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Maternal and Child Survival Program

Technical Consultation on Reporting and Mapping Maternal Deaths in Countries with High Maternal Mortality

Summary Meeting Report

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Abbreviations

ASHA	Accredited Social Health Activist
BEmOC	Basic Emergency Obstetric Care
BEmONC	Basic Emergency Obstetric and Newborn Care
CDC	Centers for Disease Control and Prevention
CEmOC	Comprehensive Emergency Obstetric Care
CEmONC	Comprehensive Emergency Obstetric and Newborn Care
CHW	Community Health Worker
COD	Cause of Death
CRVS	Civil Registration and Vital Statistics
DHIS2	District Health Information System
DHS	Demographic and Health Survey
DSS	Demographic Surveillance System
EmOC	Emergency Obstetric Care
EmONC	Emergency Obstetric and Newborn Care
GIS	Geographic Information System
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
ICD	International Classification of Diseases
IDSR	Integrated Disease Surveillance and Response
MCH	Maternal and Child Health
MCSP	Maternal and Child Survival Program
MDG	Millennium Development Goal
MDSR	Maternal Death Surveillance and Response
MM	Maternal Mortality
MOM	Mapping Outcomes for Mothers
MMR	Maternal Mortality Ratio
MNH	Maternal and Newborn Health
MOH	Ministry of Health
MWRA	Married Women of Reproductive Age
NORAD	Norwegian Agency for Development Cooperation
PAHO	Pan American Health Organization

PRE-EMPT	Pre-eclampsia and Eclampsia Monitoring, Prevention, and Treatment Project
PRMR	Pregnancy-Related Mortality Ratio
Q/A	Questions and Answers
RAPID	Rapid Ascertainment of Pregnancy-Induced Deaths
RAMOS	Reproductive Age Mortality Study
SDG	Sustainable Development Goal
SMGL	Saving Mothers Giving Life
SoWMy	State of the World's Midwifery
UDS	Universal Data Set
UN	United Nations
USAID	United States Agency for International Development
VA	Verbal Autopsy
VHT	Village Health Team
WCA	Women of Childbearing Age
WHO	World Health Organization
WRA	Women of Reproductive Age

Executive Summary

Every year, almost 300,000 women die from complications related to pregnancy and childbirth, with the vast majority of deaths in low- and middle-income settings.[1] Although maternal mortality declined by 45% globally between 1990 and 2013, many countries will not achieve Millennium Development Goal 5 by 2015.[2] As the global community moves to the Sustainable Development Goals, better routine data are needed to ensure appropriate monitoring of progress toward maternal mortality reduction targets.

Data visualization using mapping and other techniques is a powerful tool that can visually display information, making it easier to understand and facilitate decision-making to adapt and improve programs and policies. Maps combine data from a variety of sources and visually display "layers" of information including: 1) population information such as where pregnancies and births are expected; 2) geographic information such as land cover and road networks, which can be analyzed to estimate travel time; 3) availability of functional health facilities; 4) quality of facility-based care; and 5) and outcome measures such as mortality.

The Maternal and Child Survival Program, the United States Agency for International Development's (USAID's) flagship maternal and child health program, convened a Technical Consultation on January 12 and 13, 2015, with experts from various disciplines to formulate recommendations and next steps for mapping maternal deaths to track progress toward global targets.

Meeting Objectives and Methods

The objectives of the meeting were to:

- Share previous and ongoing work in this area
- Discuss priorities for future work
- Develop an action plan for moving forward
- Provide recommendations to be disseminated at the Summit on Measurement and Accountability, sponsored by the World Health Organization (WHO), USAID, and World Bank, to be held in Washington, D.C., in June 2015

The event included plenary sessions, discussion, and group work. Approximately 72 participants from over 22 global health organizations, government agencies, donors, universities, and other groups participated in the meeting.

Overall, there was consensus that mapping maternal deaths is important and work in this area should continue. In addition, the group concluded that maps that display related information to **prevent** maternal deaths are also needed; this information would include availability of care, quality of care, and other outcomes for maternal, perinatal, and newborn health. Other overarching discussion points included:

[1] WHO, UNICEF, UNFPA, The World Bank, United Nations Population Division. 2014. *Trends in Maternal Mortality 1990–2013*.. Geneva: WHO. (May)
[2] Fulfilling the Health Agenda for Women and Children, The 2014 Report. Countdown to 2015.

1. Mapping has potential to improve decision-making and accountability. However, it is essential to consider the end user, and maps using different platforms will need to be tailored to the end user. Maps for facility-level managers or district health management teams may be different from maps for national-level policymakers.
2. Maps are only as good as the data they are made from. There are limitations to availability and quality of maternal death information—and maps should be developed based on available data and tailored to the question and the end user.
3. Standardization was a theme repeated throughout the Consultation. This includes standardizing methods for data collection and mapping, as well as for collecting and compiling geocodes of health facilities.
4. There is a need to build capacity at all levels—both in terms of capacity to use existing data to create maps and also in terms of capacity to interpret and understand maps to promote decision-making.

Throughout the Consultation, participants worked in small groups to develop and prioritize recommendations that "will have the greatest impact" to promote mapping of maternal deaths and other relevant indicators. The four groups addressed: 1) Data Sources and Quality; 2) Data Visualization and Analysis; 3) Data Use; and 4) Sustainability and Scalability. Each of the groups identified a facilitator and a rapporteur, and developed recommendations that were shared with the larger group. There were also several overarching and cross-cutting recommendations that came out of the discussion. Then all participants voted for the top five recommendations overall, and these recommendations will form the basis of the action plan moving forward. The recommendations listed below were the top 10 recommendations based on the prioritization exercise.

TOP 10 RECOMMENDATIONS FOR MATERNAL MORTALITY MAPPING THAT WILL HAVE THE GREATEST IMPACT

1. In addition to mapping maternal mortality, map actionable items to prevent maternal deaths, such as expected pregnancies/birth, availability of care, quality of care, and other outcomes for maternal, perinatal, and newborn health.
2. Ensure that mapping feeds into social accountability mechanisms for communities and civil society.
3. Develop or adapt a capacity-building approach for decision-makers on data visualization including maps on maternal death and related data.
4. Use a bottom-up approach for capacity building, ownership, and development.
5. Develop a universal data set (UDS) with common fundamental geo-coded data, master facility lists, etc., using data from all relevant sectors, including vital registration. This UDS should be regularly updated and available to all stakeholders.
6. Develop guidance on standards and parameters of maternal health data (e.g., travel time) to map, including actionable items.
7. Design perinatal and maternal surveillance in an integrated format at all levels by Ministries of Health. Data should also be tracked and used.
8. Operationalize Maternal Death Surveillance and Response (MDSR) for mapping. This work should be supported by WHO and donors.
9. Fund, over a sustained period of time, the development and validation of community-level, GIS-linked, verbal autopsy-supported data collection methods/strategies.
10. Determine optimal context-specific incentives/disincentives for maternal death reporting by families, frontline health workers, and facility staff/managers.

After presentation of the recommendations, participants discussed and agreed upon next steps, including:

1. Expand the Consultation Steering Committee, and create a Coordinating Committee. This Coordinating Committee would have quarterly calls to share information, ideas, and next steps.
2. Conduct regular webinars to share information and facilitate dialogue on this topic.
3. Write and submit a peer-reviewed paper from the Consultation. This paper may include case studies of where mapping maternal deaths has led to decision-making, changes in policies, and other outcomes.
4. Disseminate recommendations at the upcoming June Summit on Measurement and Accountability.
5. Hold a follow-up meeting at the Summit on Measurement and Accountability in Washington, D.C., in June 2015 or at the Global Maternal and Newborn Health meeting in Mexico City, Mexico, in October 2015.

Background

Every year almost 300,000 women die from complications related to pregnancy and childbirth, with the vast majority of deaths in low- and middle-income settings.[3] Although maternal mortality declined by 45% globally between 1990 and 2013, many countries will not achieve Millennium Development Goal (MDG) 5 by 2015.[4] The majority of data used to track progress toward global targets is based on estimates, due to the lack of quality data on maternal deaths, especially in high-burden countries. As the global community moves to the Sustainable Development Goals (SDGs) to 2030, the target for Ending Preventable Maternal Mortality is a global average of 70 per 100,000 live births. Better routine data are needed to ensure appropriate monitoring of progress toward these targets. In addition, there is a need to ensure that existing data are used for decision-making and program improvements.

Data visualization using mapping and other techniques is a powerful tool that can visually display information, making it easier to understand and facilitate decision making to adapt and improve programs and policies. Maps combine data from a variety of sources and visually display "layers" of information including: 1) population information such as where pregnancies and births are expected; 2) geographic information such as land cover and road networks, which can be analyzed to estimate travel time; 3) availability of functional health facilities; 4) quality of facility-based care; and 5) and outcome measures such as mortality. These different layers of information provide a complete picture of availability, access, and use of care in areas where pregnancies and births are expected—and different modeling scenarios can show potential improvements in provision of care, referral networks, and impacts on mortality.[5]

The Maternal and Child Survival Program (MCSP), the United States Agency for International Development (USAID's) flagship maternal and child health (MCH) program, convened a technical Consultation on January 12 and 13, 2015, with experts from various disciplines to formulate recommendations and next steps for mapping maternal deaths. The meeting provided an opportunity for geographers, public health practitioners, epidemiologists, and statisticians to share technical updates and progress on use of maps to facilitate decision-making and promote accountability, which is crucial to monitoring and tracking progress toward global, national, and sub-national targets.

Meeting Objectives and Methods

The objectives of the meeting were to:

- Share previous and ongoing work in this area
- Discuss priorities for future work
- Develop an action plan for moving forward
- Provide recommendations to be disseminated at the Summit on Measurement and Accountability, sponsored by the World Health Organization (WHO), USAID, and World Bank, to be held in Washington, D.C., in June 2015

[3] WHO, UNICEF, UNFPA, The World Bank, United Nations Population Division. 2014. *Trends in Maternal Mortality 1990–2013*. Geneva: WHO. (May)
[4] Fulfilling the Health Agenda for Women and Children, The 2014 Report. Countdown to 2015.
[5] Tatem AJ et al. 2014. Mapping for maternal and newborn health: the distributions of women of childbearing age, pregnancies and births. *Int J Health Geogr*. 4;13:2. doi: 10.1186/1476-072X-13-2.

The event included plenary sessions, discussion, and group work. Presenters highlighted programmatic opportunities and challenges around two main themes:

1. Current experiences with mapping maternal deaths; and
2. Opportunities to integrate mapping maternal mortality into existing platforms/innovations.

The group work included four groups who worked together to formulate recommendations in these areas:

1. Data Sources and Quality
2. Data Visualization and Analysis
3. Data Use
4. Sustainability and Scalability

Participants

Approximately 72 participants from over 22 global health organizations, government agencies, donors, universities, and other groups participated in the meeting.

Welcome Session

Ariel Pablos-Méndez, Assistant Administrator for Global Health, USAID, welcomed participants to the Consultation. He stressed the importance of using technology moving toward 2030 and that the Summit on Measurement and Accountability scheduled for June would be an important contributor to this goal. Dr. Pablos-Méndez observed that health has been ahead in modeling mortality estimates, but that household surveys have become expensive, making it difficult to track progress toward global targets; investments in people and technology are needed. Part of the challenge is weak health systems in the very countries where the majority of maternal deaths occur. Approaches using mobile and mapping technology need to be developed to support these health systems and their ability to measure maternal deaths. Dr. Pablos-Méndez noted that technology is not the only answer and that how data are collected and presented needs to be examined. Some technology has existed for a long time, but the challenge is having quality data to plug into the technology. In Latin America, many districts have no maternal deaths, and it is important to highlight what worked to reduce maternal deaths in these districts. The recent drive for more information on health status, not just deaths and births, is necessary for comprehensive maternal health programs. Dr. Pablos-Méndez reminded participants that the global target for Ending Preventable Maternal Mortality (EPMM) is a global average of 70/100,000 live births by 2030 and that the maternal health community has a done a good job of positioning itself. He concluded by stating that changes in economic growth and increased female education make post-2015 a perfect time to rally behind cross-sectoral solutions and that measurement and links with technology are essential to promote these goals.

Dr. Pablos-Méndez also launched USAID's publication *Ending Preventable Maternal Mortality: USAID Maternal Health Vision for Action Evidence for Strategic Approaches* to accompany its USAID Maternal Health Vision for Action, which was released in June 2014. This document provides the evidence behind strategic approaches outlined in the Maternal Health Vision for Action.

Allisyn Moran, Senior Maternal Health Advisor, USAID, explained that mapping is important because the MDGs linked to maternal health are the least likely to be achieved and that geographic information system (GIS) and other mapping tools may offer some solutions to this problem. The Consultation was designed to review the state of the art of mapping maternal deaths to understand where the challenges are and how it can be used for accountability. Dr. Moran acknowledged that a great deal of work has been done in the area in the last few years, such as the March 2013 Maternal and Newborn Health Mapping Mash-up in Southampton, UK. She suggested that the Consultation build off that effort by concentrating on how we can use mapping and visualization with existing data as well as discussions on additional data needed to track progress in maternal mortality reduction. She concluded by saying that the work of the Consultation will feed into upcoming Summit on Measurement and Accountability, which will outline focus areas for post-2015.

Barbara Rawlins, Monitoring and Evaluation (M&E) Team Leader, MCSP, explained that MCSP is a global, USAID Cooperative Agreement to introduce and support high-impact health interventions with a focus on 24 high-priority countries, with the ultimate goal of ending preventable child and maternal deaths (EPCMD) within a generation. The vision statement of USAID's flagship maternal and child survival project is: "Self-reliant countries equipped with the analytical tools and effective systems enabling them to be on track to end preventable child and maternal deaths." Ms. Rawlins reviewed the Consultation agenda, explaining that there would be three sessions over 2 days:

Session 1: Current Experiences with Mapping Maternal Deaths
Session 2: Opportunities to Integrate into Existing Platforms/Innovations
Session 3: Formulating Recommendations and Next Steps

She explained there would be opportunities for questions and answers after each block of presentations. She also explained that participants would be asked to join working groups that would meet on both days to develop recommendations focusing on: Data Sources and Quality; Data Visualization and Analysis; Data Use; and Sustainability and Scalability. The recommendations would feed into the last session, Formulating Recommendations and Next Steps.

Leo Ryan, Senior Vice President and Director, International Health and Development Division, ICF International, facilitated the Consultation. Mr. Ryan explained that in addition to the working groups, participants should think about success factors and challenges involved in mapping as they listened to presentations, and to write those ideas on sticky notes to put in "parking lots" posted on the wall of the meeting room. (Annex 4 reflects the success factors and challenges noted in the parking lots.)

Session 1: Current Experiences with Mapping Maternal Deaths

Twelve presentations were given, including three that were part of a larger panel of in-country experts. The sessions presented experiences with: 1) mapping maternal and neonatal health (MNH)—past, present, and future; 2) data sources for maternal deaths; 3) country examples from Malawi, Ghana, Mozambique, Mexico, Indonesia, India, and Tanzania; and 4) special studies conducted by Saving Mothers Giving Life (SMGL) and the Pre-eclampsia and Eclampsia Monitoring, Prevention, and Treatment (PRE-EMPT) project. Summaries of the presentations and question and answer sessions follow.

Presentation: Mapping MNH—past, present, and future

Presenter: Jim Campbell, Director, Health Workforce, WHO; Executive Director, Global Health Workforce Alliance

Summary and Lessons Learned

International activities around mapping for maternal and newborn health began in March 2013 and are ongoing. While the goal is to measure and map every pregnancy, birth, and birth outcome, there is also a need to understand the causes and factors behind adverse outcomes. Therefore mapping should include several layers—health outcomes, coverage of health care (health workforce and health facilities), pregnancies and births, women of childbearing age (WCA), and the population.

There is a push from the WHO Secretary General to disaggregate data by the different levels. This includes understanding the difference between access to a health care worker and access to a health care worker in an enabled environment or access to quality services. It is also important to move beyond national levels to the subnational level, visualizing data for different levels of administration. There is especially a need for visibility in different district levels. By disaggregating data and decentralizing and devolving monitoring and planning, health authorities can better understand equities and inequities between communities and vulnerable groups, and better target actions to ensure dignity for all. This will feed into measurement and accountability for health discussion.

There need to be standard approaches to measurement at a global level and a move to a disaggregated subnational lens that maps health equity. An example is linking the State of the World's Midwifery (SoWMy) findings with GIS to ensure fair distribution of services and priority for those worst off. We can use geography to ensure that measurement and accountability opportunities are strengthened by linking GIS to result measurements logic: Input→ process → output → outcome → impact.

There are common linkages and a shared interest around universal health coverage, but a great need for a coordinated effort to improve data and measurement. As maps are used more, decision-makers and health care administrators can learn from within countries and across countries. The impossible can be possible within a country.

Presentation: Data sources for reporting and mapping maternal deaths

Presenter: Allisyn Moran, USAID

Summary and Lessons Learned

In March 2013, ICS Integrare and the University of Southampton (UK), supported by the Norwegian Agency for Development Cooperation (NORAD), hosted a technical mash-up meeting in Southampton, as part of ongoing research on "Mapping for Maternal and Newborn Health." This was the first meeting among institutions interested or working on the use of GIS in MNH. The meeting report is available at: http://integrare.es/mapping-for-maternal-and-newborn-health-innovative-application-of-gis-2/

One of the appeals of mapping is that various data can be layered on the same map, presenting the interaction between the data. Maps can simultaneously present data on: expected pregnancies/births; geographic information (land cover, road network); functional health facilities (basic emergency obstetric care [BEmOC] and comprehensive emergency obstetric care [CEmOC]); human resource availability; equipment/supplies; and key outcomes and impact. It is also possible to model travel time, referral networks, and other variables.

There are numerous maternal mortality data sources. Some are population-based, such as civil registration vital statistics, census, health and demographic surveillance sites, and special studies (e.g., SMGL). Others may be institutional or facility-based, such as health facility surveys and Health Management Information Systems (HMIS). Reviewing facility-level maternal deaths is a good starting point.

There are several considerations when mapping. It is always important to look at the data source and consider its shortcomings. Is it population- or facility-based? If facility-based, what proportion of deaths is captured? What is the quality of the data? Is the geocoding facility- or district-level? Overall, there is a need for more standardized geocoding.

It is also important to consider who is going to use the map and who can generate it. If it is for district-level decision-making, who can produce it at the local level and how can capacity at the local level be supported? Are DHIS2, ArcGIS, or modeling required? The resources and time needed to create maps and how the data are used always need to be considered.

As we move forward in a post-2015 agenda world, we need to consider the evidence we have on how maps are used for different contexts, the added value of mapping, and the next steps to ensure the best return on investment.

Recommendations need to be framed in terms of how we can make the best use of resources and information:

- Which outcomes are most appropriate for mapping?
- What types of maps are needed for different levels of decision-makers (district, national, global)?
- How to build capacity to develop maps?
- What are next steps for short, medium, and long term?

Presentation: Assessing geographic access to skilled maternity care (emergency obstetric care [EmOC])

Presenters: Karin Stenberg, WHO; Steeve Ebener, WHO Consultant

Summary and Lessons Learned

WHO is supporting the mapping of maternal health services as part of efforts related to supporting national health planning, in the context of operationalizing the United Nations (UN) Secretary General's strategy for women's and children's health. Access to EmOC was assessed in four countries—Burkina Faso, Cambodia, Lao PDR, and Malawi.

This effort links several dimensions that influence the accessibility to care and, in the longer run, mortality and morbidity outcomes. The analysis links population data on births (number, distribution) with specific health services/interventions (here EmOC, identified with specific facility location coordinates), through data regarding the landscape terrain and traveling time from the household to the facility, transportation modes, and available resources within the health care centers (material and human resources)— all within a GIS.

An assessment of how current systems are equipped to deal with population needs and how pregnant women have access to the current health care infrastructure can:

- Provide evidence on health system barriers to care from the supply perspective (accessibility constraints and infrastructure) and their implications for expanding universal access to maternal health services
- Inform policy discussions on how to optimize/target spending of the "marginal dollar" for maternal health at country level
- Provide guidance on financial resource requirements for different scenarios aiming at expanding access to health services

The analysis draws upon the Tanahashi framework to evaluate two aspects of coverage of EmOC services: 1) accessibility coverage, i.e., "what EmOC is physically accessible within 2 hours' travel time"; and 2) EmOC geographic coverage, or "what EmOC is available," i.e., what percentage of the geographically accessible facilities have the capacity required for the estimated caseload within a two-hour travel zone. Further analysis is undertaken to compare the percentage of the population with geographic access to EmOC services with the actual use of services.

Geospatial data collected included the location of facilities, administrative boundaries, the water network, the road network, population distribution, land cover, and a digital elevation model (DEM) for elevation. Statistical data were gathered from censuses and projections, facility-level data, Demographic and Health Surveys (DHS), and health information systems.

The analysis makes use of AccessMod, which is a WHO-supported GIS extension that works with ESRI ArcGIS platform to perform additional analytical functions, such as examining the capacity of each facility to deliver services in relation to a particular travel time, and running scale-up scenarios. These are important functions related to strategic planning and forecasting of population health needs.

AccessMod is freely available at http://www.who.int/kms/initiatives/accessmod/en/.

The maps that are produced allow an evaluation of accessibility and geographic coverage, and identification of inequities in access across regions within a given country.
The comparison with data on actual service utilization allows for analysis of potential barriers to care-seeking behavior. For example, in the countries studied, a large number of unattended home deliveries occur in areas that have good EmOC accessibility coverage with enough capacity.

Maps are being used to: 1) inform Ministry of Health (MOH) planning units, 2) demonstrate GIS value added as part of health planning and as an approach for modeling resource requirements for different scenarios in the context of universal health coverage, and (3) engage interest in the use of GIS to assess inequities and health system constraints. This type of mapping is relevant for both 2015 and post-2015 initiatives to promote informed strategic planning and equity in health care.

Lessons learned:

- There is a need to build local GIS capacity for continuous analysis (the process has started in the countries concerned, but further support is needed).
- There is added value in making available an open access version of AccessMod (currently ongoing).
- There is a need to revise global benchmarks for EmOC availability, i.e., to move away from simple population density ratios toward an assessment of accessibility measured in travel time.

Note: The model used a norm that women should be able to access EmOC within 2 hours of travel time. The main scenario used was that women would walk from their homes until the road network was reached and, after this, travel at a certain speed with a motorized vehicle to an EmOC facility. For women with complications requiring comprehensive EmOC, the model allows for an additional 2 hours of travel time from BEmOC to CEmOC.

Presentation: Example of census data – Ghana

Presenters: Zoe Matthews, University of Southampton; Andy Tatem, University of Southampton/WorldPop

Summary and Lessons Learned

Maternal deaths were mapped in Ghana using census data for the numerator and denominator. The census was conducted using a short questionnaire in a face-to-face interview. Not all countries collect maternal death data in the census, but recently 21 African countries, 10 Asian countries, six Latin American countries, and one country from Oceania did. Questions included in the census are intended to ascertain if any women of reproductive age (WRA) had died during pregnancy or within 6 weeks after giving birth. Census data yield information on pregnancy-related deaths (all deaths occurring during pregnancy and the postpartum period) rather than maternal deaths (deaths occurring during pregnancy and up to 6 weeks postpartum from any cause related to or aggravated by the pregnancy or its management, but not from incidental causes). As a result, true maternal deaths may be overestimated; however, this overestimation may be compensated by the fact that some pregnancy-related deaths (e.g. from induced abortion) may not be reported. In addition, the number of reported births and deaths during a census is usually biased (downward) because of the periodicity of the census.

Census data may be used to estimate the Pregnancy-Related Mortality Ratio (PRMR), which may serve as a proxy for maternal mortality if a country has poor birth and death registration. To calculate the PRMR from census data, the following adjustments are required:

PRMR = (A x B)/C x 100,000

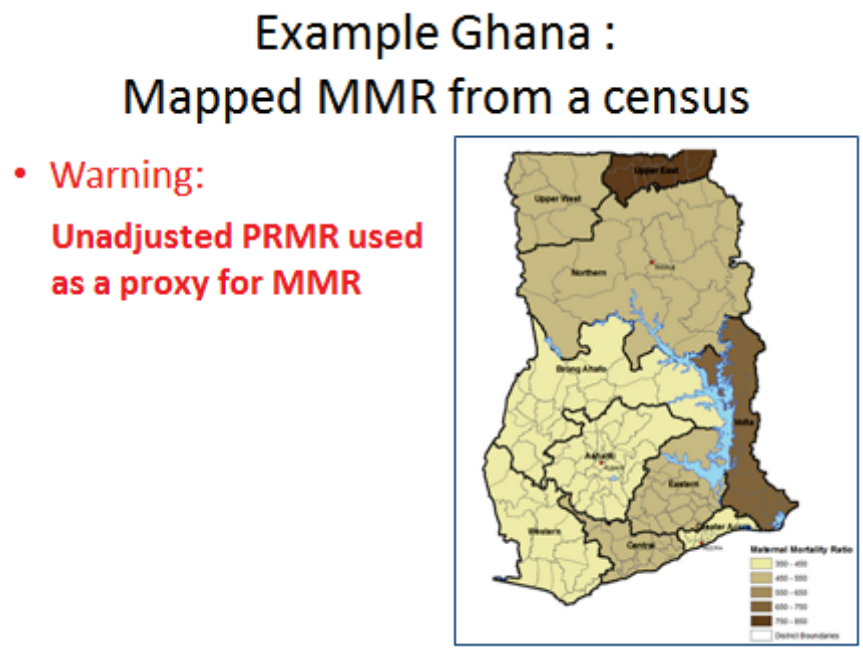
A. Female deaths (15–49) –Mortality must be adjusted using the growth balance method
To evaluate how well reported deaths cover the population, the general growth balance (GGB) method is used. The GGB is derived from the demographic balancing equation: the growth rate of the population equals the difference between its entry and exit rates. This requires two census counts from which age-specific growth rates can be calculated.

B. Proportion of female deaths that are pregnancy-related
No formal method exists for evaluating accuracy of pregnancy-related deaths. However, pregnancy-related deaths should approximately follow the fertility pattern of women because the risk of dying during or shortly after pregnancy is related to the proportion of women who were pregnant during the period for which data were collected.

C. Reported births – Births must be adjusted using the P/F Ratios
P = average parity (cumulated lifetime fertility) of a cohort of women up to a given age;
F = cumulated age-specific fertility rates. The ***P/F ratio*** method expresses these two quantities in relation to each other in the form of a ratio for each age group and attempts to assess the completeness of birth recording.

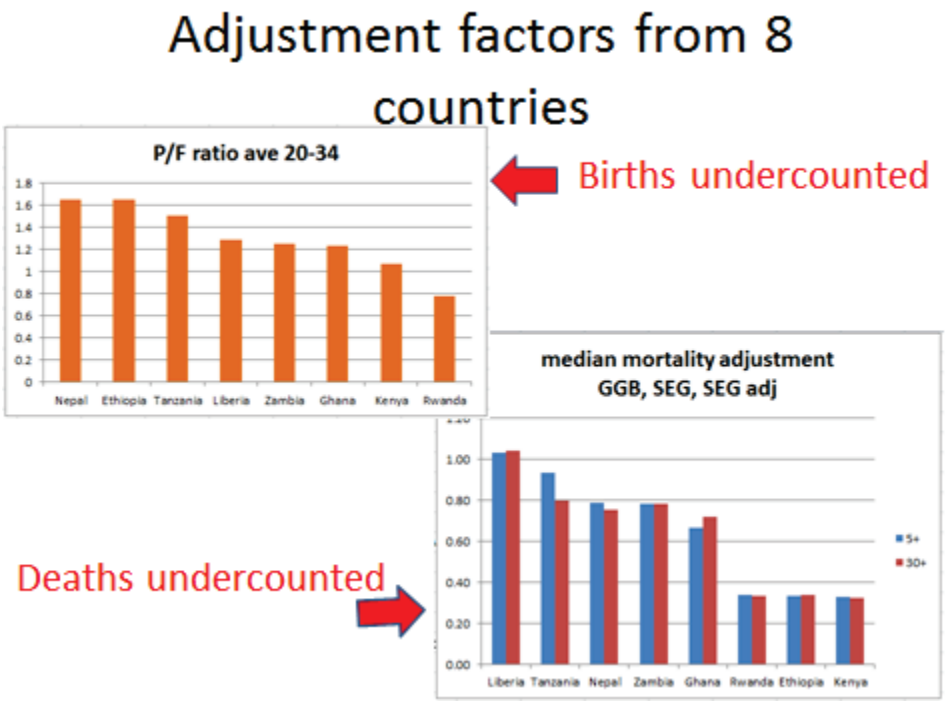
In Ghana, the "maternal mortality ratios" (MMRs) were calculated using census data and then mapped. This map (see Figure 1) was published as part of the census, but these data were not adjusted. From this mapping exercise using unadjusted data, it appeared that maternal mortality was highest in the northern part of the country.

Figure 1. Example of Mapped Maternal Mortality in Ghana



After adjustment, however, the highest PRMR was actually in the Greater Accra region. In Accra, there are many WCA, which affects assumptions when making adjustments. Recently there was a conference of eight countries, including Ghana, that have maternal mortality (MM) questions on the census to discuss how to make adjustments. In general, adjustments had to be made because of underreporting of births and deaths (see Figure 2).

Figure 2. Data Adjustment Factors from Eight Countries



It is also possible to disaggregate data by urban/rural residence and age of the woman. After adjustments are made, the pregnancy-related deaths are quite high—higher than WHO estimates. The software used is a WHO spreadsheet and the analyses used are described in the WHO booklet.

There are problems with census data, but these data are available in many countries and we can use them to map the big picture and understand the current situation to assist in developing the post-2015 agenda.

Lessons Learned

- We need to use census-collected maternal/pregnancy-related death data in a different way.
- A suggested way forward is to do modeling based on better subnational denominator data.
- We should look into using census data on PRMR as one database to construct geostatistical surfaces of MMR.

The WorldPop project was initiated in October 2013 to combine the AfriPop, AsiaPop, and AmeriPop population mapping projects. It aims to provide an open access archive of spatial demographic datasets for Central and South America, Africa, and Asia to support development and health applications.

There are two approaches for high-resolution mapping of denominators: bottom-up, where census data are outdated/unreliable and it is necessary to integrate high-resolution settlement mapping with survey data to produce population estimates independent of census data; and top-down, which uses disaggregation of administrative unit-based census/official estimate counts.

Many countries have good census data, but some do not. For example, the last census in the Democratic Republic of Congo was in 1984. Vietnam is an example of a country for which detailed and contemporary census data exist, making it possible to map population at fine spatial detail through the disaggregation of administrative unit-based census counts to 100 x 100 meter grid cells that are not limited by administrative boundaries. When census data are outdated or unreliable, as in Nigeria, and estimates of population age structures are required, geostatistical approaches can be used to construct detailed data layers representing estimates of, for example, WCA per 1x1 km grid cell.

WorldPop is working with the Bill & Melinda Gates Foundation to determine whether satellite data can be used to identify communities and estimate numbers of residents where no census exists.

Gridded population estimates make it possible to create maps that link the location of health facilities to key denominators, such as number of births, to assess whether needs are being met, intervention coverage equity, or more advanced spatial analyses. New data are available that make it possible to track shifts in population. For example, in Namibia it is possible to map how population density changes month to month by tracking anonymized call data records.

More information is at www.worldpop.org.uk and www.flowminder.org.

Presentation: Example of facility survey data – Mozambique

Presenters: Patsy Bailey, FHI 360; Kavita Singh, MEASURE Evaluation/University of North Carolina, Chapel Hill

Summary and Lessons Learned

In 2007–2008 the Mozambican Ministry of Health led a national health facility assessment to identify gaps in maternal and newborn health services. The survey targeted a census of hospitals and high-level health centers and a 40% random sample of lower-level health centers. The mapping analysis was performed with data from 427 geocoded facilities. Merged with the MNH assessment facility data were other GIS layers including administrative boundaries, population, births, road networks, elevation, and ground cover.

The 2005 and 2013 MMRs were estimated as 680 and 480, respectively. Mozambique might be considered a country showing characteristics of stage II in the obstetric transition: high fertility and mortality, an increasing demand for services but a weak health system. Mozambique's further burden of communicable diseases may set it apart somewhat from other stage II countries.

Our series of maps begins by showing subnational differences in the magnitude of maternal mortality. The first map shows data from a verbal autopsy follow-up study to the 2007 census. Although only 213 maternal deaths were identified, they represent deaths that occurred in the community as well as in health facilities. The map suggests that maternal mortality is higher in northern provinces than in southern provinces. Kavita Singh and colleagues estimated that 55% were attributable to direct causes, 23% to malaria, and 18% were HIV-related.

The facility assessment documented 2,199 maternal deaths over the 12-month period before the survey, including a subset of 712 reviews of maternal deaths. The institutional MMR was estimated at 555, but unlike the population-based estimates, the map suggests more facility-based deaths occurring in facilities in southern provinces than in northern provinces. Almost two-thirds (65%) of the institutional maternal deaths were due to direct obstetric causes and 35% indirect, mostly malaria and HIV. As one moves from north to south, the problem of malaria diminishes while the opposite is true for HIV (prevalence is highest in the south). The percentage of maternal deaths where malaria and HIV were implicated or contributed mirrored these north-south patterns.

Two-thirds of the deaths occurred in hospitals and were concentrated in just six hospitals. Several of these six overlapped with the five hospitals that had a direct obstetric case fatality rate over 20%, suggesting poor quality of care upon arrival at the hospital and/or difficulties accessing care in a timely fashion. The final maps, in fact, reinforce underlying difficulties that pregnant women face in accessing health care; population-based cesarean delivery rates are low and the number of uterine ruptures high, especially in the north of the country. The spatial modeling shows that 33% of the population can reach a comprehensive emergency obstetric and newborn care (EmONC) facility within 2 hours, and only 53% within 4 hours.

In 2012, a second national assessment was conducted, targeting 947 health facilities. An updated series of maps will be forthcoming and is likely to show progress in reducing institutional maternal deaths. The extent to which progress has been made to address access and quality of care, as well as the health system's response to malaria in pregnancy and HIV-infected pregnant women, will be determined.

Lessons Learned

- Mapping is labor-intensive and requires high-level skills.
- GIS coordinates are sometimes hard to access.
- WorldPop data are a superb resource.
- We need greater public access to datasets that lend themselves to spatial analysis.

Questions and Answers (Q&A) on Country Maternal Mortality Mapping Experiences

After presentations by Jim Campbell; Allisyn Moran; Karin Stenberg and Steeve Ebener (Burkina Faso, Cambodia, Lao PDR, and Malawi); Zoe Matthews (Ghana) and Andy Tatem; Patsy Bailey and Kavita Singh (Mozambique), there was an opportunity for questions and answers. A summary of the discussion follows:

Question	Response
Q: Where did the 2-hour rule for travel time come from?	A: The 2-hour benchmark is based on a UN publication monitoring EmOC. It is loosely based on how long it would take a woman to die from postpartum hemorrhage. There is also evidence that a second delay of greater than 2 hours has been reported to be significantly associated with in-hospital maternal mortality.
Q: If we use live births as the denominator to calculate the maternal mortality ratio, as we reduce number of stillbirths, this number will be undermined and we will need something better.	A: Death over live births is problematic but it is the best we have right now. The real justification for using live births is that it is familiar and relatively easy. But it is an estimate that pregnancy will result in death, we don't have the number of pregnancies. It was pointed out that the MMR was always a ratio rather than rate, but it's inaccurate if you have twins, etc. Andy Tatem does estimate pregnancies so perhaps that can be used. MMR also undervalues family planning; avoiding a pregnancy is not captured.
Q: Since so many women die at home and are not captured in the institutional MMR, how useful is it? Also, don't all those adjustments that need to be made to census data just make them estimates?	A: Facility data are selective, but if measured over time it can show a trend; but it is problematic
Q: How can we get more real-time data on maternal death? There are long delays now.	A: In order to get more recent data, it is necessary to combine administrative, hospital, civil registration and census data. Another option is giving phones to community health workers (CHWs) to collect data that can be uploaded on a monthly basis. This cost-effective approach is regional at the moment, but operational and working.
Q: Data interpretation has been discussed, but how have the data been used to cause change? And what is the country-level capacity to use these data?	A: The Haitian system monitors EmOC facilities in an ongoing monitoring system. The data are reacted to as they are reported and timeliness is there. This is an interesting application of GIS in a country.
Observations: • We map deaths, but there's nothing we can do about them. We should also map all the prevention processes that we can act upon to prevent deaths. • There needs to be a naming convention; 2 hours to EmOC, or EmOC Capable. There is a difference.	

Presentation: Experience from Mexico
Presenter: Juan Eugenio Hernandez Avila

Summary and Lessons Learned

The National Institute of Public Health of Mexico has developed an area of expertise in GIS applied to public health, in particular with the Mexico MOH to develop a GIS Web-based on vital statistics, administrative health records such as hospital discharge data, as well as other demographic and geographic data.

Geographic information has been used in public health since the nineteenth century, but the age of information technology makes map making and spatial analysis easier and faster. Using the Internet to gather and share information makes it more accessible in real time to all who need it with the appropriate resolution to support decision-making at the local, state, national and regional levels.

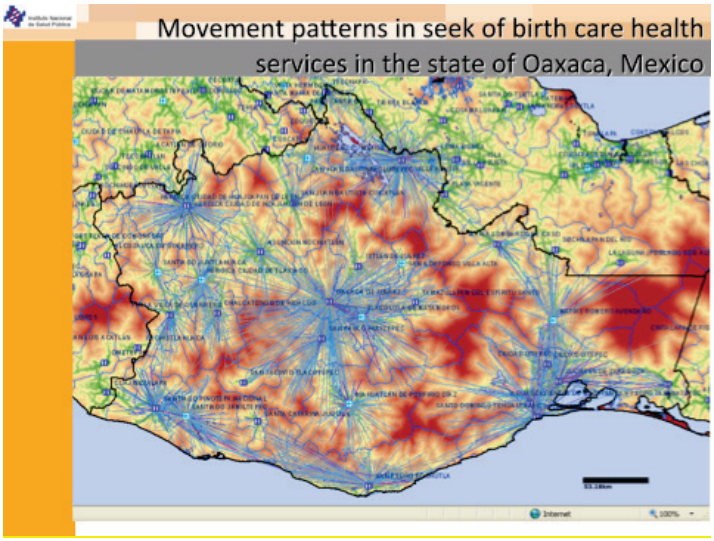
The information generated by the surveillance system must be accurate, timely, complete and consistent. It must also be relevant, useful and most of all accessible to anyone who needs it. Much of the data that needs to be integrated into a surveillance system comes from different agencies; data on populations may come from the census bureau and data from the distribution of health care clinics and hospitals may come from other institutions within the health sector.

GIS allows the integration of tabular data commonly used in epidemiology and public health to be translated into maps; these maps reflect the geographic relationships of health outcomes and the distribution of risks or other health-related information such as the distribution of health care infrastructure.

The maps produced by GIS are not only figures; they represent a series of complex queries to the databases that support them. A GIS system is in fact a relational database system that operates with common index variables to relate information in different tables, but relates each record in the database to a cartographic feature (points, lines or areas) in the maps. GIS organizes geo-referenced information in layers according to their geographic locations, making it is possible to perform data analyses and queries based on the location of the features in each layer and thus generate new variables based on their geographical relationships.

Geographical models were developed to estimate the travel time from each location in the country to the nearest health facility. Health facilities were classified according to their capacity and type of services provided, as well as the institution. Hospital discharges were also mapped according to the place of residence of the mother (patient). Spider graphs were produced to depict the movement patterns between place of residence and the hospital where the services were demanded, making it possible to see how people move from rural areas to urban areas in search of birth care services. Vital statistics (birth registry) data were also mapped in this way (see Figure 3 below).

Figure 3. Example of Map Showing Movement Patterns for Birth Care, Mexico



Being able to map travel to meet the demand for EmOC helped advocate for the need for more EmONC services closer to home by demonstrating that many women were travelling 8 or more hours for care. Mapping helped decision makers promote universal EmONC. Women can now get these services in any hospital in Mexico. Mapping also enabled the identification of hospitals that provided EmONC services but were not used.

Web-based GIS applications allow data integration and use of information in all governmental levels (local, state, national). They provide a common framework to gather and share information, data input can be done over the Internet to a common database or through use of distributed databases, data are accessible to all who need them as soon as they are entered, and the training curve is less steep.

Users of the Web-based GIS surveillance system access it using a Web browser (such as Internet Explorer) and an Internet connection. If there is a query for a map, it translates that into a command understandable by the map generator, which in turn obtains the appropriate data from the database servers (tabular data and cartographic data) and produces the map. The map is returned to the Web mapping application as an interactive image and it is then served to the user through the Internet. The user receives the map and can interact with it to request new information or analysis.

Lessons Learned

We need:

- Technology transfer, e.g., capacity building, to countries in the Mesoamerican region
- Development of human resources
- Information technology and communication infrastructure
- Establishment of the basis for a unified epidemiological surveillance system in the region, a Web-based GIS with distributed databases (one per country)
- Replication of a set of indicators for all the region

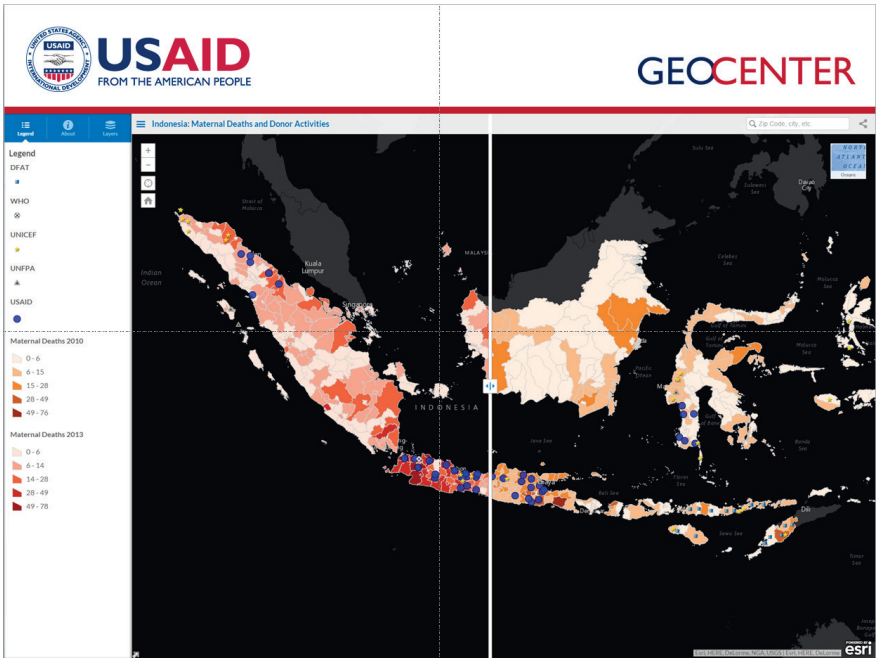
Presentation: Example of Mapping HMIS data – Indonesia
Presenter: Patrick Gault, USAID GeoCenter

Summary and Lessons Learned

The goal of the GeoCenter is to improve the effectiveness and efficiency of USAID's development programs by geographically prioritizing resources where they will maximize development impact. The GeoCenter team works directly with field missions and Washington-based bureaus to integrate a geographic approach into the strategic planning, design, monitoring, and evaluation of USAID's development programs. The GeoCenter currently supports a USAID GIS Community of Practice that includes 27 Mission-based GIS specialists and over 430 staff who have received GeoCenter training.

The GeoCenter was invited to the Technical Consultation to demonstrate the value of visualizing routinely collected HMIS data for improved decision-making and geographic awareness of maternal health indicators. By coordinating with the USAID/Indonesia Health Office and the Mission's GIS Specialist, the GeoCenter created a Web map displaying several data layers: 2010 and 2013 maternal death by district using HMIS data from the Indonesia MOH and the location of health activities being implemented by different donor organizations (see Figure 4). Mapping and analyzing these data over time provide valuable insight in a range of decision-making processes such as planning, monitoring, and evaluating health interventions as well as facilitating donor coordination. Adding additional layers of data that represent other sector-specific interests to this type of map can serve as an extremely powerful tool for achieving integrated and place-based development.

Figure 4. GeoCenter Map Showing Layers of Data, Indonesia



Lessons Learned

Lessons learned from the mapping experience in Indonesia include:

- There is a need for routinely collected, standardized data.
- While this approach may seem obvious to those familiar with maps and geographic data, there is still a need to demonstrate this type of approach to incentivize data collection and dissemination.

Presentation: Saving Mothers Giving Life Initiative: Experiences with mapping maternal deaths

Presenter: Florina Serbanescu, Field Support Branch, Division of Reproductive Health, Division of Reproductive Health

Summary and Lessons Learned

To address the challenging problem of maternal mortality, the Saving Mothers Giving Life (SMGL) initiative was started in 2011 through a public-private partnership. It aimed to rapidly reduce maternal deaths using multifaceted health systems strengthening approaches at the district level. It was based on pre-existing, well-developed, and well-defined platforms in-country: the President's Emergency Plan for AIDS Relief (PEPFAR) and MCH platforms in the four districts in Uganda (Kabarole, Kamwenge, Kibaale, and Kyenjojo) and four districts in Zambia. Hillary Clinton officially launched the initiative in June 2012. The overarching goal is a 50% reduction in maternal mortality.

Phase 1 of SMGL, which occurred from 2011 to 2013, was described as a "big push" with a rapid startup and implementation. During Phase 1 (June 2012–May 2013), the SMGL initiative implemented interventions to strengthen district health systems in four districts each in Uganda and Zambia. By adding eight more facilities with surgical capacity, it reached a sufficient number of EmONC facilities per 500,000 population in each district and a more equitable distribution of these services.

Approximately half of all women in sub-Saharan Africa deliver at home without skilled care and timely access to emergency services; this puts them and their newborns at increased risk of dying from pregnancy-related complications should they arise. The SMGL initiative focuses on reducing maternal deaths when these emergencies occur, by addressing the three delays:

- Delays in deciding to seek appropriate care
- Delays in reaching care (vouchers were successful)
- Delays in receiving timely, quality care at the facility

The partnership works to address these issues in a number of ways:

- Raising awareness and mobilizing communities to encourage more women to seek facility births
- Facilitating access to facilities, through enhanced communications, transportation, and referral networks
- Improving quality of care through supporting the training of health care providers, community midwives, and other health workers by improving facility infrastructure, and by procuring needed supplies

Phase 1 results are as follows:

- Decline in facility-based MMR:
  - By 35% in facilities, from 534 to 345 maternal deaths per 100,000 live births (Uganda)
  - By 35% in facilities, from 310 to 203 maternal deaths per 100,000 live births (Zambia)
- Decline in population-based MMR by 30%

SMGL partners measured facility-based maternal mortality at the baseline and endline of Year 1 using a Rapid Ascertainment of Pregnancy-Induced Deaths (RAPID) methodology. SMGL partners also measured community-based maternal mortality at the baseline and endline of Year 1 using a retrospective Reproductive Age Mortality Study (RAMOS) methodology; they also established a community maternal death surveillance and response (MDSR) system to monitor the change in maternal deaths in real time and recommend immediate actions (verbal autopsies [VAs]). Both the RAMOS and MDSR built upon and expanded the existing community health information system established by the MOH and were centered on CHWs organized in village health teams (VHTs). Through the SMGL initiative, over 4,000 VHTs were trained to screen for deaths associated with pregnancy and conduct VA interviews. There is one for CHW for 100–300 households, to identify any deaths of WRA. Data were collected during routine monthly monitoring visits. All parish VHTs met regularly to submit their reports on WRA deaths that occurred in their communities and discuss routine activities related to demand creation and community mobilization that they had undertaken during the previous month. Their reports were compiled and submitted to the sub-district health coordinators.

A VHT member visited each household in his or her village to ask if any women had died during a specified period of time, and to find out if any of these women had been pregnant at the time of death or in the preceding 3 months. All deaths reported by VHTs were followed by household visits conducted by two-person teams of health and development workers (one team per sub-district). The interviews were conducted approximately 6–8 weeks after the death. Supervisors reviewed completed questionnaires and submitted them to trained physicians to assign cause of death (COD) using the tenth revision of the International Classification of Diseases (ICD-10). Two trained physicians assigned each COD independently, with a third physician reviewing causes that required reconciliation.

When a maternal death was reported in RAMOS but not identified through facility-based reviews, it was added to the enumeration of facility-based maternal deaths. This improved the case detection of facility maternal deaths and accounted for changes in the notification and reporting of maternal deaths in medical records. Of note, SMGL has promoted the importance of routine maternal death notifications and audits, and the facility reporting of these deaths greatly improved between the SMGL baseline and endline.

The MDSR Verbal Autopsy questionnaire collects detailed information on circumstances and factors contributing to death; antenatal, delivery, and early postnatal care information; medical histories; patterns of accessing health care services prior to death; and delays in accessing care. It also collects Global Positioning System (GPS) coordinates of each household that has experienced a maternal death. Information from the VA is not well-recorded and not used in the final analysis; GPS data were used only for estimating travel time.
In Uganda, SMGL undertook a separate analysis of the population coverage of health facilities, going beyond a simple approach that uses a straight-line distance (typically a 10- or 15-km radius around each facility). Actual landscape and the availability of different means of transport were taken into account for detailed measurement of geographical access to obstetric care at birth.

Improved comprehensive emergency obstetric and newborn care (CEmONC) reduces most mortality. We used WHO's AccessMod program to estimate the length of time to reach health services (modeled for the effects of motorized transport) and the population coverage of EmONC. AccessMod takes into account important factors that impact on travel time: Terrain (slope, topography), land cover and physical barriers (e.g., lakes, rivers), and transportation networks (walking, motorized vehicle). It allows for more realistic estimates of travel time to health facilities than GIS straight-line distances and produces estimates of

population coverage and accessibility. In our analyses we assumed that women walk across rugged terrain (slope/landcover) to roads where they can get transportation to maternal services.

First, we mapped the location of facilities through GPS coordinates during health facility assessments. Next, steepness of terrain and vegetation were mapped. Walking through thick vegetation is slower than walking through farmlands and pasture. Integrating these maps, we were able to estimate the travel time to CEmONC facilities.

Before the SMGL intervention, only 30% of births were to women who lived within 1-hour (dark green color) and 62% within 2-hour (light green color) travel time of seven existing CEmONC facilities. This proportion increased to 44% (1 hour) and 77% (2 hour), respectively after nine more hospitals and health centers were upgraded to provide CEmONC care. Improvements in geographic accessibility to CEmONC services were primarily the result of upgrading health centers to perform obstetric surgeries. In addition, subsidized transport vouchers for motorcycles were provided for communities with poor accessibility to EmONC facilities.

Maps were used primarily for local response:

- Facility upgrades to improve access to basic and comprehensive EmONC
- Placement of maternity waiting homes
- Subsidized transportation vouchers in three districts
- One district allocated resources for building a bridge that helped connect several communities with high mortality rates to the main road

There are currently plans to conduct rigorous remapping of all communities and include their GPS coordinates into the mortality surveillance database for modeling.

Lessons learned and Recommendations

- The correct geo codes are needed for accurate mapping.
- Mapping and geographic analyses should be planned and executed early in the project and inform implementation.
- Verbal autopsy collected GPS coordinates for each maternal death, but quality was poor; analyses of the effect of distance to EmONC on mortality were planned but are still pending.
- Continuous supervision and quality assurance of the SMGL maternal mortality surveillance system are needed.
- GPS coordinates of each locality should be verified by the Monitoring and Evaluation personnel.
- Estimates on population density will be updated with the data collected during the endline mini-census (population and WRA enumeration).

Presentation: Mapping adverse maternal outcomes and associated determinants in Gaza and Maputo Provinces, Mozambique

Presenter: Prestige Tatenda Makanga, Co-Principal Investigator, Mapping Outcomes for Mothers (MOM), PhD Candidate in Health Geography at Simon Fraser University

Summary and Lessons Learned

The Mapping Outcomes for Mothers (MOM) in Mozambique is part of the PRE-EMPT initiative (http://pre-empt.cfri.ca/), which consists of five interrelated objectives to be conducted over a 7-year period (November 2010–October 2017) in collaboration with the Manhica Research Centre in Maputo, Mozambique. The theme of PRE-EMPT is to develop, test, and introduce new knowledge that will reduce the unacceptable maternal, perinatal, family, societal, and global impacts of pre-eclampsia and the other hypertensive disorders of pregnancy. One part of the initiative is the Community-Level Interventions for Pre-Eclampsia (CLIP). The project uses mini - Pre-eclampsia Integrated Estimate of RiSk (miniPIERS) to identify women at risk of mortality and requiring immediate transfer to a facility (within 4 hours–1day), and establishes links between communities and facilities to measure maternal deaths. All cases suspected to be maternal deaths are investigated using a verbal autopsy. The outcomes collected from both the facility and community are used for spatial modeling of community risk factors, comparing socio-economic, geographic (e.g., flood risk), and health systems-related variables to the occurrence of adverse maternal outcomes.

MOM has developed a mobile health application (MOM app) to run on a smartphone for use by CHWs to predict local maternal risk and recommend strategies that could work based on what is known about the environment where the pregnant woman lives. Health systems and services factors and certain social and environmental variables inform individual maternal risk. The MOM app will avail place-specific information of community-level risk factors to CHW in the field and link pregnant women to local resources (e.g., emergency transport, community support groups). Ultimately, the goal is for data from MOM to inform targeted intervention.

GPS-enabled tablets are used as part of household surveys where WRA and pregnant women are identified in the community. Software used includes Open Data Kit Collect, Open HDS, and ArcGIS desktop and ArcGIS Server. Analyses used include Network Analysis (Closest Facility, Routing, and Service Area), and Geographically Weighted Regression.

High-resolution neighborhood coordinates pull together information from other sources. To understand transport systems, roads were digitized at the community level and classified as major/minor, paved/unpaved, and trails. Flooding greatly impacts the transportation system and, in some cases, results in totally isolated communities that cannot access EmONC facilities, so MOM investigates the impact of this variable on the maternal outcomes.

Data are starting to be used in the following ways:

- Use of the data can help CHWs with their field navigation.
- Transport to CEmONC facilities can be improved by identifying communities that have transport-related needs
- CHWs will know barriers to access, such as education and transport, and recommendations for addressing them.
- Targeted interventions can be designed at the household and community levels based on mapping results.

Lessons Learned

- Collaboration with mapping agencies is essential to sustain and scale up mapping efforts.
- Coordinated mapping practices are needed to reduce duplication of efforts.
- Local Spatial Data Infrastructure initiatives need to be strengthened.

Q&A on Country Maternal Mortality Mapping Experiences

After presentations by Juan Eugenio Hernandez Avila, Patrick Gault, Florina Serbanescu, and Prestige Tatenda Makenga, there was an opportunity for questions and answers. A summary of the discussion follows:

Question	Response
Q: In Mexico, was the mapping linked to the other process (confidential inquiry) that is under way? How certain are we of this information if we know that elsewhere there is underreporting of maternal death?	A: We are concerned about this too. We use the RAMOS approach to find as many deaths as possible, but agree that more needs to be done to register deaths. National Institutes of Health in Mexico has agreements with the Census Bureau, Institute of Statistics, and the army. It is an effort to compile all the information, but there are definitely caveats. When we match data sets from various sources we can sometimes fill in gaps—can sometimes see problems through the inconsistencies between systems.
Q: Was the research team that did the study in SMGL separate from the implementation team?	A: No, data were collected as part of the program initiative; it was not an external evaluation. We tried to count as many women as possible of reproductive age and we believe we counted the majority of maternal deaths. We estimate higher rates than those estimated by WHO or the government. We had 4,000 data collectors working on a population of 2 million.
Q: How was capacity built in Mexico to be able to do this? How frequently are the data updated?	A: The National Institute of Public Health has been working on GIS capacity since 1997. In 2005, data became more available because of some health projects. Mortality data are integrated every year; census every 5 years; roads every 4 years. Regarding capacity building—the Institute developed a Web-based application that is easy to use and trained 32 state managers. The Institute works with advocacy groups to improve data. The bad news is that with the change of government, work has stalled. The Federal level has to revive it.
Q: In SMGL you have cause of death for community-based and facility. Are they the same?	A: Causes are the same but magnitude of change is different. We are looking at concordance of causes of death.
Q: SMGL used paper data collection, but using more high-tech approaches provides better accuracy and affordability over time. And you can monitor your monitors.	A: In Uganda, the health facility assessment was done using PDAs (personal digital assistants) but there were so many complications it was not supportable. There are things that happen in interviews with paper and pencil that are not possible in electronic form.

Question	Response
Q: Who has worked with the private sector? Social insurance companies are springing up. Is it possible to use any of their data to get a bigger picture?	A: In Mexico, 25% of births are in private hospitals. The government is working with insurance companies, but also wants a public health approach. South Africa launched Mom Connect, a unique ID for pregnant women linked to insurance. The system engages all the partners in health service provision. This may provide a precedent to look into. SMGL in Uganda works with PACE and Marie Stopes and those data are incorporated into GIS. They are trying to take a systems approach in a geographic area, so any clinic that says it does deliveries is included in the network. Maps will show where services are available, whether they are public or private.
Q: How many maternal deaths are there in a population of 2 million?	A: 300

Presentation: Web-based maternal mortality surveillance system—Colombia

Presenter: Joaquin Gomez, Facultad de Medicina, Universidad de Antioquia, Colombia; Director, Center Nacer in Sexual and Reproductive Health, Universidad de Antioquia

Summary and Lessons Learned

Colombia's Web maternal mortality surveillance system has been led by the MOH and the National Institute of Health, in partnership with the Pan American Health Organization (PAHO), WHO, led by the Colombia Representation in collaboration with the Regional Office (the Latin-American Center for Perinatology, Women and Reproductive Health (CLAP/SMR)) and WHO/Headquarters (Department of Maternal, Newborn, Child, and Adolescent Health), and The Sexual and Reproductive Health Center Nacer of the University of Antioquia, with the sponsorship of USAID.

The surveillance cycle is a process that allows for case identification, data collection, and analysis that will inform recommendations and interventions, which when implemented, require monitoring and results evaluation.

This tool responds to differing needs in the country for the public health surveillance of maternal death. It has a hard-copy format and will be implemented in those basic facilities that do not have computer or Internet access.

A desktop format will be use in basic facilities with limited or no Internet access. These facilities will use a local computer application that forms part of the MM surveillance system.

Facilities, cities, and states with Internet access will use a Web-based format.

The primary purpose of the surveillance system is to obtain better information for decision-making. The system consists of seven modules and two sub-modules.

- Module 1. Reports of deaths in women between 10–54 years old aim to identify all deaths of WRA and maternal deaths according to pregnancy history and death causes. This module has helped to improve the sensitivity to identifying maternal death cases.
    - Sub module 1. Negative Notification aims to demonstrate that all steps for active case finding of maternal deaths were completed by the facilities.
- Module 2. Notification of maternal deaths confirmed. Once a maternal death is confirmed, it is reported formally to public health authorities.
    - Sub module 2. Maternal Deaths Notification from other sources. Aims to report confirmed or suspected maternal deaths cases among women 10–54 years old that lack a death certificate or identification document or both.
- Module 3. Pregnancy verification. When a maternal death cannot be confirmed or ruled out using the clinical history, data are verified to confirm or rule out history of pregnancy in the year prior to her death, through the interview of relatives or friend.

- Module 4. Family interview/verbal autopsy. Once maternal death is confirmed and reported, a "family interview" is conducted to collect personal, family, and social data of the deceased woman, as well as a reproductive history and details of past health events that may be related to the death cause.

  When a maternal death occurs outside the hospital or cause of death information is not available, in addition to the family interview, a "verbal autopsy" must be done.

- Module 5. Clinical care of the deceased dead woman. This module is completed whenever the maternal death occurred in a health facility.

- Module 6. Case summary and technical report. The case summary is an automated report generated by the Web platform. It describes the main women, family, community, and health system determinants. It includes relevant data from the prenatal and delivery care, and summarizes the care received during the final event that led to death. It includes analysis of the care provided and conclusions to classify the maternal death and to corroborate the causes.

- Module 7. Action plan. Recommendations and interventions are a list of the major factors and situations identified by the committee's analysis of which factors contributed to the maternal death and which interventions were identified as a priority to prevent additional deaths from occurring under similar circumstances.

The surveillance system is in the process of expanding throughout the national territory.

Lesson learned: Need to improve the generation of action plans from individual and grouped analysis that are conducive to strengthening and improving decision-making at the institutional, municipal, state, and national levels.

Presentation: Improving resource allocation for HIV programs using geospatial tools in Iringa, Tanzania

Presenters: John Spencer and Marc Cunningham, Senior Geospatial Technical Specialist, MEASURE Evaluation

Summary and Lessons Learned

When there are strong data and effective data products, better decisions can be made. In Tanzania's Iringa region, maps and geospatial data proved to be important tools for regional planning for HIV programs. Over the course of 2 years, MEASURE Evaluation worked with local authorities in the Iringa and Njombe regions of Tanzania to collect data and use GIS to produce data products that led to better insight into HIV transmission and effective programmatic responses.

GIS was the keystone to an integrated, cost-effective effort to collect data on HIV transmission dynamics and use those data to improve treatment options in the region. The project consisted of three basic steps:

- Collect data on HIV transmission and available services and build catchment-area specific estimates
- Assess and strengthen the ability of decision-makers to use/interpret data
- Build capacity in the use of GIS and data products for decision-making through workshops and mentoring

As a result of these steps, district health management teams were able to map the collected data, illustrate priorities for HIV treatment, and identify appropriate locations for new facilities and updating of existing facilities to offer new HIV services.

The approach used in Iringa has applicability in other countries and other programmatic areas. Criteria for successful transfer of the approach include identifying appropriate staff to possess GIS capacity and providing long-term mentoring, accurate assessment of data use capabilities, and effective dissemination of findings from data collection.

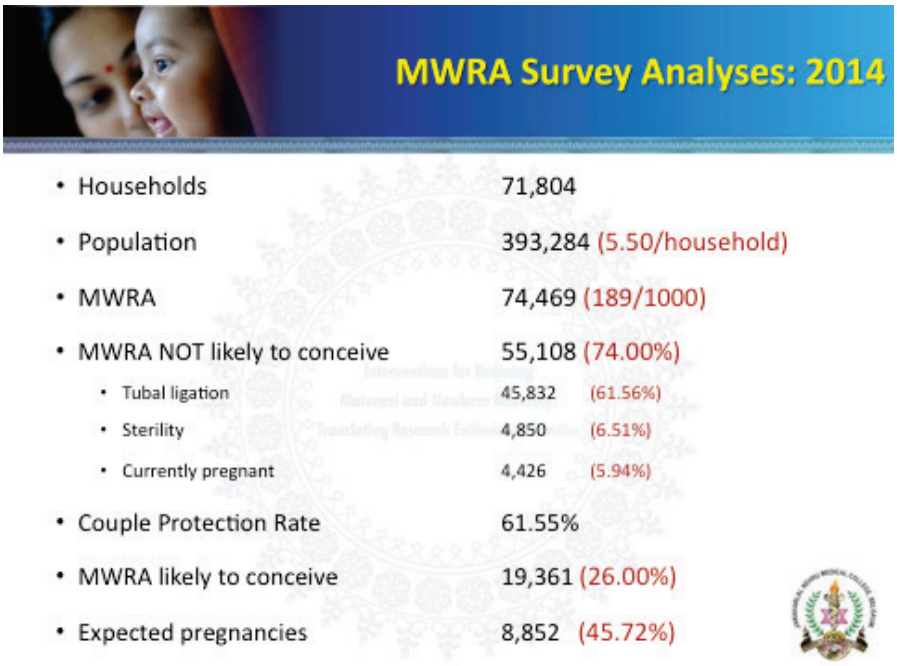
Presentation: Maternal Newborn Health Registry
Presenter: Narayan Honnungar, KLE University's JN Medical College

Summary and Lessons Learned

The Maternal Newborn Health Registry in India's Belgaum and Bagalkote Districts is a "Pregnancy Tracking System" established in 2008 to quantify and understand the trends in pregnancy outcomes in low-resource geographic areas over time, in order to provide population-based statistics on stillbirths and neonatal and maternal mortality.

The process starts with the Annual Household Survey of Married Women of Reproductive Age (MWRA), which was adapted from the MOH's Household Reproductive and Child Health and Eligible Couple Survey. It is conducted by Accredited Social Health Activist (ASHA)/Anganwadi workers and supervised by an Auxiliary Nurse Midwife and Registry Administrator. The survey enrolls MWRA, identifying women as currently pregnant, unlikely to conceive, or likely to conceive and uses the data to estimated expected pregnancy rates for the 24 clusters. The 2014 analysis estimates that there will be 8,852 pregnancies in 2015 (see Figure 5).

Figure 5. Sample Data from MWRA Survey, India



Using the pregnancy tracking system over time made it possible to map a reduction in maternal deaths from 39 in 2009 to 16 in 2014. In 2009, the MNH Registry study area included 20 clusters with a population of 648,436 and 20,000 pregnancy outcomes including 39 maternal deaths. In 2014, 18 clusters with a population of 388,235 and 11,714 pregnancy outcomes were captured, including 16 maternal deaths. The MM maps also made it possible to assess the distribution of maternal deaths in geographical areas and their relationship to health facilities, monitor trends of maternal deaths over time, and plan strengthening of health care services for reducing maternal mortality.

Using a perinatal registry provides population-based indicators of adverse pregnancy outcomes, associated risk factors, and trends over time; permits assessment of maternal and newborn care practices in communities and facilities; helps plan interventions to address mortality/morbidity unique to sites; and enables capturing the perinatal outcomes of Cluster Randomized Trials, pre-post studies, programmatic intervention, and changes in health care policy.

Lessons Learned

- Simplify annual household surveys to identify women who are "likely to conceive" and target services at the preconception period.
- Limit data collection to key variables to ensure quality.
- Regular monitoring, supportive supervision, and periodic refresher training are essential to sustain accuracy of data.
- Incentivize ASHAs and CHWs for early registration of pregnancies and tracking of the outcomes.
- Encourage health workers to capture and report adverse pregnancy outcomes honestly and accurately.
- The Maternal Newborn Health Registry model could form the basis for a national vital registry system.
- The processes employed could be adopted to strengthen the Mother Child Tracking System

Discussion with In-Country Experts

After presentations by Joaqin Gomez (Colombia), John Spencer (Tanzania), and Narayan Honnungar (India), there was a facilitated discussion. A summary of the discussion follows:

Facilitator: It is impressive that this is a national system in India. Tanzania had lots of examples of how the local-level managers used the data. Same for Colombia, and there is the prospect of being taken up by government. What is the biggest challenge in getting the government and local stakeholders to get involved and lend support?	**Panelists:** Frequent changes of authority are a big problem; it is very destabilizing. All of the data need to come to one central place, the MOH. People change all the time in the MOH, though, so you always need to recalculate how to move the system. The real challenge is convincing activists that the pregnancy registry is important. Politically, it is easy to mobilize the worst-off districts. In a less needy area, it is harder to mobilize. The issue of competing priorities makes it important to have the most influential people at the table at the right time. In order to get local governments to buy into using a HIV map, for instance, it was necessary to build the capacity for them to track other things they wanted to know about such as trash bin location.
Facilitator: What should we do about political challenges?	**Panelists:** The best way to involve the political people is to work with them. If they don't own a part of the problem, they will never be part of the solution. It is clear there is an incentive to map maternal mortality. This benefits the politicians, but it helps to have buy-in at higher levels to encourage buy-in at all levels. There is a political side, but it there is also a two-way exchange. The top-down strategy from the MOH falls apart when the administration changes. The surveillance system at the local level can work from the bottom up. The best way for a national surveillance system to survive is if it serves the people collecting the data.

Facilitator: It is impressive that this is a national system in India. Tanzania had lots of examples of how the local-level managers used the data. Same for Colombia, and there is the prospect of being taken up by government. What is the biggest challenge in getting the government and local stakeholders to get involved and lend support?	**Panelists:** Frequent changes of authority are a big problem; it is very destabilizing. All of the data need to come to one central place, the MOH. People change all the time in the MOH, though, so you always need to recalculate how to move the system. The real challenge is convincing activists that the pregnancy registry is important. Politically, it is easy to mobilize the worst-off districts. In a less needy area, it is harder to mobilize. The issue of competing priorities makes it important to have the most influential people at the table at the right time. In order to get local governments to buy into using a HIV map, for instance, it was necessary to build the capacity for them to track other things they wanted to know about such as trash bin location.
Facilitator: We clearly have an IT slant to this meeting. Data we get out are only as good as data we put in. Please comment on the technology angle—what is one thing you could tell us about that we would not otherwise know that went terribly wrong with the technology?	**Panelists:** This is the opposite of the question, but in Colombia, there are technical people and it is driven by the MOH, which works the best for an efficient system. In Tanzania, there were prerequisites for people who were coming to the training, but the disaster was using 2 of 4 training days for basic Excel and computer training.

Q&A with Panel of In-Country Experts

After the facilitated discussion with Joaqin Gomez (Colombia), John Spencer (Tanzania), and Narayan Honnungar (India), there was an opportunity for questions and answers. A summary of the discussion follows:

Question	Response
Q: How much did the HIV program in Tanzania cost? What is the cost-benefit?	A: We relied on the PLACE survey and low-tech GPS and cameras, etc. to keep costs down. The collection of the GPS coordinates was done during supportive supervision visits for the most part. So, it was not an additional cost. The presenter did not know the overall cost. In India, the survey costs 10 Rupees per person; so it is not a problem.
Q: Could you say that the Tanzania project had more resources because it was for HIV?	A: We did have more resources because it's under the HIV portfolio, but tied to that is not understanding where your services are and what they are; need to consider cost of *not* doing this work.
Q: For India, how do we get to a routinized system that is nationally adopted? Were your efforts in addition to the routine registers and state-level enumeration? Is this a refinement of these data elements? What did it take for you to make a convincing case to the state?	A: We use 1,000 population as the base. 60–70 women will get pregnant in a year. We are not collecting any additional data—just collecting minimum data and have simplified the data collection process.
Q: In India, you're doing pregnancy surveillance and tracking outcome—astonishing. How did you reduce maternal deaths from 39 to 16 over the years? Is there real improvement in maternal health, or a shift in data? How can you be confident?	A: We are confident there is real improvement in maternal health because we have been addressing quality at the health center level and there are big improvements in transportation.
Q: In Colombia, you have good data in the district—do you want it to be a national project?	A: The system has lots of steps. One step is that when a facility has maternal death it enters it into the system. At the same time this information goes to the state and national level and insurance. Everyone is alerted about the death. If the patient goes to the second and third levels, all levels need to add the information they have. Only the state has state-level information. Only the national level has all information. This is the integration of all levels. The state may have interventions similar to those of national level.
Q: India reduced the clusters to improve the quality of the data, but we'd like to know how the maternal mortality went down over time, apart from the size of clusters changing.	A: The improvement in the transportation system and quality of health services explains the reduction in MM.
Observations: • We are trying to track maternal mortality when a woman dies at the hands of a provider and find out who's to blame. When they do an autopsy, there needs to be separation between the providers and cause of death. Need a separation due to conflict of interest. • Need to consider what the political stake is for all stakeholders – why would they support it?	

Session 2: Opportunities to Integrate Into Existing Platforms/Innovations

Four presentations were given, which were followed by group work to catalogue lessons learned and recommendations for next steps. The presentations were: 1) Maternal Death Surveillance and Response; 2) Infectious Disease Surveillance; 3) Universal Registries/mHealth; and 4) DHIS2. Summaries of the presentations and discussion follow.

Presentation: Maternal Death Surveillance and Response (MDSR) Presenter: Matthews Mathai, World Health Organization/Geneva

Summary and Lessons Learned

Most maternal deaths are preventable. In order to end preventable maternal deaths, accurate information on how many women died, where they died, and how they died is essential, but is currently inadequate. The maternal death surveillance and response (MDSR) system is being promoted by WHO and partners to contribute to better information for action. MDSR is a continuous action cycle linking the health information system and quality improvement processes from local to national levels. It includes the routine identification, notification, quantification, and determination of causes and avoidability of all maternal deaths, as well as the use of this information to respond with actions that will prevent future deaths. MDSR builds on maternal death reviews and underlines the critical need to respond to every maternal death.

The goal of MDSR is to end preventable maternal mortality, and the focus moves from death reviews to surveillance with response to findings from death reviews. Objectives of the MDSR are: 1) to provide information that effectively guides actions to end preventable maternal mortality at health facilities and in the community; and 2) to count every maternal death, permitting an assessment of the true magnitude of maternal mortality and the impact of actions taken to reduce it. Currently the cause of maternal death is not available for many maternal deaths—to end preventable mortality, establishing the COD is essential.

The MDSR cycle includes surveillance and response. The following steps are part of the cycle and are directly related to accountability mechanisms: Identify deaths (vital registration) – Report deaths (MMR tracking)—Review deaths (quality of care measurement)—Response action (quality of care/quality Improvement initiatives). MDSR is important for the following reasons: 1) responding to calls for ending preventable deaths requires better measurement and better information; 2) it allows country ownership of data in real time; 3) it makes maternal death visible at local and national levels; 4) it provides information for action to prevent maternal deaths at local, health facility, and district levels; 5) it sensitizes communities and facility health workers; 6) it connects actions to results, permitting measurement of impact; 7) it is part of the accountability process; and 8) successful MDSR helps strengthen national civil registration and vital statistics, quality improvement, and other health information systems.

The WHO technical guide for implementing MDSR is: *Maternal Death Surveillance and Response: Technical Guidance. Information for Action to Prevent Maternal Death* and can be accessed at: http://www.who.int/maternal_child_adolescent/documents/maternal_death_surveillance/en/. To date, all 75 high-burden countries have been oriented through workshops, a global pool of experts has been developed, countries have prioritized MDSR in work plans, and country experiences are being documented and shared.

WHO is monitoring policy related to MDSR and found: 34 countries notify maternal deaths within 24 hours, which is a 79% increase; 53 countries review all maternal deaths, which is a 66% increase; 55 countries have facility-based death reviews; 30 countries have community-based reviews; and 20 countries have national committees that review maternal deaths every quarter.

It is expected that when MDSR is initiated there will initially be an increase in the number of maternal deaths due to improved surveillance, but this is generally followed by a decline. The example of Tamil Nadu, India, showed that this was the case. Data from the MDSR were mapped in Tamil Nadu and districts identified that had no decline and had the highest MMR.

Presentation: Integrated Disease Surveillance and Response (IDSR)

Presenter: Helen Perry, Centers for Disease Control and Prevention (CDC)

Summary and Lessons Learned

USAID's enduring support for CDC's work has been essential to its success. For the first two decades of the 21st century, communicable diseases continued to be the main cause of death, illness, and disability in the African region.

Integrated Disease Surveillance and Response (IDSR) is a comprehensive, evidence-based strategy for strengthening national public health surveillance and response systems in African countries. Effective and efficient surveillance and response systems contribute to reduced morbidity and mortality from disease outbreaks and other public health events (see Figure 6). IDSR had its beginnings in 1993, with the conception of International Disease Surveillance. In the mid-1990s, Africa experienced several devastating outbreaks of cholera, meningococcal meningitis, yellow fever, and Ebola, and, as a result, in 1998, Member States of the WHO Regional Office for Africa (AFRO) and their technical partners adopted IDSR for use in the region so that countries could better detect and respond to the leading causes of illness, death, and disability. Within Africa, IDSR is the agreed-upon framework for implementation of core capacities under the International Health Regulations (IHR) (2005).

IDSR's key components are:

- Use **standard case definitions** to identify priority diseases, conditions, and events
- **Report** suspected cases, conditions, and events **to the next level of the health system**
- **Analyze** and interpret data collected **(*including mapping*)**
- **Investigate and confirm** suspected cases, outbreaks, and events
- **Prepare to respond** to outbreaks and other public health events
- Coordinate and mobilize **resources** to respond appropriately
- **Provide feedback** within and across levels of the health system
- **Monitor and evaluate** the system and component activities
- Conduct operational research to inform better practices and processes

The net result of IDSR is that outbreaks are detected earlier and there is a more timely and effective public health response. Countries, like Kenya, use IDSR to generate weekly epidemiological reports. The infrastructure for surveillance in many low-resource countries relies on a range of capacities. The less technology available, the slower and more limited the analysis.

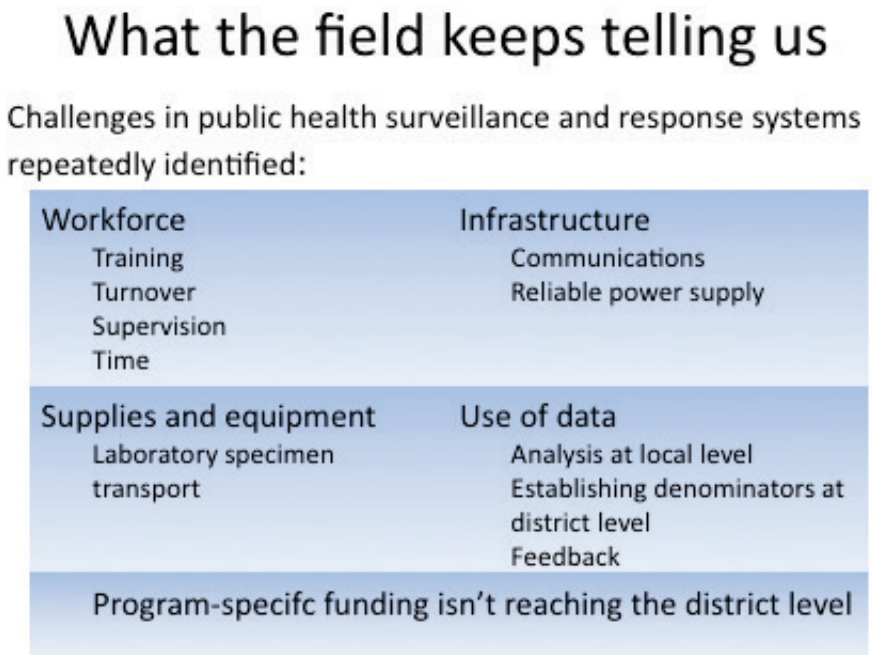
Maternal death is one of the indicators in IDSR, because half of maternal deaths occur in the Africa region. In addition to providing a standard case definition, the IDRS provides background information concerning maternal deaths, a surveillance goal, recommended public health actions, and guidance on analyzing and interpreting data.

A joint mission to Cameroon in 2014 to document how IDSR is working through the Maternal Death Surveillance and Response (MDSR) system made the following recommendations regarding joint planning

between the two systems: improve community-level detection and reporting of maternal deaths (village reporting); disseminate standard case definition for use across all levels and all facilities; strengthen analytic competencies with district-level staff, including standard operating procedures through IDSR; and implement clear feedback about MDSR data to all levels.

Lessons Learned

Figure 6. Identified Challenges in Surveillance and Response Systems



Presentation: The use of universal registries and mHealth systems (e.g., OpenSRP) for routine reporting of maternal deaths, service delivery, and vital events

Presenter: Garrett Mehl, Department of Reproductive Health and Research, WHO/Geneva

Summary and Lessons Learned

As countries strive toward universal health coverage, mobile wireless technologies—mHealth tools—in support of enumeration, registration, unique identification, and maintenance of health records will facilitate improved health system performance. Electronic forms and registry systems will enable routine monitoring of the coverage of essential interventions for individuals within relevant target populations. Country-level health information systems that enable national aggregate record keeping and low-cost, open-source robust systems such as District Health Information Systems (DHIS2) and Open Medical Record Systems (OpenMRS) have facilitated facility-level medical records.

Most of these innovations remain vertical in their approach, that is, addressing single problems faced by health systems. A cascading model can be used to facilitate prioritizing and operationalizing the role of integrated mHealth strategies by illustrating how health systems lose performance because of bottlenecks at successive levels, each dependent on the previous layer. A framework to help prioritize investments and opportunities for collaboration is vital, especially given the complexity of health systems, where the receipt of quality care by clients is often contingent on several preceding layers of enabling conditions. Knowing who is in need of services, having the necessary human resources and commodities in adequate supply, and connecting these together at the right time and place are elements critical to success.

A reproductive registry includes information on all individuals and their reproductive health data that accounts for services provided, health status, health and vital events, and service needs at individual and aggregate levels and provides mechanisms to facilitate appropriate action to realize universal coverage for reproductive health. Digitizing routine health information systems (paper registries) is being done to strengthen accountability and vital events reporting. The core principles of a universal health registry are: each client has a unique ID; for each type (mother, child), there are defined data properties to capture core health observations needed between systems; the registry represents the master record (updated centrally across systems); and client data properties are used to derive indicators based on row level population data.

The digitization of the system makes it possible to consolidate multiple registers into a "Smart Registry" for RMNCH in an Open Smart Register Platform (OpenSRP). The OpenSRP can track population enumeration, health, and vital events notification and reporting; coverage and quality of family planning services; coverage and quality of antenatal care; efficient identification, referral, and management of high-risk pregnancies; and timely identification and management of postpartum complications and neonatal distress. All of this information is accessible on a smartphone. The Smart Registry Paradigm is: enumeration and unique identification of population; use of individual identifiers that are persistent and ensure continuity of care; use of a registry approach with individual registers that reflect domains of health and existing information flows and work flows; standardized data elements and indicators; systematic and routine screening for identification of disease states and life stages; and consistent user interface elements across deployments, facilitating replicable training methodology approaches. OpenSRP provides the frontline health worker with: 1) registration tools; 2) client

and service provision management; and 3) mortality notification forms. THRIVE is a multi-site research study adapting the OpenSRP in Indonesia, Bangladesh, Pakistan, and India.

Lessons Learned

- Routine and simple triggers from community level notifying of a birth or mortality—when linked to universal registries—can be used to initiate broader systems, including those valuable for mapping and analyses related to service delivery.
- Routine universal registries matter for monitoring health and vital events, catalyzing universal access to health services, and ensuring system accountability, particularly to vulnerable populations.

Presentation: DHIS2

Presenter: Vikas Dwivedi, Maternal and Child Survival Program (MCSP)

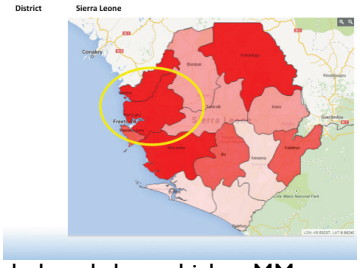
Summary and Lessons Learned

The Health Information Systems Program (HISP) developed the District Health Information System (DHIS2). The core development activities are managed and coordinated by the Department of Informatics at the University of Oslo, and supported by The Norwegian Research Council, NORAD. DHIS2 supports HMIS client-level records and aggregate electronic reporting. Forty-six countries are in some stage of implementing DHIS2. The system runs on any Internet browser and is available in eight languages.

Mapping of maternal mortality using the GIS function of DHIS2: For the purpose of reporting and mapping maternal mortality, DHIS2 supports aggregate reporting of the number of maternal deaths and maternal deaths by cause at the health facility and higher levels. DHIS2 also has functionality of capturing client-level data (at health facility level) or integrating with OpenMRS for client-level data. DHIS2 has several features that support MM mapping: it uses Google Maps as the mapping landscape. The database structure of DHIS2 captures three key pieces of information that are very useful to generate maps for MM: the what (maternal death and cause of death); the where (organizational unit where the death occurred, i.e., the health facility); and the when (period). It captures data by health facility, enabling analysis by health facility aggregated at district levels. Users at different levels can use these levels and time period to create maps for MM (see Figure 7).

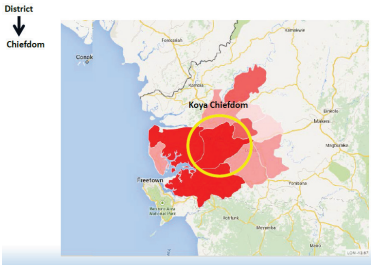
Figure 7. Example: Mapping Mortality in Sierra Leone at National, District, Chiefdom, and Health Facility Levels

Level 1 of map showing a national-level MM by districts in a year. This is helpful in prioritizing districts with high MM.



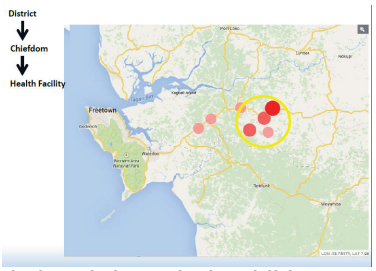
dark red shows higher MM

Level 2 of map allows managers to focus on district with high MM and identify Chiefdom within district with high MM,



dark red shows higher MM

Level 3 of map shows health facilities within Chiefdom with high MM.



dark red shows higher MM

The GIS and mapping features allow the addition of up to four thematic layers on top of a facility and boundary layer. The thematic layers relevant to MM could be expected pregnancies/birth, geographic information (land cover, road network), functional health facilities, human resource availability, available equipment and supplies, and maternal deaths. In this map of Sierra Leone, the dark red indicates the highest number of maternal deaths, which can be focused further to identify which clinics have the most deaths and need the most reinforcement.

DHIS2 has several **other features** that support MM reporting, including: collecting data; running quality checks; accessing data at multiple levels; reporting aggregate data; performing data analysis; and producing charts and graphs, and dashboard/pivot tables.

Data quality checks: The data quality check feature provides data input validation and min-max outlier analysis; detects missing data; tracks analysis and timeliness of reports; and provides follow-up analysis on reported data.

Open Source: DHIS2 is a Free and Open Source Software (FOSS), which provides the benefits of: lower costs (no license costs); freedom to make the changes per the user requirements; access to source code to enable integration and interoperability; and it is supported by a global network of developers, thus giving access to cutting-edge research and development knowledge. When developers make changes, they are immediately available on the Web.

Integration and interoperability: DHIS2 also supports SDMX-XD standard to enable interoperability and data exchange between systems. This is essential, in case of a need for data validation and exchange between census, mhealth reporting system, civil registration and vital statistics (CRVS), demographic surveillance system (DSS), and other vital events reporting systems.

Lessons Learned

- Challenges with current availability of **technology.** Need for simpler tools at lower levels of health facility with no or low technology and Internet access.
- Understanding barriers to **using data** for decision-making (capacity and processes). Need for a **comprehensive approach for building data use capacity.**
- Focus on visualization, process, and sharing/dissemination as drivers of using data/information.
- Need for development of a national **Health Information System Architecture** (for maternal mortality reporting) to identify linkages between CRVS, DSS, special studies, and health facility-based information system. This will be helpful to reduce duplications in data collection and support data validation.
- **No minimum standards and indicators** for health facility-based reporting of complications and cause of maternal deaths.
- Standardization of **cause of death** reporting using ICD10 codes.
- Support for development of a comprehensive system capturing information from health facility to **community (need action at community level)** and between information systems such as CRVS, DSS, and others.

Q&A with Panel of Experts on Opportunities to Integrate into Existing Platforms/Innovations

After presentations by Matthews Mathai, Helen Perry, Garrett Mehl, and Vikas Dwivedi, there was an opportunity for questions and answers. A summary of the discussion follows:

Question	Response

Question	Response
Q: How good are these systems at identifying women who do not use the health system? And do these systems risk double counting?	A: Double counting can happen when women deliver in a different place from where they live. Sometimes maternal deaths are unreported when they occur in an emergency room rather than a maternity, but we are still more worried about under-counting than over-counting. Strengthening community-based reporting is good, but not a simple recommendation. The continuum of surveillance activities is important to keep in mind. Sometimes we compress that system into one line, but there are a number of steps along the way. WHO looks at that continuum as an early warning system. In another piece of work on interoperability, 60 different systems were identified. Capturing home deliveries is an issue. If you enumerate the country before the pregnancies and get an updated denominator, that will help capture who is delivering at home by capturing service events. Doing a census of eligible couples at the local level requires a full architecture system from district to community. There will be a better answer when we meet again.
Q: Unique identifiers are important—but the creation and fidelity of these is very difficult on the ground. What are challenges related to this?	A: A couple of countries are tackling this issue and the CDC document on unique IDs is good. At the project level, this is not a problem, but at the national level it is. Bangladesh is working on a national system and we are hoping that India's unique identification system will work. India has a biometric ID system, but not enough of the population has registered at this point.
Q: Are social behavioral scientists part of THRIVE?	A: Yes, behavioral scientists are involved. The issues around reporting deaths are different from those around births; understanding cultural barriers is important.
Q: It sounds like DHIS2 is flexible, but which countries are using it? When quality issues are found, what is done to correct them?	A: On the quality issue, when health facilities report on a regular basis a supervisor can send back messages saying data are "out of range" or incomplete. This is part of the approval process. If the data are not approved, they do not move up the reporting chain. India has rolled out DHIS2 at the national level. Tanzania and Uganda have rolled out at the health facility level. Community level is not completely rolled out, but systems are about 95% complete in both countries.
Q: The work that goes into the maps is often underestimated. It looks like they just "pop up." What would you say about generation and audience?	A: The purpose of the maps is to reduce maternal mortality. At the advocacy level, they can be used to change policy. The focus of IDSR is on district level; so capacity building should focus on that level. Identifying where maternal death is happening enables making changes to prevent maternal death. It is a process that people go through with a high impact that influences policy action.
Q: It is good to see that IDSR integrates infectious diseases. Apparently MDSR is being taken on by new countries, but IDSR is focused in African countries—where are we? Is the CDC asking countries to focus on this?	The CDC has been doing IDSR for more than 15 years and progress across the African region is mixed. We monitor countries under various stages in the process. For about 28 countries, they reliably produce feedback bulletins (which was not happening just a few years ago). There is a major opportunity under the global health security agenda to address issues of staff turnover and power source. IDSR offers a structure to maternal death surveillance. The steps used to monitor cholera are the same. CDC monitors processes. IDSR is part of WHO's Ebola Preparedness checklist. IDSR provides a systematic way to strengthen health systems. "The funny thing about surveillance is when you do it, it works" (CDC employee). When disease crosses national boundaries, there is more interest in financing it – but if a problem is internal to country, it is competing with the rest of the world for attention and funding.

Question	Response
Q: Do these systems represent a scientifically valid step forward to reducing maternal death—yes or no?	A: Helen Perry and Matthews Mathai responded "Yes". Vikas Dwivedi said, "Every death counts—can identify all deaths and respond." Garret Mehl said, "Yes, but we need complementary approaches that triangulate to give 'named death' not just a number."
Observations: When we talk about sustainability and scale-up, there is measuring maternal death and using maps to summarize that. The map production is a separate process that is not really explained. Where are the maps coming from and for whom are they intended? The end user needs to be kept in mind. Maybe district and provincial level is sufficient, but need higher resolution (city or community level) to really make changes at the local level.	

Session 3: Formulating Recommendations and Next Steps

Two presentations were given, which were followed by group work to catalogue lessons learned and recommendations for next steps. The presentations were: 1) Beyond maternal mortality—Cause of Death and using ICD-10MM to standardize data; and 2) Putting it all Together. Summaries of these presentations follow.

Presentation: The WHO application of ICD-10 to deaths during pregnancy, childbirth, and the puerperium: ICD-MM

Presenter: Doris Chou, Medical Officer, Adolescents and At-Risk Populations, World Health Organization/Geneva

Summary and Lessons Learned

To measure progress toward MDG 5, the cause of each maternal death needs to be documented and defined, using WHO standards. Although the Maternal Mortality Estimation Inter-Agency Group (MMEIG) estimated 289,000 maternal deaths in 2013, the COD is known in only a fraction of cases. This primarily occurs despite definitions/coding rules related to maternal mortality within the International Classification of Disease, 10th revision (ICD-10) because interpretation of the rules and definitions is inconsistent.

In ICD-10, a maternal death is defined as "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 causes." An incidental/coincidental death is the death of a woman who just happened to be pregnant/postpartum woman at the time of death. However, attribution of deaths as "related to," "aggravated," or "incidental/coincidental" is difficult and inconsistent.

The resulting inconsistency in death attribution leads to misclassification of maternal deaths extracted from vital registration that in turn may bias the understanding of the magnitude and causes of maternal death. Misclassification of deaths is most commonly seen in deaths associated with cardiovascular disorders, central nervous system disorders, injuries, and indirect conditions. Large numbers of maternal deaths are also showing up in other data sets and not classified as maternal deaths. Additional issues are that some providers may not understand how to assign COD or may not be trained to complete death certificates.

Part of the solution to misclassification is the WHO guide "The WHO Application of ICD-10 to deaths during pregnancy, childbirth, and puerperium: ICD MM" (http://www.who.int/reproductivehealth/publications/monitoring/9789241548458/en). This document is meant to simplify and standardize the capture of maternal deaths from Civil Registration and Vital Statistics (CRVS) and other sources of data, assist with classification of maternal COD, and complete gaps in the documentation of obstetric causes of death. ICD MM is part of MDSR.

The ICD-MM is intended to contribute to the 11th revision of the ICD. In principle, a "classification" system for maternal deaths must be useful and understandable to those that use it, i.e., clinicians, epidemiologists, and program planners. To meet all the requirements of each user, a specific condition/disease entity/**underlying cause** should be **exclusive** of all other conditions. **The underlying cause** is the disease

entity that initiated the events resulting in the death of the woman—there can be only one underlying cause.[6] Multiple conditions may contribute to (or be associated with) but do not directly cause her death; these conditions may be pre-existing or develop during the sequence of events leading to death. There may also be several "immediate" causes that contribute to the COD. The following example was given: A woman died after postpartum hemorrhage. The underlying cause of death is uterine atony; contributory causes are postpartum hemorrhage and hypovolemic shock; a contributory condition is anemia.

The maternal death ICD-MM classification system should be adopted by all countries to ensure a consistent methodology in maternal COD attribution. Co-morbidities also need to be documented/captured. Through use of the same classification, reliable comparisons can be made within and between countries and regions. Applying this classification should help to identify the health system shortfalls that countries need to address in order to reduce fatal outcomes of pregnancy and childbirth.

[6] Multiple (underlying) cause coding is possible but essentially limited to very few datasets.

Presentation: Putting it all together

Presenter: Alexandra Silfverstolpe, Managing Director and Co-founder of Data Act Lab

Summary and Lessons Learned

Data Act Lab is a Swedish data visualization firm that focuses specifically on development issues. It was created to facilitate decisions about allocation of aid money and ensure that these decisions are not made in isolation of important factors. These factors include: where are the needs, who else spends money where, and on what, where things are going in the right direction, and where they are not.

One way to visualize data is to create maps. But there are many other ways one can visualize data; it all depends on what you want to do. What is the purpose of visualizing the data? What questions are you trying to answer with the data? What story do the data tell you? One example is a project that Data Act Lab is currently working on with the Brookings Institution (financed by Gates Foundation) called Investments to End Hunger.

The overarching goal of this project is to encourage data-driven, evidence-based policymaking in the effort to end global hunger by 2030 (ending hunger meaning ensuring global food and nutrition security).

- The project looks at three factors: 1) needs, 2) policy environment, and 3) resources.
- The project is based on two underlying assumptions: effectiveness will be maximized when funding is concentrated: 1) where the needs are greatest, and 2) where the potential for impact is highest.
- The project will visualize data covering needs, the policy environment, and financial resources for 140 countries. Using data visualization, we can stack several layers of data on top of each other and by doing so we hope to be able to identify missed opportunities, meaning areas and/or countries with great needs, with a good policy environment, and which currently lack financial resources to move people out of hunger. By using financial resources smarter we may be able to move more poor people out of poverty and hunger.
- It is a very interesting project. It aims to take one of the future Sustainable Development Goals and build a data/digital model for smarter investments. To date, no one has brought together the disparate data necessary to do so. With data visualization, we hope to be able, in an easy way, to make complex data useful and actionable.

In order for data visualization to succeed, the following very basic but important issues must be addressed:

- There needs to be a very clear understanding about the motivation behind a project's inception. Often when data visualization fails it is because the exact purpose has not been clear from the outset.
- The target audience needs to be clearly identified: Who is it for? Is it supposed to be a tool for aid practitioners? Researchers? The general public?
- The purpose of visualization needs to be clearly understood: Is it supposed to be a tool that is explanatory (do you want to tell a story) or rather exploratory (allow the user to play around with the data)?
- Data collection should be selective: Just because you have a lot of data, does not mean that it is relevant to show it all
- Make sure that visualization of data is simple and clean. You should succeed in giving people an accessible route into the data. Make sure that the efforts needed from the reader or user to understand how to use and interpret visualized data are ultimately rewarded with a worthy amount of insight gained.
- There are multiple ways to visualize data. Carefully choose the type of visualization that will tell the best story.

Recommendations

During the Consultation, participants were asked to join one of four working groups: 1) Data Sources and Quality; 2) Data Visualization and Analysis; 3) Data Use; and 4) Sustainability and Scalability. Each group assigned a facilitator and rapporteur, and was tasked with prioritizing recommendations from their group that "will have the greatest impact" to promote mapping of maternal deaths and other relevant indicators.

The following is the full list of recommendations from each group, including a fifth category—high-level/cross-cutting issues—of recommendations that were identified by more than one group.

Data Sources and Quality

There is need, in the short term, to:

- Fund, over a sustained period of time, development and validation of community-level, GIS-linked, verbal autopsy-supported data collection methods/strategies.

There is *need*, in the medium term, to:

- Determine optimal, context-specific incentives/disincentives for maternal death reporting by families, frontline health workers, and facility staff/managers.
- Create and maintain a readily available inventory of geo-coded facilities including level of services, and optimally, quality of care.
- Strengthen the capacity in-country to classify deaths of women of reproductive age (WRA), fetuses, newborns, and children under 5, optimally maintaining the mother-baby dyad.
- Complete an inventory of current efforts on collection of maternal deaths.

There is need, in the long term, to:

- Continue investment by countries and donor community to build complete civil registration and vital statistics (CRVS) systems in every country

Additional points:

- Actionable items to prevent maternal deaths should also be mapped.
- To enable better access to high-quality geospatial data, groups involved in MM mapping should engage with spatial data infrastructure groups.

Data Visualization and Analysis

- Develop standards and principles for data visualization and mapping
- Develop guidance on standards and parameters of maternal health data (e.g., travel time) to map, including actionable items.
- Develop a job aid decision tree on displaying maternal death and related data.
- Develop or adapt a guidance document on the ethics of mapping data.
- Report continuous data when it is collected as continuous data.
- Disaggregate data according to age (e.g., so adolescent pregnancies can be identified).

Data Use

- All relevant sectors, including vital registration, should contribute data to a universal data set (UDS) with common fundamental geo-coded data, master facility lists, etc., regularly updated and available to all stakeholders.
- MOHs should design and implement perinatal and maternal surveillance in an integrated format at all levels.
- Country planners should design and maintain dashboards that collect and display data on all primary causes of death and critical factors of health system capacity and available resources in country.
- Use the district health managemeant team to map pathways women (and those who died) took and delays experienced to get to the facility and which facilities were actually used vs. those in timely range
- Global and national partners need to work together to improve transparency and capacity of countries to generate data.
- Document evidence on how mapping data have been used at all levels of the health system.

Additional points:

- This process should feed into social accountability mechanisms for communities and civil society.
- Use existing data to feed into MDSR.

Sustainability and Scalability

- WHO and other donors should make MDSR operational for mapping.
- Advocate and emphasize that MDSR combined with information systems can be used for mapping.
- Widely implement DHIS2 and mHealth to operationalize maternal mortality mapping using standards.
- Donors and partners should provide technical support and help governments develop investment plans.
- Cost mapping efforts.
- USAID and others should fund a special webinar/meeting/workshop on availability of geospatial data with special reference to maternal and child health and related data.

High-Level/Cross-Cutting Recommendations

There is need to:

- Build in-country capacity to map, interpret maps, and use maps for priority setting, using a bottom-up approach to promote ownership.
- Standardize approaches.
- Identify and involve end users in the development process.
- Perform an inventory of current activities in order to avoid duplication of effort.
- Document current use of maps.
- Link the discussion of maternal mortality (MM) mapping to the post-2015 agenda.
- Develop a framework for measuring progress using mapping of maternal mortality.

Overall, there was consensus that mapping maternal deaths is important and work in this area should continue. But maps of related information are also needed to PREVENT deaths. This includes availability of care, quality of care, and other outcomes for maternal, perinatal, and newborn health. Other overarching discussion points included:

1. Mapping has the potential to improve decision-making and accountability. However, it is essential to consider the end user, and maps using different platforms will need to be tailored to the end user. Maps for facility-level managers or district health management teams may be different from maps for national-level policymakers.
2. Maps are only as good as the data they are made from. There are limitations to availability and quality of maternal death information—and maps should be developed based on available data and tailored to the question and the end user.
3. The importance of standardization was repeated throughout the Consultation. This includes standardizing methods for data collection and mapping, as well as for collecting and compiling geocodes of health facilities.
4. There is a need to build capacity at all levels—both in terms of capacity to use existing data to create maps and also in terms of capacity to interpret and understand maps to promote decision-making.

Participants voted for the top five recommendations overall, and these recommendations will form the basis of the action plan moving forward. The recommendations listed below were the top 10 recommendations based on the prioritization exercise.

TOP 10 RECOMMENDATIONS FOR MATERNAL MORTALITY MAPPING THAT WILL HAVE THE GREATEST IMPACT

1. In addition to mapping maternal mortality, map actionable items to prevent maternal deaths, such as expected pregnancies/birth, availability of care, quality of care, and other outcomes for maternal, perinatal, and newborn health.
2. Ensure that mapping feeds into social accountability mechanisms for communities and civil society.
3. Develop or adapt a capacity-building approach for decision-makers on data visualization including maps on maternal death and related data.
4. Use a bottom-up approach for capacity building, ownership, and development.
5. Develop a universal data set (UDS) with common fundamental geo-coded data, master facility lists, etc., using data from all relevant sectors, including vital registration. This UDS should be regularly updated and available to all stakeholders.
6. Develop guidance on standards and parameters of maternal health data (e.g., travel time) to map, including actionable items.
7. Design perinatal and maternal surveillance in an integrated format at all levels by Ministries of Health. Data should also be tracked and used.
8. Operationalize Maternal Death Surveillance and Response (MDSR) for mapping. This work should be supported by WHO and donors.
9. Fund, over a sustained period of time, the development and validation of community-level, GIS-linked, verbal autopsy-supported data collection methods/strategies.
10. Determine optimal context-specific incentives/disincentives for maternal death reporting by families, frontline health workers, and facility staff/managers.

Next Steps

Allisyn Moran provided thoughts for next steps. She thanked participants for excellent participation and discussion. Dr. Moran noted that bringing together such diverse participants from different disciplines had led to new connections and new ideas—and the need to continue to facilitate this network. She suggested the following next steps:

1. Expand the Consultation Steering Committee, and create a Coordinating Committee. This Coordinating Committee would have quarterly calls to share information, ideas, and next steps.
2. Conduct regular webinars to share information and facilitate dialogue on this topic.
3. Write and submit a peer-reviewed paper from the Consultation. This paper may include case studies of where mapping maternal deaths has led to decision-making, changes in policies, and other outcomes.
4. Disseminate recommendations at the upcoming June Summit on Measurement and Accountability.
5. Hold a follow-up meeting at the Summit on Measurement and Accountability in Washington, D.C., in June 2015 or at the Global Maternal and Newborn Health meeting in Mexico City, Mexico, in October 2015.

Closing Remarks

Jeff Smith, MCSP's Maternal Health Team Leader, thanked participants on behalf of **Koki Agarwal**, MCSP Director, who was in the field. Dr. Smith noted that the work done during the Consultation will help colleagues in the field do their work better. He observed that MNH has suffered from a dearth of data for many years, and that although colleagues in malaria and HIV are further ahead, the work done at the Consultation proves that it is possible to gather and examine the data to make changes. Information is power and the key to the 21st century. The work done at the Consultation and that we will continue to do is based on our ability to gather information and use it to improve services.

Katie Taylor, Deputy Administrator, Global Health, USAID, expressed her appreciation for having such a high-caliber group come together at this time to focus on mapping, as well as her hope that 2015 will be the "Maternal Year." Ms. Taylor referred to the important link between the Maternal Mortality Mapping Consultation and USAID's launch on January 12, 2015, of its publication *Ending Preventable Maternal Mortality: USAID Maternal Health Vision for Action Evidence for Strategic Approaches*. She observed that sometimes it is hard to strike a balance between data quality and data availability. Ms. Taylor thanked the participants saying, "the depth of passion, experience, and intelligence you all bring to the table is something I deeply appreciate."

Appendix 1. Concept Note

Concept Note: Technical Consultation on Reporting and Mapping Maternal Deaths in Countries with High Maternal Mortality

January 12–13, 2015, Washington, D.C.

Background

Every year, almost 300,000 women die from complications related to pregnancy and childbirth, with the vast majority of deaths in low- and middle-income settings.[7] Few countries will achieve Millennium Development Goal 5 (MDG 5) by 2015 of reducing maternal mortality by 75% from 1990 levels.[8] In April 2014, the global community reached consensus on targets for Ending Preventable Maternal Mortality by 2030. In June 2014, USAID released its Maternal Health Vision for Action 2014–2020, which sets a frame for USAID's work to 2020, and which we see as an important contribution to achieving global targets for 2030 and 2035.[9]

Global targets require accurate and timely data to monitor progress. This is challenging for maternal mortality targets due to lack of empirical data on maternal deaths. There are a variety of data sources for maternal death including civil registration and vital statistics (CRVS), routine health information systems, health facility records, household surveys, and census data. In the majority of low- and middle-income countries, where the vast majority of deaths occur, routine information systems are weak and countries rely on household survey, census data, and UN estimates using modeled data to track progress toward MDG 5. Household surveys for maternal mortality are conducted infrequently (every 5 or 10 years), are expensive, and have large confidence intervals, which prevent disaggregation to sub-national levels. As a result, it is difficult for countries to track progress and support targeted, evidence-based interventions to reduce maternal mortality at sub-national levels or among vulnerable populations. With the recommendations of the Commission on Information and Accountability for Women's and Children's Health (COIA), there is global commitment to improve routine data collection systems, such as CRVS and health information systems, and countries are making progress in these areas.[10] However, these systems require financial and human resource investments and will take time to mature and function. In the meantime, there is a need to develop and test innovative approaches for collecting data on maternal death more frequently to guide programs and resource allocation.

In addition to data on maternal deaths, there is a need to ensure that data are used at sub-national levels for decision-making. Data visualization using mapping and other techniques is a powerful tool that can visually display information, making it easier to understand and use by decision-makers. Maps often combine data from a variety of sources and can visually display "layers" of information including: 1) population information such as where pregnancies and births are expected; 2) geographic information such as land cover and road networks, which can be analyzed to estimate travel time; 3) availability of functional health facilities; 4) quality of facility-based care; and 5) outcome measures such as mortality. These different layers of information provide a complete picture of availability, access, and use of care in areas where pregnancies and births are expected— and different modeling scenarios can show potential improvements in provision of care, referral networks, and impacts on mortality.[11] The WHO-supported project "Investing the marginal dollar

[7] WHO, UNICEF, UNFPA, The World Bank, United Nations Population Division 2014. *Trends in Maternal Mortality 1990–2013*. Geneva: WHO. (May)
[8] Fulfilling the Health Agenda for Women and Children, The 2014 Report. Countdown to 2015.
[9] USAID. 2014. Ending Preventable Maternal Mortality: USAID Maternal Health Vision for Action. USAID: Washington, DC. (June)
[10] See http://www.who.int/woman_child_accountability/about/coia/en/ for more information on COIA.
[11] Tatem AJ et al. 2014. Mapping for maternal and newborn health: the distributions of women of childbearing age, pregnancies and births. *Int J Health Geogr*. 4;13:2. doi: 10.1186/1476-072X-13-2.

for MNH" uses the capacity of geographic information systems (GIS) to analyze physical accessibility and geographic coverage of the emergency obstetric care (EMOC) services in five countries: Burkina Faso, Cambodia, Laos, Malawi, and Rwanda.

A global network of geographers, public health practitioners, epidemiologists, and statisticians has been formed to facilitate dialogue and develop state-of-the-art guidance and maps for maternal and newborn health (Mapping for MNH Network). To date, maps have been developed in Ghana, Bangladesh, and Mozambique and are in process in Malawi and Ethiopia. These maps are useful to facilitate dialogue with policymakers and ministries of health around building and/or updating health facilities for universal access to quality care, advocating for improving quality of care and improving referral networks.

Maps that display maternal deaths on a routine basis are also helpful to aid decision-making. These maps would show change over time and would allow district/regional health management teams to assess progress as well as compare their data to neighboring areas. This competition could lead to increased action and accountability for reducing maternal mortality.

USAID Vision for Mapping Maternal Deaths

In June 2014, USAID launched its Maternal Health: Vision for Action, which outlines USAID's strategy for improving maternal survival in USAID's 24 priority countries, which account for 70% of global maternal deaths. One of the 10 strategic drivers is promoting data for decision-making and accountability, which is crucial to monitor and track progress toward global, national, and sub-national targets. USAID supports mapping and use of data on maternal deaths to facilitate decision-making and improve programs.

The Maternal and Child Survival Program, USAID's flagship MCH program, will convene a technical consultation on January 12 and 13, 2015, with experts from various disciplines to formulate recommendations and next steps for mapping maternal deaths. The objective of the consultation will be to: 1) share previous and ongoing work in this area; 2) discuss priorities for future work; and 3) develop an action plan for moving forward. The recommendations will be disseminated at the Summit on Measurement and Accountability, sponsored by WHO, USAID, and the World Bank, to be held in Washington, D.C., in June 2015.

Appendix 2. Final Agenda

Technical Consultation: Reporting and Mapping Maternal Deaths in Countries with High Maternal Mortality

January 12–13, 2015

Washington, D.C.

Renaissance Dupont

1143 New Hampshire Avenue Northwest, Washington, D.C. 20037

Purpose

Identify the progress, challenges and opportunities and vision for mapping of maternal deaths in countries with high maternal mortality.

Objectives

1. Share previous and ongoing work in this area
2. Discuss priorities for future work
3. Develop recommendations and next steps

Monday, 12 January, 2015		
TIME	**TOPIC**	**FACILITATOR**
8:30–9:00 am	Welcome, Introductions, and Overview of Meeting and Anticipated Outcomes	MSCP, USAID
	Opening remarks	Ariel Pablos-Mendez
Session 1: Current Experiences with Mapping Maternal Deaths		
9:00–9:15 am	Mapping MNH – Past, Present, and Future	Jim Campbell (by video)
9.15–9.30 am	Data Sources for Mapping Maternal Deaths	Allisyn Moran
9:30–9:45 am	Example from Geographic Data – Malawi	Karin Stenberg/Steeve Ebener (by video)
9:45–10:00 am	Example of Census Data – Ghana	Zoe Matthews
10:00–10:15 am	Example of Facility Survey Data – Mozambique	Patsy Bailey/Kavita Singh
10:15–10:30 am	Coffee Break	
10:30 – 11:00 am	Questions and Discussion	Barbara Rawlins
11:00 – 11:15 am	Experience from Mexico	Juan Eugenio Hernandez Avila
11:15–11:30 am	Example of HMIS Data – Indonesia	Patrick Gault
11:30–11:45 am	Example of Special Study – Saving Mothers Giving Life	Florina Serbanescu
11:45–12:00 am	Example of Research Study – PRE-EMPT	Tatenda Makanga
12:00–12:30 pm	Questions and Discussion	Barbara Rawlins

Monday, 12 January, 2015		
TIME	**TOPIC**	**FACILITATOR**
12:30–1:30 pm	Lunch	
1:.30–2:30 pm	Panel of In-Country Experts • Challenges, successes for MM measurement • Using mortality data for decision-making	Joaquin Gomez John Spencer Narayan Honnungar
2:30–3:00 pm	Discussion	Barbara Rawlins
3:00–3:30 pm	Break	
3:30–5:00 pm	Group Work • Lessons learned, recommendations for next steps	Leo Ryan
5:00–5:30 pm	Report-Out and Discussion	Leo Ryan
5:30–5:45 pm	Wrap-Up	MCSP, USAID

Tuesday, 13 January 2015		
TIME	**TOPIC**	**FACILITATOR**
8:30–8:45 am	Review of Day One	USAID, MCSP
Session 2: Opportunities to Integrate into Existing Platforms/Innovations		
8:45–9:00 am	Maternal Death Surveillance and Response	Matthews Mathai
9:00–9:15 am	Infectious Disease Surveillance	Helen Perry
9:15–9:30 am	Universal Registries/mHealth	Garrett Mehl
9:30–9:45 am	DHIS2	Vikas Dwivedi
9:45–10:30 am	Questions and Discussion	Kavita Singh, Leo Ryan
10:30–10:45 am	Coffee Break	
10:45–11:00 am	Beyond Maternal Mortality – Cause of death and using ICD-10MM to standardize data	Doris Chou
11:00–11:15 am	Putting it All Together	Alexandra Silverstolpe
11:15–11:30 am	Report-Out and Discussion	Kavita Singh, Leo Ryan
11:30 am–1.00 pm	Working Lunch	
Session 3: Formulating Recommendations and Next Steps		
1:00–2:30 pm	Group Presentations and Discussion	Leo Ryan
2:30–3:00 pm	Break	
3:00–4:00 pm	Prioritization on Recommendations	Leo Ryan
4:00–4:30 pm	Next Steps	MCSP, USAID
4:30 pm	Closing Remarks	Katie Taylor

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Appendix 4. Parking Lot Results

Challenges to Mapping Maternal Health Data
Geographic Information Systems • There is not a shared vision for mapping as a standard for presenting data. • GIS capacity is limited in some countries. • Methods for defining the accuracy of geocodes (district, village, etc.) are not standardized. • Data sets are not tagged with standardized units (e.g., district name). • Open street maps might not have a comprehensive enough road network for analysis at the community level • Travel time analyses that assume rapid mechanical transport on roads are incredibly sensitive. • There is limited access to and availability of GIS software. • A clear definition of GIS infrastructure may not be available at the country level (district boundary GIS files, facility maps, population data by district). • Data currently available in-country may not be formatted for use with GIS software. • There are limited numbers of personnel in-country that have the necessary capacity to format data for GIS, use GIS software, and conduct spatial analysis. • The challenges of working with mapping for health professionals are not well-defined. • Not all data and maps are equal, so there is a need to better quantify, communicate, and map this uncertainty.
Confidentiality • Confidentiality and protection of data (especially geographic data) need to be addressed and carefully considered.
Scalability and Sustainability • Scalability and sustainability of local data infrastructure require an intervention to build the underlying data system. • Need in-country expertise in making maps and in map literacy.

Choice of Data Types to Map
• Difficulty to account for quality of services when mapping accessibility (distance) to services and facility readiness (human and other resources).
• Data points to map are not standardized/there is not agreement on what needs to be mapped:
  • CEmONC only because they reduce mortality
  • Facilities designated as basic emergency obstetric and newborn care (BEmONC) and CEmONC
  • Facilities by signal functions
  • Quality of care (e.g., there is no point in mapping maternity waiting homes if quality of care is the problem)
  • All maternal deaths vs. differentiating between maternal deaths that occur in facilities and the home
  • Other outcomes such as service availability and human resource availability
  • Maternal deaths beyond 6 weeks—pick up causes of death such as peripartum, cardiomyopathy
• Benchmarks for travel time (2 hours BEmONC and CEmONC) are not standardized.
• With increasing facility-based deliveries, facility maternal deaths may increase even as maternal deaths decrease.

Data Quality • Denominators may not be well-defined or accurate. • The accuracy of maternal death diagnoses cannot always be guaranteed. • Data quality in both census and facility cannot always be guaranteed. • Data quality in census is influenced by how good the adjustment factors are and, more important, if numbers are adjusted. • Population-based maternal death data and facility-based maternal death data need to be reconciled. • Artifacts caused by referral, i.e., misattribution to referral facility. • Difficult to know how good are models and how/if they account for ongoing programs.

Challenges to Mapping Maternal Health Data
Data Availability (or lack of) • CVRS data not universally available in low-resource settings. • Census data are only available periodically. • Need to determine how to get more real time or record data. • It is difficult to get up-to-date population data. • Availability of data from health facilities is not consistent. • Need to develop a system to get a comprehensive census of global facilities. • Not all countries collect maternal deaths as part of their census survey. • Only sparse data are available, even when of good quality, especially at sub-national level. • When recording maternal deaths in facility data, need to track where the woman came from (domicile) as well where she died. • ICT infrastructure needs continued improvements.
Data Use • Level of country demand/interest is not known; need to know if these data interest only donors or the governments • Very little documentation on how/if governments use maps • Very little documentation on how maps have been used for decision-making; need better documentation • Difficult to interpret maps at sub-national or district level when there are small numbers of deaths • Data are not interpreted in a standardized, consistent manner.
Synergy • How can we promote synergy among different initiatives such as MEASURE Evaluation Phase 4? • Can be political challenges including change in personnel/support that affect use of maps

Success Factors for Mapping Maternal Health Data

Collaboration
• Collaborative inter-institutional efforts to collect data
• To keep costs down after collecting GPS coordinates, collaborate with other data collection efforts (example, supportive supervision)
• Web-based resources:
  • World Pop data are a great resource
  • Web-based application

In-Country GIS • Receptive governments • In-country GIS capacity
Local Buy-In/Leadership • Leadership/demand for these data at highest levels in the global community. • Involving key leaders who can help mobilize action and resources. • Buy-in created at multiple levels.
Choice of Data Types to Map • Simplicity balanced against accuracy is critically important.

Promising Approaches for Mapping Maternal Health Data
Census • Using geostatistical models in areas with poor census data (using satellite data). • Work toward standardizing census to include questions on maternal deaths in all countries. • Using census data for mapping since it is national, but must adjust the data for underreporting.
Equity • Development of equity measures.

Promising Approaches for Mapping Maternal Health Data
Cross-Sectional • Encourage collaboration across sectors, health, statistics/census, military, etc. • Learn from other similar fields—mapping for MNH, while for fields such as malaria it is much more mature.
Mobile Phones • Using mobile phone data to understand population mobility (Namibia).
Web • Very specialized GIS skills centralized but Web or other interfaces provide access to more casual users • Develop Web-based application to create maps. • Promote use of open access Web-enabled GIS, making data available (open access).