume, urban comprehensive EmOC facilities; centrally located/easily accessible, and reported to have had a high institutional maternal mortality ratio (Table 1).

Table 1: Comparative characteristics of district referral and central region referral maternity units

Characteristics	District	Central
Catchment population	600,000 – 700,000	>5.5 million
Catchment area	Lilongwe District	Central Region (9 districts)
Type of hospital	Secondary	Tertiary
Bed Capacity	220	220
Ave. no. of maternal deaths per month	2	1
Ave. no. of admissions per month	1420	270
Ave. no. of deliveries per month	1117	250
Ave. no. of deliveries per day (24 hrs.)	40	9
Total no. of nurses in LW	23	12
Ave. no. of nurses per day shift	7	4
Max. no. of nurses per day shift	9	5
Max. no. of nurses per night shift	7	4
Max. no. of nurses per day shift (wkend)	7	4
Max. no. of nurses per night shift (wkend)	7	4

Sources: NSO 2011, Malawi; District Health Office, Lilongwe

Data and Data Collection Tools

A medical record extraction form and a structured facility-based questionnaire, were adapted from the WHO guidelines, *Beyond the numbers: Reviewing maternal deaths and complications to make pregnancy safer*¹⁸. A medical record extraction form was used to extract information on parity, gravidity, medical history, and antenatal visits were extracted from the medical charts of the deceased women in the study. The Facility Staff Interview Questionnaire was used to interview the healthcare workers. It included open-ended questions to document individual healthcare worker's accounts of the death in question, his/her views on the condition of the patient, the medical diagnosis, treatment, and support and barriers to providing treatment.

Data Analysis

An obstetrician/gynecologist who has worked at the study sites since 2005 reviewed all the maternal death case notes and respective facility-based transcripts. The purpose of his review was to triangulate the data, confirm the documented causes of death or to provide alternative causes where appropriate. Each case was discussed with the first author to determine what failures occurred and what could have been done differently.

To also aid in the analysis a directed approach to content analysis¹⁹ was used. This approach was

used because the three main components of the maternal healthcare delivery system and existing maternal death research helped determine the initial coding scheme and relationships between the codes which Mayring referred to as deductive category application²⁰. The transcripts were read carefully to form a general impression of what healthcare staff said about the respective maternal death cases. The transcripts were then re-read to understand the context in which the maternal deaths occurred. Based on the definitions of the three components, all text that appeared to describe any aspect of the maternal healthcare delivery system were highlighted. Through the deductive category application all highlighted text were compared and sorted according to the predetermined categories that reflected the three components of the maternal healthcare delivery system, which were SBA, EE, and RS.

The first and third author who is an obstetrician/gynecologist reviewed and discussed each case for a second time to come to a final agreement on the faulty maternal healthcare delivery system component.

Ethical Considerations

This study was carried out in compliance with the Helsinki Declaration. Ethical approval was granted by The College of Medicine Research Ethics Committee in Malawi (Proposal No. 10/08/703) and The Regional Committee for Medical and

Health Research Ethics in South-Eastern Norway (2008/16105). Furthermore, permission to conduct the study was obtained from the relevant

authorities, e.g. senior management at the two maternity units.

Findings

Table 2. Summary of Maternal Deaths and Maternal Healthcare Delivery System Malfunctions

GP	Age	Yrs of School	No. ANC visits	HIV Status	Cause of Death	Place of Death	Maternal Healthcare Delivery System Component			Comment
							SBA	EE	RS	
G1P0	27	12	UNK	-	Puerperal sepsis	Intensive care unit (ICU)	X			C/S performed, large fibroid discovered but wasn't removed, and no specialist consulted. She stayed at the hospital for 6 days and was referred 5 days post op. The patient should have been referred soon after observing the complications i.e. the same day of operation
G2P2	24	12	5	+	Peritonitis postpartum	High dependency unit (HDU)	X			Home delivery, during next day postnatal examination placental lobes were missed, returned 4 days later in severe abdominal pain
G1P2	33	12	UNK	-	Pre-eclampsia	HDU	X			Reported to have been severely anemic, with pneumonia and hypertension, but none of these problems addressed prior to being referred
G1P1	18	9	4	-	Heart failure pulmonary embolism	High-risk postnatal ward	X			Patient arrived at 7, not seen until 9:50, died at 10pm
G2P1	28	10	4	-	Intrapartum hemorrhage due to ruptured uterus	Labor ward	X	X	X	Previous scar discounted, clinician not available, poorly monitored, operating theater full, referral refused at tertiary level
G4P2	35	UNK	3	+	PPH	ICU	X			Patient not prepped/stabilized prior to referring/operation. Hb 2.2, yet not transfused
G5P5	35	UNK	UNK	UNK	Anemia	Postnatal ward	X			Referral documentation inadequate, but not a main contributor in the death
G10P9	39	UNK	UNK	UNK	Peritonitis postpartum	ICU				No problems on the district hospital's side
G3P1+1	33	UNK	UNK	+	Anemia	ICU	X			Ultrasound scanning performed and intrauterine death discovered, but didn't induce. Patient was sent home and returned 3 days later then referred
G6P5+1	37	8	6	-	PPH	Labor ward	X			Quality of the evacuation was questioned; clinician being implicated in causing death
G2P1	25	UNK	2	+	septicemia post delivery	Postnatal ward	X			Wrong drug administered, sepsis overlooked, stayed 4 days extra when condition observed wasn't improving
G4P2+1	32	UNK	2	+	lactic acidosis (HIV-related)	ICU				No problems on the district hospital's side
G3P2	23	UNK	UNK	+	Sepsis & induced abortion	Outside the gates of the referring hospital (after being	X			1 st admission only seen in outpatient department: Thorough history not taken, examination not done, not referred, given antimalarial drugs and sent home

G10P7 +2	25	0	2	-	Cardiac arrest, severe pre- eclampsia	referred) ICU	X	Was not accompanied to tertiary hospital, bled profusely at IV injection site, but this was not the main contributor for the death
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SBA= Skilled Birth Attendant, EE= Enabling Environment, RS= Referral System *Initial referral from primary health center, then to secondary level, last to tertiary level. Through chart reviews and interviews with the families, friends, TBAs and healthcare providers, we gathered demographic and clinical information, and information on facility factors that may have contributed to the respective deaths. These factors were categorized according to the appropriate maternal healthcare delivery system component.

Medical charts of 14 maternal deaths were reviewed and data extracted. Thirteen nursing staff members and one clinical officer were interviewed. Each death is summarized in Table 2. Two cases had initially been referred from the primary health center. Three deaths occurred at the district referral hospital while the remaining 11 were referred to the central region referral hospital and subsequently died. For most of the maternal deaths reviewed (11 out of 14 cases) a large number of the shortcomings were categorized with the SBA component. Specifically, inadequate clinical work-ups (history taking and documentation), inadequate monitoring, missed and incorrect diagnoses, delayed or incorrect treatment, delayed referrals and transfers, patients not being stabilized before referring and outright negligence were all reported. There was only one maternal death in which shortcomings were reported for all three components. In this particular case, it was noted in the chart that the woman died from a ruptured uterus. According to the accounts given by the healthcare workers who were involved in this case, they did not know what was causing a foul smell so they wanted the clinician to review her, but he was unavailable because of other cases pending in the operating theater (SBA, EE). They called another clinician on call who advised them to refer the patient to the central hospital. Healthcare workers at the central region maternity unit refused to take the patient because they assumed the presenting complaint was not critical (RS). From the partogram sheet it was noted that there was no descent of the head after four hours and that cervix dilation was checked only once on admission (SBA). One of the healthcare workers disclosed that he decided to take a nap, even though he acknowledged that the ward was busy and that his colleagues had a full caseload (SBA, EE). Additionally, the operating

theater was full, with several cesarean sections being performed that evening (EE). During her time in the labor ward, the patient made repeated requests for assistance, but the healthcare workers delayed in attending to her. Aside from this one case, shortcomings in either EE or RS were not identified. Similarly, there were two maternal death cases in which no shortcomings were identified.

Discussion

The aim of the paper was to describe some of the breakdowns within the maternal healthcare delivery system that might have potentially contributed to the maternal deaths reviewed. This section is organized according to the three components of the maternal healthcare delivery system that were investigated.

Skilled Birth Attendant

Through our investigation what was made apparent was that the skilled birth attendants' provision of care was suboptimal. Treatment was inappropriate, delayed or not provided at all. These findings run contrary to several studies that circumstantiate the correlation between the presence of skilled birth attendants and the reduction of maternal mortality^{12, 21-24}. At the same time, however, these findings are similar to those observed in other studies²⁵⁻²⁸. What was surprising, or alarming, was that such skilled birth attendant malfunctions occurred at a newly erected district referral hospital (2.5 years old), which is a comprehensive emergency obstetric care facility that prides itself on being state of the art. The previous maternity was riddled with deficiencies, malfunctions and suboptimal quality of care²⁹, which helped to explain though not excuse the

high maternal mortality ratio. It was envisioned that the newly constructed maternity unit would resolve some of these problems, including staff morale, and that it would gradually mitigate maternal mortality³⁰. It was also assumed that the healthcare workers performing the eight signal functions in concert would have the knowledge and skills to stabilize and refer women to the next level of care when necessary¹².

Delays in deciding to seek care or in reaching the district referral hospital might have contributed to the maternal deaths by further delaying the timely provision of care needed. However, Thaddeus and Maine assert that "...blaming the patient for seeking care late obscures the fact that the health care system often fails the patient"³¹. Something among (or within) the participating skilled birth attendants prevented them from providing care effectively. One explanation might be a sense of helplessness. Mbaruku and Bergström's study in Kigoma, Tanzania revealed that prior to their intervention, most of the staff were convinced that the maternal deaths were due to circumstances beyond their control, which tended to justify passivity³². They noted that the staff tended to forget their potential capacity to solve obvious problems. Other alternative explanations could be a lack of knowledge and technical competence, negative attitudes, burnout and human resource shortages³³⁻⁴⁰. These factors were not assessed in the current study, hence calling for further investigation.

In our study, a shortage of staff was only reported for one case. This might be explained by the fact that besides staff being disproportionately located within district and regional hospitals, the Ministry of Health introduced the locum scheme in 2005 to address the acute human resources crisis⁴¹. The strategy allows off-duty health workers or those on holiday to be compensated between 600 and 900 Malawi kwacha a day (equivalent to \$3.61 and \$5.42, respectively) for covering shortages. Therefore, the human resources are in place, but perhaps the required vigilance, technical competence, critical decision making skills and commitment are not.

In 2008, Lungu and Nkosi concluded that the locum scheme had initially shown some promising effects for mitigating the problems created by staff

shortages, but that a number of problems had also been identified⁴². For example, there were no guidelines or policies on how to systematically implement the scheme in a standardized, consistent manner. The remuneration for the locum work was an incentive, but it was not attractive enough to make health workers opt for it when other alternative incentives were available. Respondents stated that while health workers used the opportunity to earn additional money as a locum, they were not necessarily providing appropriate care during the assignments. They also reported observing colleagues sleeping while on assignment or at their regular post due to locum duties. In the case where the participating nurse-midwife technician admitted to taking a nap while the death occurred, he was not on his regular post, but in fact was on locum duty. Assessing the locum status of all the participating healthcare workers and its effect on care provided was not conducted for this study. Future studies that investigate this phenomenon are warranted.

Enabling Environment

Based on the maternal death cases investigated, there were no reports of lacking equipment, drugs or supplies. However, what might have been masked is limited supervision which influences the work environment and maternal outcomes^{38, 43}. We asked participating healthcare workers whether there were barriers to executing action plans or providing care to the deceased woman in question, but we did not explicitly ask or prompt them about the nature of the supervision they receive. Management and supervision within the Malawian health care system has been described as being ad hoc, extremely limited and almost exclusively negative or corrective in nature⁴³. Also, senior management has been accused of being unaware of what staff are doing⁴³. In Malawi, human resources for health care are centrally managed at the Ministry of Health, meaning that department leadership has no real authority to attract or remove staff. This makes it difficult, or nearly impossible, to ensure adherence to protocols and guidelines. A lack of consistent technical and supportive supervision may have demotivated or reduced staff confidence in performing up to standard.

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Another factor that may have adversely affected the work environment, and consequently influenced the quality of care provided, is the staff's caseload^{38,43,44}. Approximately 40 deliveries occur each day at the district referral hospital, but information on how many deliveries each staff assists is not systematically recorded, nor did we ask.

Referral System

Aside from the case in which the referral request was denied, there were no glitches in the existing referral system itself. The district referral hospital has five functioning ambulances and is approximately three kilometers away from the central region referral hospital. Specialists are still shared between the two hospitals, so communication is constant. With that said, there were still delays in referring and problems with patients not being stabilized before transfer, which points back to the skilled birth attendants and their knowledge, skills and attitudes. A complementary explanation is that existing policies are not fully understood or procedures are not executed in a standardized way and not monitored. In this study, most of the participating nursing staff was unclear about whether they had the authority to refer patients. This has major implications on the timing of care, particularly when a clinician is unavailable.

Limitations

Limitations inherent to the study merit discussion. First, the sample size was small. Had the time period been extended, e.g. from January 1, 2010 – January 1, 2012, more cases would have presumably been included and perhaps a different pattern might have been observed. Second, the study was conducted at referral level hospitals which inherently introduces selection bias. A larger proportion of referral level hospitals' caseload involves more complicated cases and tend to have a higher chance of dying. Therefore, a certain group of women could be over represented in the sample. However, this does not negate the fact that the cases investigated were sub optimally managed. Similarly, women who died at home or en route were not included. The characteristics and

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circumstances surrounding their deaths might be significantly different from the ones reviewed. This leads to under representation of maternal deaths of a certain profile.

Third, through interviewing staff it was assumed that they would report any barriers to providing care such as a shortage of staff, drugs or blood. If the study was complemented by surveying the availability of blood and blood products, antibiotics and other essential pharmaceutical commodities, then the interpretations of findings could be based on a more accurate picture of the conditions under which the staff provides care, as well as possibly adding more depth to the findings. Comparing the type of healthcare worker involved in providing care during the obstetric emergencies e.g. enrolled nurse, registered nurse, or obstetrician might have added more depth to the findings and provided alternative assessments of patient management and outcomes. Fourth, due to the fact that autopsies are generally not performed in low-income countries^{45, 46}, the cause of death was elucidated through the review of the information extracted from medical charts, and details gleaned from the interviews conducted with healthcare workers.

The obstetricians/ gynecologists who analyzed the data are susceptible to error, and their conclusions were based on their respective clinical judgments in the absence of reliable clinical and/or laboratory data to supplement the diagnostic procedure. Lastly, the data were cross-sectional in nature and therefore do not allow for causal conclusions.

Conclusion

Though circumscribed in scope and limited by a number of methodological issues, this study contributes to the research on maternal mortality in low-income countries. It documents various breakdowns within targeted components of the maternal healthcare delivery system.

This study provides a catalytic step and glaring evidence which suggests that further investigations in the skilled birth attendant component should be considered. Devising interventions based on these future investigations is likely to have an impact on maternal mortality.

Contribution of Authors

Viva Combs Thorsen conceived, designed and conducted the study; analyzed the data and wrote the initial drafts of the manuscript. Tarek Meguid co-wrote the initial drafts and analyzed the data. Johanne Sundby and Address Malata revised subsequent drafts of the paper. All authors read and approved the final manuscript.

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