

Improving Mortality Statistics through Civil Registration and Vital Statistics Systems

Strategies for country and partner support

Outcome of a technical meeting

Geneva, 4–5 November 2014



© World Health Organization 2014

All rights reserved. Publications of the World Health Organization are available on the WHO website (www.who.int) or can be purchased from WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel.: +41 22 791 3264; fax: +41 22 791 4857; e-mail: bookorders@who.int). Requests for permission to reproduce or translate WHO publications –whether for sale or for non-commercial distribution– should be addressed to WHO Press through the WHO website (www.who.int/about/licensing/copyright_form/en/index.html).

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by the World Health Organization to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall the World Health Organization be liable for damages arising from its use.

Contents

Contents.....	3
Executive summary.....	4
Introduction.....	12
Purpose and Premise	13
Data sources for mortality statistics.....	14
Strategic priorities for generating mortality statistics	20
Recommendations for CRVS investment plans	25
Analytical approaches for dealing with discrepant mortality indicators	27
Conclusion	29
Annex I – Meeting agenda and list of participants.....	31
Annex II – Summary description of sources of mortality statistics	37
Annex III – Methods for determining causes of death.....	47
References	53

Executive summary

This document offers guidance on strategies for strengthening vital statistics in national civil registration and vital statistics (CRVS) plans, with a focus on mortality and cause-of-death statistics, which are urgently needed to inform public health decision-making and monitor progress towards national and international health goals. The document has been developed through a consultative process that brought together country representatives from the health, civil registration and statistics sectors, technical experts, researchers, and representatives of agencies, donors and development partners and encapsulates the outcome of their deliberations.* The aim is to set out a set of practical options for CRVS strengthening that have the potential to lead to rapid improvements in the availability and quality of mortality statistics, including causes of death.¹ The document summarizes key mortality-related indicators and describes the strengths and limitations of different data sources. It goes on to describe the best options for generating mortality statistics, proposes principles for selecting data sources, and identifies priority actions for strengthening CRVS while improving the availability and quality of mortality statistics. It concludes with recommendations on the contents of CRVS investment plans based on country starting points and capacities.

Mortality statistics are critical for development

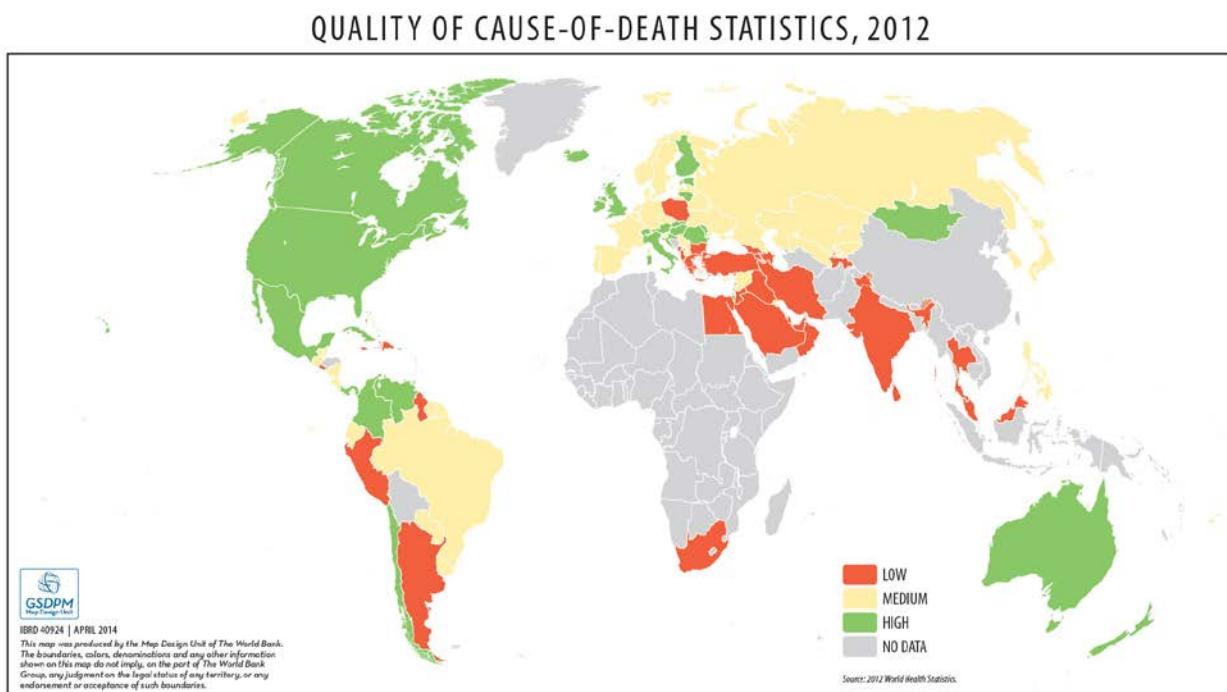
Demand for better mortality statistics is increasing in countries and globally in order to set public health priorities and track progress towards national and international targets and goals such as the post-2015 health and development agenda. For the past 50 years, this demand has been met through recourse to a variety of data sources such as the census, household surveys, health facility information systems, and mortality enumeration or surveillance in sample or selected sites. Such methods have contributed significantly to improved knowledge on patterns of mortality around the world but it is acknowledged that they offer, at best, interim solutions to the challenge of generating mortality data that are sufficiently reliable, timely and detailed to underpin public health decisions. In the long term, what is needed is universal registration of all births and deaths through the national civil registration system and the production of vital statistics, including the application of standards-based methods for determining causes of death.

Reliable and continuous mortality statistics are currently not available in many countries

Currently, only a handful of low-income countries have CRVS systems that record 90% or more of all deaths. In the majority of developing countries, death registration coverage is low and many countries, especially in sub-Saharan Africa, do not report death registration coverage at all. In these settings, it is not possible to generate data on even the most basic mortality indicators such as crude mortality rates from the routine civil registration system. The situation is even more problematic when it comes to the quality of cause-of-death statistics. Cause of death information is compiled in two primary ways: through the collection and coding of routine medical certification records from health facilities; and through collecting information about community deaths through sampled collections methods using verbal autopsy. Up to 80 percent of deaths occur outside of health facilities in low- and middle-income countries and there is a lack of incentives for families, doctors, registries, and health services to register events accurately. Only 81 of 194 countries can report high-quality or medium-quality data on deaths and causes of death (Figure 1). This means critical mortality indicators, such as newborn, infant, child and maternal mortality and death rates due to HIV/AIDS, tuberculosis, and other diseases, are estimated from very limited information.

* The document has been developed through a consultative process involving country representatives from the health, civil registration and statistics sectors, technical experts, researchers, and representatives of agencies, donors and development partners. As part of this process, a technical meeting was convened by WHO in November 2014 (see Annex I, Agenda and List of participants). Improving Mortality Statistics as part of Strengthening Civil Registration and Vital Statistics Systems, World Health Organization, Technical Meeting, November 4–5, Chateau de Penthes, Geneva, Switzerland.

Figure 1. Quality of cause-of-death statistics, 2012



Countries and development partners are investing in a range of strategies

In order to meet the demand for mortality statistics in settings with dysfunctional or weak CRVS systems, countries and development partners have made use of a wide range of alternative data sources, including:

- Vital events enumeration in representative sample areas coupled with verbal autopsy to determine probable cause of death;[†]
- Household surveys using direct or indirect methods of mortality estimation, sometimes coupled with a follow-on study using verbal autopsy in order to ascertain causes of death for reported recent deaths.
- Longitudinal health and demographic surveillance in selected sentinel sites (HDSS);
- Censuses, sometimes coupled with a follow-on study using verbal autopsy in order to ascertain causes of death for reported recent deaths.
- Health care facility data;
- Community-based reporting.

Some data sources, such as the census and household surveys have been of proven effectiveness for generating all-cause mortality indicators, including crude deaths rates, life expectancy and mortality in children under 5. Other sources, such as HDSS and facility-based information systems can produce detailed information but the data are not representative of the general population. Moreover, most data sources have limitations with regard to cause of death statistics and data for subnational administrative areas. As attention turn to the challenges of the post 2015 health and development agenda, meeting the need for mortality data that is available on a continuous basis, for both national and subnational areas, and that includes cause of death, can only be met through universal civil registration and vital statistics, as summarized in Table 1.

[†] These methods are commonly known as ‘sample registration systems (SRS)’ and ‘sample registration systems with verbal autopsy (SAVVY)’. In this document we eschew the use of the word ‘registration’ as these methods do not, in fact, register vital events but only enumerate them. In other words, they provide no legal documentation on the occurrence of a vital event (birth or death) to individuals.

Table 1. Comparison of data sources for generating mortality indicators

Statistics & key indicators	Level of estimate	CRVS	Household surveys	SRS/SAVVY	HDSS	Health facility records	Population censuses
Deaths by age & sex	National	Yes	Yes	Yes	No	Partially *	Yes [¶]
	Subnational	Yes	Limited	Limited [#]	Partially	Partially *	Yes [¶]
	Socioeconomic differentials	Limited [°]	Yes	Limited [#]	Partially	No	Yes [¶]
	Trends	Yes	Partially [□]	Yes	Yes++	Partially *	Partially [¶]
Infant and child mortality rates	National	Yes	Yes [□]	Yes	No	Partially *	Yes [¶]
	Subnational	Yes	Limited [#]	Limited [#]	Partially	Partially *	Yes [¶]
	Socioeconomic differentials	Limited [°]	Yes	Limited	Partially	No	Yes [¶]
	Trends	Yes	Yes	Yes	Partially	Partially *	Partially [¶]
Maternal mortality ratio	National	Yes	Yes [□]	Yes	No	Partially *	Yes **
	Subnational	Yes	Limited [□]	Limited [#]	Partially	Partially *	Yes **
	Socioeconomic differentials	Limited [°]	Limited [□]	Limited	Partially	No	Yes **
	Trends	Yes	Limited [□]	Yes	Partially	Partially *	No
Causes of death	National	Yes [§]	Limited ^{&}	Yes	No	Partially §*	Limited ^{&}
	Subnational	Yes [§]	Limited ^{&}	Limited [#]	Partially	Partially §*	Limited ^{&}
	Socioeconomic differentials	Limited+	Weak	Limited [#]	Partially	No	Limited ^{&}
	Trends	Yes	No	Yes	Partially	Partially §*	Limited

* Not nationally representative unless all deaths occur in health facilities

¶ For a recent period by indirect estimates

For higher level administrative areas (regions, provinces) only

□ Wide confidence intervals for detailed analyses

++ For the surveillance area only

□ Use of direct or indirect methods

** With assessment and possible adjustment: methods do not always work

§ Through use of the International Classification of Diseases (ICD)

& Through follow on survey and verbal autopsy (VA)

° Possible if registration records can be linked to socioeconomic data in a population register.

The momentum for CRVS strengthening is an opportunity to improve mortality statistics

There is growing momentum to strengthen civil registration and vital statistics (CRVS) systems in order to meet the needs of individuals for identity documentation, improve country governance and administration, and generate improved vital statistics for accountability, equity and monitoring. With high-level policy commitment and development partner support, countries are conducting reviews of the current status of CRVS, and formulating improvement strategies and investment plans. However, country CRVS system development plans do not always adequately address the generation and use of improved vital statistics, especially on mortality and causes of death. Clear guidance and support are needed to ensure the statistics component is included as an integral part of CRVS investment planning, including strategies for improving mortality and causes of death statistics that are integrated with and supportive of CRVS system strengthening in countries. What is required is not a research initiative, but an approach that is part and parcel of country CRVS system strengthening plans. This will help avert the creation of separate, competing systems and enhance the likelihood that investments in mortality statistics will be seen as integral to CRVS development.

Guiding principles

The basic premise is that meeting the demand for mortality statistics is no longer a matter of choosing between CRVS and other data sources – surveys, censuses, sentinel and sample registration systems, and facility-based data – but one of ensuring that these additional sources are used optimally alongside CRVS in an integrated strategy.

CRVS systems and other mortality data sources should be seen as mutually complementary rather than competing ways of generating key mortality indicators. The potential of additional data sources to contribute to CRVS strengthening should be fully exploited and CRVS investment plans should include linkages to additional data sources to maximize the availability and quality of mortality statistics. Country decision makers and development partners should align around the following good practice principles:

- Routine, continuous and complete collection of mortality data through CRVS will produce the best national and subnational mortality information over time. The identification of other sources to produce mortality data keeps this long-term vision in mind.
- Mortality data collection activities are carried out in the context of broader national strategies to strengthen CRVS systems.
- The potential of innovative approaches, including IT and mobile technologies, to accelerate and simplify the process of data collection, compilation, record linkage, and analysis, is fully and systematically exploited and accompanied by careful monitoring.
- The utility of mortality statistics from different sources, including incomplete civil registration systems, is optimized by conducting regular assessments of completeness and accuracy of mortality data, and the application of statistical methods and techniques to deal with discrepant values and obtain best estimates.
- New data collection efforts are introduced in ways that support and contribute to CRVS development.

Priority-setting and integration

The vision is to strengthen CRVS systems to generate reliable and continuous vital statistics including mortality statistics and cause of death. Key considerations to be borne in mind when selecting mortality data sources are the expected uses and users the information. This implies sharing available mortality data with analysts and users while respecting standards for individual privacy and data confidentiality. Building links across sectors and programmes will avoid fragmentation, maximize data utility, and develop capacities for the compilation, analysis, and use of mortality data.

In selecting data sources and data collection methods it is important to be guided by available evidence on the extent to which different data sources meet criteria such as reliability, cost-effectiveness, scalability and

sustainability. It is also essential to keep in mind the various users of mortality statistics and the different uses of mortality data. For example, health sector managers at local administrative levels use facility-based mortality data to highlight emerging health threats and to evaluate quality of care. For these groups, accuracy and timeliness are of critical importance. By contrast, national level decision makers need to be able to monitor trends and assess the extent to which interventions designed to reduce premature mortality are achieving the desired results. The need is for mortality data that are nationally representative, can be disaggregated by subnational administrative areas, and are sufficiently timely to support national planning. At international level, cross-country comparability and alignment with global standards for mortality statistics are key considerations. Not all data sources can meet all these expectations and trade-offs have to be made when identifying priorities for investment. Based on a review of available and potential data sources, potential strategic options for countries include:

- Building links between the health sector, civil registration authorities and national statistical agencies and establishing a formal, functional coordination mechanism and clarifying roles and responsibilities.
- Ensuring that sample registration systems are closely linked to – and preferably integrated with – the CRVS system and health facility reporting, where relevant through the use of unique identifiers to enable record linkage across mortality data sources.
- Conducting regular surveys with mortality data collection as part of a national household survey plan, with application of verbal autopsy (VA) in a follow-on survey using standard tools and automation where feasible. Surveys should also include questions on place of death, and registration status, in order to facilitate estimation of registration coverage.
- Improving the reporting of births and deaths by health facilities, including completeness and timeliness, and ensuring that all births and deaths that occur in health facilities are notified to the civil registration authorities along with relevant key characteristics such as age, sex, date, location and cause of death.
- Building health sector capacities for the accurate certification of cause of death and statistical coding according to the International Classification of Diseases (ICD) standards. This also comprises the use of the simple list of causes of death developed by WHO for use in setting where capacities for full ICD implementation are not available.²
- Collaborating with registration authorities and the health sector to apply verbal autopsy appropriately in settings where medical certification of all deaths is not feasible. For example, in some settings there may be high completeness of death reporting in urban areas, but no data on causes of death.
- Including in the census questions on recent deaths in the household and additional questions on place of death, and registration status, in order to facilitate estimation of registration coverage. Where feasible, the census can also be used to implement verbal autopsy in a follow-on study.
- Using mortality data from health and demographic surveillance in sentinel sites (HDSS) to validate and calibrate mortality statistics derived from other sources.
- Developing a supportive legal framework and define administrative framework and processes to enable sharing and use of aggregated data, in accordance with agreed standards for confidentiality and data security. In addition, mechanisms should be established for sharing of individual record information with the health department as part of public health surveillance.

The wide range of available sources for generating mortality statistics is both an asset and a challenge. The variety of strategic options implies that countries at different stages of statistical development will be able to identify ways of producing the needed mortality data. On the other hand, there is a risk of diverting limited resources in multiple directions none of which will prove entirely satisfactory. CRVS investment plans should prioritize interventions that will yield improved mortality statistics in the short term while simultaneously contributing to CRVS enhancement. The balance of interventions selected will depend critically on country contexts and capacities.

Recommendations for CRVS investment plans

The current momentum for CRVS and increased demand for mortality statistics and the potential availability of significant new financing imply the need for a targeted approach that can generate results within a realistic time frame using innovative approaches including the use of IT. CRVS systems provide the foundation or platform, complemented by additional data sources that are implemented in such a way as to strengthen CRVS while generating nationally representative and timely mortality statistics.

National CRVS plans should prioritize CRVS platform development and identify complementary data sources as a function of country needs and capacities. The National Bureau of Statistics in collaboration with the Ministry responsible for Civil Registration, the Ministry of Health and other relevant Ministries and institutions should be the responsible agencies. The budget should be developed on the assumption that currently available mortality data collection efforts, for example through the census and household surveys, will continue to be funded from other sources. This enables the CRVS investment plan to focus on using new funding for innovation and overall CRVS platform development. In selecting additional data sources to complement CRVS, decision-makers should take account of country context and capacities for data collection, analysis and interpretation bearing in mind the pressure on human, technical and financial resources, which are often in short supply.

For countries with the weakest CRVS systems, here defined as death registration coverage below 60%, we propose a four-pronged strategy consisting of:

1. **CRVS platform development**: Establishing or strengthening the CRVS platform, including setting up a national coordination mechanism that brings together stakeholders from the registration, statistical and health sectors and the development of a national CRVS improvement plan. Key components of the plan should be advocacy and action to improve the identification and registration of deaths, for example, through improved links between civil registration and health facilities, between civil registration and burial and religious institutions, and community outreach. Ensure that all deaths are reported by age, sex and location and that health facilities report causes of death. Reach consensus with regard to the sharing and use of data for public health and statistical purposes, in accordance with agreed standards and principles.^{3,4}
2. **Innovation**: Introducing birth and death enumeration/registration in representative civil registration administrative areas (sample vital registration - SVR).[†] In these areas, all births and deaths would be identified through active case finding, in close collaboration with the health sector. This could help overcome the current inertia in civil registration systems that rely solely on individuals to come forward to register deaths. Hospital deaths would have cause ascertained through medical certification using the short version of ICD developed by WHO.² Community deaths would have probable cause determined through verbal autopsy (VA) conducted in collaboration with the health sector and using standardized tools.³ The potential of IT for data collection, compilation and analysis, including for coding causes of death, would be maximized.
3. **Health facility-based mortality statistics**: Supporting capacity development for physicians and coders to ensure the correct completion of the international death certificate and the determination of underlying cause of death according to ICD standards, including through automated coding. Countries in lacking the capacities to code to ICD 3- or 4-digits should use the WHO simple ICD code list.² In settings without medical staff able to ascertain underlying cause of death, statistics should be reported on deaths by age, sex, date and location. The health sector (through the HMIS) should ensure that deaths occurring in facilities (public and private sector) are notified to the civil registration authorities and that aggregated mortality statistics are reported to the national statistics office.

[†] Note that this approach differs from sample registration systems (SRS/SAVVY) in that it uses existing civil registration areas as the sampling frame rather than the conventional approach based on randomly selected geographic areas. Through close collaboration between the civil registration, health, and statistical authorities, it is also designed to go beyond enumeration of vital events to include actual registration of events through the civil registration authorities and the compilation of data to generate nationally representative mortality statistics.

4. **Optimizing data from multiple sources:** Capacity development for the analysis and interpretation of data from multiple sources is essential in order to extract the maximum value from available data. It is essential to draw upon all expertise in the country – including in statistical offices, academia, public health and research institutions – as well as technical expertise from other countries. This also implies expanding the potential of the census and household surveys to generate data on all cause mortality by age and sex, for example, adding follow-on verbal autopsy studies in households reporting recent deaths. Moreover, the inclusion of additional questions in censuses and surveys on whether or not reported deaths were registered and place of death would provide valuable information for subsequent data analysis and estimation of registration completeness. Mechanisms for sharing individual and aggregated data across departments as well as with bona fide researchers and analysis should be put in place in order to maximize the utility of available data.[§]

The allocation of funding to each component will of course depend on country capacities, costs, and priorities. However, countries may take into consideration the following issues:

- The establishment of SVR is likely to be the most costly strategy but will yield the most rapid results in terms of improved availability of nationally representative mortality and fertility statistics. Moreover, this strategy, because it is based on existing civil registration sites, will simultaneously enhance capacities for CRVS development overall. In the long term, the SVR will be integrated into the comprehensive CRVS system.
- Although they do not generate nationally representative statistics, health facilities are key to the production of reliable cause of death data. All CRVS investment plans should include training physicians to correctly complete the international death certificate and coders to appropriately apply ICD codes. Facility statistics on deaths by age, sex and cause as well as date and place of death should be compiled and reported. The health sector (through the HMIS) should ensure that all deaths occurring in facilities or in which medical personnel have been involved are notified to the civil registration authorities and that aggregated mortality statistics are reported to the national statistics office.

For countries with inadequate but emerging civil registration systems, here defined as death registration completeness between 60–79%, the strategy includes:

1. **CRVS platform development:** Improving registration completeness especially in marginalized populations and in remote areas. Where registration coverage is high but data on causes of death are not available, collaborating with health authorities to apply verbal autopsy to registered deaths. Ensuring the quality of registration documentation such as (such as key characteristics of the decedent) in order to permit the compilation of reliable and complete mortality statistics. Where SRS/SAVVY systems exist, they should be gradually integrated into the national CRVS system. In addition, establish mechanisms for the sharing and use of data for public health and statistical purposes, in accordance with agreed standards and principles.³⁴
2. **Innovation:** Promoting record linkage across mortality databases through the use of unique individual IDs. Supporting the use of IT for data collection, transmission and compilation at all levels.
3. **Health facility-based mortality statistics:** Supporting capacity development for physicians and coders to ensure the correct completion of the international death certificate and the determination of underlying cause of death according to full ICD standards, including through automated coding. Ensuring that all facilities, both public and private sector, mortality statistics should be reported on deaths by age, sex, date and location. The health sector (through the HMIS) should ensure that deaths occurring in facilities are notified to the civil registration authorities and that aggregated mortality statistics are reported to the national statistics office.

[§] Australia Bureau of Statistics (2014) Statistical data integration.

<http://www.abs.gov.au/websitedbs/d3310114.nsf/Home/statistical+data+integration>

4. **Optimizing data from multiple sources:** Developing capacities for regular data quality assessment and for the analysis and interpretation of data from multiple sources in order to extract the maximum value from available data. Undertaking systematic analyses of CRVS at the sub-national level in order to maximize the utility of data from areas with high levels of death registration, for example in urban centres. It is essential to draw upon all expertise in the country – including in statistical offices, academia, public health and research institutions – as well as technical expertise from other countries. Mechanisms for sharing aggregated data across departments as well as with bona fide researchers and analysis should be put in place in order to maximize the utility of available data.⁶

Countries with adequate civil registration (death registration completeness 80% and over) should focus on achieving universal coverage of all vital events, ensuring the availability and quality of vital statistics and conducting regular reviews of data quality, especially with regard to cause of death information. Where death registration coverage is high but cause of death ascertainment is weak, apply verbal autopsy to registered deaths, in collaboration with the health sector. The census and household surveys with mortality questions should be used to generate estimates of registration completeness.

Table 2 summarizes these recommendations.

Table 2. Strategies for CRVS development plans in order to generate reliable, continuous and representative mortality statistics, including causes of death

	Registration coverage <60%	Registration coverage 60–79%	Registration coverage ≥ 80%
CRVS platform	Multi-sector coordination; improve registration coverage; apply verbal autopsy to registered deaths.	Improve registration coverage; apply verbal autopsy to registered deaths; absorb SRS/SAVVY into CRVS.	Focus on completeness.
Innovation	Sample vital registration (SVR) in representative CRVS areas with verbal autopsy; links to health sector.	Record linkage across mortality databases through unique individual IDs.	Record linkage across mortality databases through unique individual IDs.
Facility statistics	Birth and death notification; certification and coding of cause of death (ICD short list).	Birth and death notification; data quality assurance; death certification and coding using full ICD.	Data quality assurance; death certification and coding using full ICD.
Optimizing data from multiple sources	Analytical use of partial data from urban areas; capacity development for data quality assurance; data analysis, interpretation and use.	Analytical use of partial data from urban areas; capacity development for data quality assurance; data analysis, interpretation and use.	Capacity development for data quality assurance; data analysis, interpretation and use.

Correctly registering and certifying the fact, age and sex of all births and deaths, and the cause of each death, is not only an appropriate recognition of all individuals and their fundamental human right to be counted, but it is also good public policy. The technical skills, political momentum, country and donor interest to accelerate CRVS systems are increasingly aligned. However, it is essential to be able to demonstrate that the production of reliable mortality and cause of death statistics in the context of CRVS improvement is a realistic and attainable goal. This guidance document, which draws upon combined knowledge and expertise from around the world, describes a pathway whereby countries and partners can prioritize investments in order to optimize the use of a range of data sources while at the same time creating sustainable, universal and effective CRVS systems.

Introduction

Strengthening the civil registration and vital statistics (CRVS) system has increasingly become a priority for many countries and the global development community. The formal registration of vital events underpins the realization of civil, social and political rights by providing evidence of individual identity and family relationships. CRVS is associated with numerous administrative and statistical benefits for public and private entities and is considered the foundation of modern administrative systems.

The establishment and maintenance of comprehensive civil registration requires political will and long-term efforts to build up the necessary administrative infrastructure and create community awareness and participation in the act of registration. However, demand is growing for reliable vital statistics – including mortality and cause of death statistics – and a global CRVS investment plan⁴ proposes explicit targets for mortality statistics, including that by 2030, 80% of deaths in children under 5 are reported, disaggregated by age and sex; 100% of causes of death in hospitals are reliably determined and official certified; 80% of countries have community assessments of probable cause of death determined by verbal autopsies using international standards. Currently, the availability and quality of mortality statistics in most countries fall well below these targets (Figure 1).

In some countries the CRVS system is sufficiently developed to achieve improvements in data availability and quality in the short-term. By contrast, where the CRVS system is rudimentary or weak, progress is likely to be too slow to meet expectations, in particular with regard to completeness death reporting and reliable cause of death ascertainment. The production of accurate and representative cause of death statistics requires complete reporting of all deaths by location, age and sex, along with well-functioning medical certification of deaths according to International Classification of Diseases (ICD) and improved and community-based mortality reporting through the use of verbal autopsy techniques.

To meet the challenge of establishing a sound evidence base for public health decision-making, there is a need to develop a strategic approach to improve mortality and causes of death statistics that is integrated with and supportive of CRVS system strengthening in countries. What is required is not a research initiative, but an approach that is part and parcel of country CRVS system strengthening plans. Such a systemic approach will avoid the creation of separate, competing systems and enhance the likelihood that investments in mortality statistics systems will be seen as integral to CRVS development.

Many countries are conducting national assessments of their CRVS and developing national strategies and investment plans. However, these plans do not always adequately address the generation of improved vital statistics, especially on mortality and causes of death. Clear guidance and support are needed to ensure the vital statistics component is included as an integral part of CRVS investment planning. This is also important in the context of the establishment of a global funding facility for reproductive, maternal, newborn, child, and adolescent health with a special window for CRVS strengthening.

This document has been developed in response to the challenge. It is the product of a consultative process involving country representatives from the health, civil registration and statistics sectors, technical experts, researchers, and representatives of agencies, donors and development partners. As part of this process, a technical meeting was convened by WHO in November 2014 (see Annex I, Agenda and List of participants).¹ The guidance in this document encapsulates the outcome of those deliberations.

Purpose and Premise

Audience and aim

This document offers guidance on the development of national strategies and investment plans designed to strengthen civil registration and vital statistics (CRVS) systems and generate improved statistics on mortality and causes of death. The document primarily targets country decision-makers and consultants involved in supporting national CRVS investment planning, as well as international agencies, development banks, funds, foundations and donors. The aim is to set out a set of practical options for CRVS strengthening that have the potential to lead to rapid improvements in the availability and quality of mortality statistics, including causes of death.

A system of civil registration that records all deaths and correctly assigns cause of death is the gold standard for the generation of mortality statistics. However, for countries with the weakest CRVS systems, the attainment of levels of completeness and quality sufficient to generate useable statistics will necessitate long-term commitment and action. It is essential to scale-up and accelerate the current momentum for CRVS improvement but to meet the need for mortality statistics in the interim, efforts to improve CRVS should go hand-in-hand with the use of additional methods. These should be seen not as stand-alone data sources but as vehicles for the active improvement of CRVS systems through collaborative linkages at multiple stages, from data collection/notification, to data compilation/sharing, analysis, dissemination, and use.

Why focus on mortality statistics?

Information on how many people die and from what causes is critical for public health decision-making, resource allocation, and programme planning. Mortality statistics are essential for setting health targets, for monitoring health and development programmes, and for tracking demographic indicators, such as the expectation of life at birth and the infant mortality rate. Mortality statistics and cause of death data provide essential epidemiological intelligence to guide policy reforms aimed at reducing premature mortality and improving the allocative efficiency and effectiveness of health systems. The timely recording of deaths by cause can provide early insights into trends in disease prevalence, thus helping to design prevention or intervention strategies. Box 1 summarizes why mortality statistics are so important for country decision-making.

The information systems and data sources needed to strengthen mortality statistics also generate statistics on fertility and other vital statistics such as nuptuality. However, this document is focused on mortality and cause of death statistics for the following reasons:

- Increasing demand for improved mortality statistics in order to underpin public health decision-making and monitoring of progress towards development goals and targets, including communicable and noncommunicable diseases as well as external causes of death.
- The need to broaden the perspective and scope of current mortality data collection efforts, which have hitherto focused mainly on infant, child and maternal mortality and high priority conditions such as HIV/AIDS.
- Growing awareness that disaggregated statistics on levels and patterns of mortality and essential for identifying and addressing inequities between population groups and geographic areas.
- The realization that currently available data sources and instruments for collecting mortality data have significant limitations, particularly in relation to representativeness, continuity, and timeliness.

Box 1: Why countries need mortality statistics

Mortality statistics are needed for multiple purposes, including:

- Calculating life tables and estimating the probability of dying at various ages by studying deaths, classified by age, sex and location;
- Monitoring the health status of a population by directly measuring mortality and analyzing causes of death and other characteristics of the dead;
- Monitoring progress towards national and international goals and targets such as the MDGs, noncommunicable diseases, and the post-2015 development agenda;
- Planning health intervention strategies to address causes of premature mortality;
- Measuring important demographic indicators of levels of living or quality of life, such as expectation of life at birth, infant mortality rate, under-5 mortality rate, and maternal mortality rate, among others.

Data sources for mortality statistics

There are a number of potential data sources for generating mortality statistics, including:

- Civil registration and vital statistics systems (CRVS);
- Vital events enumeration in representative sample areas coupled with verbal autopsy to determine probable cause of death; **
- Household surveys (episodic or continuous) using direct or indirect methods of mortality estimation; possible follow-on survey to apply verbal autopsy to reported deaths in order to ascertain cause of death.
- Longitudinal health and demographic surveillance in selected sentinel sites (HDSS);
- Censuses; possible follow-on survey to apply verbal autopsy to reported deaths in order to ascertain cause of death.
- Health care facilities;
- Community-based reporting.

Annex II includes a summary description of the major data sources for mortality statistics, with a focus on the extent to which each data source can generate key mortality indicators and the strengths and limitations of each method. Annex III describes the methods used to obtain statistics on causes of death.

In practice, countries are using various permutations and combinations of these different methods for producing mortality statistics, but there is considerable fragmentation and heavy dependence on external funding, leading to lack of country ownerships, overlap and duplication. These problems could be significantly attenuated through a more system approach that starts by addressing the need to build country CRVS systems as the basic platform for vital statistics, including mortality, and uses complementary data sources as part of a considered, long-term strategy rather than as stand-alone, disconnected activities.

** These methods are commonly known as '*sample registration systems (SRS)*' and '*sample registration systems with verbal autopsy (SAVVY)*'. In this document we eschew the use of the word 'registration' as these methods do not, in fact, register vital events but only enumerate them. In other words, they provide no legal documentation on the occurrence of a vital event (birth or death) to individuals.

Factors to take into consideration when selecting data sources

To date, these alternative methods for generating mortality statistics have tended to work in isolation from one another – separated by geographic application or vertical programme-specific requirements. Little attention has been paid to how these systems can be analytically aligned or operationally integrated to create a more comprehensive view of mortality, or to strengthen routine administrative data sources. This document argues that there is a need to create productive synergies across data sources, while maintaining the overall vision of a comprehensive and functional CRVS. In the interim, choices about which combination of sources to use to generate mortality statistics in a specific country setting will depend on a number of factors, including:

- **Data needs**: The choice of data source and data collection methods will depend to a great extent on the level of detail required of the mortality statistics, for example whether data are needed on all-cause or cause-specific mortality and data needs are subnational administrative levels.
- **Opportunities and challenges**: Currently implemented sources for mortality data and feasibility of introducing additional methods to produce reliable mortality statistics that meet quality criteria, including representativeness, accuracy, periodicity and sustainability.
- **Context and capacities**: Technical, human and financial resources needed for the introduction of new data collection methods for mortality statistics and for the analysis of statistics derived from currently available methods.

► Data needs

Main statistics and indicators commonly required for tracking mortality include:

- Numbers of deaths by sex, age group, and location;
- Crude death rates;
- Age and sex-specific mortality rates by location;
- Age distribution of deaths (males and females);
- Neonatal mortality rates by location;
- Infant mortality rates by location;
- Under 5 mortality rate (probability of dying by age 5, 5q0) by cause and location;
- Maternal mortality ratios by age, cause and location;
- Distribution of deaths by cause (males, females);
- Age distribution of causes of death (males, females);
- Leading causes of death by sex and age group;
- Adult mortality rate (45q15)
- Probability of dying between ages 30-70 years (40q30) due to cardiovascular disease, cancer, diabetes, or chronic respiratory disease;
- Life expectancy at birth;
- Adult life expectancy at various ages.

Decision-making about which data sources to prioritize for generating these indicators must be guided by short and longer-term considerations. Some data sources, such as the census and household surveys have demonstrable value for generating all-cause mortality indicators, including crude deaths rates, life expectancy and mortality in children under 5. However, they have limitations with regard to cause of death statistics and data for subnational administrative areas. Civil registration of vital events, including the recording of deaths and causes of death, is the source able to produce the most comprehensive information (Table 1).

► Opportunities and challenges

The range of options for CRVS strengthening will depend to a great extent on the country starting points (Table 2). Country decisions about which data sources to prioritise requires achieving a balance between the potential of each data source to generate the needed mortality statistics and the implementation challenges involved. Table 3 provides a summary of the main strengths of the various data sources and also considers some of the implementation challenges and costs. The purpose of this section is to set the scene for the subsequent discussion on strategic interventions to generate mortality statistics in the context of efforts to strengthen CRVS.

► Context and capacities

The overall country context and capacities for registration of deaths and for data collection, analysis and interpretation needs to be taken into account when decided on which data sources to prioritize for generating mortality statistics. Each data source places demands on country human, technical and financial resources, all of which are generally limited.

In some settings, health systems are weak, statistical systems inadequate, and CRVS is dysfunctional or non-existent. This is particularly true in countries that are facing or emerging from complex emergencies, war or civil strife. In such settings, the challenge is how to generate the most basic mortality indicators, such as overall mortality rates, and mortality in children. The census or household surveys may provide the most feasible and efficient ways of generating the needed statistics.

In many countries, although the legal framework and administrative structures for civil registration exist, the technical skills required to generate mortality statistics may not be available or exist in different sectors – such as the health sector, national statistics offices, public health institutes and academia – but with insufficient coordination to maximize the potential of available information. National statistics offices are responsible for the planning and implementation of the census and of household surveys but often have limited capacities in data analysis and rely heavily on external expertise. Moreover, the demands imposed by the census and the large number of household surveys may impede national statistics offices from performing routine data analyses required for administrative data sources such as CRVS. Within the health sector, analytical capacities within the health management information system (HMIS) are inadequate and the potential for capacity development through linkages with institutes of public health and researchers remains to be exploited.

Training and capacity development are urgently needed. For example, although cause of death certification is a key responsibility of physicians, they rarely receive the training they need to do so effectively, either during medical education or subsequently when in service. The result is that performance is often mediocre with damaging effects on the quality of cause of death statistics produced. There is a need to develop a cadre of statistical clerks and expert coders (nosologists) in order to ensure correct coding of causes of death to statistical categories as recommended by the ICD. The potential of automated systems for coding hospital deaths should be fully exploited although this does not obviate the need for skilled statistical clerks and nosologists. Capacity development is also urgently needed in the critical analysis of the quality of mortality data and to interpret inconsistent data from different data sources. The growing reach of innovation, especially use of IT and mobile devices to record and report deaths and causes of death, imposes its own demands on human resources. IT systems require maintenance and updating as well as the kinds of computer skills that are often in short supply in the public sector.

Some data sources, notably household surveys and DHSS, are externally funded by multilateral agencies, funds and foundations. Others, especially those that are associated with routine administrative systems such as CRVS and health facility information systems rely heavily on in-country financing. The latter may be more sustainable in the long term but suffers from severe under-investment in many countries.

Table 3. Opportunities and implementation challenges of different data sources for generating mortality and cause of death data

Data source	Opportunities	Implementation challenges	Cost considerations
CRVS	<p>Continuous sources of national and subnational mortality data by age, sex, date, location and cause.</p> <p>National and subnational cause of death determined according to ICD standards.</p> <p>Data generated for lowest administrative levels.</p>	<p>Requires sound legal framework and inter-institutional collaboration across sectors, especially health, statistics, interior etc.</p> <p>Significant administrative and management challenges for registration at local levels.</p> <p>Passive system relies on civil society collaboration for notification of deaths. Need to establish collaboration with health sector and burial/religious authorities in order to ensuring notification of deaths.</p>	<p>Costs significant but integrated into national administrative systems.</p> <p>Need for capacity building for registration data compilation and analysis.</p> <p>Passive system implies that costs of registration are borne by individuals and families.</p>
SRS/SAVVY	<p>Continuous source of mortality by age and sex.</p> <p>Nationally representative.</p> <p>Can include verbal autopsy (preferably with automated allocation of cause of death).</p> <p>Useful for evaluating completeness of death registration CRVS.</p> <p>Offers a vehicle to introduce innovative reporting (IT).</p> <p>Use of unique ID systems permits record linkage to enhance identification of deaths.</p>	<p>Limited subnational mortality statistics.</p> <p>Cause of death based on VA uncertain.</p> <p>Active case finding of deaths is cumbersome and costly.</p> <p>Consensus on need to find ways of making sample systems faster, cheaper, simpler, better.</p> <p>Complexity of data analysis results in delays in publication of statistics.</p> <p>Is a system of enumeration of vital events not registration. Little experience on effective linkage to CRVS.</p>	<p>Requires substantial field staff, with designated staff in statistical offices or research institutions.</p> <p>Heavy analytical demands.</p> <p>Ability to generate data for local administrative levels limited by sample size considerations and costs.</p>
Household surveys	<p>Nationally representative, data can be disaggregated by key stratifiers (province, SES)</p> <p>Integrate mortality with other topics.</p> <p>Cause of death module using VA can be included, generally as a follow-on module.</p> <p>Potential to include questions for deaths in recent period to assess completeness death registration.</p>	<p>Discontinuous; possible problems with recall error and selection bias.</p> <p>Relatively small sample of deaths for VA; insufficient for all but major causes.</p> <p>Absent links with CRVS systems.</p>	<p>Costly when conducted but costs can be spread over multiple years.</p> <p>Generally externally funded.</p> <p>Can be integrated with other topics but risk of overloading questionnaires thereby reducing quality of the data.</p>
HDSS	<p>High quality data.</p> <p>Can be used to assess functioning of CRVS system.</p>	<p>Not nationally representative.</p> <p>Active case finding of deaths is cumbersome and costly.</p>	<p>Largely externally funded for research purposes.</p>

Data source	Opportunities	Implementation challenges	Cost considerations
	<p>Can be used to develop and test innovative methods such as mobile notification/registration.</p> <p>Capacity development for vital statistics.</p>	Weak links with existing local civil registration systems.	
Census	<p>Comprehensive across whole population.</p> <p>Generates data for local administrative areas.</p> <p>Potential to analyse data across multiple socio-economic stratifiers.</p> <p>Follow-on surveys can apply VA to determine causes of death in the population.</p>	<p>Varying degree of underreporting of deaths in censuses and large uncertainties around the completeness of death reporting.</p> <p>Census mortality estimates require adjustment using demographic techniques.</p> <p>Limited utility for monitoring due to infrequency of census.</p>	<p>Relatively few additional questions required in census questionnaire.</p> <p>Data quality assurance problematic.</p> <p>Census is costly but can absorb a few additional questions on mortality.</p> <p>Post-census follow-up with VA relatively costly and problem of loss to follow up.</p>
Health facilities	<p>Medical records include detailed information to reliably certify deaths and causes of death.</p> <p>Physicians have skills and capacities to reliably certify cause of death according to ICD standards.</p> <p>Trends by age and sex can sometimes be useful to ascertain changes in patterns of cause-specific mortality. Automated coding permits consistent coding at facility and/or central levels.</p>	<p>Not nationally representative data unless high coverage of hospital deaths.</p> <p>Generates distribution of causes of death, not levels and trends.</p> <p>ICD not always well applied and complex to use.</p> <p>Need to develop capacities for accurate cause of death certification. ICD coding requires specialist skills.</p>	<p>Training in certification in medical curricula and in-service.</p> <p>Need to develop cadre of nosologists.</p> <p>Electronic communication systems needed to facilitate transfer and compilation of facility and district data.</p>
Community-based reporting	<p>Low costs, potentially wide reach.</p> <p>Potential of mobile devices to notify deaths to health/civil registration authorities.</p> <p>Potential to link to CRVS.</p>	<p>Competing responsibilities of CHWs.</p> <p>Quality variable and underreporting of deaths.</p>	Needs extensive supervision and quality evaluation.

Comparative costs and benefits

Decision-making on choice of data sources to generate mortality statistics is constrained by the absence of reliable comparative information on costs and benefits of different approaches. There are major methodological challenges in comparing costs across sources because of differences in the scope of data collection, frequency, accuracy (especially for causes of death), population coverage etc. A systematic framework to guide investment decisions by donors and governments on methods of data collection for vital statistics and health information has been developed but has not yet been populated with empirical information on costs from countries.⁵ One comparative costing of different ways of collecting information on births and deaths concluded that household surveys are relatively expensive compared with continuing surveillance of vital events. Recurrent costs alone for large household surveys generally range from USD 600 000 to USD 1 million.⁶

Both sentinel and sample surveillance systems require active follow-up of vital events, which has important cost implications. A typical sentinel HDSS site monitors a rural population of 70 000–100 000 people. However, reliably tracking causes of death at the more-detailed levels may require up to 10 times as many people to be monitored. Normally, an HDSS employs approximately 30 field enumerators with bicycles; seven enumerator supervisors; three key-informant supervisors; three migration supervisors; and three verbal autopsy (VA) supervisors with motorcycles; one demographer; one data manager; and five data clerks with one vehicle. The total annualized running costs for a core sentinel HDSS is in the order US\$ 250 000 per year. Costs are lower in urban HDSS sites where events are generally easier to track.

Sample systems, such as the Indian Sample Registration System, involve the use of part-time officials who continuously record births and deaths complemented by an independent survey team which interviews all sample households, specifically asking about births and deaths in the previous six months. The two sets of event records are then matched, and any discrepancies investigated. The cost per death enumerated in the India SRS system is estimated at UD\$12.50.⁶ A fully implemented SAVVY system should also be capable of producing sub-national data, but in practice is normally limited to the provincial or regional level, rather than the district level, due to cost considerations. Sustainability may be a challenge. For example, the system of disease surveillance points in China became almost non-functional in 2001/02 because of budget constraints. After an assessment in 2004, and the injection of additional resources, the system was strengthened and adjusted to improve its representativeness.

If, as we argue in this paper, CRVS is the gold standard for generating reliable, continuous and comprehensive mortality statistics, what would it cost to scale up such systems in settings where they are currently dysfunctional or weak? A recent study on the costs of the South Africa CRVS system projected total annual costs for complete registration of births and deaths and for the production of vital statistics amounting to US\$ 7.7 million, or US\$ 4.4 per vital event (births and deaths) or US\$ 0.30 per capita.

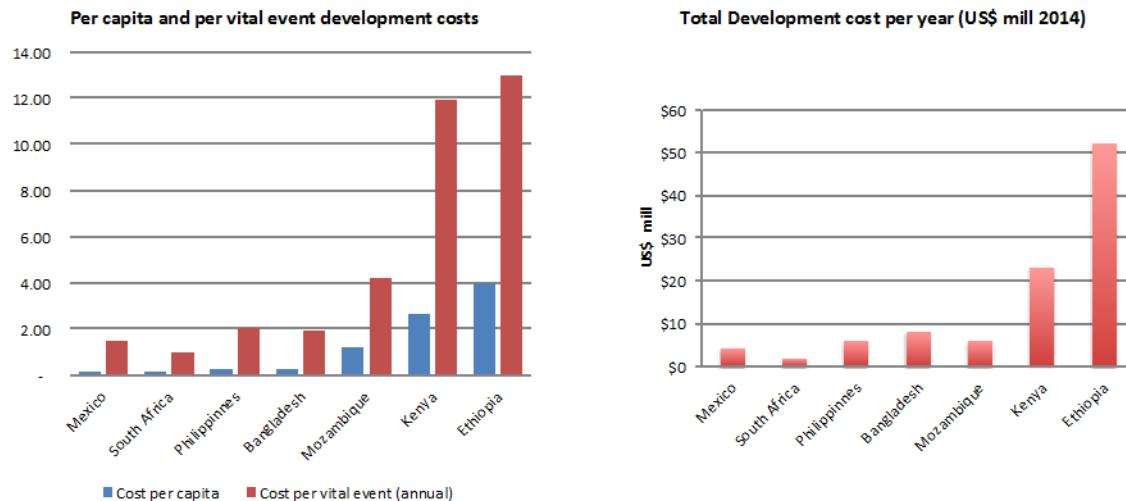
The World Bank has estimated the additional financial resources needed to scale up universal civil registration of births, deaths, and other vital events, and ensure access to legal proof of registration by 2030. It has also produced order-of-magnitude estimates of the incremental costs from 2015 to 2024 to stimulate discussion and planning of support for national implementation plans. The work builds on the country-specific costing exercises conducted in Bangladesh, Kenya, Ethiopia, Mozambique and the Philippines (Figure 2). The costing exercise developed provides estimates for four cost categories: (a) development costs (incremental costs or additional funds for establishing and strengthening CRVS systems); (b) incremental recurrent costs for maintaining CRVS systems; (c) international support to CRVS, including sharing knowledge and strengthening the evidence base; and (d) monitoring and evaluation. The costs in each plan were disaggregated into fixed/start-up/capital costs and variable/operating costs. The total costs (without inflation adjustment) vary from under US\$ 30 million in countries with existing capacity, rising to over US\$ 365 million in Ethiopia, which only established a National Vital Events Registration Agency in October 2013. Placing the investment in a population context, the country costs translate into a range of under US\$ 1 per capita in countries such as such as the Philippines and Bangladesh, to between US\$ 1 and US\$ 4 in Mozambique and Ethiopia (Figure 3). The cost per vital event (births and deaths) ranges from under US\$ 2 to over US\$ 13. These costs do not include the possible costs (direct, indirect, and

⁶ Prabhat Jha, personal communication

opportunity costs) that accrue to individual and families who bear the responsibility for registration of vital events.

Cost comparisons alone are insufficient to guide decision-making; it is equally important to consider the relative benefits of the different approaches, not only in terms of mortality statistics, but also in terms of benefits to individuals of documentation establishing individual identity and family relationships.

Figure 3. Estimated costs for scaling up CRVS, selected countries, 2014



Strategic priorities for generating mortality statistics

Proposed core principles guiding investments in data sources

Bearing in mind the need to strengthen civil registration and vital statistics systems for the benefit of individuals, governance and statistical systems, efforts to improve the availability and quality of mortality statistics should adhere to the following good practice principles:

- Routine, continuous and complete collection of mortality data through CRVS will produce the best national and subnational mortality information over time. The identification of other sources to produce mortality data keeps this long-term vision in mind.
- Mortality data collection activities are carried out in the context of broader national strategies to strengthen CRVS systems.
- The potential of innovative approaches, including IT and mobile technologies, to accelerate and simplify the process of data collection, compilation, record linkage, and analysis, is fully and systematically exploited and accompanied by careful monitoring.
- The utility of mortality statistics from different sources, including incomplete civil registration systems, is optimized by conducting regular assessments of completeness and accuracy of mortality data, and the application of statistical methods and techniques to deal with discrepant values and obtain best estimates.
- When the ability of existing sources to produce the needed mortality data are demonstrably inadequate, new data collection efforts are introduced in ways that support and contribute to CRVS development.

Discussion on priority-setting

The vision is to strengthen CRVS systems to generate representative and reliable vital statistics including mortality statistics and cause of death. In support of this, the immediate objectives are to maximize the utility of all available methods of mortality data collection, build links across data sources in order to avoid fragmentation and maximize data utility, and develop capacities for the compilation, analysis, and use of mortality data. Table 4 offers a summary matrix to inform decision regarding the selection of an appropriate balance of data sources depending on the completeness of the national civil registration system, availability of additional data sources, and data needs. Countries are broadly grouped according to status of CRVS systems and estimated registration coverage. Options are identified for strengthening CRVS systems, for making best use of interim methods to generate mortality statistics, and the potential contribution of innovation, including IT to accelerate progress.

During the technical meeting at WHO, participants reached consensus around three different strategic approaches:

- Strategies for mortality data collection that are evidence-based and relevant in countries with weak or emerging CRVS systems;
- Strategies that are evidence based and that can be useful as short-term methods to fill mortality data gaps but that should eventually be phased out as CRVS systems develop; and
- Strategies for which there is currently insufficient evidence to support their widespread application at the present time.

Approaches for which there is currently insufficient evidence to support their inclusion on country CRVS plans include the use of community informants to report deaths and births. The evidence thus far indicates that such reporting is incomplete and unreliable and therefore community-based approaches are not recommended for inclusion in country CRVS and mortality statistics plans.⁷

An approach for which there is good evidence and that could help fill critical mortality data gaps in the short term include the use of sample registration systems. However, it was agreed that the use of the word ‘registration’ is misleading given that these approaches consist of enumeration only and carry no implications for individuals in terms of legal documentation. There was also consensus that such enumeration systems are more likely to be sustainable if they are carried out in collaboration with existing civil registration authorities, particularly in urban areas where some form of civil registration exists in many low- and middle-income settings. This can help create demand for birth and death statistics on the part of national and local authorities, and ensure political commitment and resource allocation. Moreover, it can help to raise community awareness of the value of civil registration and vital statistics for local-level planning and programme implementation, as well as for individual legal identity and the civil and political rights that ensue. However, SRS/SAVVY systems should not be stand-alone and should eventually be phased out as CRVS systems improve. In support of this, the meeting recommended that the SRS/SAVVY approach be modified and implemented using CRVS administrative areas as the sampling frame – herein called sample vital registration (SVR). The strategy would be jointly implemented by the civil registration authorities, the health sector and the national statistics office with support from country researchers and academic institutions. This would help ensure ownership, sustainability and eventual integration into the universal civil registration system.

The potential of household surveys, including continuous surveys, to generate more detailed mortality data, using verbal autopsy techniques, could be further explored in settings with dysfunctional or weak CRVS systems. The newly developed WHO short form of the verbal autopsy tool⁴ could greatly simplify the application of VA in association with surveys and censuses and thus contribute to the improvement in the availability of mortality and cause of death statistics.

Because HDSS sites in selected areas do not generate nationally representative mortality statistics, they are only of limited value in the current context and their role confined to quality validation and calibration of data obtained from routine registration systems. Nonetheless, countries that already have HDSS sites in rural areas could consider adding sites in urban areas to improve representativeness of cause-of-death distributions. Where HDSS sites exist, efforts should be made to forge links to existing birth and death registration systems, and to

health information systems – especially where health-facility staffs have been trained to determine causes of death. The introduction of unique identification numbers in many HDSS sites as well as in health facilities could contribute significantly to improved data quality through record linkage across databases. Establishing demographic surveillance sites can help to enhance capacity for the enumeration of births and deaths as well as the use of VA to ascertain causes of death. However, this will not yield nationally representative statistics. The evidence base for the implementation on the approach, including reliability, cost-effectiveness, scalability and sustainability;

The potential uses and users of the mortality statistics affects the desired balance between mortality data that are nationally representatives and internationally comparable with mortality data that are available on a continuous basis and useful for local administrative decision-making. Bearing this distinction in mind, there was consensus that common priority actions for consideration include:

- Building links between the health sector, civil registration authorities and national statistical agencies and establishing a formal, functional coordination mechanism and clarifying roles and responsibilities.
- Ensuring that sample registration systems are closely linked to – and preferably integrated with – the CRVS system and health facility reporting, where relevant through the use of unique identifiers to enable record linkage across mortality data sources.
- Conducting regular surveys with mortality data collection as part of a national household survey plan, with application of verbal autopsy (VA) in a follow-on survey using standard tools and automation where feasible. Surveys should also include questions on place of death, and registration status, in order to facilitate estimation of registration coverage.
- Improving the reporting of births and deaths by health facilities, including completeness and timeliness, and ensuring that all births and deaths that occur in health facilities are notified to the civil registration authorities along with relevant key characteristics such as age, sex, date, location and cause of death.
- Building health sector capacities for the accurate certification of cause of death and statistical coding according to the International Classification of Diseases (ICD) standards. This also comprises the use of the simple list of causes of death developed by WHO for use in setting where capacities for full ICD implementation are not available.²
- Collaborating with registration authorities and the health sector to apply verbal autopsy appropriately in settings where medical certification of all deaths is not feasible.
- Including in the census questions on recent deaths in the household and additional questions on place of death, and registration status, in order to facilitate estimation of registration coverage. Where feasible, the census can also be used to implement verbal autopsy in a follow-on study.
- Using mortality data from health and demographic surveillance in sentinel sites (HDSS) to validate and calibrate mortality statistics derived from other sources.
- Collaborating with registration authorities and the health sector to apply verbal autopsy appropriately in settings where medical certification of all deaths is not feasible.
- Developing a supportive legal framework and define administrative framework and processes to enable sharing and use of data, in accordance with agreed standards for confidentiality and data security. This should include sharing of individual record information as part of public health surveillance.^{5 7}
- Maximising the quality and utility of routinely collected information by establishing mechanisms for aggregated data with bona fide researchers and analysts, using procedures that protect confidentiality that align with international best practice principles.^{3 4}

⁷ Centers for Disease Control and Prevention (201\$0 Standards to Facilitate Data Sharing and Use of Surveillance Data <http://www.cdc.gov/nchhstp/programintegration/SC-Standards.htm#DATA-SHARINGfor Public Health Action>. See also <http://www.cdc.gov/nchhstp/programintegration/Data-Security-FAQ.htm>

Table 4. Options for generating mortality statistics in the context of CRVS

Death registration coverage	Activities to strengthen CRVS	Role of additional data sources to generate mortality data	Potential for innovation
Dysfunctional and weak CRVS (registration coverage <60%)	Advocacy for CRVS Establish legal basis and administrative mechanisms.	<p>Sample registration:</p> <p>Sample vital registration (SVR) using CRVS areas as the sampling frame plus verbal autopsy (VA) in order to generate representative statistics and build capacities for eventual universal civil registration.</p> <p>Link deaths identified through active case findings with civil registration authorities.</p> <p>Use existing SRS/SAVVY to estimate registration coverage.</p>	<p>Sample registration:</p> <p>Automated coding of responses to VA questionnaires.</p> <p>Use unique identification numbers to link SAVVY and CRVS databases (with protection of confidentiality).</p>
	Establish national coordinating committee involving key stakeholders, including registrars, statistics office, ministry of health etc.		
	Address disparities in registration coverage among marginalized and hard-to-reach populations.	<p>Facility data:</p> <p>Ensure that all facilities compile statistics on deaths by age, sex, date and location.</p> <p>Notify deaths to registration authorities.</p> <p>Encourage families to register deaths and facilitate where possible.</p> <p>All deaths occurring with medical supervision are correctly classified according to ICD.</p>	<p>Facility data:</p> <p>DHIS reporting of deaths by age, sex, date, location.</p> <p>Physician training for CoD certification.</p> <p>Incorporation of CoD certification into medical school curricula</p> <p>Automated coding of cause of death.</p>
	Compile and analyse mortality data in settings with relatively high coverage, such as urban areas.		<p>Independent, centralized recoding of locally determined coding</p> <p>Possible task shifting for cause of death assignment</p>
	Ensure timely reporting of mortality statistics from registration system even if complete only for urban areas		
		<p>Household surveys:</p> <p>Generate statistics on overall mortality by age and sex; child & maternal mortality.</p> <p>Use survey data to estimate registration coverage.</p>	<p>Household surveys:</p> <p>Application of VA in sample of households reporting recent deaths with automated coding to estimate cause-specific mortality fractions.</p> <p>Continuous mortality survey if capacities and funding are available.</p>
		<p>Census:</p> <p>Generate statistics on overall mortality by age and sex; child & maternal mortality.</p> <p>Use census data to estimate registration coverage and population at risk of dying.</p>	<p>Census:</p> <p>Application of VA in sample of households reporting recent deaths with automated coding to estimate cause-specific mortality fractions.</p> <p>Questions on place of death & registration status census.</p>
		<p>Sentinel sites:</p> <p>Use mortality data from sentinel surveillance systems to complement community and facility reporting.</p>	<p>Sentinel sites:</p> <p>Unique ID systems to enable record linkages with health facility data and civil registration system where sufficiently developed.</p>

Death registration coverage	Activities to strengthen CRVS	Role of additional data sources to generate mortality data	Potential for innovation
Functional but inadequate CRVS (registration coverage 60–79%)	Ensure adequacy of legislative framework for CRVS.	Facility data: Ensure that all facilities record and report information on deaths by age, sex, date and location, including notification to the CR authorities. Ensure that all deaths occurring with medical supervision are correctly classified according to ICD. Where the legal framework allows (and depending on feasibility) provide registration in health facilities.	Facility data: DHIS reporting of deaths by age and sex. On-line training for physicians. Empower non-physicians with appropriate training to certify the fact of death and notify civil registration authorities. Potential task shifting for cause of death ascertainment in settings without physicians. Automated coding of cause of death data in health facilities. Independent, centralized recoding of locally determined coding
	Establish national coordinating committee involving key stakeholders, including registrars, statistics office, ministry of health etc.	Sample registration: Gradually phase out SRS/SAVVY systems. Use sample registration to check completeness of death registration.	Sample registration: Automated coding of responses to VA questionnaires. Unique ID systems to enable record linkages between sample registration and available civil registration records.
	Address disparities in registration among marginalized and hard-to-reach populations.		
	Compile and analyse mortality data in settings with high coverage, such as urban areas.		
	Use demographic methods to adjust for bias and missing values.		
	Ensure timely reporting of mortality statistics from registration system even if complete only for urban areas.	Household surveys: Use census and household survey data to check completeness of civil registration. Generate statistics on all-cause, child & maternal mortality.	Household surveys: Data collection using hand-held devices. Include questions on place of death in household survey questionnaires.
	Undertake regular data quality assurance (completeness, accuracy, plausibility, timeliness etc.)	Census: Generate statistics on overall mortality by age and sex; child & maternal mortality. Use census data to estimate registration coverage and population at risk of dying.	Census: Add questions on registration status and place of death in settings where mortality questions are included in the census
		Sentinel sites: Use sentinel sites as check on civil registration in the relevant area.	Sentinel sites: Unique ID systems to enable record linkages with health facility data, sentinel sites and civil registration records.
Death registration coverage 80% or higher	Ensure services are accessible and appropriate for hard-to-reach populations. Data quality assurance. Timely reporting of mortality statistics.	Facility data: All registered deaths and deaths in health facilities are correctly certified and coded to ICD causes of death. All deaths in health facilities notified to registration authorities. Coordination and data sharing between facilities and registration authorities.	Facility data: On-line training for physicians. Automated coding of cause of death data in health facilities. Automated data quality checks (e.g. ANACOD). Centralized coding of cause of death

Recommendations for CRVS investment plans

In the light of the urgency of producing usable, nationally representative mortality statistics and the complex array of available data sources, we propose that countries consider an approach that simultaneously strengthens the CRVS platform while introducing innovation in order to rapidly accelerate the availability and quality of mortality statistics and optimizing the use of additional data sources, including facility-based data.

National CRVS plans should prioritize CRVS platform development and identify complementary data sources as a function of country needs and capacities. The National Bureau of Statistics in collaboration with the Ministry of Health and other relevant Ministries and institutions should be the responsible agencies. The budget should be developed on the assumption that currently available mortality data collection efforts, for example through the census and household surveys, will continue to be funded from other sources. This enables the CRVS investment plan to focus on using new funding for innovation and overall CRVS platform development. In selecting additional data sources to complement CRVS, decision-makers should take account of country context and capacities for data collection, analysis and interpretation bearing in mind the pressure on human, technical and financial resources, which are often in short supply.

For countries with the weakest CRVS systems, here defined as death registration coverage below 60%, we propose a four-pronged strategy consisting of:

1. **CRVS platform development**: Establishing or strengthening the CRVS platform, including setting up a national coordination mechanism that brings together stakeholders from the registration, statistical and health sectors and the development of a national CRVS improvement plan. Key components of the plan should be advocacy and action to improve the identification and registration of deaths, for example, through improved links between civil registration and health facilities, between civil registration and burial and religious institutions, and community outreach.^{3 4 5 16} In addition, consensus should be reached with regard to the sharing and use of data for public health and statistical purposes, in accordance with agreed standards and principles.
2. **Innovation**: Introducing vital events registration in representative civil registration administrative areas (SVR).⁸ In these areas, all births and deaths would be identified and registered through active case finding, in close collaboration with the health sector. This could help overcome the current inertia in civil registration systems that rely solely on individuals to come forward to register deaths. Hospital deaths would have cause ascertained through medical certification using the short version of ICD developed by WHO.² Community deaths would have probable cause determined through verbal autopsy conducted in collaboration with the health sector and using standardized tools. The potential of IT for data collection, compilation and analysis, including for coding causes of death, would be maximized.
3. **Health facility-based mortality statistics**: Supporting capacity development for physicians and coders to ensure the correct completion of the international death certificate and the determination of underlying cause of death according to ICD standards, including through automated coding. Countries in lacking the capacities to code to ICD 3- or 4-digits should use the WHO short ICD code list.² In settings without medical staff able to ascertain underlying cause of death, statistics should be reported on deaths by age, sex, date and location. The health sector (through the HMIS) should ensure that deaths occurring in facilities (public and private sector) are notified to the civil registration authorities and that aggregated mortality statistics are reported to the national statistics office.
4. **Optimizing data from multiple sources**: Capacity development for the analysis and interpretation of data from multiple sources is essential in order to extract the maximum value from available data. It is essential to draw upon all expertise in the country – including in statistical offices, academia, public health and research institutions – as well as technical expertise from other countries. This also implies expanding the potential of the census and household surveys to generate data on all cause mortality by age and sex, for example, adding follow-on verbal autopsy studies in households reporting recent deaths. Moreover, the

⁸ Note that this approach differs from sample registration systems (SRS/SAVVY) in that it uses existing civil registration areas as the sampling frame rather than the conventional approach based on randomly selected geographic areas. It is also designed to go beyond enumeration of vital events to include actual registration of events through the civil registration authorities.

inclusion of additional questions in censuses and surveys on whether or not reported deaths were registered and place of death would provide valuable information for subsequent data analysis and estimation of registration completeness. Mechanisms for sharing data across departments as well as with bona fide researchers and analysis should be put in place in order to maximize the utility of available data.⁶

The allocation of funding to each component will of course depend on country capacities, costs, and priorities. However, countries may take into consideration the following issues:

- The establishment of SVR is likely to be the most costly strategy but will yield the most rapid results in terms of improved availability of nationally representative mortality and fertility statistics. Moreover, this strategy, because it is based on existing civil registration sites, will simultaneously enhance capacities for CRVS development overall. In the long term, the CRVS sample sites will be integrated into the comprehensive CRVS system.
- Although they do not generate nationally representative statistics, health facilities are key to the production of reliable cause of death data. All CRVS investment plans should include training physicians to correctly complete the international death certificate and coders to appropriately apply ICD codes. Facility statistics on deaths by age, sex and cause as well as date and place of death should be compiled and reported. The health sector (through the HMIS) should ensure that all deaths occurring in facilities or in which medical personnel have been involved are notified to the civil registration authorities and that aggregated mortality statistics are reported to the national statistics office.

For countries with inadequate but emerging civil registration systems, here defined as death registration completeness between 60–79%), the strategy includes:

1. **CRVS platform development**: Improving registration completeness especially in marginalized populations and in remote areas. Ensuring the quality of registration documentation such as (such as key characteristics of the decedent) in order to permit the compilation of reliable and complete statistics. Existing legacy SRS/SAVVY systems should be gradually integrated into the national CRVS system. In addition, consensus should be reached with regard to the sharing and use of data for public health and statistical purposes, in accordance with agreed standards and principles.^{3 4 5 16}
2. **Innovation**: Promoting record linkage across mortality databases through the use of unique individual IDs. Supporting the use of IT for data collection, transmission and compilation at all levels.
3. **Health facility-based mortality statistics**: Supporting capacity development for physicians and coders to ensure the correct completion of the international death certificate and the determination of underlying cause of death according to full ICD standards, including through automated coding. Ensuring that all facilities, both public and private sector, mortality statistics should be reported on deaths by age, sex, date and location. The health sector (through the HMIS) should ensure that deaths occurring in facilities are notified to the civil registration authorities and that aggregated mortality statistics are reported to the national statistics office.
4. **Optimizing data from multiple sources**: Supporting regular data quality assessment and capacity development for the analysis and interpretation of data from multiple sources in order to extract the maximum value from available data. It is essential to draw upon all expertise in the country – including in statistical offices, academia, public health and research institutions – as well as technical expertise from other countries. Mechanisms for sharing data across departments as well as with bona fide researchers and analysis should be put in place in order to maximize the utility of available data.⁶

Countries with adequate civil registration (death registration completeness 80% and over) should focus on achieving universal coverage of all vital events, ensuring the availability and quality of vital statistics and conducting regular reviews of data quality, especially with regard to cause of death information. The census and household surveys with mortality questions should be used to generate estimates of registration completeness. Regular censuses are also needed to provide data on the population at risk of dying.

Analytical approaches for dealing with discrepant mortality indicators

Very few countries rely on a single data sources to generate mortality statistics. In practice, even low-income countries generally have at least three distinct sources of mortality data – the census, household surveys (such as DHS or MICS) and facility data. Many low-income countries also have data from HDSS. Others may have incomplete CRVS data. Problems may arise when policy makers are faced with discrepant values of mortality indicators derived from different sources. Sometimes, the reasons for the discrepancies are clear, for example when facility data are not representative of the general population or available civil registration statistics are incomplete. In other instances, discrepancies arise even when similar data collection methods are used, such as indirect estimates from the census and from household surveys.

A solution is to maximize the utility of the data points from different sources by using analytical techniques to maximise comparability across data sources and render the information more representative of the population in general. This also involves addressing limitations inherent to all data sets, such as missing values, bias and reporting error. Analytical techniques can address these challenges in a transparent and consistent manner, in order to present the most reliable information to data users. Data imputation and adjustment may be needed in order to generate improved population-based estimates for key indicators. The aim is to make sense of data derived from different sources. Such analytical techniques are complex to perform and should involve institutions with the requisite capacities, including the national statistics office, researchers and academic institutions.

Is there a role for mortality estimation?

In this paper we have used the term '*statistics*' to describe the production of numerical values for health indicators or quantities of interest largely based on empirical data collection. However, in order to meeting the growing demand for global and country data on levels and trends in mortality caused in large measure by the need to monitor global goals and targets such as Child Survival and the Millennium Development Goals, the global health community has turned to the potential of statistical '*estimates*' to fill critical data gaps. These estimates are the outcome of statistical modelling methods that impute values for missing data items, adjust for biases, and enhance comparability over time and between countries.

The UN Inter-agency Group for Child Mortality Estimation (IGME) regularly undertakes analytical reviews of available country data to produce global estimates of child mortality. This involves careful assessment of the quality of available mortality data and adjustment of values to account for known bias or exclusion of data sets judged to be of inadequate quality. Figures 4 and 4a show plots of the estimates derived from multiple sources in Nigeria and the Philippines. A wider range of data sources is used in Philippines than in Nigeria and there is greater convergence of the values from different data sources in Philippines compared with Nigeria, hence the wider margins of uncertainty around the Nigeria estimates. Because of the retrospective nature of the indicator estimates, IGME uses forward estimation or prediction based on statistical modelling to generate the most likely recent value for the child mortality indicator. Problems may arise when the predicted values differ from those reported by national decision-makers. Differences may be the result of the data adjustment processes or the statistical method used to determine trends and predict current values.

For estimating maternal mortality, a similar approach is used to bring together all datasets judged to be of acceptable quality. These data are then adjusted to account for misclassification and underreporting. For example, maternal mortality figures derived from civil registration are adjusted upwards due to well-documented misclassification of maternal deaths as non-maternal. This occurs even in countries with well-functioning civil registration systems, mainly because of the difficulty of differentiating maternal deaths due to indirect causes from deaths in pregnant women that are coincidental, in other words not related to pregnancy or its management. Furthermore, because of the relative paucity of maternal mortality statistics compared with child mortality, an additional feature is the use of covariates to estimate trends and current values. The use of covariates, which may have a tenuous or uncertain relationship to maternal mortality, can result in major discrepancies in global estimates compared with country reported data.

Figure 4. Under five mortality rate, Nigeria, 1955-2015

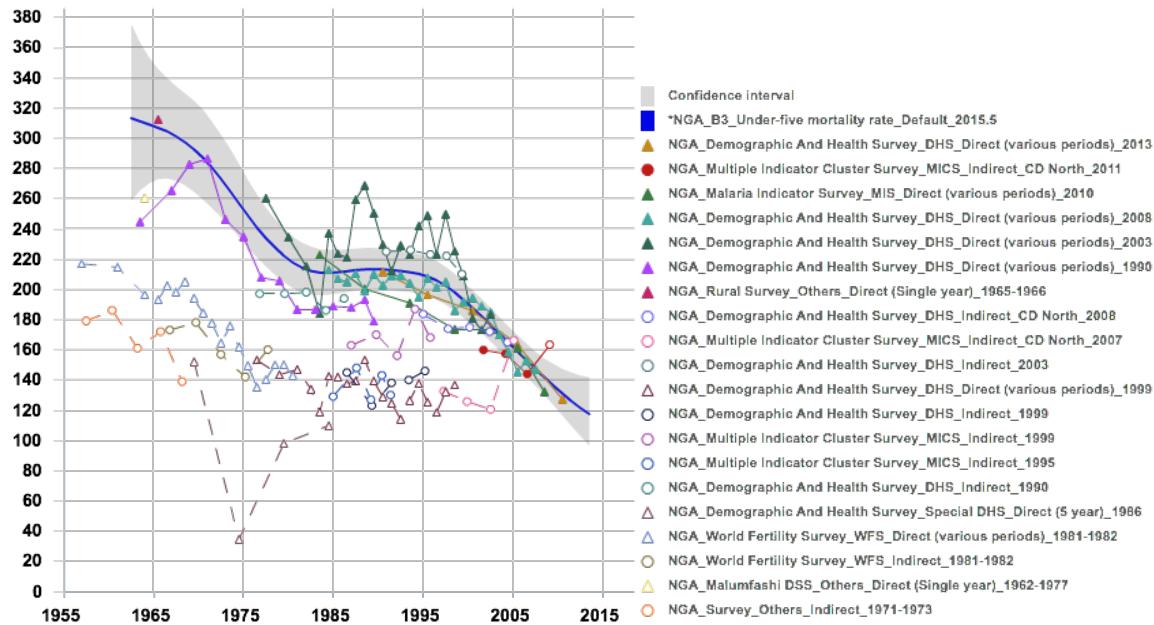
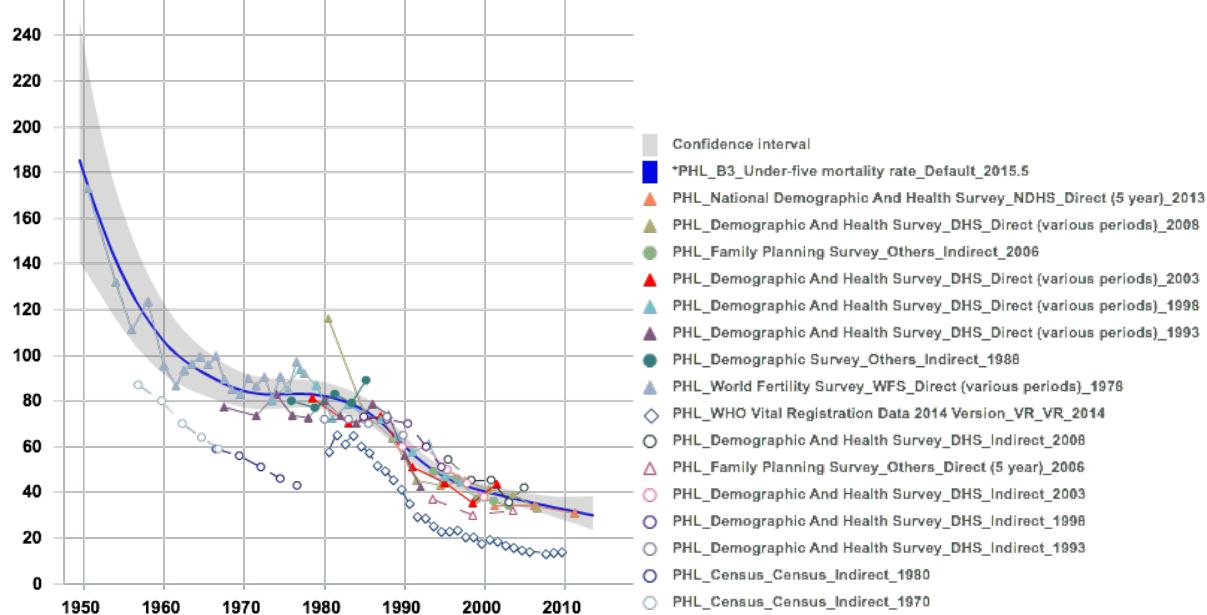


Figure 4a. Under five mortality rate, Philippines, 1950-2015



Source: <http://www.childmortality.org>

The development of statistical estimates initiated with UN agencies – notably the UN Population Division, UNAIDS, UNICEF, UNFPA, the World Bank and WHO. The Institute for Health Metrics and Evaluation (IHME) at the University of Washington in Seattle is a more recent player, using country data to develop global and country estimates of trends in the global burden of disease (GBD) and cause-specific mortality. The GBD is a systematic, scientific effort to quantify the comparative magnitude of health loss to diseases, injuries, and risk factors by age, sex, and geography over time around the world. This enormously ambitious undertaking is the most comprehensive effort to date to measure epidemiological levels and trends around the world.⁸ The GBD represents an alliance of technical brainpower and powerful computing that enables the application of highly sophisticated statistical (such as Bayesian methods and ensemble modelling) approaches to make the most effective use of such data as are available to fill data gaps and generate comparable estimates for key health variables that are comparable over time and across countries. In its most recent iteration, the GBD measures the

impact of 291 diseases and injuries, and 67 risk factors in 187 countries. The guiding principle of the GBD approach is that generating sound estimates requires analysing all available sources of information for a population, essentially carrying out a massive ‘data audit’ and then correcting for problems with the data using covariates.

There is no question that the development of global estimates and the GBD exercise have proved enormously influential in tracking trends in key indicators over time and in identifying issues of public health concern that may have been neglected due to the paucity of available data. The broad picture such estimates paint is informative and of significant utility. Problems arise, however, at the level of detail, when an individual country is faced with estimates for an important indicator produced by a remote agency that seem to bear little relationship to the observed reality in the country.⁹ Moreover, there may be substantial country-specific differences between UN and IHME estimates for under-five mortality due to differences between the data and trend fitting methods used by the two groups.¹⁰ These differences not only cause confusion about the true extent of progress but also risks fostering policy inactivity if the reasons for the discrepancies are not made clear.¹¹

In general, the involvement of country representatives and researchers in such estimation exercises has been minimal, often confined to serving as providers of data sets for analysis by others.¹² As a result, the estimates are rarely accepted and owned by country policy-makers and, therefore, not used to guide policy-making and health programming. No matter how advanced the statistical techniques and complex the modelling tools, unless they are themselves able to understand, interpret and judge the estimates produced by external parties, few country decision-makers will have complete confidence in their accuracy.¹³ In the absence of in-depth country participation, estimates will continue to be perceived as just estimates—that is, not true measurements of mortality levels and trends.¹⁴ Despite the best intentions of agencies to involve countries in the review of the estimates, few countries can muster this degree of analytical and computing power needed to evaluate and replicate highly complex statistical methods.

We suggest that the way forward lies in supporting countries in collecting data using a range of approaches and methods and in undertaking detailed analytical reviews in order to make most effective use of available statistics from all sources. Development partners and technical agencies can play a role by developing and disseminating analytical frameworks, principles, and specifications. Ultimately, countries themselves should be in the lead when it comes to developing estimates, with development partners and academics providing methods, guidance, and technical support. This is closer to the model used by UNAIDS in supporting countries to develop estimates of HIV incidence, prevalence and mortality. But the approach has significant costs and requires long-term commitment to capacity development and to building coalitions of expertise in countries.

Conclusion

Correctly registering and certifying the fact, age and sex of all births and deaths, and the cause of each death, is not only an appropriate recognition of all individuals and their fundamental human right to be counted, but it is also good public policy. The technical skills, political momentum, country and donor interest to accelerate CRVS systems are increasingly aligned. However, it is essential to be able to demonstrate that the production of reliable mortality and cause of death statistics in the context of CRVS improvement is a realistic and attainable goal. This guidance document describes a pathway whereby countries and partners can prioritize investments in order to optimize the use of a range of data sources while at the same time creating sustainable, universal and effective CRVS systems.

Annex I – Meeting agenda and list of participants

Agenda

04 November 2014

Presenters		
9:00 – 12:00	Session 1 Towards an integrated CRVS system	
9:00	Introductions, welcome, background	WHO, UNECA, Canada
9:30	CRVS strengthening developments and situation on vital statistics & draft guidance for countries	Carla Abouzahr
Key Questions		
	<ul style="list-style-type: none"> <i>Design:</i> What can continuous birth and death registration systems provide in terms of mortality trends? What approaches are used for causes of death? Are data publicly available? <i>Quality:</i> What ways are used to ascertain the completeness and quality? <i>Resources:</i> What are the human capacity and financing needs for the successful implementation of the system? Of quality control mechanisms? <i>Integration:</i> How are the different systems integrated? What does it take to further integration? 	
10:30	Coffee break	
11:00	UK: generating real time statistics from multiple systems	Cleo Rooney
	India: quality ascertainment, use of vital statistics, VA	Prabhat Jha
	South Africa: Using HDSS and record linkage to estimate completeness of death registration	Cho Kabudula
	Discussion	
12:30	Lunch break	
13:30–15:30	Session 2 Sample registration systems	
Key Questions		
	<ul style="list-style-type: none"> <i>Design:</i> What should an adequate SRS look like? How long does it take to set it up and generate nationally representative vital statistics? What are the sample size requirements for the production of reliable and stable mortality estimates at the subnational level? Can data be in the public domain? How is verbal autopsy implemented? <i>Quality:</i> What is the reliability and timeliness of SRS-based vital statistics? How is completeness of events assessed? <i>Resources:</i> What are the human capacity and financing needs for the successful implementation of verbal autopsy on a continuing basis? <i>Integration:</i> How can SRS be set up in a way that it strengthens CRVS? What are the experiences of linking active surveillance of deaths with the routine civil registration system? 	
	Viet Nam: SRS investment, results	Chalapati Rao
	Indonesia: design of a new SRS	Suwarto Kosen
	Tanzania: national SAVVY experience	Honorati Masanja
	Zambia: national SRS experience	Martin Nyahoda
15:30	Coffee break	
16:00–18:00	Session 3 Household surveys (and census)	
Key Questions		
	<ul style="list-style-type: none"> <i>Design:</i> How often are surveys with mortality data collection needed? What is the validity of different methods of data collection? What are the limitations of household surveys for collecting cause-specific mortality data? Can continuous surveys be a good alternative? Can verbal autopsy focus on deaths identified through the registration system – on a sample or all? <i>Quality:</i> what is the reliability of survey-based mortality and cause of death statistics? Can surveys help assess completeness of events in CRVS? <i>Resources:</i> what resources – human capacity and finances – are required for a regular survey program? For a continuous survey? <i>Integration:</i> how can surveys become an integral part of CRVS strengthening? 	
	Continuous survey experience in Peru	Shea Rutstein (remote)
	Collection of mortality data through recent deaths methods	Sam Clark
	Collection of adult mortality data through sibling histories	Bruno Masquelier
	Use of summary birth histories to generate recent estimates of under-five mortality	Romesh Silva
	Use of verbal autopsies in household surveys	Daniel Chandramohan
	Summary of the verbal autopsy / social autopsy meeting in Baltimore, August 2014	Bob Black

05 November 2014

Presenters

9:00 – 9:30	Session 3 Household surveys (and census)	
	Lessons learned from Health and Demographic Surveillance Sites	Peter Byass (remote)
9:30–12:30	Session 4 Innovative approaches	
	<i>Key Questions</i>	
	<ul style="list-style-type: none"> • <i>Design</i>: Are there innovative approaches that are feasible and sustainable for the collection and analysis of mortality and cause of death data? • <i>Quality</i>: What is the quality of the information that these methods generate? • <i>Resources</i>: What are the resource requirements? • <i>Integration</i>: How could they be incorporated in CRVS strengthening? 	
	South Africa rapid mortality monitoring	Pam Groenewald
	Results from the real-time monitoring project	Romesh Silva
10:30	Coffee break	
	Results from the real-time monitoring project	Bob Black
	Hyek mortality monitoring project: hybrid of demographic surveillance system and sample surveys	Sam Clark
	Mapping maternal deaths in Nigeria	Allisyn Moran
	Use of automated coding in low income settings	Sam Notzon
	Improving hospital data on causes of death	WHO
13:00–14:00	Lunch break	
14:00–16:00	Guidance for country strategies and investment plans document <ul style="list-style-type: none"> • Regional strategies to improve mortality and causes of death (UNECA) • Views and plans - global agencies: UNICEF, UNSD, UNPD, WHO, USG etc. 	Carla AbouZahr Raj Mitra Partners

List of participants

Participant name Organization	Participant contact info (email address)
Carla ABOU-ZAHR Consultant	Carla.abouzahr@gmail.com
Jacob ADETUNJI USAID	jadetunji@usaid.gov
Mohamed ALI EMRO	alim@who.int
Maru AREGAWI Global Malaria Programme	aregawim@who.int
Isabel BERGERI HIV/AIDS	bergerii@who.int
Robert BLACK Johns Hopkins University	Rblack1@jhu.edu
Ties BOERMA Health Statistics and Information Systems	boermat@who.int
Peter BYASS UMEA University	peter.byass@epiph.umu.se
Daniel CHANDRAMOHAN London School of Hygiene & Tropical Medicine (LSHTM)	Daniel.chandramohan@lshtm.ac.uk
Sam CLARK University of Washington	work@samclark.net
Pamela GROENEWALD South African Medical Research Council (MRC)	Pamela.Groenewald@mrc.ac.za
John GROVE Gates Foundation	John.grove@gatesfoundation.org
Peter HANSEN GAVI	phansen@gavi.org
Dan HOGAN Health Statistics and Information Systems	hogand@who.int
Robert JAKOB Health Statistics and Information Systems	jakobr@who.int
Prabhat JHA University of Toronto	jhap@smh.ca
Chodziwadiwa KABUDULA University of Witwatersrand	Chodziwadiwa.kabudula@wits.ac.za
Soewarta KOSEN Ministry of Health, Indonesia	Soewarta.kosen7@gmail.com
Daniel LOW-BEER HIV/AIDS	lowbeerd@who.int
Honorati MASANJA Ifakara Health Institute	hmasanja@ihi.or.tz
Bruno MASQUELIER Louvain University	Bruno.masquelier@uclouvain.be

Participant name Organization	Participant contact info (email address)
Colin MATHERS Health Statistics and Information Systems	mathersc@who.int
Sam MILLS World Bank	smills@worldbank.org
Raj MITRA UNECA	rmitra@uneca.org
Allisyn MORAN USAID/Bureau of Global Health	amoran@usaid.gov
Sam NOTZON CDC	Fcn2@cdc.gov
Martin NYAHODA Central Statistical Office Zambia	Martinny2@yahoo.co.uk
George PARIYO GAVI	gpariyo@gavi.org
Cynthia PINTO BOSCHI Epidemiology, Monitoring and Evaluation	pintoc@who.int
Chalapati RAO University of Queensland	c.rao@sph.uq.edu.au
Cleo ROONEY Consultant	Cleo_rooney@hotmail.com
Shea RUTSTEIN ICF Macro	shea.rutstein@icfi.com
Keith SABIN UNAIDS/Strategic Information and Monitoring	sabink@unaids.org
Lale SAY Adolescents and at-Risk Populations	say@who.int
Anneke SCHMIDER Health Statistics and Information Systems	schmidera@who.int
Romesh SILVA Johns Hopkins University	Rsilva@jhu.edu
Gretchen STEVENS Health Statistics and Information Systems	stevensg@who.int
Bill WEISS USAID	wweiss@usaid.gov
Gloria WISEMAN DFATD Canada	Gloria.wiseman@international.gc.ca
Danzenh YOU UNICEF	dyou@unicef.org
Jinkou ZHAO Global Fund	Jinkou.zhao@theglobalfund.org

Annex II – Summary description of sources of mortality statistics

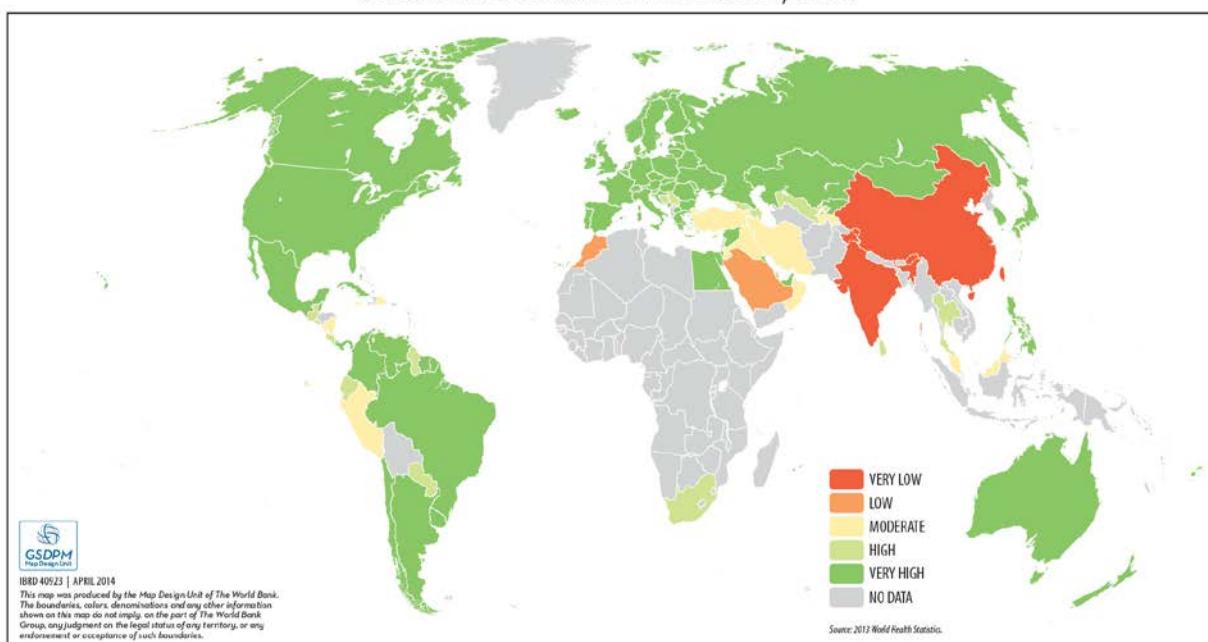
Civil registration

In principle, civil registration is the most effective and efficient source of statistics on births and deaths. Its prime function is to provide individuals with documentation needed to establish legal identity and family relationships and, by extension, exercise their civil rights, access services and participate in modern societies. Characteristics of the civil registration method are that it is compulsory, universal, continuous, permanent, and confidential. These characteristics ensure that the vital statistics generated by way of registration are complete, continuous, correct and timely, and available at national and subnational levels, including for local administrative areas. The usefulness of civil registration records as a main source of mortality statistics, including causes of death, is universally recognized.

The strengths of the civil registration system for producing mortality data cannot be fully realized unless registration coverage levels are high (90% or higher). Currently, however, only a handful of low-income countries attain such levels and many countries, especially in sub-Saharan Africa imply do not report death registration coverage (Figure 5). Nonetheless, it is possible to produce useable mortality data even when registration is less than complete, particularly if registration levels exceed 60%. In some circumstances, methods to correct for missing data and bias may be feasible.

Figure 5. Status of death registration coverage, 2013

DEATH REGISTRATION COVERAGE, 2013



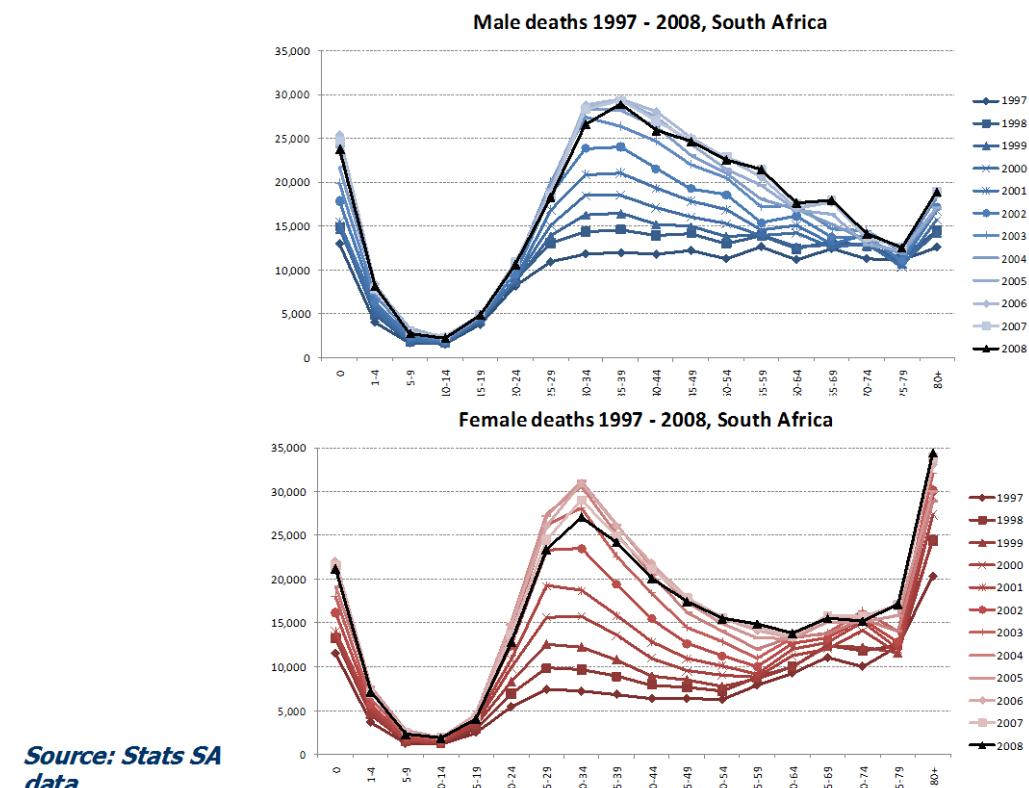
The situation is even more problematic when it comes to the quality of cause-of-death statistics. Cause of death information is compiled in two primary ways: through the collection and coding of routine medical certification records from health facilities; and through collecting information about community deaths through sampled collections methods using verbal autopsy. Up to 80 percent of deaths occur outside of health facilities in low- and middle-income countries and there is a lack of incentives for families, doctors, registries, and health services to register events accurately. Only 81 of 194 countries can report high-quality or medium-quality data on deaths and causes of death (Figure 1). Alarmingly, 42 of the 46 African member states cannot report credible death registration data, and of the 75 low- and middle-income countries prioritized by the Commission on Information and Accountability for Maternal and Child Health (COIA), only 14 report figures on death registrations to WHO. This means critical mortality information, such as deaths of newborns, children, and mothers, or mortality from HIV/AIDS, tuberculosis, and other diseases, are estimated from very limited information.

Although civil registration systems in developing countries frequently fail to record all events, incomplete data that are available can still be used (although are often not tabulated because of concerns about quality). Analytic methods are available for assessing the completeness of registration of adult deaths; if reporting is complete

enough for the recorded deaths to be plausibly representative of all deaths in terms of age distribution (Preston¹⁵ suggests a minimum level of completeness of around 60%) the data can be adjusted to give largely unbiased estimates of adult mortality.^{16 17} Currently available registration coverage data are insufficiently precise to estimate exactly how many countries might have sufficiently complete data to make reliable estimates but it is possible that it could be as many as 100.

There are additional examples of uses of incomplete data. Civil registration is usually more complete in cities, especially capital cities, of developing countries than it is in rural areas. Analysts have taken advantage of such data to examine issues such as seasonal variation in mortality and the effects of HIV on mortality (Figure 6).^{18 19 20 21}

Figure 6. Trends in age-specific mortality 1997-2008, South Africa



At the very least, the civil registration system should be able to compile and report statistics on deaths by age and sex even if the ascertainment of causes of death is inadequate. The value of such data has been shown to be considerable, for example in tracking changes in the age distribution of deaths following the introduction of HIV prevention and treatment interventions.

Potential of other data sources for producing mortality statistics

Mortality statistics can be generated from other sources, for example by including questions on deaths in the household in the decennial population census or in household sample surveys and using direct or indirect demographic techniques to estimate mortality rates. Mortality statistics are also produced through demographic and health surveillance in selected or nationally representative sites.²² In settings with high levels of health care utilization, health records can also be used to generate mortality statistics if deaths are linked to a system for certification of deaths and ascertainment of cause of death. In practice, in many settings, deaths occur at home and in the absence of contact with the formal health care system.

For many countries, these additional sources of data are critical for supplying important indicators needed for planning and monitoring purposes, mainly at the national level. However these approaches are suboptimal compared with civil registration in terms of their ability to produce overall and cause-specific mortality data for the whole country and its subnational levels, on a timely and continuous basis. The UN describes them as “short-to medium-term” measures that cannot replace functional civil registration and vital statistics (CRVS) systems and urges caution in their use, particularly when analysing trends and precise levels.

Sample enumeration or registration systems

Sample enumeration systems involve a significant number of sites – assessed by the national statistics office to be collectively representative of the country – established to monitor the vital statistics of the populations covered. The overall results are then considered to be statistically representative of the national situation. Through the use of verbal autopsy techniques, sample enumeration systems, such as in India and China, can generate data on both overall mortality and cause-specific mortality, hence the name Sample Registration with Verbal Autopsy (SAVVY).

SAVVY differs from HDSS in that it is essentially mortality enumeration rather than health and demographic surveillance. As a result, follow-up is less intense and the denominators used to calculate population statistics may not be as robust as those in an HDSS site. SAVVY is thus more suited to monitoring mortality rates and causes of death in populations, rather than functioning as a vehicle for research purposes, and can be very useful for planning purposes. Both SAVVY and HDSS approaches use a common methodology for ascertaining cause of death, namely verbal autopsy (see below).

The best-known example of SAVVY is the Indian Sample Registration System, which started in 1964 and expanded to cover the whole country by 1970.²³ In approximately 7000 sample areas, part-time officials continuously record births and deaths. In addition, twice a year an independent survey team interviews all sample households, specifically asking about births and deaths in the previous six months. The two sets of event records are then matched, and any discrepancies investigated. The final count of events is the total of all matched events plus those recorded only by the officials plus those recorded only during the household interview. Independent evaluation suggests that the system captures about 85% of all deaths.

In principle, in order to avoid duplication of efforts, sample registration systems should function in coordination with existing civil registration systems. In practice, however, sample registration is conducted as a quite distinct exercise from civil registration, even when overall responsibility for sample registration lies with the same national institution responsible for civil registration, as is the case in India. A common criticism of sample registration systems is that rather than being an interim step toward complete registration of vital events, they become stand-alone initiatives that contribute little to the enhancement of a national civil registration and vital statistics system.

There is currently little experience on how to forge functional linkages between sample or surveillance systems and the CRVS platform despite widespread recognition of the need to overcome the current fragmentation. One strategy would be to use the civil registration administrative structure as the sampling frame for the introduction of true sample registration – as opposed to enumeration – systems along with verbal autopsy to determine cause of death. In this paper we have called this innovative approach sample vital registration (SVR). It has the strengths of SAVVY in terms of active case finding and application of verbal autopsy, while simultaneously providing the framework for the construction of a functional CRVS system that could be gradually extended to cover the whole country.

Household surveys

In the majority of low-income and a number of middle-income countries, monitoring progress towards the Millennium Development Goals (MDGs) is greatly reliant on household surveys for estimating mortality indicators such as child and maternal mortality. For estimating mortality in children, surveys use either indirect methods with summary birth histories (children ever born, children still alive or, preferably full birth histories, whereby every sampled woman (in some settings limited to ever-married women only) is asked about the date

of birth of each of her live-born children, whether the child is still alive, and if not, how old the child was at death. These data permit the calculation of under-five mortality rates for the previous 15–20 years. The surveys typically include small but nationally representative samples of 3000–30 000 households although some surveys are much larger. The small samples allow for careful monitoring of the quality of data, but restrict the ability to make precise estimates of some indicators for subnational areas or population subgroups.

Surveys generate retrospective estimates of mortality. The average lag period of the latest observation in surveys (relative to the completion of fieldwork) based on direct estimates from a full birth history is about 2 years. For estimates based on summary birth histories from women aged 25–29, the average lag period is about 4.7 years. However, the data can be re-analysed to provide estimates for the year prior to the survey (although the confidence intervals are larger if the reference period is smaller). In addition to the lag time between the reference year and the date of data collection, additional time is required for processing data, finalizing the report and releasing the estimates, giving an average total delay time (lag time and production time) of about 3 years for direct and 5.7 years for indirect estimates.²⁴

Maternal deaths are identified using either direct or indirect methods. Direct methods involve asking respondents about recent deaths in the household and, when deaths are identified in women of reproductive age, asking extra questions about the timing of the death in relation to pregnancy (pregnancy-related mortality). These methods can generate estimates with a reference period of about 2–3 years before the survey, which is acceptable for monitoring purposes. However, large sample sizes are needed to produce reliable estimates, and the estimates of maternal mortality will have very wide confidence intervals, making it difficult to monitor changes over time. For example, a 2007 household survey in Ghana involved 240 000 households and produced estimates with a confidence interval of \pm 30 per cent.²⁵ By comparison, typical confidence intervals for estimates of child mortality are about \pm 10 per cent.

Sample size requirements are significantly reduced when sisterhood or sibling survival methods are used to indirectly measure maternal mortality in household surveys^{26 27}. With this method, a representative sample of respondents is interviewed about the survival of their adult sisters to determine: the number of ever-married sisters; how many are alive; how many are dead; and how many died during pregnancy, delivery or within six weeks of pregnancy. There are two variants of sisterhood methods. The original indirect method, which has been used; for example, in multiple indicator cluster surveys supported by the United Nations Children's Fund (UNICEF), uses quite small sample sizes. However, this method is not appropriate in settings in which fertility levels are low (i.e. a total fertility rate <4) or in which substantial migration or other social dislocation has occurred. The direct sisterhood method, used in the demographic and health surveys (DHS) supported by the United States Agency for International Development, collects more information than the indirect method (e.g. the age of all siblings, age at death and year of death of those deceased). However, this method requires larger sample sizes, more questions and a more complex analysis.

Sisterhood methods are relatively cost effective because the sample sizes are smaller than those of surveys based on recent household deaths. However, the wide confidence intervals make trend analysis difficult. Also, sibling survival methods produce retrospective rather than current estimates of maternal mortality—around 5–7 years before the survey for direct sisterhood methods and 10–12 years before the survey for indirect methods. Sibling survival methods (and censuses) may underestimate overall mortality because of inherent biases in survey data (e.g. survival and recall bias).²⁸ Statistical methods that correct for these biases have been developed, but debate about the adjustment of estimates from sibling survival data is unresolved.^{29 30} In several countries, verbal autopsy modules in health surveys or special mortality surveys³¹ are used to obtain an idea of the relative importance of causes of death.

A well-conducted household survey is a complex and expensive undertaking, especially in poor countries where large populations live in remote and hard to reach areas or undocumented in sprawling cities. Inevitably, cost considerations mean that sample sizes have to be limited and the resulting estimates often have wide confidence intervals, which renders the analysis of trends problematic. As a general rule, the methods used to estimate mortality in household surveys perform poorly when it comes to measuring mortality in adults and assessing causes of death both in adults and children.

A potential innovation is the use of continuous surveys, which use panels of clusters in multiple annual rounds to produce annual estimates of mortality with smaller standard errors. However, they require strong commitment from the government for long-term data collection, and strong institutional capabilities to manage the survey and considerable technical assistance in key areas.

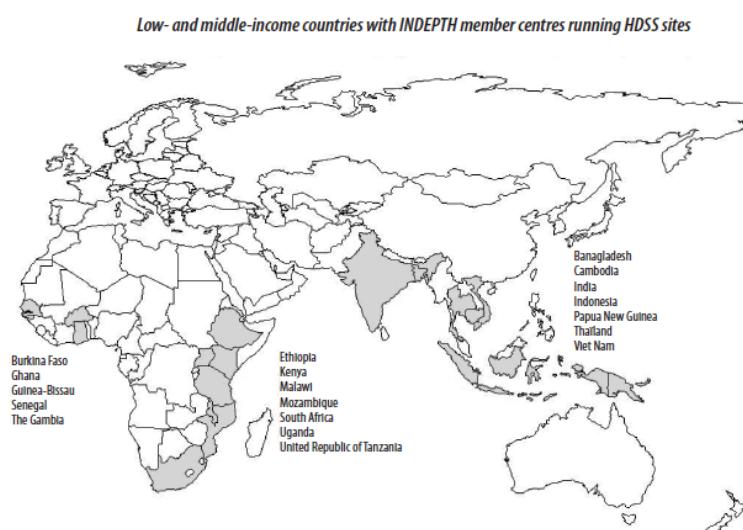
Longitudinal health and demographic surveillance systems (HDSS)

In a number of low-income countries, long-term surveillance of health and population is ongoing in selected sites, most of them in rural areas. These sites have usually been selected in order to introduce and evaluate public health interventions or tools such as oral rehydration therapies or antiretroviral medicines. In 1998, a number of previously independently functioning HDSS sites in developing countries came together to form the International Network for the Demographic Evaluation of Populations and Their Health in Developing Countries (INDEPTH). As of 2012, there were over 40 HDSS sentinel field sites operating in Africa and Asia (Figure 7). At these sites, all vital events occurring in contiguous populations of between 50 000 and 200 000 people living in defined rural or urban areas are being monitored over time. HDSS sites can answer complex research and evaluation questions because they generate data that are more complex, complete and contextualized than are produced by sample registration or civil registration systems. On the other hand, the relatively small number of HDSS sites in an individual country means that the results obtained may not be applicable to areas that are distant from the site, particularly in large countries with considerable geographical and socioeconomic diversity. In order to generate data that reflect the whole country, it is necessary to select surveillance sites that are statistically representative of the national situation.

Ensuring representativeness is a major challenge as surveillance sites are not necessarily representative of the national population. In the case of sample registration systems, vital events might be missed entirely due to sampling design or choice of sample population. In both sentinel and sample registration systems, the data-collection and checking systems can delay access to results with adverse effects on their timeliness.

As a general rule, existing HDSS sites were established for research purposes such as testing and evaluating interventions to reduce fertility, and infant and child malnutrition and mortality. For example, one of the longest-running sites (in Matlab, Bangladesh) was set up to evaluate interventions to prevent child mortality due to diarrhoeal diseases. More recently, surveillance sites have been established to test interventions for the prevention or management of HIV/AIDS and malaria. Dependence on research funding brings both benefits and risks. It helps to maintain a high standard of demographic enumeration and application of VA techniques, but introduces stresses with regard to continuity of funding.

Figure 7. Countries hosting one or more HDSS sites (around 2010)



Another issue requiring further examination is the extent to which HDSS sites are connected to ministries of health, and to what extent the data they generate are actually used to guide national health and development decision-making. While research findings from HDSS sites are well publicized in the academic literature, not enough is known about the use of the statistics they generate by the health sector, national statistics offices or other decision-makers. To help resolve this issue, HDSS sites in some countries are now being taken over or co-funded by the Ministry of Health. For such sites, an annually updated burden-of-disease profile can be produced that summarizes the proportion of the mortality burden that can be addressed by targeted, locally available and cost-effective interventions.³² In many countries there is a significant backlog of mortality data produced by the routine civil registration system that have not been compiled and remain under-used because of a lack of capacity and resources in the agencies involved. There would therefore be great benefit in promoting the transference of the enhanced skills developed in HDSS to routine civil registration systems.

The census

The census is also widely used as a vehicle for implementing demographic techniques for generating mortality statistics and appears to perform well in terms of child mortality though less so for adult mortality.³³ The census is used to provide data on the population at risk of dying, produce summary birth histories for all women aged 15–49, counting the number of live-born children for each woman, the number still alive and the number that have died. The proportions of children who have died of women in different age groups can help to estimate under-5 mortality by standard demographic methods.³⁴ Although this approach cannot estimate age patterns of child mortality, it can provide estimates of recent trends, differentials by population subgroup and differentials by small areas.

In the 2010 round of population censuses, some countries included questions about deaths in each household by age and sex in a reference period before the census.³⁵ Methods have been developed to assess the completeness of reporting of deaths ascertained in this way.³⁶ These methods make crucial assumptions: that the reported deaths are representative of all deaths in the population; that reporting of age at death is accurate; and that net migration is zero (unless estimates of age-specific net migration are available), and that the coverage of the census is the same for all ages and the completeness of death reporting is the same for all ages above a certain age limit (usually age 15). At best they estimate coverage only relative to an intercensal (typically a period of 10 years) average level of mortality, but evidence shows them to be an inexpensive approach to adult mortality estimation in the absence of complete civil registration.³⁷

The population census can also contribute to estimates of adult mortality by including simple questions on survival of parents of each respondent. Brass first developed an approach to estimate adult mortality from survey information about survival of parents; the method has been refined since.^{38 39} The basic idea is that the proportion of respondents of a specific age whose mother or father has died will vary with the level of adult mortality. This method is attractive because the basic questions are so simple and can also be included in household surveys, but the estimates obtained are of average mortality over a long period in the past, and seem to underestimate overall mortality somewhat.⁴⁰

The census has been used to identify certain specific causes of death. A question about the time of death relative to pregnancy can be asked to estimate pregnancy-related mortality ratios with somewhat equivocal results.^{41 42} It is also possible to ask a question about whether death resulted from injury. A broader set of causes of death can be identified by following up households reporting a death, or a sample of them, after the census to do a verbal autopsy (see below) to identify the cause of death as precisely as possible. The challenge with such follow-up surveys is that of successfully locating the respondents identified in the original census. However, a similar approach in Mozambique attained a verbal autopsy coverage rate of 84% of eligible households.⁴³ This approach is not designed to identify all deaths that might have been missed in the census. Any underreporting of deaths in the census would bias downwards death rates.

The infrequency of the census renders it of limited value for monitoring purposes. On the other hand, the census has some advantages compared with sample surveys. For example, because the census is a complete population count, the estimates so derived do not have margins of uncertainty associated with sampling (confidence intervals). However, census estimates have uncertainty arising from non-sampling issues such as respondent

recall error and bias. Evidence consistently suggests that the census significant underreports deaths in the household. Unlike survey-based confidence intervals these cannot be quantified. The volume of information collection in the census means that quality assurance is difficult, often resulting in lower data quality and lack of in-depth information.

Facility-based mortality statistics

In settings where most deaths occur in the health sector and where population denominators are known or can be estimated, hospital-based reporting can be used to generate population-based mortality rates by age, sex and cause. However, even where most deaths in a country occur outside of hospital facilities, routine hospital data is still an important source of mortality data. A priority in all settings is to ensure the availability and quality of facility-based data on mortality, including causes of death. The International Classification for Disease (ICD) is available to assist with coding medically certified deaths in hospital settings (see more detailed discussion in Annex II below).

It is essential to consolidate all available data on births and deaths that occur in public and private sector health facilities, especially those in urban areas where a relatively high numbers of deaths occur in the health care system. If the inclusion of all hospitals serving urban populations is not feasible, then the strategy should be implemented in a sample of urban areas, preferably including the capital city. Once data have been compiled, a detailed evaluation of data quality should be carried out, using established mortality data quality checks. These should particularly check for the under-registration of deaths, and for the quality of cause-of-death certification and coding. In principle, it should be easier for countries to collate, check and remedy errors in mortality data generated by hospitals, given that the majority of such deaths are likely to have been registered, and certified by a medical practitioner. Particular priority should be given to providing training in the correct certification of causes of death to doctors in urban hospitals as well as training of expert coders.

In settings where each individual has a unique identification number (assigned at birth as part of the CRVS system, or additionally assigned by the health sector) the value of facility mortality statistics can be greatly enhanced by record linkage. For example, computerized algorithms can be used to link death certificates of reproductive-aged women with maternal identifiers on birth and foetal death certificates, or to compare records between the death registry and hospital discharge databases. This has enabled more complete identification of all maternal deaths, reductions in misreporting and more accurate monitoring of the maternal mortality ratio. It has also contributed to improved understanding of the causes and circumstances of maternal deaths.

Community-based mortality statistics

The possibility of working with community-based mechanisms to generate mortality statistics is currently underexploited. The health sector has multiple points of contact with individuals, such as immunization and outpatient visits, as well as community outreach. These could be used as opportunities for the notification of deaths to registration authorities.⁴⁴ Community health workers (CHWs) are increasingly serving as vital events reporting and registration agents—a role that improves CRVS system coverage, while providing local areas with real-time health information for planning and improvement.^{45 46} However, initial results have found significant under-reporting of deaths and thus underestimation of mortality rates.⁷

There is also a need to establish effective linkages between registration and village leaders, religious authorities and funeral services in order to identify deaths and garner information on the age and sex of the decedent. The possibility of using mobile communication devices for notification of deaths by age and sex at community level is an area for further research.⁴⁷

Methods that are implemented through household surveys cannot produce stable indicator values at local administrative levels. Household surveys and censuses rely on retrospective reports of events and are thus prone to selection bias. For example, both full and summary birth histories exclude births and deaths of children of women who have died. Any strong association between the risk of death of the child and that of the mother will bias estimates of child mortality and distort associations with predictor variables. With limited exceptions, such as maternal mortality and external causes of death, these methods cannot generate reliable data on causes of

death in the population. Health facilities may be able to generate good quality cause of death data but lack of population representativeness is a serious weakness.

The main limitation of data from sentinel surveillance is that they are restricted to small geographic areas, which are usually intervention trial sites with small populations, and numbers cannot be generalized reliably. This limitation does not apply to sample registration systems as by definition the sites are selected to be nationally representative.

Sample registration systems can produce data at local levels if sample sizes are sufficiently large. They can also generate data on causes of death by using verbal autopsy techniques. However, the nature of the system of active case-finding, obtaining and checking data, such as that used by the Indian Sample Registration System delays access to timely results. Moreover, sample sites might entirely miss health events because of the sampling design or choice of sample population.

Both sentinel and sample surveillance systems require active follow-up of births and deaths, which has important cost implications. The establishment of a nationally representative sample registration system is a major undertaking and should only be considered if local technical and human resource capacities permit and there are assurances of sustainable funding over the long term.

Facility information systems are limited by lack of representativeness and common problems of poor quality of the data. On the other hand, the health information system does have the capacity to produce a continuous stream of data at national and subnational levels and if ways can be found to address bias, could potentially provide important information on patterns of cause-specific mortality. The potential of the health sector to utilize its community outreach capabilities to identify deaths by age and sex at community level remains to be fully exploited.

Annex III – Methods for determining causes of death

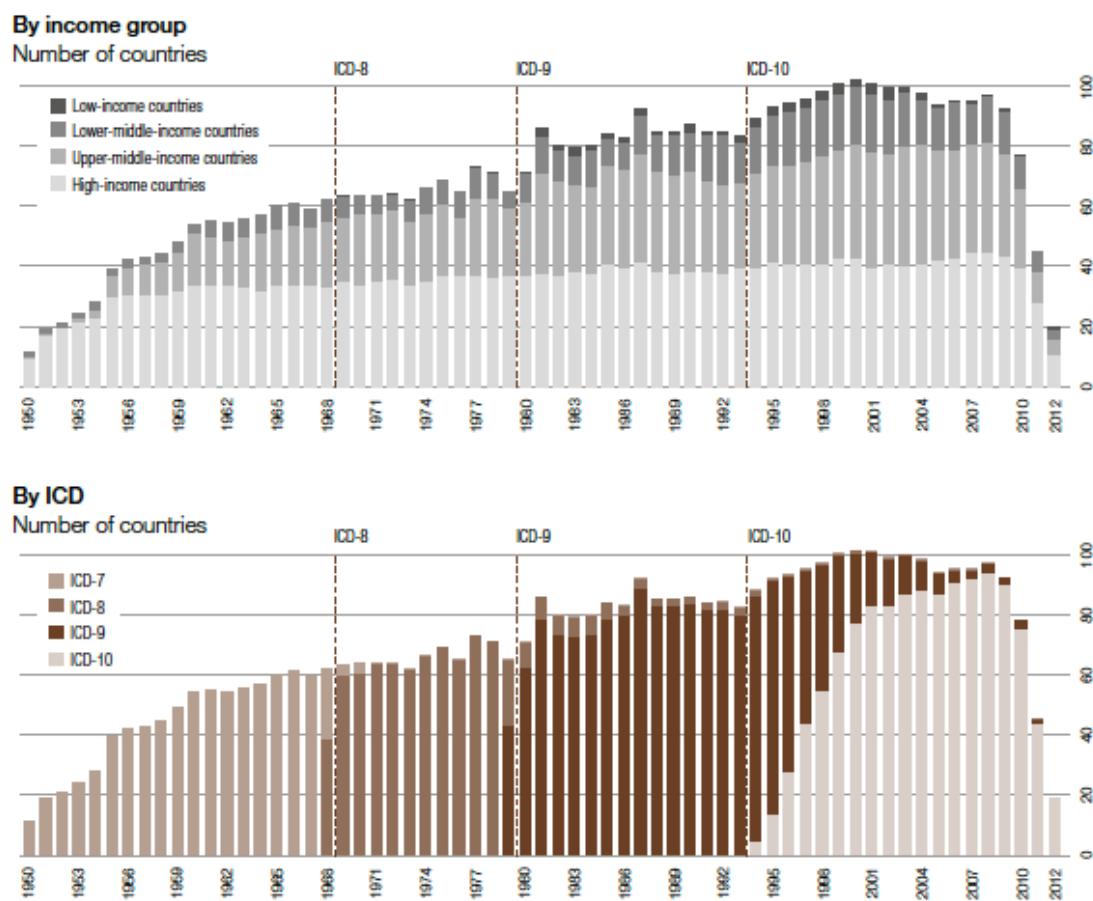
The International Classification of Diseases

In a well-functioning civil registration system, registered deaths are medically certified and cause of death ascertained according to the standards set out in the International Classification of Diseases (ICD).⁴⁸ The application of these standards enables the production of high quality statistics on causes of death in the population disaggregated by age, sex and location. The ICD is updated and revised every decade or so in order to reflect the latest knowledge available on the etiology of major diseases and health conditions. Figure 7 shows the number of reporting countries over time along with an indication of which revision of the ICD was used. One striking feature has been the variable time lag between the introduction of a new revision of the ICD and its roll-out in countries. From ICD-7 to ICD-8 and from ICD-8 to ICD-9 the adoption of each new revision happened relatively quickly. However, the corresponding rate of change from ICD-9 to ICD-10² was slower, and it took until 2005 (around a decade) to achieve a level of 90% of countries using ICD-10. Some countries – including Denmark, Switzerland and Turkey – never adopted ICD-9, moving instead directly from ICD-8 to ICD-10. WHO is currently developing the 11th revision of the ICD. From a statistical perspective, ICD revision presents a number of challenges due to breaks in the statistical series. Although WHO recommends that countries maintain dual systems for a period of transfer from one revision to the next, this represents a considerable burden for coders and is not always done. Moreover, interim updates of the ICD between major revisions also occur, making the tasks of coders even more complex.

As is also shown in Figure 8, only around 32 countries regularly reported cause-of-death information in the mid-1950s. This number increased to 66 countries in the mid-1970s and to 90 countries in the mid-1990s. Since then, however, the average number of countries annually reporting cause-of-death information in line with the ICD has virtually stagnated at 97 out of a total of 194 countries. Whilst high-income countries have been generating such information on a routine basis for many years, the majority of low- and middle-income countries continue to struggle to produce reliable cause-of-death statistics in accordance with ICD standards.

This failure to progress can be attributed to two challenges. The first challenge is to give physicians responsible for issuing death certificates the training and skills required to correctly complete the international form of the death certificate. Unfortunately, such training is rarely built into medical curricula and in-service training is often neglected. Various educational materials for certifying physicians have been developed but their use remains limited.^{49 50 51 52} However, experience indicates that once physicians have understood the importance of correct cause-of-death certification, they can readily acquire the needed competencies to do so.

Figure 8. Trends in cause-of-death data reporting by country income group and ICD revision.



Because of the typically observed lag of 18–24 months before countries report finalized latest data, it should not be inferred from these charts that reporting for the most recent years has decreased.

The implementation year of the ICD revisions are indicated by the dashed lines.

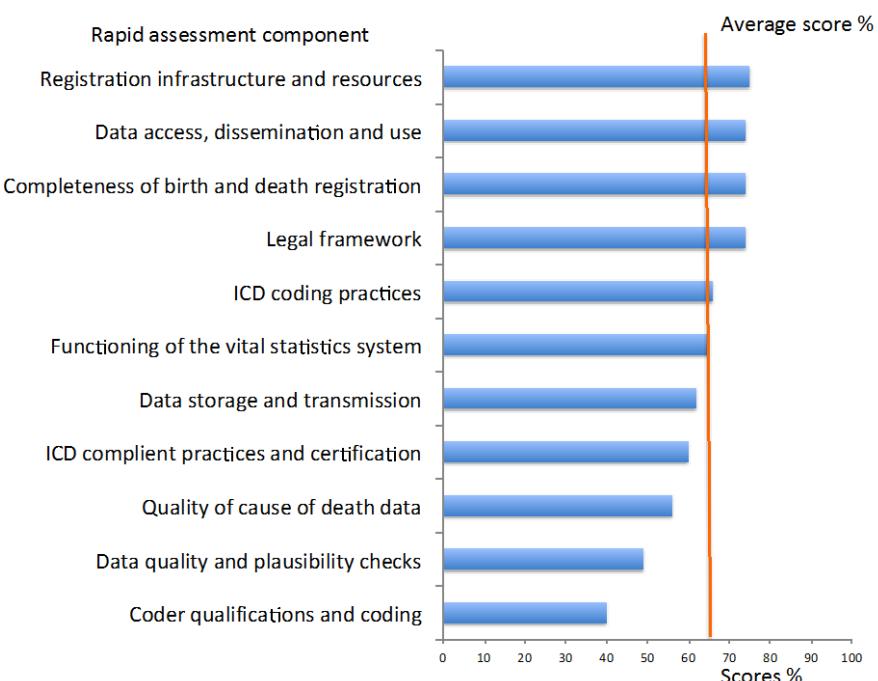
The second challenge is to ensure that the cause of death on the certificate is correctly assigned an appropriate statistical code contained in the ICD. This is not easy. Due to the growing complexity of the ICD, only expert statistical coders and classification experts can use it properly. In response, software programmes for coding and selection have been developed.⁵³ These use computerized mortality-coding tools to ensure the consistent application of ICD rules and produce comparable cause-of-death data. In addition, on-line training tools are available to build capacities both among certifying physicians and coders.⁵⁴ However, these approaches are yet to be scaled up to a level sufficient to secure improvements in cause of death reporting at global level. Moreover, the use of automated coding is limited to those causes of death that are relatively straightforward to code. Complex cases and all deaths due to external factors have to be coded by expert nosologists.

The ICD was initially conceived as a system for the classification of deaths, primarily for public health purposes. However, following the 8th revision it morphed into a system for the classification of “diseases and related health problems” and the morbidity component has assumed greater dominance.⁵⁵ Of the 12 421 codes in the ICD-10th revision, only about 3,000 are actually useful for classifying causes of death. There is an unresolved tension between statistical users of the ICD and administrative users. Statistical users need continuity for trend analysis and broad levels of disease aggregation, consistent with diagnostic reporting on death certificates. The latter need to most up-to-date and detailed diagnostic terminology and entry specificity.³⁴ The ICD claims to meet both needs but in practice falls short when it comes to readily generating statistics on causes of death.

Although the ICD offers short or condensed lists for tabulating mortality data, the selection criteria are not clearly defined, making their utility for policy and planning questionable. From a public health policy perspective, what is needed is a short list of cause groups that provides an overview of the health situation in a country and assists decision-makers and researchers in visualizing prevailing and emerging mortality trends.⁵⁶

Evidence of the difficulties involved in the implementation of ICD comes from countries that have undertaken assessments of their civil registration and vital statistics systems using a tool developed by the World Health Organization (WHO) and the University of Queensland.⁵⁷ The assessment involves a review by country stakeholders, including the government agencies responsible for the registration, statistics, health and other sectors as appropriate for each country. The tool consists of 25 questions about the functioning of national CRVS, grouped into 11 subject areas: the legal framework for CRVS; infrastructure and resources; organization and functioning; coverage of birth and death registration; data storage and transmission; use of the International Classification of Diseases; cause-of-death certification and quality; statistical coding of causes of death; coder qualification and training; data quality and plausibility; and data access, dissemination and use. Each question asks the assessors to select one of four scenarios that most closely reflects the country situation. A numerical value (0, 1, 2 or 3) is attached to each scenario, which indicates how well this aspect of the system functions and scores can be added for the 25 questions and converted into a percentage. The overall score offers a reasonable indication of the functionality and quality of the national CRVS system (Figure 9).⁵⁸

Figure 9. Distribution of CRVS rapid assessment scores in 27 countries in the Asia and Pacific regions, circa 2010-12



However, in a major step forward, WHO is currently developing an ICD shortlist for use in countries where the capacities for ICD coding to 3 or 4 digits is currently not available. This simple list of causes of mortality has identified major causes of mortality drawing upon the ICD special tabulations and the Global Burden of Disease analyses.⁵⁹ The short list has a similar look and feel to the ICD and is entirely compatible with it. It consists of 106 causes of death grouped into 13 subcategories. It is accompanied with simple instructions for adapting to country settings, including the development of a data dictionary and training materials. It also includes an integration data presentation tool that enables the automatic production of summary charts. As country capacities improve, it would be possible to graduate from the simple list to the more detailed and complete ICD.

Verbal autopsy

When deaths occur outside the health care setting and medical certification of causes of death according to ICD rules is not possible, an additional method is to apply verbal autopsy (VA). Both HDSS and sample registration systems use VA to ascertain patterns of mortality in the population. VA is a process for diagnosing causes of death based on responses collected by a health worker from families and/or caregivers to a series of structured

questions on the signs and symptoms experienced by the deceased, and their duration.⁶⁰ The responses are usually reviewed by a physician to determine the probable cause of death.

However, physician review is time consuming and demanding and not a good use of the physician's time. In recent years, automated methods have been applied to determine the cause of death from the received responses without the need for a physician. One approach – InterVA – is now in widespread use in HDSS sites.⁶¹ More recent research has generated new automated techniques that claim to perform better than physicians – though these techniques need to be field-tested in a range of settings before they can be recommended for universal application. Automated methods have the advantage of speed and reduce the burden on physicians who are generally required to prioritize their clinical responsibilities over other activities.⁶²

Although the use of VA generates useful cause-of-death information at the population level – i.e. cause-specific mortality fractions – the technique is less reliable for ascertaining cause of death on an individual basis. In addition, causes of death ascertained using VA cannot be used for legal purposes, which usually require more rigorous medical certification.

Facility-based mortality statistics

Information about cause of death from health facility records provides another approach to the generation of cause-of-death statistics. Indeed, the civil registration system relies on information provided by the health sector on numbers of deaths by age, sex and cause, particularly in settings where national legislation stipulates that deaths be certified by a health care worker prior to disposal of the body. This information should be part of the routine HMIS system and integrated into the District Health Information System (DHIS). The information should be shared with the civil registration authorities.

The information collected by the health sector is not always effectively shared with the civil registration system but is nonetheless a potentially valuable source of data on numbers and causes of death. Even though recording of cause of death in hospitals is far from perfect in countries with inadequate statistical systems, the recorded cause has substantial information content, especially if assessed in combination with case notes.

For determining causes of death, WHO standards explicitly require that the certification of cause of death in health care facilities be restricted to trained physicians. This is problematic in countries with weak health systems and insufficient numbers of physicians able to certify cause of death, especially in remote or rural areas and among marginalized population groups. Several countries, such as Mozambique, Ethiopia and some Pacific Island countries, are considering shifting responsibilities for medical certification to other cadres of health care workers such as trained nurses. If accompanied by the introduction of automated coding methods at facility level, this could greatly improve the availability and quality of facility-based statistics on causes of death.

Deaths occurring in hospitals cannot usually be regarded as a random sample of all deaths in a population and will be biased by various characteristics, including the underlying cause of death. On the other hand, if the selection process can be satisfactorily modelled, the recorded distribution can be weighted appropriately to calculate a distribution representative of the whole population. Information from hospital records also gives valuable insights into underlying and multiple causes of death, which is increasingly relevant in view of the rising proportion of non-communicable diseases worldwide.

Not only are facility-based data on causes of death not representative at the population level but also it is difficult to estimate reliable denominators for the calculation of mortality rates and ratios. Thus, hospital reporting on cause-specific mortality is generally limited to distribution of causes of death rather than population-based cause-specific mortality rates. Nonetheless, facility-based data may be of value if methods can be found to adjust for bias and missing values. Moreover, hospital-based mortality data are also important for assessing quality of health care, for example through audit of preventable mortality such as maternal and perinatal deaths.

References

- ¹ Improving Mortality Statistics as part of Strengthening Civil Registration and Vital Statistics Systems, *World Health Organization*, Technical Meeting, November 4-5, Chateau de Penthes, Geneva, Switzerland.
- ² <http://www.who.int/healthinfo/indicators>
- ³ WHO, <http://www.who.int/healthinfo/statistics/verbalautopsystandards/>
- ⁴ World Bank and WHO. Global investment plan for civil registration and vital statistics strengthening. Washington DC. 2014.
- ⁵ Jimenez Soto E, Nguyen K, Detrick Z, Hodge A, Lopez AL (2013) An economic evaluation of data collection methods for vital statistics Working paper series No 28 <http://www.uq.edu.au/hishub/wp28>
- ⁶ Health Metrics Network (no date) technical note on the costs of alternative approaches to collecting population and vital events data. Accessed May 2014 from http://www.who.int/healthmetrics/resources/Technical_note_on_costs.pdf
- ⁷ World Health Organization (2014) Using innovative approaches in the health sector to strengthen and modernize civil and vital statistics (CRVS) systems: guiding principles and good practices. Report of a technical meeting sponsored by the World Health Organization in collaboration with Canada, UNICEF, USAID and the World Bank Geneva, 17–18 December 2013
- ⁸ Institute for Health Metrics and Evaluation (2013). The Global Burden of Disease: Generating Evidence, Guiding Policy. ISBN 978-0-9840910-6-5 © 2013 Institute for Health Metrics and Evaluation Seattle, WA.
- ⁹ Mola G, Kurby B (2013) Discrepancies between national maternal mortality data and international estimates: the experience of Papua New Guinea. Reproductive Health Matters Volume 21, Issue 42, Pages 191–202, November 2013 DOI: [http://dx.doi.org/10.1016/S0968-8080\(13\)42725-8](http://dx.doi.org/10.1016/S0968-8080(13)42725-8)
- ¹⁰ Dwyer-Lindgren L, Gakidou E, Flaxman A, Wang H (2013) Error and bias in under-5 mortality estimates derived from birth histories with small sample sizes Population Health Metrics 2013, 11:13 doi:10.1186/1478-7954-11-13
- ¹¹ Alkema L, You D (2012) Child Mortality Estimation: A Comparison of UN IGME and IHME Estimates of Levels and Trends in Under-Five Mortality Rates and Deaths. PLoS Med 9(8): e1001288. doi:10.1371/journal.pmed.1001288
- ¹² Sankoh O (2010) Global Health Estimates: Stronger Collaboration Needed with Low- and Middle- Income Countries. PLoS Med 7(11): e1001005. doi:10.1371/journal.pmed.1001005
- ¹³ Walker N, Bryce J, Black RE. (2007) Interpreting health statistics for policymaking: the story behind the headlines. Lancet. 2007 Mar 17;369(9565):956-63. Review. PMID: 17368157
- ¹⁴ The PLoS Medicine Editors (2010) Can We Count on Global Health Estimates? PLoS Med 7(11): e1001002. doi:10.1371/journal.pmed.1001002
- ¹⁵ Preston SH. Use of direct and indirect techniques for estimating the completeness of death registration systems. In: United Nations Department of Social and Economic Affairs. Population Studies No 84: data bases for mortality measurement. New York: United Nations, 1984. 66–67.
- ¹⁶ UN Population Division. Methods for estimating adult mortality. ESA/P/WP.175. New York: United Nations, 2002.
- ¹⁷ T. A. Moultrie, R. E. Dorrington, A. G. Hill, K. Hill, I. M. Timæus & B. Zaba (Eds.), Tools for Demographic Estimation: International Union for the Scientific Study of Population. <http://demographicestimation.iusspp.org>

¹⁸ Fargues P, Nassour O. Seasonal variation in urban mortality: the case of Bamako, 1974–1985. In: van de Walle E, Pison G, Sala-Diakanda M, eds. Mortality and society in sub-Saharan Africa. Oxford: Clarendon Press, 2007: 99–122.

¹⁹ Wade A, Hane A, Coll-Seck A, et al. Impact of HIV/AIDS on adult mortality in Dakar, Senegal: Approach based on vital registration. Int Conf AIDS, Jul 7–12 ,1996; 11: 401.

²⁰ Dlodlo, RA, Fujiwara, PI, Hwalima, ZE, Mungofa, S, Harries, AD (2011). Adult mortality in the cities of Bulawayo and Harare, Zimbabwe: 1979–2008. J Int AIDS Soc, 14 Suppl 1:S2.

²¹ Masquelier, B.; Waltisperger, D.; Ralijaona, O.; Pison, G. & Ravelo, A. The epidemiological transition in Antananarivo, Madagascar: an assessment based on death registers (1900–2012) Glob Health Action, 2014, 7, 23237

²² United Nations Statistics Division (1983) Manual X: Indirect Techniques for Demographic Estimation, No. 81 (United Nations publication, Sales No. E.83.XIII.2), chap. II

²³ Registrar General of India & Centre for Global Health Research (2006). *Maternal mortality in India: 1997–2003. Trends, causes and risk factors*. New Delhi, Registrar General. Retrieved 22 August 2012 from: http://www.mpr.gov.in/health/Maternal_Mortality_in_India_1997-2003.pdf

²⁴ UNICEF and USAID. Real-time child mortality meeting. Technical meeting report. New York, December 19 2012.

²⁵ Ghana Statistical Service (GSS), Ghana Health Service (GHS) and Macro International (2009). Ghana Maternal Health Survey 2007 , GSS, GHS and Macro International, Maryland, USA.

²⁶ Stanton C, Hobcraft J, Hill K et al (2001). Every death counts: measurement of maternal mortality via a census. Bulletin of the World Health Organization 79(7):657–664.

²⁷ Hill K, Queiroz BL, Wong L et al (2009). Estimating pregnancy-related mortality from census data: experience in Latin America. Bulletin of the World Health Organization

87:288–295

²⁸ Obermeyer Z, Rajaratnam JK, Park CH et al (2010). Measuring adult mortality using sibling survival: a new analytical method and new results for 44 countries, 1974–2006. PLoS Medicine 7(4):e1000260. doi:10.1371/journal.pmed.1000260.

²⁹ Gakidou E and King G (2006). Death by survey: estimating adult mortality without selection bias from sibling survival data. Demography 43(3):569–585.

³⁰ Masquelier, B 20143 Adult mortality from sibling survival data: a reappraisal of selection biases. *Demography* 2013, vol. 50, issue 1, pages 207-22810/2012; DOI: 10.1007/s13524-012-0149

³¹ For instance, the Afghan Public Health Institute, Ministry of Public Health, Central Statistical Organization, ICF Macro, IIHMR India and WHO EMRO. Afghanistan mortality survey 2011. Calverton, Maryland. A special case is the post-census survey conducted in Mozambique. Mozambique National Institute of Statistics, US Census Bureau, MEASURE Evaluation, Centers for Disease Control and Prevention. Mortality in Mozambique: results from a 2007–2008 post census mortality survey. Chapel Hill, USA: MEASURE Evaluation.

³² de Savigny D et al. (2008). *Fixing Health Systems* (2nd ed.). Ottawa, International Development Research Centre, in collaboration with the Ministry of Health and Social Work, United Republic of Tanzania.

<http://idl-bnc.idrc.ca/dspace/bitstream/10625/35669/1/127528.pdf>

³³ Hill K et al. (2007) on behalf of the Monitoring of Vital Events (MoVE) writing group.. Who Counts? 3. Interim measures for meeting needs for health sector data: births, deaths, and causes of death. The Lancet, 370(9600):1726–1735. doi:10.1016/S0140-6736(07)61309-9.

- ³⁴ UN. Manual X: indirect techniques for demographic estimation. New York: United Nations, 1983.
- ³⁵ UN Statistical Division. 2010 World programme on population and housing censuses. New York: United Nations, 2007.
- ³⁶ UN Population Division. Methods for estimating adult mortality. ESA/P/WP.175. New York: United Nations, 2002.
- ³⁷ Hill K. Metodos para estimar la mortalidad adulta en los paises en desarrollo: Una revision comparativa. Notas Poblacion 2003; 76: 81–113.
- ³⁸ Brass W, Hill K. Estimating adult mortality from orphanhood. International Population Conference Liège: International Union for the Scientific Study of Population, 2007.
- ³⁹ Timæus I. Estimation of mortality from orphanhood in adulthood. Demography 1991; 28: 213–27.
- ⁴⁰ Blacker J. 1984, Experiences in the use of special mortality questions in multi-purpose surveys: the single-round approach, in Data Bases for Mortality Measurement. New York: United Nations, pp. 79–89
- ⁴¹ Hill K, El Arifeen S, Koenig M, Al Sabir A, Jamil K, Raggers H. How should we measure maternal mortality in the developing world? A comparison of household deaths and sibling history approaches. Bull World Health Organ 2006; 84: 173–80.
- ⁴² Stanton C, Hobcraft J, Hill K, et al. Every death counts: measurement of maternal mortality via a census. Bull World Health Organ 2001; 79: 657–64.
- ⁴³ Mozambique National Institute of Statistics, U.S. Census Bureau, MEASURE Evaluation, U.S. Centers for Disease Control and Prevention. 2012. Mortality in Mozambique: Results from a 2007–2008 Post-Census Mortality Survey. Chapel Hill, USA: MEASURE Evaluation.
- ⁴⁴ World Health Organization (2014) Using innovative approaches in the health sector to strengthen and modernize civil and vital statistics (CRVS) systems: guiding principles and good practices. Report of a technical meeting sponsored by the World Health Organization in collaboration with Canada, UNICEF, USAID and the World Bank Geneva, 17–18 December 2013
- ⁴⁵ Singh P, Sachs JD. 1 million community health workers in sub-Saharan Africa by 2015. *Lancet*. 2013; 382(9889):363–5
- ⁴⁶ Gadabu OJ, Manjomo RC, Mwakilama SG et al. (2014) An electronic register for vital registration in a rural village with no electricity in Malawi Public Health Action vol 4 no 3 <http://dx.doi.org/10.5588/pha.14.0015>
- ⁴⁷ The mHealth Compendium, MSH & USAID contains case studies that document a range of mHealth applications being implemented throughout Africa and, in some cases, in other regions.
<http://www.msh.org/sites/msh.org/files/2012-usaid-mhealth-compendium-web.pdf>
- ⁴⁸ World Health Organization (2010). International Statistical Classification of Diseases and Related Health Problems, 10th Revision. Geneva, World Health Organization.
- ⁴⁹ National Center for Health Statistics (2003). Physicians' Handbook on Medical Certification of Death. Hyattsville, United States Department of Health and Human Services. DHSS Publication No. (PHS) 2003–1108. Retrieved 22 August 2012 from: http://www.cdc.gov/nchs/data/misc/hb_cod.pdf
- ⁵⁰ World Health Organization (2010). Cause of Death on the Death Certificate in line with ICD-10: Quick reference guide. Geneva, World Health Organization. Retrieved 22 August 2012 from:
http://apps.who.int/classifications/apps/icd/icd10training/ICD-10%20Death%20Certificate/html/ICD-10_Resources/causeofdeathflyer.pdf

⁵¹ Australian Bureau of Statistics (2008). Cause of Death Certification: Australia, 2008. Information Paper, ABS Catalogue No. 1205.0.55.001. Retrieved 22 August 2012 from:

[http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/475BC02643DB45EDCA25750B000E38A4/\\$File/1205_055001_2008.pdf](http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/475BC02643DB45EDCA25750B000E38A4/$File/1205_055001_2008.pdf)

⁵² Rampatige R et al (2012) Handbook for doctors on cause-of-death certification. Health Information Systems Knowledge Hub, University of Queensland School of Population Health.

⁵³ IRIS – Automated coding system for cause of death – Version V4.0.38 (2011). Available for free download at: http://www.cepидc.vesinet.inserm.fr/inserm/html/IRIS/iris_project.htm

⁵⁴ World Health Organization. ICD-10 interactive self learning tool.

<http://apps.who.int/classifications/apps/icd/icd10training/>

⁵⁵ Moriyama IM, Loy RM, Robb-Smith AHT. History of the statistical classification of diseases and causes of death. Rosenberg HM, Hoyert DL, eds. Hyattsville, MD: National Center for Health Statistics. 2011.

⁵⁶ Becker R, Silvi J, Ma Fat D, L'Hours A, Laurenti R (2006) A method for deriving leading causes of death. Bulletin of the World Health Organization 2006;84:297-304. Accessed 20 May 2014
http://www.scielosp.org/scielo.php?pid=S004296862006000400014&script=sci_arttext&tlang=en

⁵⁷ World Health Organization & University of Queensland Health Information Systems Knowledge Hub (2010). Rapid assessment of national civil registration and vital statistics systems. Geneva, World Health Organization (WHO/IER/HIS/STM/2010.1). Retrieved 22 August 2012 from:

http://whqlibdoc.who.int/hq/2010/WHO_IER_HSI_STM_2010.1_eng.pdf – also available as an electronic spreadsheet allowing for the automated calculation of results at:
http://www.who.int/healthinfo/CRVS_electronic_final.xls

⁵⁸ Mikkelsen L (2010). Rapid assessment of vital statistics systems: evaluation of the application of the WHO/HIS Hub tool in 26 countries in the Asia-Pacific region. Working Paper No. 10. University of Queensland School of Population Health, Health Information Systems Knowledge Hub, Brisbane, Australia. Retrieved 22 August 2012 from: <http://www.uq.edu.au/hishub/all-publications>

⁵⁹ Institute for Health Metrics and Evaluation (2013). The Global Burden of Disease: Generating Evidence, Guiding Policy. ISBN 978-0-9840910-6-5 © 2013 Institute for Health Metrics and Evaluation, Seattle, WA.

⁶⁰ World Health Organization (2012). Verbal autopsy standards: Ascertaining and attributing causes of death. The 2012 WHO verbal autopsy instrument. Release Candidate 1. Geneva, World Health Organization.

⁶¹ <http://www.interva.net>

⁶² Lopez AD, et al. (eds.) (2011). Verbal autopsy: innovations, applications, opportunities – Improving cause of death measurement. A thematic series. *Population Health Metrics*, 9. Retrieved 22 August 2012 from: http://www.pophealthmetrics.com/series/verbal_autopsy