

**EXPERT CONSULTATION
ON METHODOLOGICAL ALTERNATIVES FOR
MONITORING CHILD MORTALITY**

12-13 July 2007
Baltimore, Maryland

Convened by
The Institute for International Programs
The John Hopkins Bloomberg School of Public Health

with support from
The Canadian International Development Agency

Consultation Report

IIP-JHU
1 September 2007

IIP-JHU

This report was prepared by Jennifer Bryce, Robert Black, Kate Gilroy, Gareth Jones and Cesar Victora, based on the information presented at the consultation. All participants were given the opportunity to review and correct the content, and their suggestions have been incorporated.

This document is intended for limited circulation. All information included in the report is linked in the narrative to the individual who presented it at the consultation, without further specification of sources.

The authors would like to thank Canadian CIDA for their support in this effort, and Barbara Ewing and Jeremy Schiefen for their help in organizing the consultation and finalizing this report.

*Institute for International Programs
Department of International Health
Johns Hopkins University School of Public Health
615 North Wolfe Street
Baltimore, MD, USA*

1 September 2007

IIP-JHU

**EXPERT CONSULTATION
ON METHODOLOGICAL ALTERNATIVES FOR
MONITORING CHILD MORTALITY**

12-13 July 2007
Baltimore, Maryland

The Institute for International Programs
The John Hopkins Bloomberg School of Public Health

with support from
The Canadian International Development Agency

Executive Summary

Rationale

The Monitoring Child Mortality (MCM) project is being developed to address growing demand for estimates of short-term changes in under-five mortality (sometimes referred to as “real-time” monitoring). This demand reflects new and expanded efforts to reduce child mortality and achieve the fourth Millennium Development Goal (MDG) on the part of countries, bilateral development agencies including those of Canada, Norway and the United Kingdom, and the United Nations. In low-income countries where health systems are weak and vital registration data are not available, commonly used demographic methods provide child mortality estimates for periods three to five years prior to measurement. MCM is assessing various methods for producing estimates at shorter intervals in these countries, possibly as a basis for performance-based disbursement of funds.

Consultation objectives

- 1) To identify, compare and contrast existing options for the measurement of all-cause mortality among children less than five years of age that are feasible for implementation in low-income countries in sub-Saharan Africa.
- 2) To begin the process of identifying a set of innovative, promising options that can be tested in low-income, sub-Saharan African countries working to achieve rapid reductions in under-five mortality and that will produce estimates of all-cause under-five mortality with known and acceptable levels of precision at intervals of 12 months or less.

Consultation program and participants

The program was developed by defining the most important methodological options related to MCM, and then identifying technical experts to present and lead a discussion about each option. Several representatives of development, donor and UN agencies requested permission to attend the consultation and were accommodated. The two-day consultation agenda included formal presentations of the major options and their possible combinations, as well as discussions about the types of monitoring information needed for various purposes. During the workshop, it became clear that MCM would focus on mortality measurement, and would complement but not replace broader programmatic monitoring objectives such as engaging communities or developing routine information systems.

Broader conclusions of the consultation

- 1) Development and improvement of vital registration systems in low-income countries should be an important long-term priority.
- 2) There are at least three equally important but distinct objectives of “real time monitoring” of under-five mortality: i) engaging communities; ii) program monitoring; and iii) mortality monitoring for evaluation or disbursement purposes. All three objectives are important and need to be pursued, but attempts to achieve all three objectives through a single system are unlikely to be successful.
- 3) Mortality monitoring intervals of less than 12 months are unlikely to produce interpretable results because of seasonality, unless they are part of a longer-term effort.
- 4) Obtaining the sample sizes needed to estimate significant changes in mortality within short time periods will be a major challenge. Preliminary estimates suggest that populations in the tens of thousands will be needed to record adequate numbers of child deaths to estimate mortality with the necessary precision.
- 5) All methodological options will need to build on and reflect country-specific characteristics; “one-size-fits-all” solutions for measuring short-term trends in under-five mortality are unlikely to emerge from the work of MCM. Targeting the highest under-five-mortality areas within a country may reduce the overall sample sizes needed to obtain valid results.
- 6) Within individual countries, the ideal design would assess the performance of two or more options relative to a method known to produce high-quality estimates. Comparing the results produced by the different options will contribute to learning and will increase the probability that adequate estimates of mortality are available on at least an annual basis.

Next steps

- 1) MCM should conduct a systematic review of the most promising options for measuring short-term trends in under-five mortality, leading to a compendium of options and their advantages and disadvantages relative to this purpose.
- 2) Mortality monitoring considerations should be taken into account in planning for the implementation of accelerated child survival activities at country level. This can ensure that opportunities for “natural experiments” are recognized and incorporated, and increase the probability that the independent evaluation complements monitoring activities that will be carried out as a part of implementation.
- 3) The value of MCM can be extended through careful coordination with the monitoring approaches promoted or employed by other international groups such as Health Metrics Network and the Global Vaccine Initiative.
- 4) Country-specific designs, along the lines recommended by the consultation participants, will be developed for up to five African countries, tailored to program implementation characteristics.

TABLE OF CONTENTS

Background and rationale for the consultation	1
.....	
Consultation objectives.....	1
Consultation program and participants.....	2
Organization of the report.....	2
Defining the scope of MCM	2
Methodological challenges	4
Obtaining adequate sample sizes	4
Defining “short” or “real time” monitoring intervals	4
Seasonality	6
Cause- and age-specific estimates	7
Uncertainty	7
A comparative assessment of monitoring options.....	7
Options based on data collected through health systems.....	7
Options based on data collected at community level	11
Combinations and special applications	20
Summary: Outputs of the comparative assessment	22
Broader conclusions of the consultation.....	23
Implications for the methodological assessment of options in countries	24
Contacts for further information.....	27
References	
Appendices	
1. Consultation participants	
2. Consultation program	
3. Summary of methodological options reviewed at the consultation	

ACRONYMS

CBIO	Census-based, Impact oriented (CBIO) projects in Bolivia and Guatemala
CHW	Community health worker
CIDA	Canadian International Development Agency
DHS	Demographic Health Surveys
GPS	Geographic positioning system
HMN	Health Metrics Network
IIP	Institute for International Programs, based at Johns Hopkins University Bloomberg School of Public Health
IMR	Infant Mortality Rate
INDEPTH	An International Network of field sites with continuous Demographic Evaluation of Populations and Their Health in developing countries
MCM	Monitoring Child Mortality, the provision name for the CIDA-sponsored project under development with IIP, within which this consultation is the first formal activity
MDG	Millennium Development Goals
MICS	Multiple Indicator Cluster Surveys
MoVE	Monitoring of Vital Events, a project under way by HMN
NORAD	The Norwegian Agency for Development Cooperation, a directorate under the Norwegian Ministry of Foreign Affairs
ORS	Oral rehydration salts solution, used to treat dehydrating diarrhea
PROLIPO	Programme de Lutte Intégrée contre le Paludisme dans l'Ouémé (ProLIPO) in Benin. ProLIPO is part of the Africa Integrated Malaria Initiative supported by the United States Agency for International Development.
SEARCH	Society for Education Action and Research in Community Health, Maharashtra, India
SEED	System of Epidemiological Evaluation of Deaths, a sample vital registration system in Mexico.
SINASC	The live birth information system in Brazil.
U5M	Under-five mortality rate
UNICEF	United Nations Children's Fund

Background and rationale for the consultation

Most low-income countries are making slow progress in addressing child mortality – too slow to achieve the fourth Millennium Development Goal by 2015. Countries, donors and development agencies are responding to the situation by redoubling efforts to stimulate and support child survival activities in countries, particularly in Africa. As a part of this movement, UNICEF and CIDA are undertaking a major initiative to reduce mortality among children less than five years of age in four countries in sub-Saharan Africa. This initiative builds on the experience of the Accelerated Child Survival and Development project that was implemented in 11 African countries between 2002 and 2004.

One challenge for the new UNICEF/CIDA child survival project, and one common to many major public health initiatives, will be obtaining accurate and timely measurements of mortality in large geographic areas with weak health systems.^{1,2} Timeliness is important, because data that are available quickly can be used to strengthen implementation options while the project is still under way, increasing the chances of overall effectiveness. For the new project, there will be a 30-month assessment period to determine the potential effectiveness of the strategic approach prior to full funding of the entire project period.

Prospective impact evaluations of complex programs under real-life conditions often require time frames of five years or more to provide full results. Experience by investigators working with the Institute for International Programs (IIP) suggests that even five years may be too short to capture the effects of new or reinforced efforts to reduce under-five mortality.³

A major component of the time lag between the occurrence of mortality and its measurement is the time needed to capture sufficient vital events (e.g. child births and deaths) to estimate child mortality precisely within constrained sample sizes. Demographic surveillance, including an initial census and periodic surveys of all households in the area (e.g. at least every four months) to update population rosters and record vital events, can produce accurate measurements of mortality. However, this option is resource intensive, costly and usually employed only in small geographical areas.

For larger populations, the most widely-used method to produce child mortality estimates at high levels of quality is a sample survey of households with use of a full birth history to determine levels and trends in under-five mortality, usually estimated at national and regional levels. The methods of mortality measurement currently in use produce estimates that refer to time periods no less than one to two years prior to the survey, depending on sample size.

The aim of the consultation was to compare and contrast alternative options for rapid mortality monitoring as a basis for making informed decisions about the design of strategies for use in the low-income countries in sub-Saharan African that will receive intensified UNICEF/CIDA support for accelerated efforts to reduce child mortality. This effort will form the starting point for developing of a broader project designed to assess systematically options for monitoring child mortality, referred to here as Monitoring Child Mortality (MCM).

Consultation objectives

1. To identify, compare and contrast existing options for the measurement of all-cause mortality among children less than five years of age that are feasible for implementation in low-income countries in sub-Saharan Africa.
2. To begin the process of identifying a set of innovative, promising options that can be tested in low-income, sub-Saharan African countries working to achieve rapid reductions in under-five

mortality and that will produce estimates of all-cause under-five mortality with known and acceptable levels of precision at intervals of 12 months or less.

Consultation program and participants

The program was developed by identifying the most important methodological options for measuring mortality as described in the literature. Members of the evaluation team then contacted experts in the field to review the list and generate further ideas and to develop the list of technical experts to be invited. Whenever possible, individuals with field experience in applying the method were given priority. Several experts who were originally invited were not able to attend due to the short lead time (contacts were made in May for a meeting in July). In addition, Hassan Mshinda, the current Coordinator of the In-Depth Network and the Director of the Ifakara Centre for Health Research and Development in Tanzania, was scheduled to attend but had a family emergency on the day of his departure; Ties Boerma prepared and presented the topics originally scheduled to be presented by Dr. Mshinda. Several representatives of development, donor and UN agencies requested permission to attend the consultation, and all were accommodated with the exception of an individual from WorldVision whose request was received the day before the consultation. A list of consultation participants is available in Appendix A; those unable to attend as well as a number of other organizations have requested copies of the consultation report and expressed interest in participating in future MCM work.

The two-day consultation agenda was structured into four major sections. The opening session was designed to provide participants with background on MCM and the consultation objectives. The remainder of Day 1 was organized into presentations of various options with ample discussion time. On Day 2, Cesar Victora opened with a summary of Day 1 discussions, followed by a session on combinations of options and approaches used with special populations (e.g., emergency settings) and one highlighting methodological challenges. In the afternoon of Day 2, participants engaged in a brainstorming session on the selection of “most likely to succeed” options in specific country settings, and reviewed a model permitting the estimation of expected country-specific impact based on coverage estimates and disease profiles. The consultation program (as implemented) is presented in Appendix B.

In addition to the formal consultation program, representatives from development agencies and donor organizations were asked at several points in the consultation to provide perspectives on the need for child mortality monitoring, and how the results might be used. These discussions are summarized in the section on “Defining the scope of the MCM project” below.

Organization of the report

The report presents topical summaries of consultation discussions and conclusions relative to MCM, rather than a chronological summary based on the consultation program. A compact disc containing the consultation presentations was distributed to all attendees at the close of the consultation on 13 July and is available from the IIP consultation organizers (see section on “Contacts for further information” on page 27).

Defining the scope of the MCM project

The aim of the consultation was to meet the immediate needs of CIDA to explore options for measuring changes in under-five mortality at more frequent intervals than those of widely-used household surveys such as DHS or MICS. An unanticipated but important issue that arose repeatedly throughout the consultation was how this aim related to the broader public health goals of engaging communities and

strengthening program monitoring capacity in low-income countries. This section of the report summarizes these discussions and reiterates the specific aim of MCM.

Consultation participants agreed that reliable estimates of child mortality rates are essential for tracking progress toward goals and as a basis for making decisions about the impact of different interventions when implemented in specific country contexts. They also recognized, however, that there is a tension between meeting the immediate needs of investors in child survival and building sustainable country capacity for sound program management. The objectives of MCM must be clear within this context.

Representatives of CIDA, The Bill and Melinda Gates Foundation, and NORAD explained the urgent need to demonstrate that their large investments in child survival are producing results. The present situation, in which changes in child mortality rates are available only every five years or so in a given country and reflect deaths that occurred two or three years in the past, is insufficient to support continued funding at high levels. Ernest Loevinson of CIDA reported that Canada was willing to invest considerable resources to identify alternative mortality monitoring strategies that would produce reasonably valid estimates in shorter time periods, even if the estimates fell short of standards of precision that would be required for academic publications. Ideally these measured mortality estimates would be sufficiently precise to support decisions about funding levels at one- to two-year intervals.

Sverre Lie of Norway underlined the growing demand for evidence of results among those investing in child survival. Norway is currently supporting country efforts to achieve MDG-4 and MDG-5 in India, Pakistan, and Nigeria, and is likely to expand this support to other countries in collaboration with partners. The guidelines for Norwegian support explicitly require measurable results as a condition for funding.

Peter Salama of UNICEF described the tension between the objective of generating mortality estimates for use in improving program effectiveness and the objective of measuring mortality more precisely to produce independent, precise, “bullet-proof” estimates. In the longer term, countries may benefit from efforts to build community-based systems that provide regular monitoring results of sufficient validity to track trends and encourage health system and community involvement. In the shorter term, those funding and implementing programs need valid and reliable measures of impact to justify continuing support and refine program options. Ideally a combination of options could be used to meet both objectives.

Mary Taylor from the Bill and Melinda Gates Foundation delineated a related tension between the need for good quality information on changes in mortality to support continued investment, and the need to engage the community as a prerequisite for effective programs. Making decisions about funding without undermining local capacity and use of data is a challenge that must be addressed.

The primary objective of MCM is to develop and field test “most likely to succeed” options to meet the short-term needs of investors, specifically CIDA and UNICEF but potentially the broader coalition of partners involved in the “Catalytic Initiative”, the Global Business Plan for MDG-4 and MDG-5 and other child survival efforts. MCM is expected to include the assessment of a range of options; the primary criterion for the selection of options to be subjected to field assessment is their potential to produce estimates of relatively short-term changes in all-cause under-five mortality with reasonable precision. As a byproduct, MCM will also assess these options in terms of their potential to contribute to longer-term monitoring efforts that might be useful and sustainable in low-income countries.

The consultation objectives were revised *in situ* as a result of these discussions. Future meetings about MCM should devote sufficient time at the beginning of the work period to ensure that all participants understand the scope and purpose of the project.

Methodological challenges

Measuring short-term changes in mortality presents a number of methodological challenges. These were initially highlighted by Ken Hill, but reiterated throughout the consultation by the technical experts. Only the most important of these challenges are described here.

1. Obtaining adequate sample sizes.

Even in countries with high rates of mortality among children less than five years of age, the death of a child is a rare event. Achievement of MDG-4 (a reduction in under-five mortality by 66% since 1990) would require an annual reduction in under-five deaths of about 4.3% in all low-income countries. Table 1 was prepared by Ken Hill to show the estimated sample sizes needed to capture a change of 4.3% in under-five mortality based on different assumptions about the current level of under-five mortality in a country (initial and final rates) and at different levels of significance and power. These estimates suggest that even a relatively imprecise estimate of changes in child mortality at the rate needed to achieve MDG4 will require sample sizes in the tens of thousands.

Table 1: Sample size requirements to detect significant change of 4.3% annually in under-five mortality rates

Under-five mortality rate		α level*	Sample size of births required for given β **	
Initial rate	Final rate		$\beta = 0.5$	$\beta = 0.2$
0.10	0.0957	0.10	16,144	43,507
		0.05	26,297	59,497
0.20	0.1914	0.10	7,222	19,419
		0.05	11,748	26,547

*Alpha level, or type I error is the probability of rejecting the null hypothesis, when in fact it was true; alpha levels of 0.05 or less are commonly used in epidemiological research

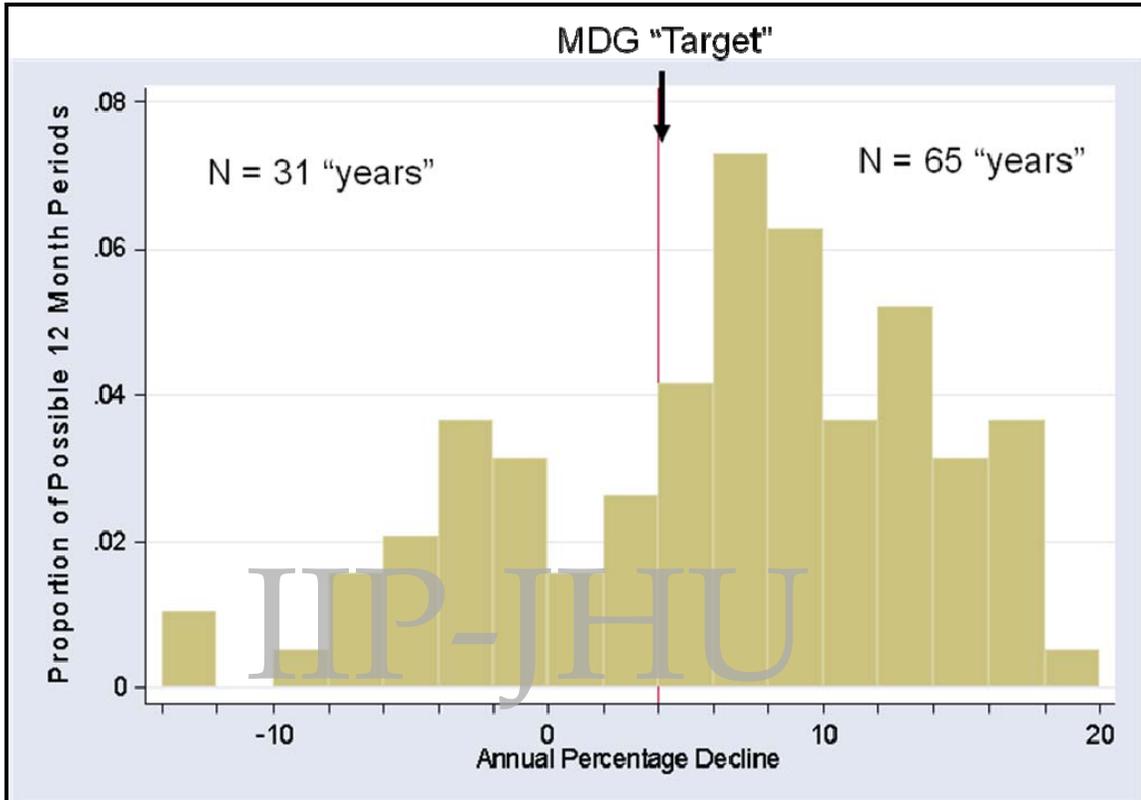
**Beta level or type II error is the probability of not rejecting the null hypothesis when it is false: power of 0.80 or more is commonly used in epidemiological research

2. Defining “short” or “real time” monitoring intervals

Ken Hill presented an example of hypothetical frequent mortality monitoring results using data from the demographic surveillance area of Matlab, Bangladesh. This surveillance site has a total population of 210,000, with roughly 6,000 annual births. The average annual decline between 1992 and 2000 was 5.6%, well above that needed to achieve MDG4. Dr. Hill calculated reductions in the infant mortality rate (IMR) for all possible 12 month periods between 1992 and 2000, a total of 96 12-month periods. Figure 1 shows that the annual percentage decline fell below the MDG threshold of 4.3% in about one-third of all 12-month periods (31/96), and above the threshold for the remainder (65/96). If performance-based disbursement had been used in

this setting, judgments about whether mortality had declined would have been incorrect for one in every three 12-month periods. Increases in IMR were recorded for 23 of the 96 sample years.

Figure 1: Change in IMR in Matlab Bangladesh between 1992 and 2000 calculated for 96 12-month periods

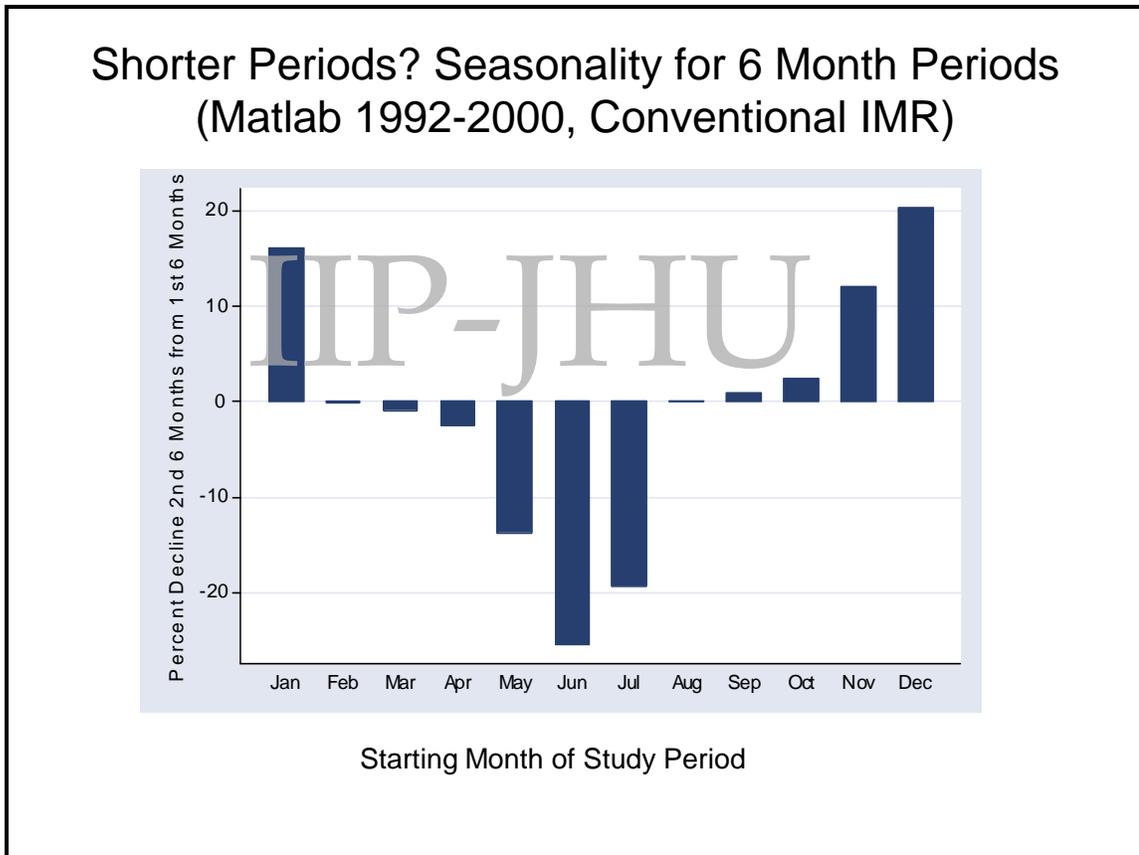


Later in the consultation, Gareth Jones raised three issues related to the frequency of “real time” monitoring. First, the periodicity of data collection and data reporting should be considered separately, and relative to the monitoring objectives. Some monitoring objectives may require data collection at intervals shorter than one year, such as the examination of seasonal patterns in morbidity or the identification of pregnancies. Reporting of results at intervals of less than 12 months, however, may not be necessary. A second issue is cost, based on the assumption that the more frequent the data collection, summary, interpretation and reporting of mortality estimates the more costly the monitoring effort will be. A third issue to be considered is the possible effect of repeated data collection on household reports of mortality. Frequent contact with households may lead to higher rates of non-response or Hawthorne effects, both of which could affect the extent to which the sample represents the underlying population over time. There are also practical aspects of data collection to be considered when deciding on an interval for reporting mortality estimates, including the effect of household mobility on the estimates and whether it is pragmatic and cost-effective to limit data collection only to mortality.

3. Seasonality

Many diseases of childhood vary across the seasons of the year. This introduces variation in mortality rates due to those causes across a 12-month period that add further complexity to the interpretation of mortality statistics, especially when the measurement period is less than one year. To illustrate this, Ken Hill again used the demographic surveillance data base from Matlab, Bangladesh, and calculated the percent decline in the IMR from one given six-month period to the next between 1992 and 2000. As shown in Figure 2, there are wide variations in the infant mortality rate from one six-month period to the next in this area of Bangladesh, even without the highly seasonal influence of malaria that can be expected to affect the temporal patterns of under-five mortality in sub-Saharan Africa. Ties Boerma also highlighted this complexity by presenting data on seasonality patterns in Senegal from 1963 to 1999,⁴

Figure 2: Percent decline in IMR for six-month periods in Matlab, Bangladesh, 1992 – 2000.



4. Cause- and age-specific estimates

Some participants highlighted the advantages of expanding the monitoring effort to include cause- and age-specific estimates of under-five mortality. Ties Boerma summarized the importance of these issues as well as the added sample sizes and complexity this would entail. The group agreed that MCM should focus on all-cause under-five mortality, if possible including disaggregation into broad age bands between zero and 59 months (e.g., neonatal, post-neonatal, 1-59 months). The potential for producing cause-specific estimates should be considered an advantage when reviewing possible options, and included as an approach to be tested if that proves feasible in any of the participating countries.

5. Uncertainty

Neff Walker led a discussion of the levels of uncertainty associated with various options to mortality monitoring. The level of precision needed will vary based on how the monitoring results will be used, and whether there are existing or planned data against which they can be compared. Further discussion of this issue will be needed as country-specific proposals are developed, due to the implications for sample sizes.

For MCM, it will be important to document each option thoroughly and determine the extent and nature of bias associated with the results. These findings can then be used in planning and interpreting results from the use of specific options as part of a national monitoring plan.

A comparative assessment of monitoring options

The technical experts presented summaries of their experience with specific options for measuring mortality among children less than five years of age; other perspectives were offered by consultation participants leading to technical discussions. This summary provides the following information about each methodological option: 1) a general description of the method; 2) country experiences with use of the method as reported by consultation participants; and 3) advantages and disadvantages relative to the objectives of the consultation and broader MCM project. The information presented in this section has been summarized in tabular form in Appendix C. This is a working table, and will be refined and expanded through further MCM work.

1) Options based on data collected through health systems

a) Full vital registration

Ties Boerma presented on behalf of the Health Metrics Network (HMN) as the Executive Secretary, Sally Stansfield, was unable to attend. Full vital registration covers large areas with prospective, ongoing recording of at least births and deaths. The system is highly dependent on health systems, as members of the population report vital events to government staff. Information on cause of death is usually available, and determined through medical certification. The time lag from death to publication of results is variable, but in the best systems may be one to two years.

Statistics on under-five mortality are generally not available in low-income countries. Examples of full vital registration systems in middle-income countries include Mexico and most areas of Brazil, both of which were presented and discussed in the consultation.

Full vital registration can produce high-quality estimates of child mortality in developed countries where registration is complete. In other countries, however, coverage is low, especially in less developed areas, and data are often of poor quality with information missing on the cause of death. Even good vital registration systems have time lags between the death and publication that are longer than those of interest to MCM. Where full vital registration is already developed and is incorporated into government systems, the cost of using these data for research purposes is low.

HMN has several initiatives under way that aim to strengthen vital events reporting systems in low-income countries. For example, the Monitoring of Vital Events (MoVE) initiative aims to:

- Develop and test innovative options for recording vital events and the identification of strategic options appropriate to diverse country settings;
- Generate better data on mortality levels, trends, differentials and causes of death by age and sex and on births;
- Encourage counting of all vital events or, where this is not possible, the highest feasible level of representativeness of sample of deaths;
- Enhance the use of mortality data for resource allocation, planning and evaluation; and
- Enhance national capacity to run and maintain government civil registration systems.

Clearly these aims are relevant to MCM, and careful coordination will be needed in specific country settings. Although the HMN emphasis on age- and cause-specific data may go beyond what is essential for MCM, some HMN development efforts (for example a toolkit titled "Stepping stones to improving the monitoring of vital events") should be reviewed by those responsible for implementing accelerated child survival programs in these countries. In some countries it may be possible for MCM to coordinate with HMN to include strengthened vital registration systems as one option to be evaluated.

The development of standardized verbal autopsy tools and an assessment tool for vital statistics systems, as well as the availability of technical and financial assistance from HMN to countries for improvement of vital registration, are potential resources for MCM. A series of papers on monitoring of vital events will be published in *The Lancet* in October 2007, providing additional evidence and information of potential relevance to MCM.

Two efforts to improve the quality of vital registration systems were also presented and discussed.

i. The SEED system in Mexico

Rafael Lozano described a special initiative of the Ministry of Health in Mexico that has been working to standardize and strengthen epidemiological surveillance based on death certificates. The Statistic and Epidemiological System of Deaths (SEED) is an electronic application that runs parallel to the routine reporting system, and is intended to produce timely annual reports of high quality. This nationally-managed system relies on local epidemiologists, who collect reports weekly from civil registration offices and prepare data bases that are sent to national level monthly.

Several aspects of the SEED experience are relevant to the aims of MCM. First, the incorporation of active surveillance methods in 2002 resulted in the identification of many more deaths than the passive system, particularly among neonates and the poor. In Mexico these discrepancies are reconciled; in other, similar settings this suggests that use of civil registration systems without an active surveillance component are unlikely to

produce valid results. Second, Mexico's experience also highlights a number of methodological challenges in surveillance systems, including reporting delays, difficulties encountered in classifying multiple causes of death, and the capture of perinatal deaths and particularly stillbirths.

The SEED tool may prove useful to HMN and others seeking to strengthen civil registration systems. MCM can learn from the detailed description of methodological challenges in Mexico, as many of them may also apply to other options to mortality monitoring in settings without civil registration.

ii. *The Live Birth Information System in Brazil (SINASC)*

Cecil Landmann described efforts by the Brazilian Ministry of Health to improve the data produced by their individual death registration system, which is based on reporting by community health systems. The rationale for this effort was that the poor quality reported from some states in the less-developed regions of Brazil precluded the estimation of a national IMR. The study team first analyzed data from all Brazilian municipalities for the period 1996-98, and developed a set of criteria for assessing the quality of information related to infant mortality at the municipality level. In the second phase of the study, eight clusters of small municipalities in the North and Northeast Regions that failed to meet data quality criteria were investigated in detail. The results identified problems in death registration as a major barrier to correct, complete and timely reporting. A positive association was found between coverage of the national Family Health Program and the adequacy of vital information at municipality level. Steps are now under way to address these problems. For the time being, IMRs reported by municipalities that meet the quality criteria are accepted as valid by the MoH, whereas census-based projections based on indirect methods are used for those municipalities where reporting is inadequate. National IMRs are calculated through the combination of these two methods (www.datasus.gov.br).

This work provides further evidence of the intensity of effort needed to identify and address shortcomings in civil registration systems. At the same time, Dr. Landmann reports that the conclusions suggest that community health workers can be active participants in this process because they identify a substantial number of deaths that are not picked up by the full vital registration system in Brazil.

b) Sample vital registration

Ties Boerma presented information on sample vital registration in response to interest expressed by consultation participants. This option covers a sample of catchment areas with prospective, ongoing recording of at least births and deaths. Data are usually collected by paid workers, sometimes through active surveillance. Similar to surveys with full birth histories, the time lag from death to publication of results is variable, but in the best systems may be one to two years. Costs include recruiting, training, supporting and supervising the data collection staff, and may therefore be high.

The only known example of this option is the India Sample Registration System. Based on the government website,⁵ the system includes about 7000 sampling units. A total of 100-150 households are drawn from each unit resulting in a total sample population of approximately six million. Enumerators, who are mainly local school teachers, are employed part-time to conduct monthly visits to each household in a village to register vital events. A dedicated surveyor visits once every six months to record birth and deaths and conduct verbal autopsies on each death. A third individual reconciles the information collected from the enumerators and surveyors.

c) Facility-based monitoring using the preceding birth technique.

Kate Gilroy reported on the use of the preceding birth technique with mothers who deliver their babies in health facilities. This method can cover large populations by asking each mother about her previous child ("preceding birth"), resulting in a retrospective estimate of early childhood mortality rates. This passive surveillance technique uses existing facility staff to collect data, keeping costs low, but requires an average of two years from the time of the child's death to the time of reporting.

The example presented was efforts by the Ministry of Health and PROLIPO in Benin, with support from the US Centers for Disease Control and Prevention. Trained health workers in facilities asked the following two questions of each woman at the time of delivery:

Question 1: "Before this birth, have you ever had a live birth"?

Question 2: If the woman answers yes, health workers ask, "Is the most recent live-born child still living?"

Responses were recorded on the national maternal health card and compiled within the local health information system. Early childhood mortality was then estimated by calculating the proportion of most-recent live children who died before the following birth. This method can be used to calculate early childhood mortality at six-monthly, yearly or other intervals, but all estimates refer to periods of 18-24 months (on average) before the data collection period.

Possible advantages of this general option relative to others reviewed in the consultation are: i) it is reasonably straightforward and inexpensive, and may therefore be amenable to incorporation into routine health information systems; ii) it may provide large sample sizes that are reasonably representative, which in turn can promote data use at local levels and support time-trend analyses in settings where high proportions of women deliver in health facilities; and iii) the results may be released every year, unlike those produced by DHS or MICS surveys. Disadvantages of this option include: i) it will not produce representative results in settings where few women deliver at public health facilities (private health facilities can be included in the option, although this may be more difficult than limiting the sample to public facilities) or if patterns of delivery location change; ii) deaths among last-born children are missed; and iii) a death recorded by the system today will have taken place on average 18-24 months ago.

d) Facility-based data calibrated through community surveys.

This method was not the subject of a formal presentation, but was discussed at some length during the consultation. In settings with reasonably high levels of health facility utilization, estimates of child deaths (perhaps even by cause) can be obtained through health records without the need to interview mothers. The results can be adjusted periodically to reflect estimates of the proportion of deaths (by age) that occur in health facilities based on data collected through household surveys.

2) Options based on data collected at community level

a) Household survey with full birth history

There was no formal presentation on this method, as most technical participants are familiar with its characteristics. Although both pregnancy histories⁶ and the use of month-by-month calendars

completed by mothers⁷ have been shown to produce the most accurate estimates of child mortality, the best-available data for most developing countries come from the Demographic and Health Surveys (DHS) implemented by MACRO, International with support from the United States Agency for International Development. These surveys utilize cluster sampling methods and can cover geographic areas ranging from small to large. The retrospective surveys use standard methods to collect full birth histories that are analyzed to estimate birth and death rates by age. Verbal autopsies are sometimes included to provide information on the cause of death. The time lag from a death to the final report is normally two to three years. Data are collected by professional (paid) interviewers, which adds expense but allows independence from the health system.

Most low-income countries have results from at least one DHS available since 2000, and most have two with the second conducted in 2005 or 2006. A listing of DHS surveys is available at http://www.measuredhs.com/aboutsurveys/search/search_survey_main.cfm?SrvyTp=country.

Advantages of this option include the fact that with adequate supervision, these surveys can produce data of good quality. Most surveys, and especially DHS, include sample sizes adequate to produce reasonable levels of precision for estimates at national or regional levels. A single survey can also be used to estimate mortality for several periods of one to two years' duration in the past. Disadvantages include systematic underreporting of some events and the high cost of training, fielding and supervising interviewers to collect data from large samples of households. MCM is likely to use this option as a standard against which to compare alternatives in most if not all participating countries.

b) Household survey with indirect mortality estimates

These surveys are similar to those described above except that mothers are asked relatively simple questions about the numbers of children ever born and who died. Indirect estimates of child mortality rates can be calculated based on the responses to these questions and assumptions about fertility patterns. The UNICEF-sponsored Multiple Indicator Cluster Surveys (MICS) usually estimate child mortality estimates using this method. Surveys with indirect mortality estimates are less useful for MCM than surveys with full birth histories because they cannot support estimates of mortality for periods of less than five years. However, these estimates may be valuable in benchmarking and validating estimates from other sources. Beginning in 2007, MICS will be conducted in some countries at three- rather than five-year intervals. Further information is available at <http://www.childinfo.org/index.htm>.

c) Rolling surveys with full birth history

Shea Rutstein presented the continuous (or "rolling") DHS. He explained that this option was developed in an effort to meet the needs of governments and donors to have periodic (at least annual) information for use in monitoring and evaluating their programs and to provide early warning if program objectives are not being achieved.

The rolling DHS uses cluster sampling techniques to collect retrospective full birth histories from mothers. Data collection is ongoing, revisiting the same geographic areas at regular intervals. The system is similar to other large-scale household surveys in that it can be implemented independently of the health system and uses professional interviewers. Costs are therefore high. The use of verbal autopsies to collect cause-of-death information is an option. Rolling surveys can produce estimates of under-five mortality for larger geographic areas (e.g., countries, regions) every two to three years; for smaller areas (e.g., districts) several rounds are needed to generate sufficient sample sizes and estimates are therefore available only every three to five years.

In the Peru rolling DHS, one-fifth of the clusters used in the Peru DHS 2000 survey were selected within each State for inclusion in the annual cycle. The listing of households in each cluster is updated in the first trimester of every year to adjust the weighting to reflect changes in number of households from 2000 survey. Surveys in a sub-sample of one-third of the included clusters are carried out in each of the remaining trimesters, producing nationally-representative results every four months. Interviews are carried out either continuously or intermittently by the same group of interviewers. The results are nationally-representative for each trimester. However, results for sub-national areas (departments or provinces) require accumulating sufficient sample size over a period of four years or so. For example, in 2007 the latest results for mortality or most coverage indicators for a given department will refer to the average value of the last five years.

Preliminary reports are prepared every six months, with rough tabulations available for each trimester. Definitive reports are prepared every 12 months for indicators with sufficient sample sizes. Reports of biological measurement (e.g., anthropometry, anemia) are prepared every other year, and fertility and mortality trends are calculated for overlapping periods (moving averages). Survey procedures are evaluated annually.

The costs of the rolling survey in Peru are summarized in Table 2, compared with the estimated cost of conducting the most recent traditional DHS survey in Peru in 2000. The results indicate that the annual costs of a rolling survey are less than one-third of the cost of a traditional DHS in the same setting.

Table 2: Estimated costs of conducting the first and second rounds of the rolling DHS survey in Peru, and the cost of the traditional DHS survey conducted in 2000 in Peru, prorated to reflect 2005 US dollars.

Item	Estimated cost (US\$)
Rolling survey: First cycle cost	
Subcontract	331,837
Total	734,837
Rolling survey: Second cycle cost	
Subcontract	463,827
Total	732,697
Traditional Peru DHS in 2000	
Subcontract	1,675,907
Total	2,557,176

Notes:

1. 3% annual inflation increase, adjustment of subcontracts for exchange rate change, totals include allocable with changes in rates.
2. Second cycle includes additional costs due to anthropometry (equipment, supplies, and staff).

The primary purpose of both types of DHS is to provide valid estimates of health indicators; programmatic goals such as building local capacity or engaging communities are secondary. The traditional DHS achieves this purpose, but is usually a massive project at country level implemented in a short period of time. The ongoing work of the survey team members is interrupted, and routine health system activities are often disrupted during the survey period. Traditional DHS surveys are usually considered “one-time” events at country level, with recruitment of special staff contracted only for the duration of the survey, and short term administrative structures and apparatus that are dismantled at the end of fieldwork and once the report is finalized. Perhaps for this reason, potentially important secondary analyses of DHS data are rarely conducted at national level. In contrast, Dr. Rutstein proposed that the rolling DHS can have advantages over traditional DHS surveys in five areas:

i. Institutional advantages

- Permanent headquarters structure and staff
- Forms part of the “normal” work routine
- Permanent field staff
- Dedicated resources (e.g., offices, equipment)

ii. Increased flexibility in survey design and procedures

- Capacity to add or delete questions to modules
- Permits partial over-sampling
- Permits adjustment for population growth and redistribution
- Permits surveying of special populations
- Annual progress evaluation

iii. Increased flexibility in budgeting

- Smaller, regular budgets
- Annually adjustable budgets
- Easier to shift costs from one year to another
- Increased ability to attract outside donors

iv. Increased flow of information

- Annual estimates of key indicators at the national, urban-rural and regional levels
- Annual reports and semi-annual preliminary reports
- State-level information available beginning in three years for the majority of indicators
- Permanent headquarters staff allows for special, ad-hoc and time-sensitive tabulations

v. Better data quality

- Ability to correct errors in questionnaires and procedures before too many interviews have been completed
- Better supervision with a smaller number of field staff
- Permanent staff are more dedicated to their jobs
- Reduction of seasonality effects and allowance of the effects of seasonality on previously collected data

The disadvantages highlighted by the speaker were that some indicators require longer periods to obtain sufficient sample sizes to support reasonably precise estimates, and some indicators are calculated over periods of time longer than one year. Reports from other consultation participants emphasized that local personnel in Peru were disappointed to learn that although national-level estimates of mortality are available annually, the periodicity of mortality estimates at regional and state levels is considerably longer at two and five years respectively.

Detailed results of the evaluation of data quality in the rolling surveys relative to the traditional DHS were not presented. Based on the graphic representation of infant mortality rates obtained through the two sources, however, it appears that the rolling surveys are producing results similar to those of the traditional DHS, at least as these methods were implemented in Peru.

d) Demographic surveillance

Ties Boerma provided a brief summary of this methodological option; most participants are familiar with the range of approaches included under this label, and little further discussion was needed. In general terms, demographic surveillance refers to methods that include a census of the population in a defined geographic area at baseline, followed by active prospective monitoring of vital events and sometimes pregnancies through regular visits to households at intervals ranging from less than three months to up to one year. Paid and closely supervised interviewers use a standard protocol to collect the information, which is usually cleaned and able to be reported in less than one year. An increasing number of DSS use electronic devices at the data collection point (PDA and GPS). Verbal autopsies are sometimes used to determine the cause of death. Sites are generally independent of the health system, and costs of developing and sustaining a site are moderately high.

Some demographic surveillance sites have been in operation for many years, such as the International Centre for Diarrhoeal Disease Control in Bangladesh (icddr,b) or the set of sites in Tanzania. Further information on existing sites is available from the INDEPTH Network, which coordinates the work of 37 demographic surveillance sites in 19 countries (http://www.indepth-network.org/dss_site_profiles/dss_sites.htm).

Demographic surveillance has many advantages as a source of mortality information for small geographic areas. The initial census and active follow-up of pregnancies reduces the under-reporting of deaths. For MCM, however, demographic surveillance has limitations, especially relative to the extent to which the results can be generalized. Only a fairly large number of DSS in a single country with adequate representation of different contexts can provide a more convincing picture. In a large country this could easily exceed ten sites. But even then there are concerns about the extent to which the system can be sustained and provide mid- to long-term data. Over time the geographic area under surveillance becomes increasingly less representative of the broader population due to the implementation of interventions in study areas and repeated household visits by interviewers.

e) Reporting by community health workers

Henry Perry described the history of efforts to monitor mortality through reporting by community health workers, beginning with the work of John Gordon and John Wyon in their pioneering community study in Khanna in the Punjab of north India from the mid-1950s to the mid-1960s, and extending through the Narangwal Project in north India, the Matlab Maternal and Child Health and Family Planning Project in Bangladesh, and the Hôpital Albert Schweitzer in Haiti.

There are numerous alternative designs for community-based monitoring, depending on what is most appropriate for the context. In some settings village elders or chiefs have been given responsibility for registering vital events in their community; in others traditional birth attendants or the local equivalent have registered vital events. One option discussed was conducting periodic surveys or introducing monitoring procedures among these types of community members who have face-to-face contact with mothers as a way of obtaining information about vital events.

Table 3 lists examples of projects that included mortality reporting by community health workers and describes how vital events were registered in each project. All projects included an initial census of the population followed by active surveillance through home visits. There is variation

across the projects in the extent of home visits (all homes or a sample), whether the home visitors are paid or not, and whether data are collected prospectively or retrospectively. In the case of SEARCH, two independent systems of vital events registration are used simultaneously to enhance the coverage of births and death. In one system, community health workers collect vital events through their ongoing work of visiting all households. In the other system, a different program staff member living in the village or nearby visits all homes every six months and collects vital events retrospectively for the previous six months.”

Table 3: How vital events were registered in selected projects that included community-based monitoring

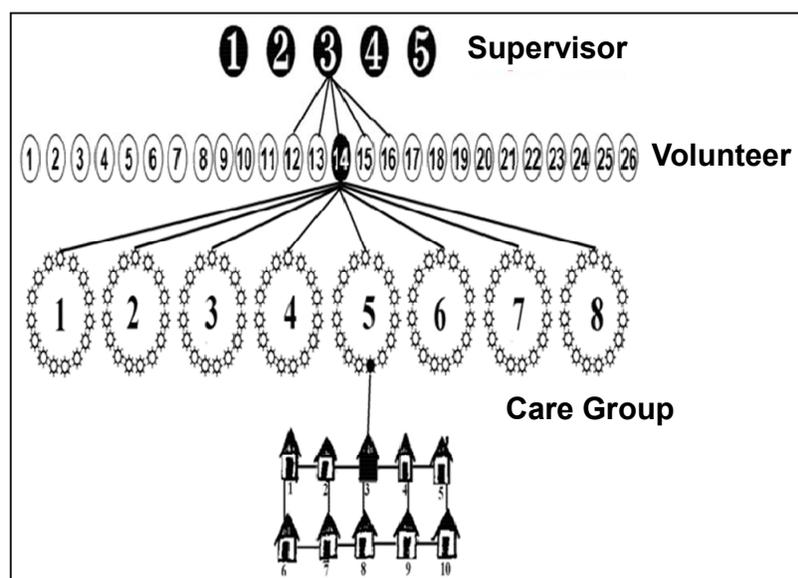
Project	How vital events were registered
Jamkhed Comprehensive Rural Health Project, India	Ongoing registration of vital events in all households by community health workers and annual reporting of findings to the entire community on an annual basis
SEARCH project, India	Simultaneous and independent prospective and retrospective registration of vital events in all households
Census-based, Impact oriented (CBIO) in Bolivia and Guatemala	Prospective registration of vital events in all households by volunteers

There are examples from Nepal and elsewhere in which vital events are collected and tabulated independently of service-delivery staff, sometimes with payment of a small fee for each vital event that is reported and confirmed by a supervisor.

Anbrasi Edwards provided details on the application of one approach, referred to as “The Care Group Model”, by government and a broad array of partners in the Chokwe district of Gaza, Mozambique.

Figure 3 summarizes the Care Group model, originally developed by World Relief. In this model, trained volunteers are responsible for visiting 10 households once a month. During the visit they provide a health message and collect information on births and deaths in the preceding month. Volunteers meet monthly with a supervisor to learn about the next

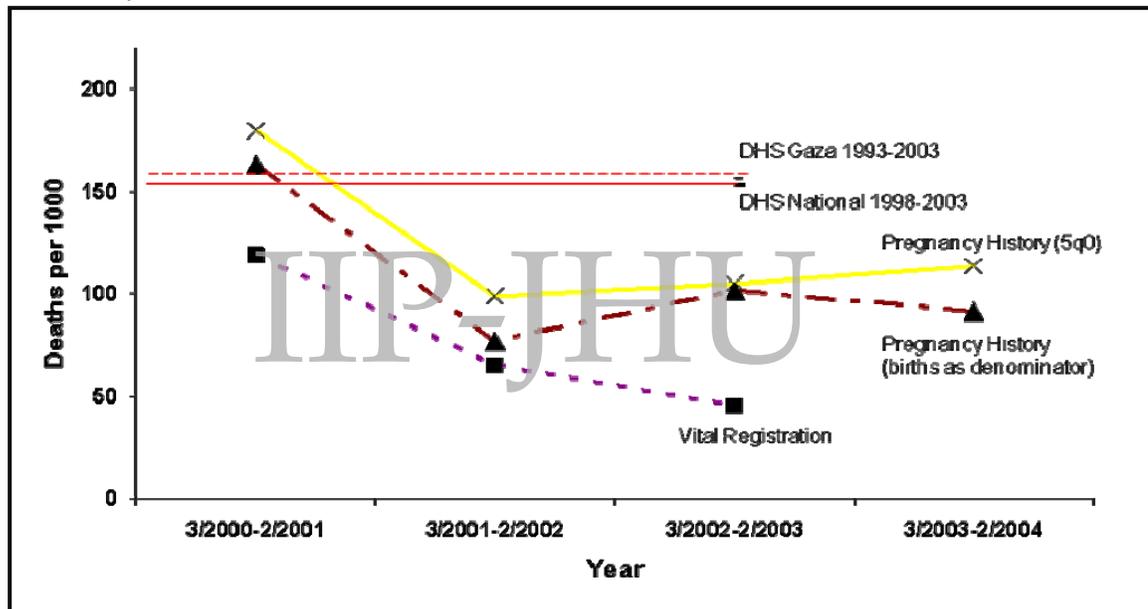
Figure 3: The generic “Care Group” model



month's health message and report vital events. One published study has verified mortality declines documented using a Care Group approach through an independent assessment of mortality based on pregnancy histories collected by outside interviewers.⁸

Monitoring of health events was an integral part of the Chokwe project, and included a community-based vital registration and health information system for routine surveillance of births, deaths and childhood illnesses. Project staff revisit a random sample of 20% of households to ensure quality of the data collected. Evidence from this system indicate a 62% reduction in under-five mortality, and this was compared to results obtained from an independent mortality assessment using a standard DHS-type pregnancy history in a sample population of 998 women. Survey results showed a 42% reduction in under-five mortality. Figure 4 compares the mortality estimates obtained from the various monitoring systems.

Figure4: A comparison of infant mortality estimates derived from various sources of data, Gaza, Mozambique, 2000-2004.



Country-specific applications of the Care Group model have been scaled up to cover several districts or entire provinces/regions by World Relief in Cambodia, Malawi and Rwanda, and by a number of other countries with support from various private voluntary organizations.

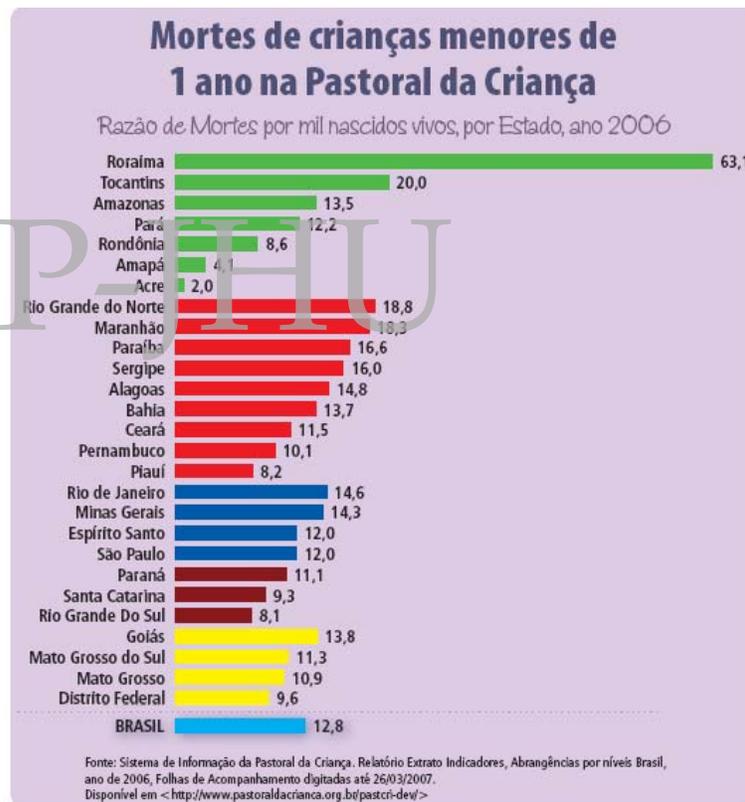
The Care Group model has particular strengths for combining monitoring objectives with community engagement and empowerment. The volunteers can play a pivotal role in linking the health system to communities, providing a platform for the delivery of various interventions. Community cost-sharing and strengthening of the social infrastructure are positive outcomes that can contribute to equitable delivery of services, especially in post-conflict settings. Limitations from the perspective of monitoring for frequent reporting to child survival investors include potential biases from community-based reporting, and the investments of time and resources needed to build and sustain community capacity. There may also be important cultural and geographic features that need to be taken into account in local contexts. MCM can investigate reports of applications of the Care Group model to learn more about the potential utility of this option.

f) Reporting by program staff

Cesar Victora reported on experience with vital events reporting by community health workers (CHWs) in Brazil. In 2002, infant mortality rates (IMR) reported from some Brazilian states varied widely depending on the source of the data. In Alagoas State, for example, the number of infant deaths per 1,000 live births were 58 from the National Census Bureau, 30 from the Brazilian registration system for births and death, 37 from reporting by Government CHWs, and 19 from CHWs affiliated with the “Child Pastoral”, a large non-governmental organization operating in Brazil since 1983 with support from the Catholic church.

Under the “Child Pastoral” program, trained volunteers (usually women) who live in the community they serve visit an average 13 children every month. Monthly meetings are held with peers and a local coordinator to reinforce the volunteers and collect reports of local health events and the prevalence of key family practices related to child survival. Information on deaths is collected using a project-specific verbal autopsy protocol. The program covers 4,063 of the 5,500 municipalities in Brazil (74%), including over one million children less than six years of age. The program is now being expanded to other countries, including Colombia, Paraguay, Angola, and Guinea-Bissau. Monitoring results have been used to assess program coverage, including inequities. Figure 5 illustrates the type of mortality information obtained from this system, showing estimated IMRs by state for 2006. The wide variability shown in some regions (e.g., North and Northeast) is not compatible with what is known from reliable sources. Also, the very low IMRs in some states are certainly underestimated.

Figure 5: IMRs in Brazil by State, 2006, based on community reports from the Child Pastorate Information System.



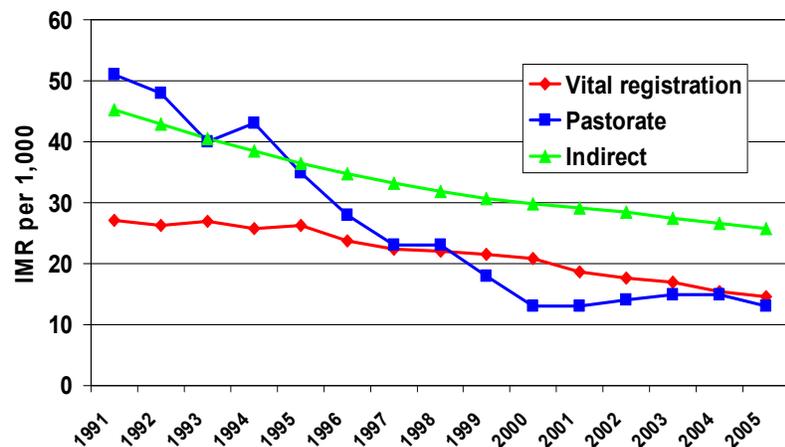
The primary objective of this information system is to provide feedback for action, rather than to produce valid population-based indicators. In this context the advantages of the system include the following: i) the indicators are simple and well understood by the leaders; ii) the results are shared regularly with communities, interpreted and acted upon; and iii) the monitoring information is available 45 days after the end of the reporting month. The Pastorate has been estimated to pay about US\$0.80 per child/month to support the community-based monitoring program.

Limitations of this option from the perspective of mortality monitoring include: i) community leaders may under-report negative outcomes (e.g. malnutrition or deaths); ii) late enrollment of children may lead to under-reporting of neonatal deaths; and iii) irregular information flow is a challenge, with about 20% of active communities failing to report each month.

In comparison, the Government CHW program in Brazil is designed to provide comprehensive primary health care with priority given to poor areas. Each team of one doctor, one nurse, one auxiliary nurse and six CHWs is responsible for about 1,000 families. Each salaried CHW visits about 150 families every month. There are about 27,000 teams operating in Brazil, covering an estimated population of 86 million living in 59% of the municipalities in the country. CHWs collect information on health care utilization and coverage as well as morbidity and mortality, and all data are entered at the municipal level. The results are usually available within a few months, and continued funding from the federal Government is conditional on regular reporting. An estimated US\$1.7 billion was invested in this health program in 2006, representing over US\$20 per person/year (this covers the provision of health care, drugs, laboratory examinations, etc, as well as monitoring). Similar to the “Child Pastoral” program, the primary aim of the Family Health Program is to improve the health of the population, with monitoring as a secondary objective. The advantages of the monitoring option include the fact that monthly reports are available for most participating municipalities, and the program’s emphasis on low-income areas means that these reports are more likely to be available in areas where vital registration is incomplete. The results can also be disaggregated to reflect small geographical areas. Disadvantages from a mortality monitoring perspective include the fact that monitoring coverage is low in the capital city and other metropolitan areas, and that the results have been found to underestimate mortality by about 10% in rural areas relative to indirect estimates.

The Brazilian experience with community-based mortality monitoring suggests that achieving good vital statistics reporting systems will require continued efforts, especially in poor health areas. Figure 6 shows estimated IMRs in Brazil since 1991 based on the “Child Pastoral” and the Government CHW monitoring systems relative to IMRs estimated using indirect methods. Reporting systems that rely on volunteer CHW are

Figure 6- Estimates rates of infant mortality in Brazil based on data reported through the “Child Pastoral” system, the Government-sponsored Family Health Project, and indirect methods collected through nationally-representative household surveys, 1991 – 2006.



problematic for mortality monitoring, because providing population-based data is not their primary purpose, and results are likely to be affected by the late enrollment of infants and biased reporting from communities. Government CHW programs appear to be a promising option for poor areas,

but require high and equitable population coverage. Once coverage targets have been achieved, these data may be used to assess short-term trends in child mortality.

3) Combinations and special applications

The evaluation team encouraged consultation participants to think in new ways about mortality monitoring, drawing on experiences in special circumstances or creative efforts to combine various options. Formal presentations were solicited in two areas and are summarized below. In addition, throughout the consultation participants were encouraged to move beyond assumptions about what could or should be done, or what has been done in the past, to identify new alternatives.

a) Mortality monitoring in emergencies.

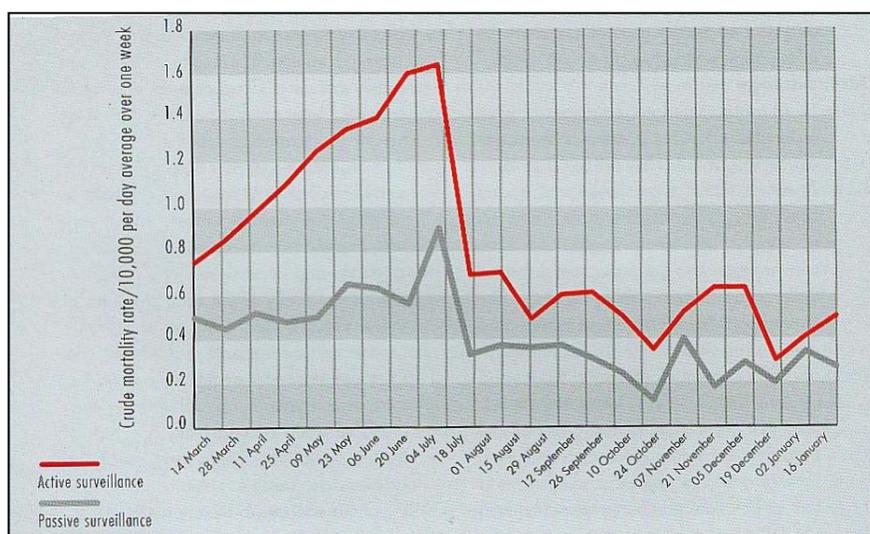
Court Robinson provided an overview of the methodological challenges of measuring mortality under emergency conditions. The characteristics of populations experiencing disasters and emergencies is highly variable – ranging from concentrated to dispersed, culturally homogeneous to polyglot, and accessible to inaccessible. One of the first challenges facing public health professionals upon arrival in an emergency or disaster situation is to characterize the population, including recent patterns of morbidity and mortality. Other challenges are also similar to those being addressed by MCM, including the need to monitor trends over the short term to assess the impact of humanitarian intervention and to produce results rapidly.

Among the four approaches to monitoring mortality commonly used in emergency settings, surveillance and surveys are particularly relevant to the consultation objectives. Qualitative/participatory options and registration systems were not reviewed in detail.

Surveillance options used in emergencies have included passive surveillance, usually relying on the collection of information from health facilities, and active surveillance including body counts and visits to burial sites. For example, deaths in Burmese refugee camps in 1992 were assembled both through collecting reports from health centers and the camp administrator's office (passive surveillance), and by counting graves and conducting interviews with religious leaders and relatives of the dead (active surveillance). Figure 7 shows the difference in levels of reported deaths produced by these two methods.

Retrospective, cross-sectional sample surveys are the most common method to estimate mortality in humanitarian emergencies. These surveys generally use the standard 30-cluster sampling design, although some have used simple random sampling or systematic sampling.

Figure 7: Deaths reported in Burmese refugee camps in Bangladesh in 1992 by active and passive methods of surveillance.



Unfortunately, in many emergency settings standard survey methods have not been used or surveys are not well documented, making it difficult to compare results across situations and/or over time. Several international initiatives are now working to address this problem.

Implications for MCM include the fact that mortality monitoring in emergencies poses challenges similar to those of documenting short-term trends in under-five mortality, and can contribute important methodological experience and insights.

b) Combining lay surveillance and periodic surveys.

Stan Becker presented an example of mortality and morbidity monitoring in which information from community informants was combined with information collected through periodic surveys. This research project was carried out in 1988-1991 in 253 Barangays of metropolitan Cebu, The Philippines, among approximately 40,000 households, representing a total population of 218,000 and approximately 16,000 children less than 30 months of age. Monitoring was carried out to: 1) monitor use of child health services; 2) measure infant and child morbidity and mortality; and 3) assess the effects of ORS use on young child mortality.

At the beginning of this project, a household census was conducted to identify households with children less than 30 months of age, each of whom was enrolled in the study (~19,000 children over the entire study period) and assigned a unique identifier. Trained interviewers visited the household of each enrolled child every six months to collect further information including vital events; cause of death was determined through verbal autopsies.⁹ Simultaneously, the study team recruited community informants (primarily midwives and health workers) to report births and deaths in each community, paying them 10 and 50 pesos for reporting a birth or death respectively to project staff. Reports obtained from interviews and community informants were compared based on the unique identifiers. The analysis is based on person-years to account for changes in the denominator caused by births and out-migration. Four hundred and twelve deaths occurred during the study period; the infant mortality rate stayed relatively constant at 50 infant deaths per 1000 live births.

This example suggests that the validity of under-five mortality estimates can be improved through the use of multiple methods. The investigators found that some deaths were reported in surveys but not by community informants, while other deaths were reported by the community informants but not captured in the surveys. Other challenges that were encountered included: 1) enumerating children at 30 months of age, both in the interviews and in the analysis; 2) accounting for in- and out-migration, especially just before or after a birth or in response to death; and 3) deciding which assumptions to use in conducting the analysis of mortality rates by person-year.

c) Other combinations

Participants discussed a number of other options, including:

- Combining estimates from vital statistics registries in urban areas and demographic surveillance systems in the rural areas;
- A "spread out" DSS that sampled and then monitored vital events – but different than a sample registration system;
- Smaller DSS-type systems with sampling of a larger number of clusters to increase representativeness, and potentially reduce the Hawthorne effect by increasing the number of sites among which monitoring activities could be rotated.

4) Summary: Outputs of the comparative assessment

The two-day consultation was successful in generating an expanded list of possible options for assessing short-term trends in under-five mortality, at least to the extent that they were able to be imagined by this group of participants. A systematic review is needed to complete and expand the list of options presented in Appendix C.

Based on these discussions, and in parallel with the longer-term goal of developing complete vital registration systems for the countries participating in the UNICEF/CIDA initiative to accelerate child survival, it appears that there are several options that merit further consideration by MCM. These include:

- a) Rolling surveys that include a full birth history, with or without verbal autopsy to assess cause of death, or perhaps this type of survey carried out in nationwide samples with a truncated birth history pertaining to child births and deaths in the previous 5 years (cluster sampled).
- b) A similar option that adds this reduced subset of questions to surveys conducted for other purposes, such as economic surveys being carried out as part of the assessment of poverty reduction strategies, as long as these surveys are carried out within an appropriate time frame for monitoring.
- c) One or more options that include recording of deaths at community level through paid workers or local key informants, with careful supervision and periodic meetings with a supervisor at frequent intervals (perhaps monthly).
- d) In settings with high levels of facility utilization, estimating child mortality rates through facility records, with regular adjustment to reflect patterns of utilization based on sample surveys of households.

There are unanswered methodological questions that will need to be addressed regardless of the methodological options selected for use in a particular country. A preliminary list of these questions was presented by Henry Perry; MCM will need to expand on this list and develop plans to generate answers as a part of the project work plan.

- Will program staff or community members “purposely” under-report deaths?
- Will vital events be under-reported for other reasons (e.g., cultural, in reporting of early neonatal deaths)?
- How can we know that the rates reported are accurate?
- How can we ensure proper supervision of reporting of vital events?
- Can “outsiders” (interviewers who are not from the local area, e.g., DHS interviewers) obtain accurate information about births and deaths retrospectively (especially for early neonatal deaths)?
- How important are trust and confidence in collecting sensitive and possibly private information such as stillbirths, births, and child deaths?

Broader conclusions of the consultation

More general conclusions of the consultation are summarized below. These may serve as recommendations to MCM and others working to improve the availability of estimates of child mortality at national and international levels.

- 1) *Development and improvement of vital registration systems in low-income countries should be an important long-term priority.*
 - a) Timely, high-coverage, accurate vital registration systems are needed in all countries
 - b) This goal may be achieved within a few years in some areas, in some low-income countries
 - c) Alternative options are needed urgently
- 2) *There are at least three equally important but distinct objectives of “real time monitoring” of under-five mortality:*
 - a) Community engagement
 - engagement of local communities in use of data to improve programs
 - involvement of local actors/ feedback
 - easy interpretability of results
 - b) Program monitoring
 - real-time information for implementation
 - involvement of local actors/ feedback
 - “good enough” accuracy – e.g. EPI surveys
 - c) Mortality monitoring for evaluation or disbursement purposes
 - frequent mortality measurements (how frequent?)
 - allow independent evaluation
 - sufficient accuracy for detecting time trends

All of these objectives are important and need to be pursued, but attempts to achieve all objectives through a single system are unlikely to be successful.

- 3) *Mortality monitoring intervals of less than 12 months are unlikely to produce interpretable results because of seasonality, unless they are part of a longer-term effort.*
- 4) *Obtaining the sample sizes needed to estimate significant changes in mortality within short time periods will be a major challenge.* Preliminary estimates suggest that populations in the tens of thousands will be needed to record adequate numbers of child deaths to estimate mortality with the necessary precision.
- 5) *All methodological options will need to build on and reflect country-specific characteristics.* “One-size-fits-all” solutions for measuring short-term trends in under-five mortality are unlikely to emerge from the work of MCM.
 - a) Country assessments will be needed to determine at least:
 - current coverage of vital registration
 - access to health facilities
 - existence and coverage of CHW systems
 - level of mortality

- b) Decisions about “most likely to succeed” mortality monitoring options will depend on at least:
- the scale of the program (national, province, district)
 - short or long-term mortality reduction objectives
 - time lag of estimates
- 6) *Within individual countries, the ideal design would assess the performance of two or more options relative to a method known to produce high-quality estimates of child mortality. Comparing the results produced by the different options will contribute to learning and will increase the probability that adequate estimates of mortality are available on at least an annual basis.*

Implications for methodological assessments of the options in countries

Recommendations for how the assessment of alternative monitoring methods should be designed and implemented were an important byproduct of this consultation and are recorded here for future reference. Points raised, although not discussed in depth due to time limitations, included the following:

- 1) *Conduct an initial assessment of mortality monitoring activities and resources at country level, and include qualitative components into the assessment design as needed.* Describing the characteristics of the setting (contextual factors) in which the child mortality monitoring will take place will be an essential starting point for designing effective options. The contextual factors must first be examined and documented through qualitative methods or context profiles in order to better implement (and possibly choose) the most promising option(s) in each setting. Important contextual factors to consider may include:
 - a) *The social structure of communities:* What is the role of village elders or leaders? Are there other community “points-of-contact”? Who assists the majority of deliveries in the communities? What is the role of community health agents both within the community and within the health system?
 - b) *Utilization of health services:* What are levels of utilization of public facilities for childbirth? For severely-ill children? Are private providers a large source of care for pregnant women and young children? What are the sources of medications in the communities?
 - c) *Urban/rural differences:* Are there major differences between urban and rural populations? Are there differences in the available systems and infrastructure in each type of location? Would different systems be more adapted to the urban versus the rural environment?
 - d) *HIV prevalence:* Is adult mortality high, so that techniques relying on mothers’ reports will miss many children? Is the work-force sufficiently stable to support rolling surveys?
 - e) *Vulnerable populations:* Who and where are the vulnerable populations that should be included in mortality monitoring? Vulnerable populations may not be connected to the individuals or systems through which vital event information is collected, even though they often at higher risk for adverse outcomes and need to be included in the monitored population.
- 2) *Take advantage of staggered implementation to design “natural experiments” that use geographic areas designated for later implementation as comparison groups.*
- 3) *Consider country-specific designs that allow comparison of two or three alternative options in addition to a “known” method that can serve as a basis for comparison.* There was wide agreement on the need for comparing, in the same population, a method known to produce high-quality estimates (such as a demographic survey with full birth histories) with possibly two other types of methods, for example (i) a simplified rolling survey and (ii) a key informant or local

worker (e.g. CHW) reporting system. It may also be possible to identify the geographic areas with the highest levels of under-five mortality in each country, and to target these areas for accelerated implementation of interventions as well as mortality monitoring, thereby reducing the overall sample sizes needed for mortality monitoring.

- 4) *Collaborate with others, including the Government and international initiatives, to construct country-level assessments of existing efforts to strengthen health information systems as well as options implemented for the UNICEF/CIDA initiative.*
- 5) *Document all monitoring options carefully, including costs, with attention to their potential for sustained, routine implementation and/or for contributing to program objectives through community involvement and empowerment.* Consultation participants recognized that the technical review and assessment of alternative options to mortality monitoring was an urgent priority. This was reflected in the high level of interest in the consultation conclusions expressed both by those who were not able to attend and by countries. The group suggested that the terms of reference for MCM work include a compilation of alternative options supported by a systematic review of evidence and experience, intended for use by those at national and international levels in developing monitoring systems to meet the needs of both investors and program implementers.

Plans to invest in accelerated child survival activities with countries by UNICEF, CIDA, Norway, Gates, USAID and others would benefit from a joint effort to plan and implement independent evaluations with the dual purpose of methodology development and impact assessment. With the imminent launch of the Global Business Plan and other initiatives that utilize performance-based disbursement of funds, demands for frequent (“real-time”) monitoring and evaluation will be even greater. Continued support of country activities based on documented evidence of improvements in maternal and child health will bring additional challenges about how to measure outputs, outcomes and impact in a timely, reliable and independent manner.

Building political commitment and creating demand for action require valid data that are updated frequently, showing progress and identifying bottlenecks that must be addressed. Although country-level evaluations can provide important insights, a systematic multi-country effort is needed to supplement and systematize these activities. The IIP evaluation team proposes that, for the common good, agencies and governments implementing these different initiatives should coordinate their efforts to conduct evaluations in different countries, using a common evaluation framework and consistent indicators of implementation, costs, coverage and impact. Results from these coordinated evaluations will then be comparable, and can be used to inform the global community about options that can achieve rapid, sustained and equitable improvement in the health of mothers and children in specific contexts. Capacity in program monitoring and evaluation can best be developed through collaborative field work; therefore the involvement of scientists and managers from the low-income countries where the evaluations are carried out is essential.¹⁰

Contacts for further information

Suggestions from consultation participants or those who read the report are welcome! Please send your comments to Jennifer Bryce at jbrycedanby@aol.com.

For copies of the presentations given at the consultation, send inquiries to Jeremy Schiefen at jschiefe@jhsph.edu

References

- 1 Claeson M, Gillespie D, Mshinda H, Troedsson H, Victora CG. Knowledge into action for child survival. *Lancet* 2003;**362**(9380):323-7
- 2 Hill K. Options to the measurement of childhood mortality: A comparative review. *Population Index* 1991, **57**(3), 368-382.
- 3 Bryce J, Victora CG on behalf of the MCE-IMCI Technical Advisors. Ten methodological lessons from the Multi-Country Evaluation of IMCI. *Health Policy and Planning* 2005; **20-S1**:i94-i105.
- 4 Delaunay et al. Decline of infant and child mortality rates in rural Senegal over a 37 year period (1963-1999). *Int J Epid* 2001, **30**:1286-1293.
- 5 India Sample Registration System. <http://www.censusindia.net/srs21.html>, downloaded August 9th, 2007.
- 6 Espeut, 2002
- 7 Becker S, Sosa D. An experiment using a month-by-month calendar in a family planning survey in Costa Rica. *Studies in Family Planning* 1992; 23(6):386-391.
- 8 Edward A, Ernst P, Taylor C, Becker S, Mazine E, Perry H. Examining the evidence of under-five mortality reduction in a community-based programme in Gaza, Mozambique. *Trans Roy Soc Trop Med Hyg* 2007, doi:10.1016/j.trestmh.2007.02.025.
- 9 Kalter, H. D., R. H. Gray, et al. (1990). "Validation of postmortem interviews to ascertain selected causes of death in children." *Int J Epidemiol* **19**(2): 380-6.
- 10 Victora CG, Black RE, Bryce J. Learning from new initiatives to improve maternal and child health: why we need a common framework. *Lancet* 2007; **370**(9593): 1113-1114.

IIP-JHU

**REPORT OF THE EXPERT CONSULTATION
ON METHODOLOGICAL ALTERNATIVES FOR
MONITORING OF CHILD MORTALITY**

12-13 July 2007
Baltimore, Maryland

Appendices

1 September 2007

IIP-JHU

IIP-JHU

Appendix 1

List of Participants

Dr. Robert E. Black
Edgar Berman Professor and Chair
Department of International Health
Bloomberg School of Public Health
615 N. Wolfe Street, E8527
Baltimore, MD 21205
(410) 955-3934
(410) 955-7159 – fax
rblack@jhsph.edu

Dr. Stan Becker
Professor
Dept. of Population and Family and
Reproductive Health Services
Bloomberg School of Public Health
615 N. Wolfe Street, E4148
Baltimore, MD 21205
(410) 955-4485
sbecker@jhsph.edu

Dr. Ties Boerma
Director
Department of Measurement and Health Information Systems
World Health Organization
Avenue Appia 20
CH1211
Geneva 27 Switzerland
boermat@who.int

Dr. Jennifer Bryce
Senior Scientist
Department of International Health
Bloomberg School of Public Health
615 N. Wolfe Street, E8610
Baltimore, MD 21205
(410) 502-9140
(410) 955-7159 - fax
jbryce@jhsph.edu

Erin Eckert
Principal Investigator/Epidemiologist
MEASURE Evaluation
ORC Macro
11785 Beltsville Drive, Suite 300
Calverton, MD 20705
(301) 572-0397
(301) 572-0999 - fax
Erin.eckert@orcmacro.com

Dr. Anbarasi Edward-Raj
Assistant Scientist
Health Systems Program
Department of International Health
Bloomberg School of Public Health
615 N. Wolfe Street, E8527
Baltimore, MD 21205
(410) 502-7663
(410) 614-1419 - fax
aedward@jhsph.edu

Melanie Galvin
Manager
Health Systems and Nutrition Programming
Multilateral Programs Branch
Canadian International Development Agency
Gatineau, Quebec, Canada K1A 0G4
(819) 956-0476

Dr. Ken Hill
Visiting Professor
School of Public Health,
Harvard Initiative on Global Health
Third Floor
104 Mt. Auburn St.
Cambridge, MA 02138
(617) 495-3699
(617) 495 -5418 - fax
Kenneth_hill@harvard.edu

IIP-JHU

Dr. Gareth Jones
301 Parnell Avenue
Ottawa, Ontario K1Z 5J7
Canada
(613) 724-2712
gareth@adeni.ca

Dr. Celia Landmann Szwarcwld
Departamento de Informações em Saúde, CICT
Fundação Oswaldo Cruz
Av. Brasil, 4365
RJ 21045
celia_is@hotmail.com

Dr. Ernest Loevinsohn
Director General
Health and Nutrition Directorate (HAND)
Multilateral Programs Branch
Canadian International Development Agency
Gatineau, Quebec, Canada K1A 0G4
(819) 997-9492
(819) 997-6632 - fax
loevinsohn@acdi-cida.gc.ca

Dr. Hassan Mshinda
Ifakara Health Research and Development Centre
Ifakara, Tanzania
Mashinda_hassan@yahoo.co.uk; hmskinda@ihrdc.or.tz

Dr. Henry Perry
Future Generations
HC 73 Box 100
Franklin, WV 26807
(304) 358-2000
(304) 358-3008 – fax
henry@future.org

Dr. Courtland Robinson
Assistant Professor
Department of International Health
Bloomberg School of Public Health
615 N. Wolfe Street, E8642
Baltimore, MD 21205
(410) 955-3928
(410) 614-3926 - fax
crobinso@jhsph.edu

Shea Rutstein
Macro International, Inc.
11785 Beltsville Drive, Suite 300
Beltsville, MD 20705
(301) 572-0200
(301) 572-0999 - fax
Shea.O.Rutstein@orcmacro.com

Dr. Peter Salama
UNICEF
psalama@unicef.org

Dr. Sally K. Stansfield
Health Metrics Network
World Health Organization
Geneva, Switzerland
stansfields@who.int

Dr. Cesar Victora
Universidade Federal de Pelotas
CP 464 96001 970
Pelotas RS Brasil
55 33 271 2442
55 53 271 2645 – fax
cvictora@terra.com.br

Dr. Neff Walker
Senior Scientist
Disease Prevention and Control
Department of International Health
Bloomberg School of Public Health
615 N. Wolfe Street, E5531
Baltimore, MD 21202
(410) 502-9034
(410) 625-2154 – fax
pneffwalker@yahoo.com

IIP-JHU

Appendix 2

EXPERT CONSULTATION ON
METHODOLOGICAL ALTERNATIVES FOR
FREQUENT MONITORING OF CHILD SURVIVAL
12-13 JULY 2007

Program

Thursday, 12 July

Session 1: Setting the stage

09.00	Welcome; why results are needed	E Loevinson
09.15	Meeting purpose and expected products	R Black
09.30	Secular trends in child mortality and their implications for this effort	K Hill

Session 2: Options for health facility/health system monitoring

10.00	Civil registration systems in low-income countries, and efforts by the Health Metrics Network to strengthen them	T Boerma
10.20	Assessment of child mortality trends using national data	R Lozano
10.40	Using existing subnational data: Experience from Brazil	C Landmann
11.00	Facility-based monitoring using the preceding birth technique in Benin	K Gilroy

COFFEE

11.45	Discussion	
-------	------------	--

LUNCH

Session 3: Options for mortality monitoring at community level

14.00	Approaches to measuring mortality impact in census-based child survival programs of NGOs	H Perry
14.20	Community reporting of vital events: The Care Group approach of World Relief	A Edward
14.40	A comparison of experience with church, volunteer and community health workers in Brazil	C Victora
15.00	Demographic surveillance approaches	H Mshinda
<i>TEA</i>		
16.00	Discussion	

Friday, 13 July

08.30	Warm-up: Can we agree on what we agreed on yesterday?	C Victora
08.50	Mortality monitoring in emergencies	C Robinson
09.10	The “rolling DHS” in Peru	S Rutstein
09.30	Combining lay surveillance and periodic surveys: Experience from The Philippines	S Becker
10.10	Discussion	
<i>TEA</i>		
11.00	Are cause- and age-specific estimates possible? Discussion	T Boerma
11.30	Defining “frequent”: the implications of 3 vs 6 vs 12 month monitoring periods Discussion	G Jones
12.00	Estimating the effect of maternal mortality due to AIDS on child mortality estimates. Discussion	S Rutstein S Rutstein
12.30	What level of uncertainty is acceptable? Discussion	N Walker

Session 6: Getting real – applying the lessons to high-priority countries

14.00	What might work for 6-monthly mortality monitoring in a worst-case country? What about feasibility and affordability? <i>[see starting assumptions on page 3]</i>	
15.00	<u>Implications of changes in context</u> How would the “most likely to succeed” option identified above change, if at all, in a country context where: HIV prevalence among the adult population was 13%? Antenatal care coverage was >90%? 40% of children with severe illness received correct care in a health facility 40% of child deaths occurred in facilities There was a reasonably valid census conducted in 2004? What other contextual features would have important implications for the “most likely to succeed” option?	

Session 7: Recommendations from the technical experts

16.00	What does this group suggest are the “most likely to succeed” scenarios for frequent monitoring of under-five mortality in low-	
-------	---	--

income countries with various epidemiological and health system characteristics?

What explicit guidance would this group offer to those implementing programs seeking to achieve rapid reductions in U5M in these settings?

- 17.00 Modeling mortality based on coverage: Child survival in the Spectrum model N Walker
- 17.30 Discussion

Table of assumptions for Session 6

Assumptions	
Epidemiology	<ul style="list-style-type: none"> Major causes of U5M are pneumonia, malaria, diarrhea, with low HIV prevalence and neonatal causes \approx 30%
Health system	<ul style="list-style-type: none"> Existing community workers are unpaid and provide health education and promote vaccination NIDs 2x year; vit A supplementation via NIDS with coverage around 70%.
Utilization	<ul style="list-style-type: none"> Careseeking for pneumonia at 1st level facilities \approx 10% Existing community workers not permitted to provide antibiotics Bednets used in pilot districts only 15% of births occur in hospitals
Planned interventions (national level)	<ul style="list-style-type: none"> Blanket coverage with long-lasting ITNs Retraining and close supervision of CHWs to provide <ul style="list-style-type: none"> ✓ case management of pneumonia (other than severe), malaria, diarrhea by trained community-level workers ✓ follow-up of all pregnant women to ensure full EPI coverage and breastfeeding/nutrition counseling IMCI at 1st level
Existing data	<ul style="list-style-type: none"> DHS 2003; MICS 2006 DHS/MICS planned for 2009 Census data from 2000, known to be flawed No other existing nationwide-system except routine MIS with current completeness estimated to be low

IIP-JHU

Appendix 3

Summary of methodological options reviewed at the consultation

	FACILITY-BASED OPTIONS			COMMUNITY-BASED OPTIONS					
	Full vital registration	Sample vital registration	Preceding birth technique	Survey with full birth history	Survey with indirect mortality estimates	Rolling surveys with full birth history	Demographic surveillance	CHW reporting	Program staff reporting
Sample or population	Population	Sample of catchment areas	Population	Cluster sample	Cluster sample	Cluster sample	Population	Population	Population
Size of area covered	Large	Several small areas	Large	Large or small	Large or small	Large or small	Small	Large or small	Small
Directionality	Prospective	Prospective	Retrospective (2 yr lag)	Retrospective (at least 1-2 yr lag)	Retrospective (usually 2-3 yr lag)	Retrospective (at least 1-2 yr lag)	Prospective	Prospective	Prospective
Frequency of data collection	Ongoing	Ongoing	Ongoing	Once, may be repeated	Once, may be repeated	Ongoing, every few years in each site	Every 4-6 mos	Monthly or every few mos.	Monthly or every few mos.
Time lag (death to publication)	Variable, ideally about 1-2 yr	Variable, ideally about 1-2 yr	At least 2 yr	Normally, about 2-3 yr	Normally, about 2-3 yr	Normally, about 2-3 yr for large areas, longer for small areas	< 1 yr	Variable, as short as 3 mos	Variable, as short as 3 mos
Type of surveillance	Passive	Active ?	Passive	Active	Active	Active	Active	Active	Active
Data collectors	Government staff	Paid staff (e.g. teachers)	Facility staff	Professional interviewers	Professional interviewers	Professional interviewers	Professional interviewers	Government CHWs	Program staff
Dependency on health systems	High	None, unless based on reporting by health workers	High	None	None	None	None	High	Depends on program
Cost (research)	Low	High	Low	High	Medium-high	High	High	Low	Low

Monitoring child mortality

Report of an expert consultation, July 2007

	FACILITY-BASED OPTIONS			COMMUNITY-BASED OPTIONS					
	Full vital registration	Sample vital registration	Preceding birth technique	Survey with full birth history	Survey with indirect mortality estimates	Rolling surveys with full birth history	Demographic surveillance	CHW reporting	Program staff reporting
Likely biases or limitations	Low coverage in many countries, usually in less developed areas; poor data quality, e.g. missing cause of death; may take long to be compiled and published.	May take long to be compiled and published; requires strong supervision; underreporting is common.	Depends on high coverage of facility delivery	Underreporting of events; untimely estimates; large samples required; very expensive	Indirect estimates do not allow capturing short term (less than 5 years) changes in mortality; underreporting of events; untimely estimates; large samples required; moderately expensive	Underreporting of events; very untimely estimates, particularly for smaller areas such as provinces; large samples required; expensive	Hawthorne effect; implementation of interventions in study areas; may be affected by migration	Poor data quality; some underreporting	Underreporting; poor data quality; may be biased towards showing impact if non-financial rewards are conditional on mortality reduction
Advantages	Low cost; produces good estimates in countries where registration is complete.	Relatively low cost; may cover a large number of clusters	Very low cost; large scale	Can produce good estimates for large geographic areas; single survey can estimate mortality for several 1-2 year periods in the past; with proper supervision, data quality is good; high precision if sample size is large	Single survey can estimate mortality for 3 to 4 5-year periods in the past; with proper supervision, data quality is good; high precision if sample size is large	Single survey can estimate mortality for several 1-2 year periods in the past, at national level; with proper supervision, data quality is good; high precision if sample size is large; use of permanent interviewers improves quality	Can produce good estimates for small areas; census of population at baseline and active follow up of pregnancies and children reduces under-reporting of deaths	Familiarity with the population reduces underreporting; low cost; payment is conditional on monthly reporting, so that time lag is small	Low cost; involvement of the population through volunteers
Examples	Mexico; most of Brazil; high-income countries	India SRS	Benin PBT	Standard DHS	MICS	Peru DHS	INDEPTH	Brazil SIAB	CARE group model; Child Pastorate in Brazil