Author's response to reviews

Title: Local problems; local solutions: An innovative approach to investigating and addressing causes of maternal deaths in Zambia's Copperbelt.

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LOCAL PROBLEMS; LOCAL SOLUTIONS: AN INNOVATIVE APPROACH TO INVESTIGATING AND ADDRESSING CAUSES OF MATERNAL DEATHS IN ZAMBIA’S COPPERBELT.

Abstract

Background

Maternal mortality in developing countries is high and international targets for reduction are unlikely to be met. In 2006, Zambia’s maternal mortality ratio was 729 per 100,000 live births according to survey data while routinely collected data captured only about 10%. In one district in Zambia’s Copperbelt Province medical staff reviewed causes of deaths but no related recommendations were documented nor was there evidence of actions taken to avert further deaths. The Investigate Maternal Deaths and Act approach was designed to address these deficiencies and comprised of four components; identification of maternal deaths; investigation of factors contributing to the deaths; recommendations for action drawn up by multiple stakeholders and monitoring of progress through existing systems.

Methods

A pilot was conducted in one district of Zambia. Maternal deaths occurring over a period of twelve months were identified and investigated. Data was collected through in-depth interviews and focus group discussions in addition to reviews of hospital records. The information was summarized and presented at six ‘data sharing’ meetings to key decision makers, during which recommendations for action were drawn up. An output indicator to monitor progress was included in the routine performance assessment tool. Contributing factors to the deaths were categorized.

Results

A total of 56 maternal deaths were investigated. Poor communication, existing risk factors, a lack of resources and case management issues were the broad categories under which contributing factors were assigned. Recommendations drawn up by the decision-makers included actions that required national level interventions, revisions in
management practices including re-allocation of district controlled resources and closer monitoring of the implementation of existing procedures. Actions taken against the recommendations illustrated the broad nature of required interventions.

Conclusion

In resource constraint settings the IMDA approach promotes the use of existing systems to reduce maternal mortality. In turn the capacity of local health officers to use data to determine, plan and implement relevant interventions that address the local factors that contribute to maternal deaths is strengthened. Monitoring actions taken against the defined recommendations within the routine performance assessment ensures sustainability. Suggestions for further research are provided.
Background

Women’s health is closely linked to a country’s economic productivity and growth [1]. In recognition of this association, reproductive health objectives and initiatives are included in the poverty reduction strategies in developing countries (for example: Mkuza –II, Zanzibar, 2010; Zambia Poverty Reduction Strategy 2004; Rwandan Economic Development and Poverty Reduction Strategy 2008). In addition investment in the wellbeing of women facilitates realization by women themselves of their fundamental human rights. Acknowledging the importance of maternal health, the United Nations has dedicated the fifth of eight Millennium Development Goals (MDGs) to reducing maternal mortality ratios.

Statistics show that maternal mortality is essentially a problem of developing countries. Of the 368,000 deaths associated with pregnancy and childbirth in 2009 worldwide, 99% were in developing countries. Out of these 57% (204,000) died in sub-Saharan Africa. Indeed, according to World Health Organisation (WHO) estimates, women in sub-Saharan Africa have a 1:31 chance of dying as a consequence of childbirth, compared with 1:4,300 in developed regions [2].

Advancement towards meeting the 5th MDG has been acknowledged in the related progress report of 2010. A global decrease in maternal deaths of 34% from 546,000 in 1990 to 368,000 in 2009 was documented. However, in the same report, the annual decline of 2.3% is shown to fall well short of the 5.5% decrease required to meet the MDG target. The reduction in maternal deaths reported for sub-Saharan Africa for the same period was 26% or an annual decrease of only 1.7% [3].

Zambia, situated in sub-Saharan Africa, is one of the countries experiencing high maternal mortality. The Demographic and Health Survey (DHS) of 2001/2 [4] estimated a maternal mortality ratio of 729 per 100,000 live births. In addition to survey data, the Zambian Health Management Information System (HMIS) aims to report maternal deaths from all health facilities on a quarterly basis. However, while the DHS and HMIS both use the International Classification of Diseases Revision 10 (ICD 10) definition of maternal deaths, until 2006, maternal deaths other than those dying of complications during delivery, were seldom captured in the routine data.

Routine data audits conducted in selected hospital records in the Copperbelt Province in 2004 indicated that only maternal deaths that resulted from complications during delivery were captured. This accounted for 10% of the maternal deaths according to the ICD 10 definition since pregnancy-related mortality accounted for 40% deaths, a further 32% were due to early
terminations of pregnancy (21% induced and 11% spontaneous) and 18% occurred in the post partum period.

In this district of Zambia reviews of the reported deaths were restricted to internal medical staff discussions that took place during the routine daily clinical handover report. Reviews were not supported by documented recommendations for follow up actions.

Therefore, other than routine reproductive health activities, ad hoc initiatives to reduce maternal mortality were typically interventions conducted systematically nationwide. Short re-fresher training courses in basic and emergency obstetric care for midwives is one example.

In summary, not all maternal deaths were captured in routine data and neither were causes of death well understood or documented. There was no involvement of non-medical staff in maternal death reviews and interventions were not designed and implemented specifically to address the prevailing issues associated with maternal deaths in this locality.

The Investigate Maternal Deaths and Act (IMDA) approach was developed and piloted to address these deficits with sustainability in mind. The approach consisted of four key components; identification of all maternal deaths according to ICD 10; investigation of all factors associated with the deaths involving a wide range of stakeholders; agreement on recommendations for actions required to address each identified factor by relevant decision-makers and monitoring implementation of recommended actions through the routine performance assessment process.

This article provides a summary overview of factors contributing to all maternal deaths that occurred in one district of the Copperbelt Province of Zambia in one calendar year using this IMDA approach. Selected examples of associated recommendations drawn up by the participants of the data sharing meetings and of resulting actions are also provided.
Methods

The methodology for pilot project followed the four components of this approach; identification of deaths; data collection; data sharing and decision-making and; monitoring implementation of recommended activities.

Research setting
The approach was piloted in one district on the Copperbelt Province in Zambia between 2006 and 2007. This district had a population of 450,000 predominantly previous or current employees of the mining industry [5]. These inhabitants lived in low cost housing settlements on the edge of the ‘high cost’ residential area or in rural villages located within 20 kilometres of the centre of the town. Government health services were provided by 16 health centres managed by the District Health Management Team of which six were equipped and staffed to provide maternity services. Complicated maternity cases were referred to a tertiary hospital situated in the middle of town.

Ambulances were, in theory, available for referrals. In practice they were often not roadworthy or otherwise ‘occupied’ transporting staff to and from duty shifts. Maternity services were, according to the national policy, free of charge. However, shortages of drugs and supplies resulted in the cost of certain items being passed on to the patients. These purchases were over and above the basic items a woman was expected to bring to the health facility for a normal delivery (e.g. maternity pads, gloves, baby clothes, chitengas, suture and razor blade).

At the tertiary hospital two doctors, experienced but not trained at post graduate level in obstetrics and gynaecology, were employed. These senior doctors conducted hospital ward rounds when they were available and attended to serious cases. Otherwise they were collected from home by the hospital transport as needed or conveyed instructions to the junior doctors by phone.

All deaths occurring within one calendar year in one DHMT catchment area made up the sample (n=56). Family and community members, health providers including community based volunteers and others intimately involved with the case in question (traditional healers, ambulance and minibus drivers etc) were included in the data collection phase.

The research team consisted of the author and principal investigator who was working as a Senior Adviser for the Ministry of Health and the co-author as research co-ordinator. In-depth interviews were conducted by four research assistants, three female and one male, who were not related to the health sector.

Identification of Maternal Deaths
Focal persons were identified at the hospital and the DHMT who were assigned with the task of reporting all maternal deaths and passing on the details of the
next of kin, with their permission, to the research coordinator. Training was provided in the use of ICD 10 definition of a maternal death (Box one).

<table>
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<tr>
<th>Box one</th>
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<tbody>
<tr>
<td>International Classification of Diseases</td>
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<tr>
<td>Revision 10 Maternal Death</td>
</tr>
<tr>
<td>The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental cause [6]</td>
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Orientation of all midwives and traditional birth attendants on the identification of maternal deaths was provided though routine DHMT meetings to encourage the reporting of deaths outside the hospital.

**Data Collection**

Zambian funerals are public affairs. Research assistants, themselves members of the local community, attended the funeral of identified women and approached the next of kin to request for an interview at their convenience. These were typically granted within seven days.

During the first and subsequent interviews, a list of persons closely connected with the woman was drawn up using a snowballing approach [7]. Interviewing with all identified as having been close to the deceased woman continued until no new information was forthcoming. Identification, interviewing and follow ups were closely supervised by the research coordinator. Neighbours, Traditional Birth Attendants, older children, relatives, friends, employers, traditional healers were among those interviewed on a case-by-case basis. Indepth interviews were also conducted with health workers, taxi /ambulance drivers and health sector managers.

The interview guidelines comprised of three ‘grand tour’ questions designed to reduce interviewer bias, building on the experience gained in a study of nurses behaviour in Bangladesh [8]. Participants were asked A. Can you tell me about this woman? B. Can you tell me about her pregnancy? C. Can you describe the events that led up to her death? Research assistants were trained in appropriate probing techniques. At the end of each interview the research assistants allowed the respondent to give their opinion on what could be done to prevent another such death occurring.

In addition to the in-depth interviews, focus group discussions were held with traditional healers and community decision-makers, such as grandmothers and elderly married men, in order to gain a deeper understanding of issues surfacing
during the interviews. Health records from antenatal clinics and from health facility files and registers were reviewed and summarized. All interviews and discussions were tape-recorded, transcribed verbatim and typed in order to allow for either manual or electronic analyses.

Data sharing
The information collected was summarized by the Principal Investigator. Demographic and socio economic information and details of health seeking behaviour were presented to establish a profile of each woman. The place of residence, date of treatment etc. were withheld to ensure anonymity. Features of the pregnancy were then described and the remaining information shared concentrated on events leading up to the death.

Key decision-makers reviewed the available data presented during the data sharing meetings to determine the factors leading to each death. Typically four or five cases were presented and discussed at each meeting. The necessary actions required to deter another death in similar circumstances were listed and those responsible for their implementation agreed upon (a sample of these identified actions are presented in the results section, table one).

At the end of the pilot project, when all deaths had been reported, investigated and reviewed, an analysis of the main contributing factors was conducted. Key themes were identified. These are presented in this article.

Monitoring and sustainability
Sustainability of the approach was ensured through the inclusion of a minimum standard indicator in the routine performance assessment tool (% recommendations implemented / % recommendations drawn up during maternal audit). Performance self-assessments were conducted bi-annually by facility or District Health Office and reviewed by the administrative level above. Technical support to address the deficits was provided as agreed during the Performance Assessment discussions, following the national health sector procedures.

Ethical considerations
Ethical clearance was provided through the Tropical Disease Research Centre, Ndola, Zambia. The Ministry of Health at Central, Provincial and District level gave permission for the research team to access maternal health records and health providers. Participants were explained the purpose of the study and written consent was obtained before interviews commenced. Transcripts were coded to prohibit identification of the participant to those outside the immediate study team.

The IMDA pilot was funded through Irish Aid, Lusaka Office.

Results
A total of 56 maternal deaths were identified within rural and urban catchment areas of health facilities located within the district. Two of these deaths occurred at home, one in the health centre and the remainder at the tertiary hospital. The age range of maternal deaths was 15-37 years old. The previous year only eleven maternal deaths were reported, all due to complications of delivery.

Factors contributing to maternal deaths
In the majority of cases, combinations of several factors were associated with a single death. The major themes that emerged during the final analysis of these factors were; poor communication; existing risk factors; lack of resources and issues related to case management. Sub-headings for each theme were also identified as illustrated in figure one. However, the authors acknowledge that there is considerable overlap of factors between themes.

Figure one. Factors contributing to maternal deaths in Copperbelt Zambia by theme, 2006 (IMDA pilot).

A. Communication
Poor communication within families, between families and health providers and within the players in the health system resulted in wrong or delayed decisions being made. There was, in particular, an unwillingness to disclose pregnancy status, abortions or HIV status, even to family members. The case of a 16 year old schoolgirl, Mwaka (alias) illustrates this reluctance. Mwaka had a relationship with a married soldier serving in a military camp situated near the school she attended. She stayed with her aunt during term time. Mwaka secretly aborted a pregnancy from this relationship, using a foreign body inserted through the vagina. This she only disclosed in her dying breathes. Her twin sister, who was also hiding a pregnancy at the time, gave this account...
“She (my sister) removed it (the blood-soaked cloth) and took it behind the house. So as mummy was cleaning outside she saw the blood. That is when she (the mother) came and confronted her but still she (my sister) refused to tell her anything. So mummy took her to the clinic.”

Her sister also commented that Mwaka would not have known how to abort a pregnancy, ‘someone must have helped her’. During an interview her mother indicated that she would have offered to take care of the child while her daughter continued her education had she been aware that her daughter was pregnant. Her own children were grown up. The cause of death on Mwaka’s death certificate was ‘septic abortion’.

Reluctance of patients and their family members to share vital information with health providers interfered with the diagnosis of seriously ill patients. This was particularly notable in stigmatised conditions such as HIV and self induced abortions as in Mwaka’s case. Cultural beliefs and norms also played a role (see below). The use of traditional herbal remedies is commonplace in Zambia and results in a display of signs and symptoms unexplained in medical textbooks. There was a reluctance to disclose use of herbal medicines to scornful health providers, resulting in considerable ‘guesswork’ by clinicians in drawing up a diagnosis.

Poor communication between health facilities also resulted in delayed treatment. The tertiary hospital attended to critically ill patients as they arrived on the maternity ward, without forewarning, from the referring health centre. This practice reduced the preparation time for medical consultation and life-saving surgical interventions at the tertiary hospital.

Similarly, within the tertiary hospital communication was less than optimal. Exchange of information between the laboratory and the ward, as well as between senior staff left the physician managing seriously ill women ‘blindfold’. This was evident from the absence of feedback relating to the requested laboratory tests, and other specialists’ expert opinions as illustrated in the summary of one patient’s hospital notes (Box two). It demonstrates that on numerous occasions' laboratory tests, specialist (surgical) opinions and HIV tests were requested by the attending physician. Limited family and health facility resources, however, may also have influenced the availability of laboratory tests results (see section resources).

<table>
<thead>
<tr>
<th>Box two</th>
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<tbody>
<tr>
<td>A summary of entries into a critically ill patient in the postpartum period.</td>
</tr>
<tr>
<td><strong>Day one-15.15</strong></td>
</tr>
<tr>
<td>- Delivered 7 days ago</td>
</tr>
<tr>
<td>- Chronically ill looking, pallor, Chest- AE down bilaterally, dull on percussion, S1, S2 normal, pus</td>
</tr>
</tbody>
</table>
aspirated on both sides
- R/O (sic. Rule out) RVD (sic. HIV)
- CXR, FBC, ESR, LFT, ICD, VCT, ATT

Day 2
- VCT requested - Chlotrimoxazole given

Day 3
- Follow up lab tests, VCT

Day 4
- No entry

Day 5
- Follow up lab tests, VCT

Day 6
- Follow up lab tests, VCT, consider ICD, Surgeon to see

Day 7
- Repeat lab tests, VCT, surgeon to see, trace lab results

Day 8
- Repeat lab tests, surgeon to see, trace lab results

Day 9
- Repeat CXR, follow up on lab results, surgeon to see

Day 10
- R/O RVD (sic HIV), follow up lab results, VCT, repeat U/E, LFT

Day 11
- FBC/ESR, Urgent HB, CXR, Surgical consultation, Lasix, CST, O2 therapy

Day 12
- Surgical consultation, CXR, Trace lab results

Day 13
- VCT

Day 14
- VCT, RPR, surgical consultation

Day 15
- VCT, RPR

Day 16
- Add slow K, Prednisolone

Day 17
- (Not seen in am)
- Certified dead at 14.26
B. Pre-existing risk factors

Physical conditions, health seeking behaviour and family circumstances were identified as pre-existing circumstances/conditions that complicated the provision of care during pregnancy, childbirth and the post partum period and thus contributed to deaths. The sub themes under each of these client risk factors are presented in figure two.

*Figure two. Breakdown of pre-existing client risk factors identified during IMDA pilot, Zambia 2006.*

Pre-disposing medical conditions such as sickle cell anaemia, HIV and a history of previous multiple caesarean sections overstretched the ability of health facilities to provide the care required for safe childbearing. Women with HIV/AIDS, already in a compromised immune state, were particularly vulnerable.

Family and community interviews revealed a plethora of traditional practices that complicated standard pre and post natal management by health providers. Reluctance to use family planning to avert unintended pregnancies and to utilise services at the local health facilities were predisposing factors contributing to maternal deaths; it goes without saying that a woman who is protected from pregnancy through family planning cannot be added to the statistics of maternal mortality.

The widespread use of alternative traditional medicines was not without complications. In particular, a locally available herbal substitute for oxytocin was used to speed up labour by intensifying uterine contractions. Even trained midwives use this natural product during their deliveries. Linked to the suspicion that a prolonged labour signified infidelity in the marriage and could lead to death
(locally known as *inchila*), labour of short duration was preferred. The same belief was also responsible for delay in seeking care on onset of labour. Traditional family norms also influenced health seeking. Women needed the financial, logistical and moral support from their male partners to receive care in health facilities as one neighbour of a woman who had died as a result of post partum sepsis illustrated.

*Her husband used to refuse to take her to the clinic ....When she was very sick she was taken by her brother on the bicycle. She delivered alone. The cord was around the neck* (referring to the cord being around the neck of the new born baby). *So she asked her older child to call the neighbour who cut the cord.*

Use of traditional practices in pregnancy, during delivery and in the post partum period was confirmed as one husband recounts after his wife died shortly after delivery.

*She complained of dizziness. Other women had come and started massaging her with African herbs (leaves).*

**C. Resources**

Delays in seeking and managing complications of childbearing were related to a scarcity of resources at family, community and health system levels.

Private ownership of transport, even bicycles, was limited to the privileged few in this district of Zambia. Walking and travel in locally-run and overcrowded minibuses were the most common forms of transport. Securing transport took precious time. In rural parts of the district, as well as some high population density areas, wheelbarrows were considered the most comfortable non motorised transport for seriously ill women. While taxis were used in emergencies, not all drivers agreed to take a woman who was bleeding in their vehicle. Once at the health centre the difficulty in securing an ambulance resulted in a high reliance on taxis for referral purposes. In the surrounding villages there was no motorised transport of any description. Selena (alias) died in a village four hours walk from the nearest health facility. Her husband described what happened...

*At around 03.00 hours in the night she told me that she felt a pain in her back. Then I said ‘Here there are no vehicles, what will happen’? We stayed and slept again till 06.00 that’s when she delivered a baby girl. It was not long afterwards, she just said don’t lift me; let me lie down a bit. When she did that, she even died. It was around 07.00 hours.*

The cause of death on Selena’s death certificate was post partum haemorrhage.
Stock-outs of drugs, supplies and even blood units for transfusion resulted in the cost of maternity care being passed onto the woman and her family. Prescriptions were given for medicines and supplies, which in turn were purchased in local pharmacies and drug stalls. These purchases required cash. Delays in sourcing cash in an emergency situation were experienced. This was the testimony of a husband whose wife died in the hospital because of a septic abortion.

...they wrote the prescription on the day she died. Ok, what happened was...my mother was at the bedside, so when I arrived I found they (doctors) had already written the prescription. So as I was leaving again (to purchase the prescribed medicines from the private pharmacy) I was called that she had died.

At the tertiary hospital the absence of a fully qualified obstetrician had several consequences. Firstly, women did not have access to the specialised care required for a serious complication. Secondly, junior doctors diagnosed and managed cases beyond their capacity. They learnt by trial and error. Errors were translated into death in extreme situations.

Blood units for transfusion were collected by the blood bank staff during mobile outreach collection sessions, typically at schools and colleges. After screening the blood was distributed according to requests and availability. Shortages of blood during school holidays were commonplace. There was difficulty in obtaining blood for transfusion at these times, even for cases where it could be predicted that blood transfusion would be required, for example for patients with sickle cell anaemia. This husband of a sickle cell patient who died in childbirth in the hospital gave his opinion...

Interviewer: Do you think the death of your wife would have been prevented?
Informant: Yes, anyway it would have been prevented if the doctors had taken measures to find the blood to replace the blood maybe it would have helped her. Because she had lost blood, you see.

D. Case management

Poor case management was exacerbated by the absence of skilled personnel for individual case management and for supervision of the junior doctors. A reluctance to take the advice of very experienced midwives on the ward further aggravated the situation.

There was evidence of ‘norms’ within the hospital that interfered with diagnosis and treatment. When the cause of death was unclear there was a reluctance of both relatives and medical staff to organise post mortems. However, traditionally a woman in Zambia is not buried with an unborn child, meaning that families paid
the hospital pathologist to surgically remove a foetus in the morgue. The opportunity to conduct an investigation during this procedure was not taken advantage of.

Malaria is typically used as a diagnosis when there is an unknown cause of illness in this previously high endemic malaria region. However, with the introduction of effective preventative and treatment initiatives, there was little evidence that the burden of malaria posed a significant risk in this district at the time. Malaria diagnosis was, however, recorded as a diagnosis unsupported by clinical signs and symptoms or laboratory confirmation. The result being that the real cause of ill health was not investigated.

There were delays in giving treatment, especially operations and antibiotics. Reasons were interlinked, poor case management, lack of supplies at the hospital and absence of readily available cash at the home all played a part.

**Recommendations**

A total of six data sharing meetings were conducted, chaired by the Provincial Health Director. Participants included provincial and district level officers including the responsible focal persons for reproductive health, hospital and health centre staff, traditional birth attendants, visiting obstetrician and representatives from the blood transfusion centre. The exact composition of the groups depended on the key issues that had emerged during data collection.

The factors contributing to the deaths were discussed during the meetings and recommendations were drawn up to ensure that a similar recurrence was avoided (see examples in table one).

The level within the health system that the recommendations were to be implemented varied. Those requiring high level interventions or significant additional resources required action to be taken initially at national level. However the results of the study provided a powerful lobbying tool for the senior district and provincial officials, for example in articulating the need for obstetricians at the tertiary hospital.

The nature of the interventions varied in nature. In addition to those requiring central level action and lobbying such as the need for an obstetrician, three additional categories of actions were required; those requiring management intervention, those that simply monitored already existing procedures and those reliant on the allocation of additional resources.

Management interventions required the action of the district, hospital or provincial officials. Examples included improvement of the availability of safe blood for transfusion and communication between and within health facilities. Intensified or
newly initiated monitoring or supervision of existing procedures, such as the patient referrals from health centre to hospital fell into the third category.

District management teams and to a lesser extent hospitals could re-allocate their resources to enable activities to be taken. Such actions included, for example, the training of midwives in the use of magnesium sulphate to improve case management of eclamptic patients at all health facilities and the re-introduction of safe birthing kits to ante-natal clients.

Selected recommendations drawn up at the meetings are presented in table one.

*Table one Examples of factors contributing to maternal deaths and recommendations for actions to be taken.*

<table>
<thead>
<tr>
<th>Problem identified</th>
<th>Recommendation</th>
</tr>
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<tbody>
<tr>
<td>Junior doctors working unsupervised. Complicated cases undiagnosed. Incorrect case</td>
<td>Obstetricians required for tertiary hospital</td>
</tr>
<tr>
<td>management</td>
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</tr>
<tr>
<td>Midwives not confident in giving magnesium sulphate in the absence of a Medical</td>
<td>Discuss in next Midwives Meeting. Provide orientation to midwives in management of pre eclampsia. Contact Nursing Council for regulations regarding midwives giving Magnesium sulphate to patients Ensure uninterrupted supply of Mag. Sulphate in all health centres conducting deliveries.</td>
</tr>
<tr>
<td>Obstetricians required for tertiary hospital</td>
<td></td>
</tr>
<tr>
<td>Incorrect case management</td>
<td></td>
</tr>
<tr>
<td>Magnesium sulphate not always in supply</td>
<td></td>
</tr>
<tr>
<td>Deaths during operation for routine Caesarian sections in women who had already</td>
<td>Counselling for bilateral tubal ligation at antenatal clinics for all clients having three previous Caesarian sections</td>
</tr>
<tr>
<td>multiple (up to 5) previous Caesarian sections</td>
<td></td>
</tr>
<tr>
<td>Clients do not have readily available cash for transport to attend health centre</td>
<td>Advice and support for birth planning for all pregnant women – design strategies to include male partners. Re-introduce safe birthing kits for pregnant women at antenatal clinics</td>
</tr>
<tr>
<td>for delivery. Patients do not have supplies required by health centre resulting in home deliveries.</td>
<td></td>
</tr>
<tr>
<td>Short time for preparing referred patients for theatre</td>
<td>Monitor the preparation of women who are referred from health centres, keep chart in labour ward. DHMT to orientate midwives in safe referrals during midwives routine monthly meeting DHMT Reproductive Health Officer</td>
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to collect monitoring sheet and provide feedback and support to health centres.

| No antibiotics available for treatment of post partum or post abortion sepsis | Maintain a supply in ICU for maternal cases |
| Blood units not always available on request especially during school holidays | Establish a Blood transfusion committee to discuss blood collection and distribution |
| Diversify the register of blood donors | Review and document ordering system. |
| Patients die undiagnosed | Conduct post mortems when maternal death cause is unknown. |

**Monitoring and sustainability**

Performance Assessment exercises were conducted every six months. The actions taken against the recommendations made at hospital, health centre and District Health Office were monitored. Examples of the interventions that were implemented were:

- Obstetrician allocated to the hospital
- Campaigns to collect blood from regular donors, regular meetings with Zambia Blood Transfusion Services and its stakeholders, ordering system put in place to document orders.
- Midwives training in use of magnesium sulphate for pre-eclamptic patients. Nursing council contacted and regulations related to the giving of Magnesium Sulphate clarified. Magnesium Sulphate ordered by District Health Office and distributed to all health centres.
- Midwives sensitised on the need for counselling for women who already had three caesarean sections to obtain consent for sterilisation for the next delivery during routine antenatal clinics.
- Birth planning sessions, both group and individual, introduced at all antenatal clinics.
- A monitoring chart relating to communication between a referring clinic and the labour ward of the tertiary hospital regarding referral cases introduced and monitored by District reproductive health officer
- A stock of antibiotics established in Intensive Care Unit (ICU) for use for septic abortion and post partum sepsis.
- Post mortem was conducted when cause of death was not clearly identified.
Discussion

The increased proportion of maternal deaths captured using this approach allowed for investigation of self induced abortions and complications in the prenatal and post partum periods that occurred in the hospital. The deaths identified that occurred at home were reported by the Traditional Birth Attendants who had been explained the ICD 10 definition of a maternal death. Opinions that home deaths were rare events surfaced during focus group discussions with TBAs. The desire to shift the responsibility of the death was reported as the reason. However, a routine investigation of all deaths occurring in the community through vital registration would give more credibility to this assumption. A study being conducted in Ethiopia uses vital registration and investigation of all deaths of women of reproductive age. This methodology should be considered in further use of the IMDA approach. A second limitation concerning the first component, identification of deaths, is the reliance on a woman dying to address maternal death risk factors. The inclusion of ‘near miss’ cases [9] should be considered, depending on number of deaths and capacity for investigation and follow up.

The summary of contributing factors illustrates that few deaths were as a result of just one cause or reason, most had several. The use of ‘grand tour’ questions and inclusion of general information about the woman resulted in a comprehensive overview of the situation that required action. This contrasts with the World Health Organisation ‘Beyond the Numbers’ [10] approach to maternal death reviews. Using semi-structured questionnaires the investigation culminates in a cause of death being attributed to each death. This allows for comparison between countries and within countries over time of biomedical causes of death. The IMDA approach, on the other hand, is primarily concerned with identifying all contributing factors as a basis for determining interventions at a local level. The cause of death on Selena’s death certificate was post-partum haemorrhage (PPH). The contributing factors were related to her physical location, lack of resources to travel to a health facility and the degree of preparedness for the eminent birth. Cultural factors including the knowledge of her husband of pre-requisites for safe of motherhood also played a role. Interventions for PPH are typically improving midwives delivery skills, use of misoprostal and the availability of safe blood. Non of these interventions would have averted Selena’s death unless other measures were taken to ensure she had access to these services. So while the ICD 10 definition was helpful in identifying more maternal deaths than previously had been, the biomedical cause of each death according to the same classification document was attributed less importance using the IMDA approach.

The recommendations were drawn up by the very people who were responsible for their implementation. As a result translation of recommendations into actions was high as illustrated by the examples. However, due to the sensitive nature of some emerging issues such as unplanned (particularly teenage) pregnancies
and strong religious convictions, direct recommendations for a change in the abortion law and introducing family planning advice as well as offering commodities to teenagers were not included formally to the list of interventions. The forum, however, provided a unique opportunity to air controversial issues, otherwise never formally discussed.

In the whole year, no recommendation was made for re-fresher training in delivery skills for midwives other than the use of magnesium sulphate for eclampsia patients. Inadequate skills in assisting deliveries was not identified as contributing to any of the 56 deaths. The intervention to provide such training during the time of the study, according to the study results, would therefore be unlikely to have a major impact on reducing the high maternal mortality ratios in this district. This is important to note since cost effective and relevant interventions were at the heart of the design of IMDA approach.

Conclusion and recommendations
In resource constraint settings the IMDA approach promotes the use of existing systems to reduce maternal mortality. In turn the capacity of local health officers to use data to determine, plan and implement relevant interventions that address the local factors that contribute to maternal deaths is strengthened. Monitoring actions taken against the defined recommendations within the routine performance assessment ensures sustainability.

The authors recommend the addition of a community-based identification system using the vital registration system and to include all deaths of women of reproductive age to improve the comprehensiveness of the identification process.

Furthermore, a comparison of the factors identified using the three ‘grand tour’ question approach and those identified using the WHO, Beyond the Numbers, semi-structured tool is recommended. Such a comparison would assist in determining the most accurate data collection technique for the determination of appropriate and cost effective interventions to reduce maternal mortality.

Finally, a follow-up study that evaluates the impact of the study through analysis of the number of women in subsequent years dying due to the same identified factors. A comparison with a neighbouring district, as control would strengthen this evaluation.

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References
3. Covering letter, peer reviewers and editorial board selection

Have you prepared a covering letter for your submission, explaining why we should publish your manuscript and elaborating on any issues relating to our editorial policies detailed in the instructions for authors, and declaring any potential competing interests? This should be provided using the 'cover letter' section of the submission process. And do you have the contact details (including email addresses) of at least two potential peer reviewers for your paper, which you will need at the same time? These should be experts in your field of study, who will be able to provide an objective assessment of the manuscript's quality. Any peer reviewers you suggest should not have recently published with any of the authors of your manuscript and should not be members of the same research institution. You will be asked to select the one or two Editorial Board members whose interests most closely match the subject of your manuscript.

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The MDG 5 related to maternal mortality is unlikely to be attained in sub saharan Africa unless interventions are introduced that address the factors contributing to the deaths. This manuscript introduces an approach that uses existing health systems to identify deaths and related contributing factors, determine and monitor relevant interventions at a local level. The methods used and results that emerged provide existing health officers with an approach that has the potential to address factors leading to deaths in a systematic and sustainable fashion without outside support. The authors declare there are no competing interests to prevent this manuscript being published.

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