



Asia Pacific Observatory
on Health Systems and Policies

POLICY BRIEF

Strengthening vital statistics systems

What are the practical interventions necessary to reduce ignorance and uncertainty about causes of death and disease burden in the Asia Pacific region?





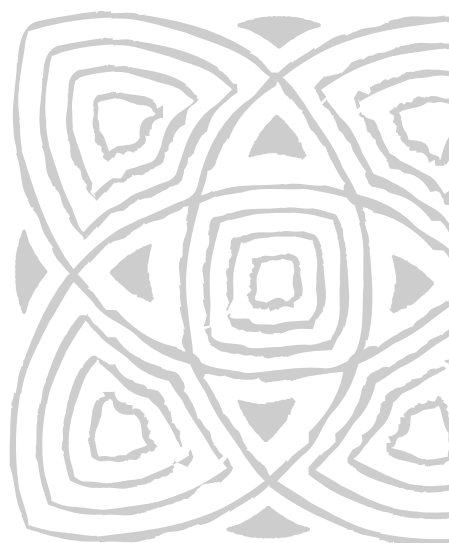
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Authorship and Acknowledgement

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Abbreviations

APO	Asia Pacific Observatory on Health Systems and Policies
AusAID	Australian Agency for International Development (former)
CCC	chance-corrected concordance
COD	cause of death
CRVS	civil registration and vital statistics (also known as vital registration)
CSMF	cause-specific mortality fraction
DHS	Demographic and Health Survey
DOA	dead on arrival
GBD	Global Burden of Disease
HDSS	Health and Demographic Surveillance System
HIS	health information system
HISHub	Health Information Systems Knowledge Hub
HMN	Health Metrics Network
ICD	International Statistical Classification of Diseases and Related Health Problems
INDEPTH	International Network for the Demographic Evaluation of Populations and their Health in Developing countries
MRD	medical records department
PCVA	physician-coded verbal autopsy
PHMRC	Population Health Metrics Research Consortium
SAVVY	sample vital registration with verbal autopsy
SPC	Secretariat of the Pacific Community
SRS	sample registration system



UN ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UQ	University of Queensland
VA	verbal autopsy
VS	vital statistics
VSPI	vital statistics performance index
WHO	World Health Organization
WHO-FIC	WHO Family of International Classifications



I. Policy Brief

“Better information. Better decisions. Better health.”

- Health Metrics Network

Why do we need to improve information about causes of death?

Reliable and timely mortality and cause of death (COD) data are essential for monitoring trends in diseases, injuries and risk factors, and critically important to guide good public policy and prevention. Such information is of particular relevance for the Asia Pacific region where populations are rapidly ageing and disease patterns are changing from communicable to noncommunicable conditions, but where health systems are taking time to adapt. The optimal method for generating good quality mortality data is through a well-functioning civil registration system which collects medically-certified COD information for all deaths. Recent assessments of national civil registration and vital statistics systems in the region have all confirmed weaknesses of these systems in many countries. A growing global awareness of the need for better vital statistics for achieving development goals has further helped create a positive policy environment for improving the region’s health information systems so that they deliver better data on causes of death. The recognition that disease patterns are changing rapidly in all countries and that we need a better understanding of current and emerging epidemiological transition in countries to more effectively allocate future health investments has contributed to the sense of urgency with regard to improving COD data in countries.

Some of the major challenges facing the Region in terms of improving knowledge about causes of death are as follows: a) lack of functioning systems that can register all deaths by age and sex; b) a large proportion of deaths occurring outside the medical system and hence with no medically-certified COD; c) systematic misdiagnosis of deaths occurring in hospitals and lack of national policies regarding the collection and use of hospital data; d) lack of awareness of interim, cost-effective substitutes for collecting COD information; e) lack of well-trained coders and medical records staff that understand the public health importance of COD data.

What can we do to reduce our ignorance and what are viable options to strengthen cause of death data systems?

A series of recommended key actions that can help overcome these challenges have been proposed in Part III of this report. Although country capacities, circumstances and starting points for system development vary enormously across the region, there are common actions which can be taken to dramatically improve knowledge about causes of death in a defined and strategic manner by groups of countries. Given the scope of the proposed measures, some of which go beyond the health sector, broad-based political support and a medium-term commitment to change will be necessary, as well as strong country leadership, strengthened analytical capacity, and to a lesser extent, financial and human resources.

Viable options for countries to rapidly improve information about leading causes of death in their populations, and how they are changing, are listed below according to the current state of civil registration and vital statistics (CRVS) system development of countries. Group 1 countries have poorly functioning CRVS systems and deserve special attention because they comprise some of the largest populations in the region with the most deaths. Group 2 countries also have weak civil registration systems but some have sample registration systems that collect COD data that are nationally representative. Finally, Group 3 consists of countries that have functioning systems able to collect COD data but continue to have problems with data quality.

This policy brief proposes a framework with a series of actions that are based on the literature and national experiences with intervention strategies according to the level of statistical development of a country. Three basic strategies are suggested:

Group 1 (countries with underdeveloped or dysfunctional systems that are unable to collect COD data)

- Strengthen mechanisms to record all deaths by age and sex through strengthened collaboration between health, justice and civil registration.
- Build up the civil registration infrastructure and train staff.
- Consider establishing a sample registration system with verbal autopsy to collect COD information.
- Introduce ICD certification and practices in hospitals and medical facilities.
- Improve medical recording practices in hospitals and health centres.
- Provide the necessary ICD training to medical staff and coders.

Group 2 (countries that already record most deaths but many without a medically-certified cause)

- Continue to improve the civil registration system so that it registers all deaths.
- Introduce verbal autopsy into the civil registration system for those deaths that are not medically certified.
- Use automated methods for processing verbal autopsies.
- Monitor the diagnostic quality of medical records and COD data.
- Provide the necessary training in verbal autopsy techniques and data verification and analysis.

Group 3 (countries that have functioning systems but with residual quality problems in their COD data)

- Identify the scope and extent of residual quality problems in the COD data.
- Use existing training tools for better medical certification and coding of death certificates.
- Carry out a medical records review of hospital COD data to verify accuracy.
- Implement data management policies in hospitals and health facilities.

For each of the three groups, we recommend a different development pathway consisting of strategic priorities and specific actions, as detailed in the accompanying working paper. Within each of the three proposed pathways for COD data development, each country will need to assess their own situation, decide on priorities and develop a feasible implementation plan with steps detailed for each priority and recommended action. Further explanation of the suggested actions/interventions can be found in sections

3 and 4 of the working paper that follows and in the referenced literature. The purpose of the working paper is to describe in detail what approaches and strategies might be adopted by countries to reduce ignorance about causes of death in the Asia Pacific region. We propose to do so by carefully looking at the different systems that produce data on causes of death and for each, we lay out some options and potential strategies that countries might follow to rapidly and cost-effectively improve the cause of death information that these systems produce. This in turn will greatly benefit country health planning by increasing critical knowledge about disease burden in the region and providing accurate information about how it is changing.



II. Working Paper

1. Introduction

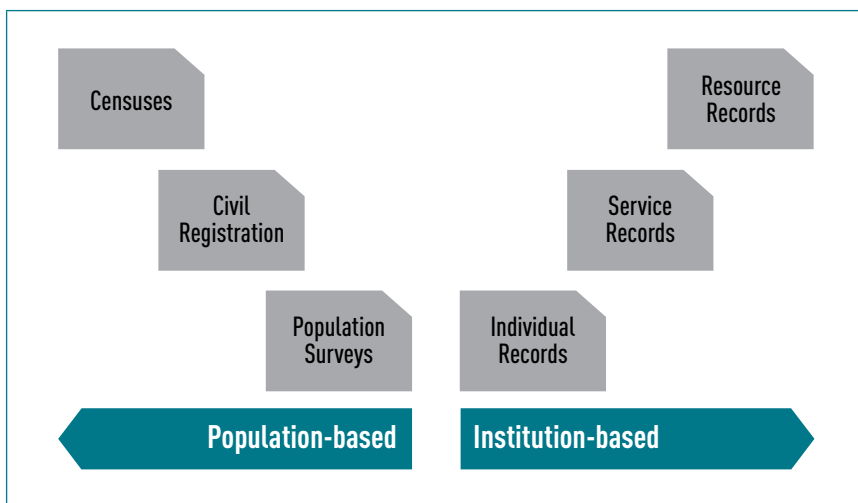
Access to timely evidence-based information on trends in diseases, injuries and risk factors, and on the performance of the health system, is crucial for policy-makers everywhere. In many of the 38 countries that make up the WHO South-East Asia and Western Pacific regions, health information systems (HIS) are unable to respond to demands for data to inform policy and research. Even the most fundamental information on the annual number, age, and sex of people who die is missing in many countries, and even fewer have data on what they died from. The reason for this lack of basic data is that many low and middle-income countries do not have adequate civil registration and vital statistics (CRVS) systems that cover the entire population, register and certify all births and deaths, and consolidate this information into vital statistics. Moreover, since the large majority of people in these countries do not die in hospitals but in the community, many deaths, even if registered, do not have a medically-certified cause, thus limiting their value for public policy.

Health systems are rarely static but are constantly having to respond to internal pressures and changes in their environments. This is very much the case in the Asia Pacific region where many countries are undergoing rapid demographic and epidemiological transitions and where the health sector is often struggling to achieve sustainable funding and deliver basic care. Politicians, policy-makers and public health professionals are increasingly faced with having to make complex choices and decisions, and therefore need an HIS that can provide answers and needed information. Both WHO and donors have invested considerable efforts and resources to strengthen HIS in the region and a number of APO countries have carried out assessments of their systems with the support of the Health Metrics Network (HMN). Few, however, have managed to implement the improvement plans that resulted.

The HMN Framework (1) for Health Information Systems divided data sources for health into two groups – population-based and institution-based

(Figure 1) – and was instrumental in highlighting that information critical to the management of health systems is not always generated by the health sector but relies on other population-based sources such as the census, civil registration, household and other population surveys, which generally are the responsibility of national statistics offices.

Figure 1: Health information data sources



Source: Health Metrics Network (2008)(1)

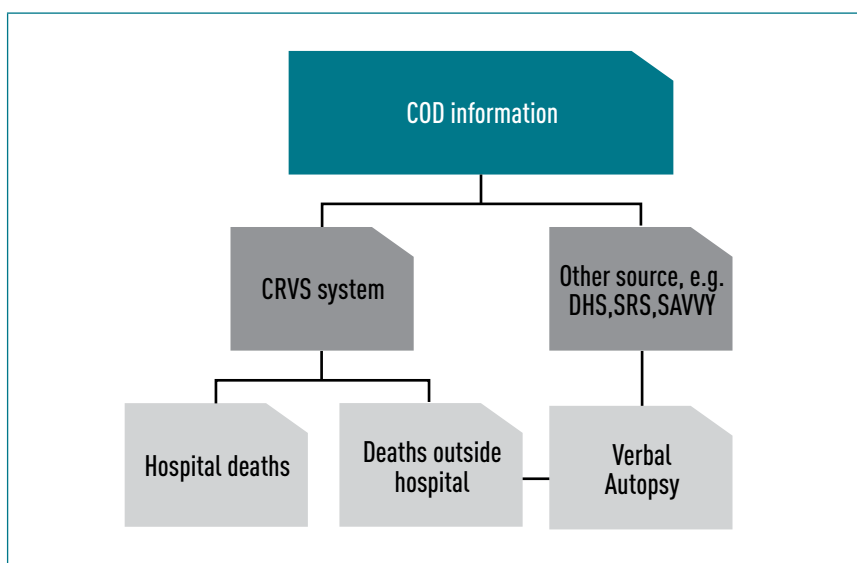
Civil registration, for instance, usually falls under the responsibility of the Ministry of Home Affairs or Justice, but because it is the only source of data that has universal coverage, in principle, it is a critical source for any HIS. Indeed, civil registration and the vital statistics that flow from it are often referred to as the “cornerstone” of a national HIS. The role of the health sector is to ensure the routine notification of vital events (births and deaths) that take place in a hospital or health centre and to certify the cause of each death, which physicians alone can reliably do. In countries where the coverage of civil registration is incomplete, the role of health institutions as informants is even more important in terms of ensuring that at least those deaths which take place under medical attention are recorded and reported to the civil registration authorities.

Vital events, and the characteristics collected on these, are key inputs for health planning, policy-making and disease prevention. For example, information on the number of live births, fetal deaths and pregnancies by age of mother constitutes the basis for maternal and child health planning. Data classified by various characteristics of the deceased, including sex, age and the cause of death, are crucial to inform public health policies and determine

population health challenges. Such data allow health analysts to monitor and evaluate disease and injury trends in the population and to evaluate the effectiveness of programmes to prevent premature deaths. Without appropriate vital statistics, the effectiveness of the health system is severely compromised, policy debates and health priorities are unsupported by evidence, and national and regional monitoring of health goals is impossible.

As stated above, the purpose of this working paper is to describe what actions and strategies countries might adopt to reduce ignorance about causes of death. We propose to do so by carefully looking at the different systems that produce data on causes of death (Figure 2). For each, we lay out some options and potential strategies that countries might follow to rapidly and cost-effectively improve the cause of death information that these systems produce. This in turn would greatly benefit national health planning and increase critical knowledge about disease burden in the region as well as provide accurate information about how it is changing.

Figure 2: Systems for generating cause of death statistics in populations



COD - Cause of Death, CRVS - civil registration and vital statistics, DHS - Demographic and Health Surveys, SRS - sample registration systems, SAVVY - sample vital registration with verbal autopsy.

Source: Asia Pacific Observatory on Health Systems and Policies

Cause of death information in most countries is generated from the CRVS system. When these systems are too incomplete or otherwise dysfunctional, some useful information on births and deaths can be obtained from sources such as Demographic and Health Surveys (DHS), health and demographic

surveillance systems (HDSS), sample registration systems (SRS) or sample vital registration with verbal autopsy (SAVVY). These data sources are often referred to as “interim substitutes” and are primarily recommended for use to generate essential policy-relevant information on births and deaths while civil registration systems are being established. (2)

In all of these interim data collection systems, cause of death information can be obtained by using an indirect method known as “verbal autopsy” (VA) which involves interviewing the family of the deceased to gather information on the signs and symptoms experienced by the deceased, from which the cause of death can be determined by a medical doctor. A number of countries in Africa have run HDSS sites on sentinel populations and, if combined with VA, have been able to generate information on mortality patterns in certain subregions. Some countries such as India and China have successfully used these methods in nationally representative samples of their populations to gather information on causes of deaths.

A rapid overview of the strengths and limitations of these various approaches to collecting mortality data can be obtained from Table 1.

Table 1: Comparison of different vital statistics sources

	Level of estimate	Civil registration system	Demographic surveillance sites	Sample registration systems	Population censuses	Household sample surveys
Births	National	Yes	No	Yes	Maybe*	Yes
	Differentials	Yes	Limited	Limited	Maybe*	Limited
Child mortality	National	Yes	No	Yes	Yes †	Yes
	Differentials	Yes	Limited	Limited	Yes †	Limited
Adult mortality	National	Yes	No	Yes	Maybe *‡	Weak ¶
	Differentials	Yes	Limited	Limited	Perhaps *‡	No
Cause of death	All	Yes	Yes §	Yes §	Maybe §	Yes §**

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

† For a recent period by indirect methods.

‡ For an intercensal period.

¶ Methods for measuring parental survival or sibling history.

§ With verbal autopsy.

** For child deaths identified by a full birth history.

Source: Hill K, et al. (3)

Information on deaths registered by civil registration comes from two sources: deaths which take place in hospitals or under coronial supervision and where the family brings the medical death certificate to the civil registration office to officially register the deceased; and those which take place outside medical facilities, generally without medical attention. These latter cases

generally have no valid death certificate certified by a medical practitioner, and hence only by using VA is it possible to get a better understanding of what these people died from.

The first part of the paper provides an overview of the state of the region's vital statistics systems and stresses the need for the health sector to take an active role in their improvement. The second part of the paper focuses on measures to improve the quality of the data already collected by the health sector (left hand panel of Figure 2). The third section introduces VA methods and discusses how to use this approach to provide useful information on what people die from when the death occurs outside a medical setting. We conclude by providing specific recommendations and strategies for countries to follow – according to their specific systems and abilities – that are feasible, cost-effective and necessary to increase the knowledge base about causes of death in populations, information that is essential for informed policy and planning.



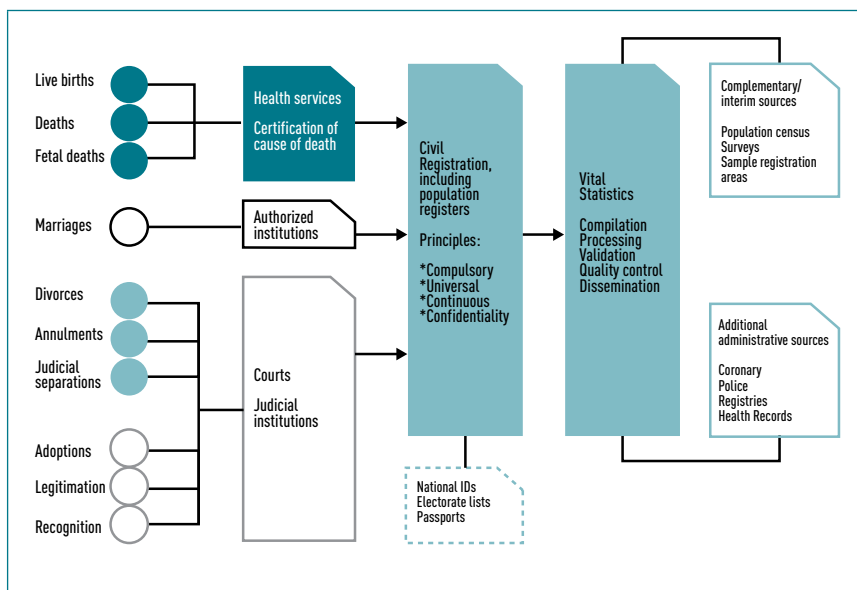
2. Improving vital statistics systems

What does a vital statistics (VS) system consist of? The United Nations defines the components that make up the VS system as those shown in Figure 3 and refers to them as constituting “a system of interacting or independent components forming an integrating whole”(4). The figure shows the critical role played by the health system in the reporting of live births, deaths and fetal deaths and in certifying the cause of death. This information is then reported to the civil registration system, either through individuals, who use the death certificate to register deaths that occur in their families, or through direct reporting from the health sector to the civil registration office. Deaths recorded by the police and the coroner should also be included to obtain an integrated, national annual compilation of births and deaths from civil registration systems. At the same time that the events are legally registered, the civil registration authorities collect critical policy-relevant information pertaining to the events such as age at death, age of the mother and usual residence. This information is then extracted and transmitted to another agency such as the national statistics office for compilation and dissemination of the vital statistics themselves.

Vital statistics systems globally

The 2007 Lancet series “WHO counts?” drew attention to the “scandal of invisibility” by which the poorest and most vulnerable people in society are typically born and die without their existence ever being registered (5). It called the lack of investment to improve vital statistics “the single most critical development failure over the past 30 years” (6). After this long period where vital statistics systems were largely ignored, the Millennium Development Goals, eight of which depend heavily on vital statistics, have helped to highlight the importance of registration systems as a core component of strong national health strategies. More recently, in 2011, the Secretary-General’s Commission on Information and Accountability for Women’s and Children’s Health further highlighted the critical role that death

Figure 3: General structure of a vital statistics system



Source: United Nations, Principles and Recommendations for a Vital Statistics System, Revision 3, 2013.

registration plays in monitoring infant, child and maternal mortality(7, 8). This has all contributed to a growing awareness and momentum for improving vital statistics systems in low and middle-income countries and has provided a critical and timely opportunity to finally overcome decades of stagnation.

Countries in the Asia Pacific Region, through the regional strategic plans and activities of the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) and the Secretariat of the Pacific Community (SPC), are now making principled long-term commitments to develop comprehensive vital statistics systems (9, 10). This has resulted in increased demand for guidance, technical support, solutions and resources for vital registration systems from a large number of countries. In response, the Health Information Systems Knowledge Hub (HISHub) at the University of Queensland, under an AusAID-funded project and in partnership with WHO and the Health Metrics Network, developed a series of tools and knowledge products to assist countries in diagnosing the strengths and weaknesses of their current CRVS systems and proposed a framework for countries to improve these. More details about this set of tools and technical guidance materials can be found at the following address: <http://www.uq.edu.au/hishub/publication-tools>.

The collection of tools consists of a Rapid Assessment Framework and a Comprehensive Assessment Framework for evaluating the state of national registration systems and their outputs (11), guidance about how to prepare a strategic and prioritized improvement plan (12), and a CRVS resource kit (3) which provides detailed guidance about how to strengthen CRVS systems and how to solve specific problems that might be encountered. Several tools specifically focus on mortality and COD evaluation such as a handbook for doctors on COD certification (13), how to properly document medical records (14) and how to evaluate the quality of mortality and COD data (15, 16), among others. Many countries in Asia, the Pacific and Africa have applied these tools in collaboration with international agencies and partners.

Before focusing in on the state of vital statistics systems in the Asia Pacific region, it is useful to briefly review the global picture of CRVS systems development in order to identify regional patterns and evaluate regional strengths. An overview of the global situation of vital statistics can be found in Philips et. al. (17) The metric used to appraise and classify countries CRVS systems is a new composite indicator called the Vital Statistics Performance Index (VSPI), which evaluates systems based on the quality of their mortality output, as well as how complete, timely and available the data are (17). The VSPI measures vital statistics (VS) performance on a continuous scale using six empirical indicators: completeness of death reporting, quality of COD data, level of detail of COD data, diagnostic validity, demographic characteristics, and availability and timeliness of data (Box 1).

Box 1: Key dimensions to assess the performance of a civil registration and vital statistics system

Completeness of death reporting

A key characteristic of a CRVS system is the extent to which it covers the entire population and manages to register all births and deaths, known as “registration completeness”. Completeness for adult deaths is measured by comparing successive census enumerations of the age structure of a population, with registered numbers of deaths at different ages (18). Completeness of death registration for children was estimated from a comparison with child mortality levels calculated from censuses and surveys. The completeness estimates used for the VSPI were generated by a combination of the two.

Box 1: Key dimensions to assess the performance of a civil registration and vital statistics system (cont.)

Quality of cause of death reporting

If data are to be used for public health policy, accurate and consistent recording of the cause of death is imperative. The index uses the concept of "garbage coding" from the Global Burden of Disease (GBD) lexicon to capture the likely extent of poor quality diagnoses in vital statistics (19). Garbage codes can range from reporting of the immediate cause of death, such as heart failure instead of the underlying cause, to vague and ill-defined symptoms such as fever. It also includes a large number of residual categories within broad disease or injury categories (e.g. ill-defined sites of cancer) as well as the broad category of ill-defined or unspecified causes of death (R codes in ICD-10) (20, 21). Garbage codes have been further categorized as either entirely meaningless (such as ill-defined causes) or somewhat meaningful (such as malignant neoplasm of unspecified site), and the overall proportion of all garbage-coded deaths was adjusted in the index to account for the proportion of each (17).

Level of detail of cause of death

A key expectation of a CRVS system is that it provides cause-specific information that is sufficiently detailed to meet the needs of most public health purposes. The indicator used for this component measures the number of separate diagnostic categories that were available to classify causes of death compared to the GBD (235 cause list) (44), chosen as the reference standard.

Diagnostic validity

A principle concern in monitoring quality of COD data is the extent to which the reported causes are biologically implausible; for example, females with prostate cancer or elderly people with neonatal conditions. A list of logically impossible combinations of these fields was developed and the proportion of all deaths which violated these restrictions was used as a measure of diagnostic validity (17). Many of these cases are obviously due to errors in data entry.

....continued on next page

Box 1: Key dimensions to assess the performance of a civil registration and vital statistics system (cont.)

Demographic characteristics

Additional critical data from a death certificate relate to the demographic information about the deceased. Knowing the age and sex of the deceased vastly increases the utility of CRVS data as they inform enumeration of the population, complement epidemiological information and can help guide policy decisions.

Availability and timeliness of data

A final and often overlooked dimension of the CRVS performance framework is public availability of data. Although it might be argued that more recent years of data or a wider spread of data years might be of greater relevance for current policy debates, there is no sound theoretical basis to determine optimal reporting patterns. However, it is likely that the previous year's data will have relevance for current epidemiological estimates. Hence the need to simultaneously measure availability and timeliness of data. An exponential smoothing algorithm is applied to the combined values of the other five indicators in order to incorporate a measure of a system's performance to continuously yield vital statistics. Less weight is given to years further in the past to emphasize the important role of current VS data to approximate current epidemiological patterns (17).

These indicators capture distinct dimensions of the strengths and weaknesses of a CRVS system and are combined in a weighted fashion according to an empirical simulation procedure; the calculation of the VSPI has been extensively described elsewhere (17). The VSPI is computed on a continuous scale from zero to one for each country-year; a VSPI value of one denotes that the available data from a given country-year perfectly represent the epidemiological profile of its source population. A value of zero implies the converse, i.e. that the data are entirely unrepresentative of a country's epidemiological conditions, as assessed by the cause of death pattern.

Vital statistics systems performance in the Asia Pacific region

The Asia Pacific countries included in this review include the WHO regions of South-East Asia (11 countries) and the Western Pacific (27 countries), henceforth referred to as APO countries. This group of countries is very diverse, comprising some of the world's biggest and smallest countries, as well as the least developed and most rapidly emerging economies. Among them are some highly developed countries such as Australia, Japan, New Zealand, the Republic of Korea and Singapore which have had complete vital registration for decades and, in some cases, centuries. However, the mortality information collected in many of the other countries in the region is too incomplete and unreliable to be used for planning purposes. Consequently, the availability of reliable mortality statistics in the region is highly variable with the result that the evidence base to effectively inform health policies and health programmes is weak.

The evaluation of vital registration systems within the APO region was done using the VSPI metric described in Box 1. Table 2 classifies the 38 APO countries into groups according to what is known about their available mortality data using the same classification as for the global analysis. Some sixteen APO countries do not seem to compile mortality data, or at least do not make this information publicly available, and as a result we have not been able to include them in the analysis and calculate a score for their systems (Table 2). For these countries, the information available on COD is likely to be extremely limited and usually based on modelled data from incomplete hospital information which represents a very small fraction of all deaths (most occur in the community). Some of the countries listed, such as Cambodia and the Lao People's Democratic Republic, are only beginning to introduce the International Statistical Classification of Diseases and Related Health Problems (ICD) (21) into their hospitals, and do not currently compile hospital data to generate vital statistics for policy use.

Since we are interested in evaluating the potential strength of a country's VS system, and the VSPI metric is calculated on annual data, we opted to use the best year (in terms of the VSPI score) rather than the most recent year since 2005 for the 22 countries for which data were available. Table 2 shows the countries arranged in descending order according to their best VSPI score, and classified into five groups according to the overall performance of their system.

Further insights into which quality components of the CRVS systems were performing poorly or functioning well can be obtained from Philips et. al. (17) who show country performance over the period 1980 to the most recent year

for which data were available (up to 2012). These very detailed figures provide useful insight into CRVS progress in specific countries and allow us to understand which components were responsible for the improvement (or decline) in CRVS system performance.

Table 2: Evaluation of the mortality output of vital statistics systems in APO countries

Countries	Best ¹ year	VSPI score	Countries without data to calculate VSPI scores
New Zealand	2007	0.94	Cambodia Cook Islands Democratic People's Republic of Korea Indonesia Lao People's Democratic Republic Micronesia (Federated States of) Nauru Nepal Niue Palau Samoa Solomon Islands Tokelau Tuvalu Vanuatu Viet Nam
Australia	2005	0.92	
Japan	2005	0.88	
Republic of Korea	2011	0.87	
Singapore	2005	0.79	
Malaysia	2008	0.75	
Philippines	2005	0.64	
Thailand	2007	0.57	
Maldives	2011	0.52	
Brunei Darussalam	2011	0.40	
Sri Lanka	2006	0.36	
Fiji	2011	0.30	
China	2012	0.25	
Kiribati	2005	0.18	
Mongolia	2010	0.15	
Tonga	2005	0.10	
Bhutan	2005	0.06	
India	2006	0.05	
Marshall Islands	2006	0.03	
Myanmar	2006	0.02	
Bangladesh	2005	0.00	
Papua New Guinea	2005	0.00	

Classification of countries based on VSPI	
<0.25	Very weak
0.25-0.49	Weak
0.50-0.69	Medium
0.70-0.84	Good
0.85+	Very good
	No data

VSPI - vitals statistics performance index

¹ Refers to the year with the highest VSPI score for the period since 2005.

Source: Global Burden of Disease database

Only four countries (Australia, Japan, New Zealand and Republic of Korea) in the region had VSPI scores sufficiently high (>0.85) to be considered as having satisfactory systems. Singapore and Malaysia have well-functioning systems (VSPI 0.70-0.85), but Malaysia has problems with the quality of its COD data (22, 23), while Singapore scores lower than expected because it disseminates data with a shortened ICD list. Maldives, Philippines and Thailand all have

systems that are operational (VSPI 0.50-0.69) and register the large majority of events, but all have problems with ensuring acceptable quality of their COD data and with fully registering certain minority populations. The Philippines also uses a less detailed COD list that limits the utility of the data. Countries in the next category consisting of Brunei, China, Fiji and Sri Lanka have civil registration systems that are clearly weaker, and based on their VSPI scores between 0.25 and 0.49, have systems that are evolving. In Sri Lanka, the CRVS system has long since been efficient in registering deaths, but for most of those who die outside of hospitals, the COD is not medically certified. The particular form the registrars use to obtain a COD, when none is reported, asks relatives to choose between a very limited number of causes. As a result, a high proportion of deaths are coded as ill-defined, with the result that the information about their cause is of very little value for public policy. In Fiji, although the CRVS system manages to record most deaths, the country has only recently begun to compile and publish COD data, hence its low score on availability. In China, on the other hand, COD data are available since the 1990s but only about one third of all deaths are registered.

The hospital data available from Kiribati, Marshall Islands and Tonga do not cover all deaths, are of poor quality and not produced or disseminated regularly, and all use a shortened ICD list of causes. Mongolia appears to have data of reasonable completeness and quality, but does not often make them available and uses an abridged ICD list. Bhutan has only recently begun to provide data for a handful of causes but registers less than one fifth of deaths with a cause, and often without indicating age or sex of the decedent. India has made remarkable progress in registration completeness, increasing from 52% in 2001 to 67% in 2010, and with five of the 19 major States now considered to register more than 90% of deaths (24). For causes of death, however, the only publicly available information for India is from hospitals which represent less than one sixth of all deaths. The low VSPI based on this information is also strongly influenced by a short COD list and poor availability (17). For countries such as Bangladesh, Myanmar and Papua New Guinea, there are no COD data publicly available and the limited hospital data which have been reported are not representative of the mortality and disease patterns in those countries.

Although death registration is a legal requirement in most countries in the region, the law is frequently not implemented and many people are either not aware of it or do not feel the need to register deaths. Moreover, registration facilities are usually located in urban areas only while the majority of people live and die in rural areas with little contact with the health system. Civil registration offices outside major cities are often poorly equipped to store, share and disseminate data. As a result, our knowledge about causes of death

in these countries is very limited, often to a handful of causes, at times with only maternal deaths shown separately.

Between 2010 and 2012, most countries in the Asia Pacific region carried out rapid assessments of their CRVS systems as part of a regional strategy to improve civil and vital registration in Asia and the Pacific (22, 23). This broader assessment covered not only the outputs of the registration systems but also the inputs and processes of the systems. The WHO and the University of Queensland (UQ) Rapid Assessment Tool (11) was used for these assessments, which allows results to be compared. The tool uses 25 questions covering 11 broad areas that are all discussed and scored by the national stakeholders in a group exercise. Each assessment question is scored on a scale from 0 to 3 and the sum of the individual scores is converted into a percentage to generate the overall Rapid Assessment score. Given the differences in scope between the Rapid Assessment and the VSPI and the fact that the Rapid Assessment score is arrived at through self-assessment, it cannot be attributed the same precision and reliability as the VSPI. The wide range for the Rapid Assessment scores (from 11 to 96%) confirms the large variation in maturity and performance of vital registration systems in the Asia Pacific region.

Vital statistics improvement strategies for APO countries

The mix of specific improvement tasks is likely to depend on the overall strength of systems and component weaknesses, which vary greatly between countries (17, 22). Hence there is no single prescribed pathway that can be taken to achieve the goal of an effective vital registration system. However, the standards of a well-functioning system that produce reliable mortality information are well described in the WHO and UQ resource kit (2), and there are tested strategies for different groups of countries which can serve as models. The series of tools described earlier in this working paper were specifically created to assist low- and middle-income countries by providing instruction about best current practice and detailed, specific strategic options for countries to help them strengthen their vital registration systems.

The resource kit, for example, outlines key improvement actions for four different types of CRVS systems (dysfunctional, weak, functional and satisfactory) and presents a generic improvement pathway for each type (2). While the role of each stakeholder is not precisely defined in each model pathway, it is clear from the specific actions that the health sector is accorded a major role. For instance, countries with underdeveloped or *dysfunctional* systems with death registration typically limited to urban areas are

recommended to focus on awareness-raising and improved facilities for registration, and to use verbal autopsy (VA) to obtain knowledge about causes of death at the population level. Health facilities and health staff, who often are among the first point of contact when births and deaths occur in families, have a critical role to play in awareness-raising and promotion of birth and death registration. Many hospitals already assist relatives in the registration process and some have an in-house registration facility. Those countries which have *weak* systems are advised to review all aspects of their current system to identify ways to quickly raise the coverage and completeness of death registration in their systems. For some, this may mean introducing sample registration to generate nationally representative data as an interim strategy. They are further advised to evaluate their hospital policies for the collection and compilation of data for statistical use, and to make sure that these policies also cover private hospitals that often do not supply any data at all to the health information or registration systems. The introduction and use of VA questionnaires and methods for collecting COD data is also recommended, for which local medical expertise is likely to be needed to ensure successful implementation. Countries with *functional* systems are recommended to concentrate on improving the quality of their mortality data. This can be done through better certification practices, training of medical staff, and ensuring computerization of the data and automated coding processes. Finally those with mostly *satisfactory* systems are advised to introduce quality control and feedback mechanisms to ensure that the data are correct and used to their full potential. As the major user of the COD data, it is clearly in the interest of the health sector to collaborate on system strengthening in order to derive maximum benefit from routine data collection systems and the often substantial investments that they entail.

The four pathways suggested by the WHO and UQ resource kit to improve national registration systems are generic plans, and circumstances and capacities vary even among countries classified in the same group. It is therefore important that those countries which have not already done so, undertake as a first step a comprehensive assessment of their existing registration and mortality reporting systems in order to collectively agree on the core elements of a prioritized improvement strategy covering all key aspects of the system. Such an assessment will provide the evidence for selecting the specific improvement actions that are most urgent, feasible, cost-effective and useful, and is likely to strengthen the case for donor support for the plan.

In sections 3 and 4 of the paper, we discuss and propose some specific contributions that the health sector can make to improve vital registration systems in the region, through strengthening COD data in countries with

weaker systems. Fully functioning systems are not overnight creations and need cooperation from many players outside the system, including the willingness of people to report births and deaths, and of doctors, midwives and hospitals to prepare notifications and accurate certification of births and deaths. It is not enough merely to pass a law that makes it obligatory to report births and deaths and to medically certify causes of death; countries have to invest in targeted information campaigns and provide incentives for registering events.

The health sector as provider of essential services to all members of society is well-placed to promote registration through its interaction with parents of newborns and relatives of the deceased. While systems are being built and registration coverage expanded, information on child deaths and maternal mortality, in particular, will still need to be collected for some time through surveys or sample registration systems, typically covering 1–2% of the population only. These and other actions – which only the health sector can effectively execute and which will significantly improve our knowledge about disease burden in Asia Pacific countries – are discussed below according to whether deaths occur in hospitals or not.



3. Improving hospital statistics

Introduction

The preceding analysis of the performance of vital statistics systems in the Asia Pacific region has clearly demonstrated several problems with country health information systems. For roughly half of the APO countries, we know very little about levels, trends and causes of adult mortality. Our knowledge about these countries' disease pattern is entirely derived from estimates with vast margins of uncertainty as they are mostly based on incomplete hospital data or, when that is not available, on data from other countries that are judged to have similar epidemiological profiles (44). Whatever data we currently have for these countries suggest that mortality levels, although falling, remain unacceptably high. To reduce risk factor exposure and lower mortality rates among adults for major chronic diseases and injuries, more and better quality data are urgently needed to inform strategies and programmes. In this section we focus on what should be a reliable and readily available data source for countries on COD patterns in their populations, namely data about the causes of the deaths that occur in hospitals. But are these data reliable? Are they accurate? What are some improvements that countries can make to derive maximum benefit from the hospital data they already collect at often considerable expense?

All hospitals regardless of the setting, as a by-product of patient's care, collect some information for clinical care, administration and management purposes. While most of the data collected are used for clinical care and understanding and responding to service demand, they also serve to generate morbidity and mortality statistics. For the purposes of this paper, we discuss only hospital data that are used for compiling mortality statistics, including causes of death. In each hospital, information contained in the medical records is generally used to derive monthly/annual statistics useful for the administration of each hospital and for national statistics. The type and extent of data collected varies from country to country and is usually decided nationally by the Ministry of Health.

The more common disease-related statistics routinely collected include the incidence of main diseases treated, procedures performed, and a series of mortality statistics such as: total deaths in hospital; maternal deaths; fetal deaths; and the cause of each of these deaths (all by age and sex). The utility of these hospital mortality statistics is closely related to how complete and accurate they are. For instance, do they cover all health institutions, i.e. private and public hospitals? Are there good reporting mechanisms from the hospitals to the Ministry of Health and is the reporting regular and timely? Are deaths from unintentional injuries which might be the responsibility of the police or coronial systems integrated into the hospital statistics when preparing tables? Regarding accuracy, do the hospitals have clear reporting procedures and standard forms for reliably determining the cause of a hospital death, and do medical staff abide by these? Are the patient records of sufficient quality to be of use to doctors to assist them in diagnosing the COD when the certifier is not the treating physician? Do doctors generally certify correctly? Are coders well trained and able to code correctly? Is there a quality assurance system in place? These and other related questions should be carefully investigated when carrying out a hospital mortality data review. The following discussion identifies some common problems and effective solutions in the form of best practices that countries can implement to improve the quality, quantity and utility of their hospital statistics on causes of death.

Collection and compilation of hospital data

Medical records from hospitals and other health facilities are a primary source of data for compiling health statistics. The collection of raw data for such statistics is an important function of the medical records department (MRD) and its staff. The data collection policy of the Ministry of Health, as well as hospitals' own information needs, which are related to the services offered, determine the type and extent of statistics collected. As the need for information on specific diseases is likely to change over time, the data collected should be regularly reviewed to ensure that they correspond to current requirements. To enable the COD data from hospitals to be nationally compiled, it is important that all MRDs use the same definitions for medical terms and that the statistics comply with standard definitions. This should be done by creating a national health data dictionary. By using WHO and ICD definitions for the collected statistics, hospital mortality patterns can be compared with other countries to benefit and benchmark national practices.

Usually the hospital, upon discharge, transfer or death of a patient, sends all relevant patient records to the MRD so that a discharge note/death certificate and a daily discharge list can be prepared. These are used for

generating hospital inpatient statistics and some hospitals also maintain a death register of all patients who died in the hospital. This is often shared with the civil registration office. The medical certificate of cause of death is usually required by the family for the official registration of the deceased and sometimes to enable the body to be buried or cremated. This form in some countries is referred to as the 'death notification form' and is given to relatives for different administrative purposes. Sometimes families confuse it with the official death certificate that only the Civil Registrar can deliver, and thus never register the death. As shown in the previous section, in many countries only a small proportion of total deaths are officially registered, and even those who die in medical settings are not always part of the records of the Civil Registrar. Hence the importance of collecting and incorporating hospital data as an important source of mortality statistics.

People who die outside hospitals may still have their death registered if they are brought dead to the hospital. This specific group are often referred to as "dead on arrival" or DOAs, and are generally treated as outpatients and not considered as a death occurring in the hospital. In some countries they are referred to the police or coroner to shed further light on the cause of death. Whatever the national policy and procedures for such cases, it is important that they are reported and integrated into the national mortality data for analysis and policy use, and that every effort is made to reliably certify their COD, even if this means carrying out a VA with the closest relative, where known.

In some countries, an important category of deaths are those who die at home but have been attended by a local physician (e.g., General Practitioner). These deaths should be registered and certified by the attending physician who will generally be sufficiently familiar with the patient's medical history to provide an accurate medical certificate of cause of death. While not, strictly speaking, hospital deaths, this information, which is generally available but may not be systematically incorporated into the cause of death statistics of a country, is likely to be of greater use for policy than verbal autopsy carried out on home deaths for which contact with a doctor prior to death was rare.

Each country, according to their capabilities, can take a number of steps to improve the collection and use of hospital mortality data. Box 2 outlines some key improvement actions likely to be relevant to many APO countries that will lead to better hospital mortality data for the national HIS.

Box 2: Key actions for improving data collection on deaths and causes of deaths in hospitals

- Define/revise national minimal data set to be collected by all hospitals for the HIS.
- Ensure that global standards and definitions are used for data definitions.
- Revise legislation (if necessary) to make the reporting of deaths obligatory for private medical facilities.
- Revise/set up reporting structures for the effective provision of data to the national HIS.
- Strengthen the HIS unit in the Ministry of Health in the analysis and interpretation of mortality data.
- Ensure that the data collected are analysed and disseminated in useful formats.
- After analysis, feedback reports should be sent to the data providers.

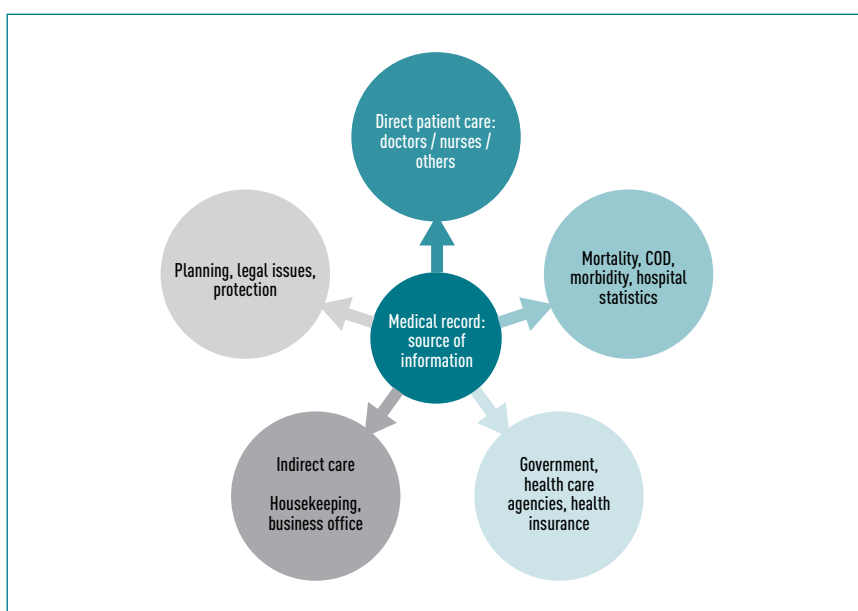
Medical records

Medical/health records form an essential part of a patient's present and future health care and are also used in the management and planning of service provision (25, 26) (see Figure 4). The quality of information contained in hospital records has received increasing attention in recent years not only to promote better health care and statistics, but also because an increasing number of countries are now funding their hospitals based on what is reported in the medical records data (27, 28, 29, 30). This is also referred to as "activity-based funding" or "case mix" funding and is based on the mix of patients treated. , Many countries now practice this funding model in their hospitals and in this connection have introduced some quality assurance procedures in their MRD, for instance, the use of checklists/audits across departments that are recorded and monitored by the MRD (31). This process has led to an improvement in reporting and has also had a positive impact on the quality of the statistical data.

The reality, however, for many countries in the region is that hospitals and health facilities have weak or dysfunctional MRD, resulting in poor health documentation/statistics, poor coding, poor access to the records, and large backlogs of records waiting to be coded and filed. The reasons why many MRD are unable to function as intended are usually related to lack of

proper policies and procedures, inadequate infrastructure and resources, and poorly trained staff. Countries should have national policies for medical records and these should clearly outline what data hospitals need to collect for their own, or national, statistical purposes. While hospitals might differ in the way they organize their MRD, they still need to ensure that both national and hospital-specific policies and procedures are strictly followed and that data are compiled according to standard formats. Having a strong and well-functioning MRD is part of the solution for improving the critical information base to support both health policy and health care programmes.

Figure 4: Uses of information recorded in patient records



COD - cause of death

Source: Adapted from WHO, Medical Records Manual: A Guide for Developing Countries, 2006 (25)

The quality of medical records is usually judged by their availability, legibility, adequacy and accountability (14, 25, 26). However, even without undertaking a comprehensive evaluation, it is possible to obtain some indication of the overall state of records and functionality of a MRD by investigating issues such as:

- Are medical records filed promptly or is there a backlog of medical records?
- Is there a master patients' index? How easy is it to retrieve files from this source?

- What is the typical time lag for completing a patient's medical record after discharge or death?
- Are all items from a sample of records coded correctly?
- Are all items in the record legible?
- Are there written procedures for the handling of medical records?
- Do staff in clinical services have a clear understanding of what documentation is required?

Medical records can be paper-based or electronic. As more and more hospitals move towards automation of their records it is important to keep in mind that the effectiveness and efficiency of the MRD will only improve if there are functioning procedures in place. The development and implementation of suitable computer applications will require detailed planning and a careful mapping of the existing manual system to define data needs and flows.

The process of computerization usually starts at the master patient index and/or admission and discharge lists. The move to a completely paperless environment, where all medical records are computerized, is more complex and a far bigger undertaking. What some countries refer to as "electronic records" are in fact records that have only been scanned rather than computerized. Despite considerable progress in computerization of medical records, very few countries have yet reached the ultimate goal of having electronic longitudinal health records with entries, and access, from multiple providers in different sites. While there is little doubt that introducing electronic applications into the hospital management system leads to increased efficiency and data quality, it is less clear what the gains might be in terms of time for health staff. For many health care professionals, who are under pressure to provide maximum services at minimum cost, documentation is not always a high priority. This is especially relevant for, but not limited to, developing country settings.

As a primary source of data, improving the quality of medical records is the first step towards improved mortality statistics and health information. To facilitate this task, a medical records committee with representatives of the different clinical services should be established in each hospital to stimulate interest and understanding of the importance of high standards of medical records and awareness of their public health uses. This committee should deal with all matters including a review of medical records and ensure that medical staff comply with existing policies and procedures.

Irrespective of whether the system is paper-based or electronic, clear procedures and an understanding of the requirements of the hospital

information system by medical officers, nurses and other health care professionals are crucial to good medical records. Box 3 lists some specific steps that can be taken to improve medical record keeping in hospitals.

Box 3: Key actions to improve medical record keeping in hospitals

- Establish a medical records committee in each hospital with membership from other departments and clinical services.
- Undertake a comprehensive review of current standards, procedures and policies regarding medical records.
- Develop a policy and procedure manual for medical records departments.
- Review patient forms used from admission to discharge to ensure that they are fit for the intended purpose.
- Employ sufficient and trained staff to meet the needs of the medical records department.
- Provide adequate training to medical records staff in compiling and coding the statistical items and offer appropriate career incentives.
- Educate relevant hospital staff on the importance of timely and accurate documentation of patient care data, emphasizing why it is important and the consequences of poor data quality.
- Introduce routine quality assurance to systematically check data accuracy, validity, reliability, legibility, and completeness of medical records.
- Introduce computerized applications into the medical records department.

Hospital certification of causes of death

It is generally assumed that hospitals accurately certify causes of death. But this is not necessarily the case (32, 33, 34). The quality of hospital death certification largely depends on how accurately doctors can diagnose the diseases and conditions present in their patients and how well they understand the concept of the underlying cause of the patient's death. How well the patient-related information is documented in medical records will also influence the accuracy of death certification, as physicians almost always need to consult the medical records to determine or confirm the underlying cause and sequence of events that led to death. It is strongly recommended

that doctors in hospitals always use the WHO International Form of Medical Certificate of Cause of Death which is designed to help doctors correctly report the sequence and duration of causes and conditions that led to a person's death, and to select the underlying cause (13, 21). If countries do not use the international death certificate form, it is highly unlikely that the underlying cause of death will be correctly reported, and hence valuable information for guiding prevention and treatment policies will have been lost.

Deaths certified by physicians are implicitly assumed to be reliable, yet accuracy depends on many factors, including training in correct death certification practices. To periodically evaluate the quality of hospital medical certification, a method known as "medical record review" can be used to investigate the reliability of hospital cause of death data. This method requires a "gold standard" against which the hospital COD reports can be compared. Autopsy would be the ideal such gold standard for validation, but it is not a practical option in most cases (35). Instead, researchers have used medical records as a reference standard for validating the accuracy of the underlying COD as reported from hospitals (34). Although all hospitals would likely have medical records, they are rarely used for periodic, routine assessments of the extent and nature of diagnostic misclassification in hospital COD data. In part, this reflects lack of awareness of the existence of diagnostic misclassification and, if known, lack of knowledge of how to use the medical records to assess the extent of diagnostic errors and how to correct them.

A recent systematic review of studies that used medical record review showed the utility of this method for investigating a range of issues relating to the reliability of hospital COD data, or mortality data from vital statistics systems, when these have been found to be deficient (34). In most cases, the specific goal of the study was to establish a misclassification matrix of diagnoses comparing data from two sources, i.e. cases reported from hospitals to the vital registration system, and the same cases independently assessed on the basis of a review of the hospital's medical records. An example of a misclassification matrix from such a study carried out in Sri Lanka is provided in Annex 1. The data in the matrix show that there are serious misdiagnoses of causes of death that occur in hospitals in Sri Lanka with many causes being 20–40% under- or over-diagnosed by doctors. For instance, only 34 of the 62 true cases of diabetes mellitus were identified, with the remaining 28 cases classified to numerous other causes. No less than 30% of deaths due to ischemic heart disease, a leading cause of death, were misclassified to other heart diseases for which clinical and preventative strategies might differ. These data clearly suggest that the true hospital COD pattern is quite different from what is reported by the official COD statistics, with serious implications for guiding health priorities.

Medical record review studies have also been carried out to assess whether deaths from specific causes, e.g. cancer, were being reliably recorded in hospital settings. If a medical record review study is based on a reasonably representative national sample of hospital deaths, correction factors can be calculated from the misclassification matrices and applied to the COD data to estimate the true set of cause-specific mortality fractions (CSMF) in the population. Box 4 provides a framework for a study to validate the quality of hospital COD data.

Box 4: Recommended framework for hospital cause of death data validation study

- Determine scope of investigation;
- obtain agreement for hospital cooperation; and
- carry out a census of available diagnostic facilities in included hospitals.

Select diagnostic categories and develop diagnostic criteria:

- Set up a small expert group of physicians to develop standard diagnostic criteria;
- establish a list of diseases which are the most important for the review; and
- develop and pilot diagnostic criteria on a sample of cases.

Select sample death certificates:

- Determine sample size;
- determine the sampling method and identify the number of death certificates to be included in the study;
- draw the sample of death certificates from the vital registration database/hospital mortality register;
- retrieve corresponding medical records from the hospitals; and
- validate the quality of ICD coding for the sample.

Select physicians to re-diagnose COD:

- Provide training in COD certification.

...continued on next page

Box 4: Recommended framework for hospital cause of death data validation study (cont.)

Trace the relevant medical records:

- Decide on criteria to assess the quality of the records;
- decide on rules to determine which records can be used and which are too incomplete;
- reassess the sample size and losses due to poor or untraceable records; and
- prepare a summary of medical record quality, availability and storage.

Review medical records:

- Design form for extracting information from medical records (see an example of such a form in the study by Rampatige et al. [35]).

Code the new COD according to ICD-10:

- Check that coding is correct.

Compare the two causes of death and analyse findings:

- Determine the extent of misclassification;
- draw up a misclassification matrix for all ages, both sexes (and by age and sex if numbers allow) to identify patterns of misclassification;
- reassign the ill-defined causes based on the misclassification matrix; and
- compare the new COD distribution of study cases with the original.

Write final report:

- Describe the study design and methodology;
- provide sample design and explanation;
- discuss findings and implications; and
- propose improvement steps as needed, e.g. for COD certification, coding and medical records.

COD - cause of death

Source: Rampatige R, et al. [35]

Coding of cause of death data

The International Statistical Classification of Diseases and Related Health Problems (21) is published by WHO and maintained by the Education and Implementation Committee of the WHO Family of International Classifications (WHO-FIC) Network. The classification is currently (2014) in its tenth revision (referred to as “ICD-10”). ICD identifies diseases by a three-character code. For example, Acute Myocardial Infarction is coded as I21 while *Plasmodium vivax* malaria is coded as B51. This process of translating diseases and related health problems to ICD codes is known as clinical coding.

Coded data are used to compare morbidity and mortality between hospitals, provinces, states and countries, and at different points in time (32). When compiled, coded health data become the statistics that are used for assessing health system performance, analysing the burden of disease, and producing summary measures of population health. WHO and its regional offices encourage use of the ICD for both morbidity and mortality coding and Member States are required to report mortality data to WHO at the three-character ICD level, which is particularly useful for public health purposes.

The process of coding death certificates is referred to as mortality coding and is either done by coders in the MRD at the hospital or preferably by a central coding unit usually in the Ministry of Health or national statistics office. Based on the death certificate, coders identify an underlying cause of death and then code this according to ICD rules. WHO defines the *underlying cause of death* as the condition/disease that initiated the train of events that ultimately led to death. However, poorly written and incomplete death certificates that are common in many countries often do not provide enough information for a coder to select a valid underlying cause of death. This may be due to doctors not having been trained in correct death certification and/or to the poor quality of the medical records which make it extremely difficult for doctors to correctly identify the underlying cause leading to death, or other reasons.

It is important to understand the interrelationship between quality of medical records, cause of death certification and coding. The quality of coding depends not only on how well trained or supervised the coders are, but also on the quality of the certification and the medical certificate that the coders work from. Lack of good quality medical records, as seen above, can negatively influence the quality of the doctor’s certification. Therefore, any initiative to improve the quality of COD data needs to consider all three aspects (i.e. hospital medical records; death certification; and coding of the cause of death) and should carefully evaluate the contribution of each of these to the poor quality COD data. Mortality coding is not trivial and

to produce good quality mortality statistics, coders have to be formally trained to be able to code correctly according to ICD rules and regulations. If coders are expected to learn on the job without sufficient training, as is the case in many APO countries, coding quality will be low. The WHO-FIC Education and Implementation Committee has designed a special standard curriculum for mortality coders for countries to use when training their coders (36, 37, 38). In the Asia Pacific region there are several WHO-FIC Collaborating Centres that regularly offer courses for trainers in ICD coding, if such courses are not available in-country. There are also resources and self-help tools available to strengthen coding efficiency and improve understanding about the importance of good coding (39, 40, 41).

Although most countries code death certificates manually, an increasing number of those that code centrally have now started using IRIS, a computer-based system for coding causes of death and for selecting the underlying cause of death (42). The aim of IRIS is to provide a cost-effective, language-independent automated coding system that helps standardize and improve international comparability of mortality statistics. IRIS is based on the international death certificate form and causes of death are coded according to ICD-10 rules and procedures.

Given that poor coding practices can seriously reduce the quality and usability of COD data, they should be regularly audited. This is even more important if the hospital funding method is based on case mix, as poor coding can result in incorrect resource allocation to hospitals (43). A clinical coding audit should be seen as an objective appraisal, designed to support staff in identifying areas where best practice is not being achieved. The exercise can play an important role in future retraining of staff by documenting error patterns found in COD coding.

In countries where mortality coding is performed centrally, coding audits and improvement strategies are relatively easy to implement. In countries where coding takes place in a large number of hospitals (decentralized coding), it is more onerous to train coders and to maintain standards. A system of centralized mortality coding has many advantages over coding in individual hospitals, including making it easier to standardize the procedures, carry out audits and maintain a trained workforce. On the other hand, hospital coding facilitates access to original patient medical records and contact with the certifier for further clarification, should that be needed. Some measures that could lead to significant improvement in the COD data in many countries are listed in Box 5.

Box 5: Key actions to improve coding

- Ensure that the coding unit has an experienced clinical coder with appropriate training and skills to act as a resource.
- Insist on coding staff being formally trained.
- Make sure that robust coding policy and procedures are in place.
- Insist on complete and original source documentation, e.g. death certificate.
- Encourage communication between physicians and coders.
- Undertake coding audits regularly.

Conclusion

Even in countries where most deaths occur in the community, hospitals are still important sources of mortality data because they are generally the only source of deaths that are medically certified. To be useful, however, hospital data have to be accurate, which means that the department responsible for medical records has to have clear procedures, maintain good quality patient records and be able to extract relevant information from them for statistical purposes. This presumes that physicians are willing to take the time to certify the cause of death correctly and to properly fill in the death certificate, and that coders are sufficiently trained to be able to code the information on the death certificate correctly. Although introducing computerization can improve data quality through facilitating edit and validity checks, computer systems are not the solution to poor quality data.

We strongly recommend that the Ministry of Health takes the lead and forms a committee for data improvement involving all concerned stakeholders, including hospital and medical records department managers, HIS representatives, public health officers, data analysts and other data users. Under the guidance of this committee and using the tools and resources recommended or referred to in this paper, improvement mechanisms and processes can be implemented in a collaborative and stepwise manner. Each country will need a different mix of actions according to the specific weaknesses with their COD data, but all are likely to produce some hospital data which, if improved, can be of value for policy and planning at various levels.

In Box 6 we summarize and list some key general actions that will lead to better quality COD data than what is currently being produced by the health system in many countries of the region.

Box 6: Key actions to improve the quality of hospital COD data

1. Establish a committee for improving hospital data at the national level to prepare a strategic plan and oversee its implementation.
2. Review the policies and procedures for collecting and consolidating COD information from hospitals (Box 2).
3. As necessary, review the functioning of medical records departments.
4. Where needed, take steps to improve medical records (Box 3).
5. Assess the quality of hospital certification using a medical records review; use the findings to put in place corrective actions and to improve public health awareness of the data (Box 4).
6. Ensure that coders are trained and their work environment supportive (Box 5).

Once these improvement processes have been implemented and are having an impact on data quality, it is important to monitor and document the change. This can be done at the macro level by annually calculating indicators such as the composite vital statistics performance index (VSPI) metric or through tools and computer applications that allow countries to check the output of their mortality systems in greater detail (15, 16, 17).



4. Using verbal autopsy methods for out-of-hospital deaths

As shown in section 2 of this paper, a large number of countries in the Region do not have COD data that can assist them in making rational decisions about how to more effectively allocate their health budgets and evaluate their health programmes. Because of the lack of functioning systems for medical certification and death registration for those who die outside hospitals, verbal autopsy is the only option available to obtain some insight into the main causes of death of these cases. Current research indicates that health trends are rapidly changing throughout the world (44) and especially in the Asia Pacific region (45). However, our knowledge about the level and speed with which disease patterns change in individual countries is limited because of the lack of reliable data. As a result, countries with the weakest systems and worst health problems are unable to plan properly or reorganize their health systems to create healthier outcomes for their populations. This section discusses the potential application of verbal autopsy (VA) methods to improve knowledge about causes of death in populations and highlights some recent advances which are likely to expand its use leading to vastly improved knowledge of COD in countries

Overview of verbal autopsy

VA is a method to ascertain the probable COD from an interview with relatives or persons who were in close contact with the deceased person and who are able to report on signs, symptoms and circumstances that preceded death. VA questionnaires typically include a set of “yes or no” questions about the presence of signs and symptoms of disease, and usually have a section (often called the “open narrative”) in which the informant can detail in his/her own words the sequence of events that led to death. They may also collect information on the contact the deceased person had had with the health care system, and any other available information that the informant can provide to diagnose the probable COD (46). VA methods have also been used to explore social, behavioral and health system factors that may contribute to death and which could have been alleviated by prevention strategies (47).

As shown in Figure 2, verbal autopsy methods can help to improve knowledge about causes of death in populations in a number of ways – either through routine application to all deaths that do not occur in hospitals, or are not diagnosed by local family physicians, but are otherwise registered in a civil registration system. Verbal autopsy can also be, and has been used, in health surveys or sample registration systems which, while not civil registration systems, nonetheless can yield useful and reliable information on causes of death for a representative sample of the population. We discuss this application in more detail below.

VA was initially developed as a research tool to try to identify the causes of individual deaths among study populations in countries where most deaths are not medically certified and hence little is known about what people in the community are dying from. The term was coined in the early 1970s in India when in-depth interviews were conducted with the family of the deceased (48). Although it has been mostly used in research settings, it can also provide reliable data about COD patterns and trends at the population level. For example, VA has been used in Demographic and Health Surveillance sites, sentinel populations and in sample registration systems in some countries to obtain information on leading COD in specific settings (49, 50, 51).

Over the past 50 years a variety of VA instruments have been developed to diagnose COD, particularly for maternal, neonatal and child deaths. However, only in the past two decades has there been a concerted research effort to improve VA methods and procedures. This eventually has led to joint standards and guidelines for implementation of VA, based on best available knowledge at the time, facilitating consistency and cross-comparability between studies (46). As a result, cause-specific mortality data according to the ICD have become available for populations that otherwise would have none because their CRVS systems were dysfunctional. Coinciding with the recent global interest and momentum to improve COD information in lower- and middle-income countries, there has been substantial research over the past decade or so to improve the performance of VA in generating reliable data on causes of death. Recent developments in VA have tended to concentrate on three main areas of scientific debate: the construction of VA questionnaires, the methods used to analyse the responses, and the set of causes of death which VA is capable of identifying.

Contribution of verbal autopsy to improving knowledge about cause of death patterns in populations

VA can be used for different purposes: (a) as a research tool in the context of longitudinal population studies (e.g. linking an individual's COD back to some

baseline exposure such as smoking); (b) as a means of correcting COD statistics, particularly deaths assigned an ill-defined diagnosis, by collecting additional information from families using a VA questionnaire; and (c) to monitor progress towards health goals and/or to evaluate whether interventions are working or not. In this policy brief we focus on the second and third applications, namely how VA might be used to improve knowledge about underlying causes of death in populations where few deaths are medically certified. In particular, we focus on how VA might be routinely applied in national mortality surveillance systems, thereby generating the essential health intelligence to inform policy debates about priorities to reduce premature mortality.

VA can also be applied to a sample of deaths in countries with non-existing or incomplete information about causes of death. If the sample is nationally representative, it allows CSMFs to be calculated. These can then be scaled up and assumed to apply for the total population (52, 53, 54). Several populous countries in the Asia Pacific Region, notably India (55), Bangladesh (56), China (57) and Indonesia (58), have already recognized that VA is the only practical option for measuring levels and trends in mortality and have integrated VA into their sample registration systems. Even using less efficient VA methods than currently available, these countries are able to generate annual data on COD to help them formulate more effective policies and to help them to better use their health resources.

Some countries that have fairly complete information on COD, but where a substantial proportion of the deaths are classified to ill-defined categories, have also used VA methods to redistribute them to probable specific causes. This greatly increases their value for health decision-making since policies to reduce premature mortality are focused on controlling specific causes of death, e.g. stroke or lung cancer, for which accurate cause-specific data are required. Countries such as Thailand (53) and Brazil (59) have applied VA to cases of ill-defined COD to greatly improve knowledge about the true underlying causes of these ill-defined causes of death, enabling them to adjust their policies accordingly. For example, in Thailand, application of VA to a representative sample of ill-defined diagnoses (which constitute about 50% of all deaths registered in the country) suggested that leading causes such as ischemic heart disease, stroke, HIV and road accidents killed between 300–450% more Thais than the vital statistics indicated (54).

Main research challenges in the application of verbal autopsy methods

In many cases, death may be caused by a complex series of events and determining the underlying cause is not always straightforward even for the

doctor who treated the patient. Normally when a person dies, the attending physician relies on medical records to establish the underlying cause of death and the sequence of events that led to the person dying. In applying VA, the most probable cause of death is assessed by a physician from the sequence of reported signs and symptoms reported by the family of the deceased. These two processes are of course fundamentally different, yet they are conceptually similar since both methods (medical certification and VA) rely on a process of knowledge about, and logic applied to symptom-cause relationships. In settings where there is no doctor, and no useful medical records to guide diagnosis, VA has the potential to yield useful information about population-level cause of death patterns since it, in effect, mirrors the clinical process and diagnostic logic applied to hospital deaths. The key challenge to more widespread use of VA in routine death registration systems is how reliably can it do so. We explore this further below.

The other main challenge limiting the routine application of VA in death registration systems has been the scope and length of the VA questionnaire (i.e. the trade-off between being able to identify sufficient causes of death of public health interest- and what questions should be asked- and the length of time for the interview: longer interviews are likely to elicit less accurate information and are more costly to administer and process. Perhaps because of the difficulties in eliciting specific symptoms and their duration with current VA questionnaires, VA has been found to perform better in diagnosing some causes of death (e.g. injuries, breast or cervical cancer) than others (such as colorectal cancer and stomach cancer) (60).

Questionnaire content is usually decided by a group of doctors (expert opinion) who are familiar with the key signs and symptoms of the diseases of interest. Several instruments are currently available, including the short form of the WHO Verbal Autopsy Questionnaire (61), the SAVVY VA questionnaire (62), and more recently, an abbreviated form of the VA questionnaire developed by the Population Health Metrics Research Consortium (PHMRC) (63). Of these, only the performance characteristics of the PHMRC questionnaire have been properly validated by comparing performance (i.e. ability to correctly predict the cause of death) against a “gold standard” data set of over 12 000 deaths collected in several developing countries for which the true cause of death was known (60). This resulted in a 40-50% reduction in the length of the VA questionnaire without any marked decline in the COD accuracy of the questionnaire (77). The performance of the reduced questionnaire was assessed at the individual level (concordance between the VA COD and the true COD) and at the population level (agreement between the CSMF derived from the short-form of the VA versus that obtained from the gold standard COD dataset).

The other big challenge in the application of VA has been the method used to determine (i.e. diagnose) the COD once information from a VA questionnaire has been collected. Essentially there are two ways to diagnose the COD: one demands physician input and the other is based on automated computer methods. Traditionally, in the so-called “physician-coded VA” (PCVA) approach, VA responses are analysed by one or more physicians who, based on their judgement, determine the most probable COD. This method, while taking advantage of local physician knowledge and experience, also has some serious disadvantages. It is expensive, particularly for sizeable samples, and has often led to long delays in obtaining COD data for populations quite possibly because physicians are busy and less likely to be motivated to diagnose reports unrelated to their patients (64). Moreover, the use of physicians to diagnose VAs places an additional burden on already weak health systems by taking them away from their primary role in providing essential health services to populations. The performance of PCVA in diagnosing the cause of death from VAs also varies considerably according to the skills of the physician and therefore lacks consistency across time and within and across countries, which is not the case with automated diagnostic methods (65).

These considerations initially led to the development of the “InterVA method”, where physicians are involved only at the stage of building the algorithm for determining the COD (66), i.e. physicians specified how a set of responses led to a specific COD using their clinical knowledge about the pathology and physiology of disease. For example, positive answers to questions like “Was a woman pregnant before she died?” and “Did she have excessive bleeding” would be clear symptoms leading to identification of maternal haemorrhage as the most probable COD. Once the data are entered into the computer and the InterVA method applied, these algorithms are applied in a standard way to arrive at a COD. While it may be important to have physician input into the algorithms that can make judgments about likely causes of death based on the local context (67), the counter-argument is that local physician views on population epidemiology exert a profound influence on the diagnoses recorded and hence are likely to detract from the comparability of PCVA across populations (68). In order to overcome these problems, a new set of automated methods to ascertain the COD based on response patterns to a VA have been developed. These data-driven methods are based purely on the empirical analysis of responses without any physician input at all, and will be discussed in more detail below.

Whatever the VA instrument used, proper training and supervision of interviewers is essential, including training in how to approach informants, manage sensitive situations, respect confidentiality of information and deal with ethical issues. Along with the use of standardized questionnaires,

standard application protocols and manuals are essential. A key question is who to use to carry out the VA interviews of families. In VA trials carried out in China and Sri Lanka, health workers were used as interviewers, but elsewhere non-medically trained interviewers have been used as well. For instance, in Mexico, the use of non-medical personnel, with proper training in health surveys, provided good results, reducing a bias in data collection that could be introduced by the medical knowledge of health personnel.

Decisions about how long to wait after the death before application of the VA should be made according to cultural standards, as appropriate mourning periods may differ. Interestingly, recent research seems to suggest that responses to a VA may be sufficiently accurate to determine the COD for up to two years after death, although more research is needed to determine whether or not there is an ideal time lag (69).

Comparative evaluation of verbal autopsy methods

Considering that there are now a number of different VA instruments and methods, it is only natural to ask what their main differences are and which of them is the most reliable and efficient for monitoring COD in populations. In Table 3, we have classified the main VA methods according to how they determine the COD.

Table 3: Methods to ascertain cause of death from a verbal autopsy

	Physician certification	Automated methods
Based on expert judgment	Physician Certified Verbal Autopsy*	
	InterVA**	
Based on empirical analysis of training data		King-Lu Direct CSMF Estimation†
		Symptom Pattern†
		Tariff†
		Random Forest†
		Ensemble Methods†

*As used by SAVVY, SRS

** As used by INDEPTH, WHO

† As used by PHMRC

Source: Murray et al. (68)

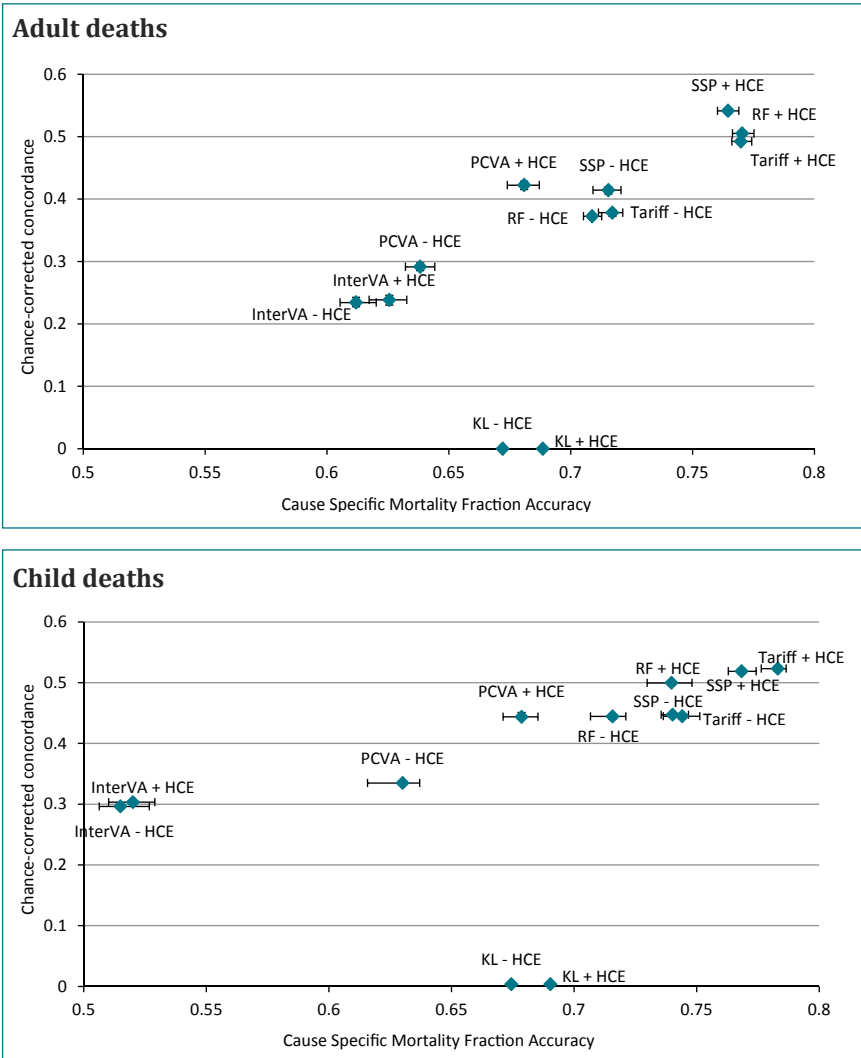
Of those methods that do not require input from physicians, InterVA is a hybrid as it combines expert physician judgment (as described earlier) with the use of Bayesian statistical methods to ascertain the COD (66, 68).

Other methods ascertain the COD from a VA solely by conducting an empirical analysis of the pattern of responses to the questionnaire. The Symptom Pattern method also uses Bayesian methods, but relies on actual reported response patterns rather than expert judgment to assign the COD (70). Random Forest uses machine learning techniques to ascertain the COD based on “decision trees” identified through empirical analysis of the data (71). Tariff is a simpler method that assigns a score or “tariff” to each item according to the number of times the item was endorsed (i.e., respondents answered “yes” to the symptom question) for a particular cause of death (72). In other words, the “tariff” method attempts to identify the strength of association between a symptom and a specific cause of death, based on the “signal to noise” ratio. Finally, the King-Lu method allows the estimation of CSMFs based on an empirical analysis of data (73).

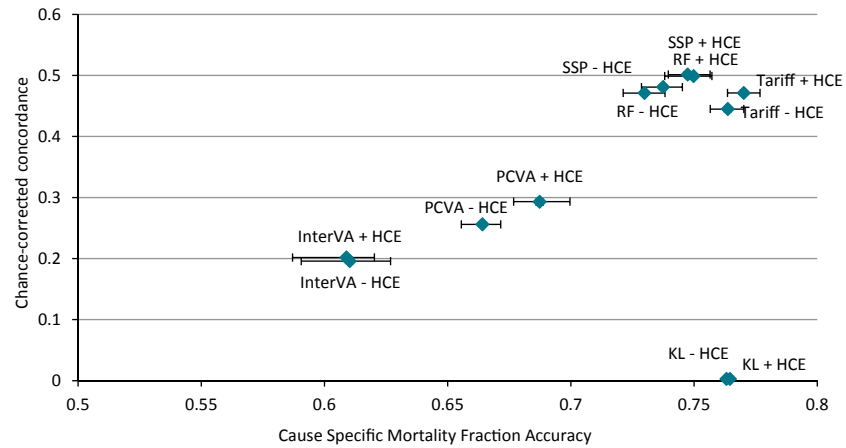
The advantage of the automated VA diagnostic methods is that they are very low cost, do not take physicians away from more important duties and can handle large datasets. But are they reliable? To specifically assess the performance of different VA methods, the PHMRC applied the different VA diagnostic methods to the same “gold standard” dataset where the true cause of death was known with virtual certainty, and compared results. The findings of this research are presented in Figure 5. This figure compares the performance of each method in accurately diagnosing the cause of death from VA responses using the long form (original) PHMRC VA questionnaire by comparing the cause suggested from the application of each method with the true cause for that death ascertained from a critical assessment of medical records for that case that fulfilled a set of pre-defined strict clinical gold standard criteria. The figure shows the performance of each method on two dimensions: the population-level accuracy, namely how reliable the method is in predicting the distribution of deaths by cause in the population (CSMF) on the X axis; and the relative performance of different diagnostic methods in getting the cause of each individual death right, corrected for chance (known as chance-corrected concordance or CCC) on the Y axis. The comparison was done separately for adults, children and neonates and according to whether or not cases had had contact with health services (health care experience-HCE) prior to death. Methods with a better performance (with higher CSMF accuracy and higher CCC) are found closer to the upper right corner in this figure. As we can see clearly from Figure 5, the diagnostic accuracy of automated methods like Symptom Pattern, Random Forest, or the more simple and intuitive Tariff method consistently outperform the PCVA method in getting the CSMF right for populations, and getting the CCC correct for individual deaths (68). Moreover, automated methods can now be readily applied using *SmartVA*, a software tool that uses the Tariff method to identify the strongest symptoms associated with each cause, to ascertain the most probable COD (74). Moreover, it does so immediately upon completion

of the questionnaire at the individual level enabling real-time determination of the cause of death reliably and cheaply. Data on these individual causes of death can then be aggregated using existing software to cheaply, quickly, and reliably measure the COD pattern in populations which do not have good medical certification.

Figure 5: Comparison of accuracy of methods to ascertain causes of death from verbal autopsy; PHMRC study.



Neonatal deaths



CSMF - cause-specific mortality fraction, KL - King-Lu, PCVA - physician-certified verbal autopsy, RF - Random Forest, SSP - Simplified Symptom Pattern, VA - verbal autopsy, HCE - health care experience

Source: Murray CJL et al. (68)

Future use of automated Verbal Autopsy

For many developing countries where civil registration exists but coverage and completeness of death registration is poor because most deaths occur outside the medical system, the best option would be to use VA methods for all deaths without a medically-certified COD and to integrate these data into current registration systems. This is now possible with the new VA methods which, as we have shown, are more accurate, cheaper and quicker to implement. Moreover, field research in different populations (Bangladesh, Papua New Guinea, Philippines, Sri Lanka) around the region has confirmed the public acceptability of these methods and that they respect ethical standards (75). While automated VA methods are efficient and reliable for collecting and tabulating information on what people die from in the community, it is nonetheless good statistical practice to tabulate and analyse these data separately from hospital deaths which have been medically certified.

The reduced WHO VA questionnaire, has (unfortunately) been specifically designed to be analysed by InterVA, one of the worst performing diagnostic methods (see Figure 5), and may well be seen as still being too long for routine application to all deaths that take place outside hospitals (76).

Field application of the instrument will shed light on this issue; on the other hand, the 20-25 minutes that it takes to apply the short form of the PHMRC questionnaire, as already demonstrated in pilot studies, suggests it is fit-for-purpose. This new instrument, which is 40-50% shorter than the original PHMRC questionnaire, provides an acceptable level of performance at both the individual and population level (77). It has already been tested in community settings in Sri Lanka with a view to integrating it into the current vital registration system to diagnose the cause of all out-of-hospital community deaths (78).

To fully benefit from these significant advances in questionnaire reduction and automated COD diagnostic techniques, they should ideally be introduced using electronic devices for VA data collection, such as tablets, notebooks or cellphones. This facilitates the application of the questionnaire, greatly reduces the amount of time between VA and the production of policy-relevant cause of death data, improves data quality, eliminates a specific phase of data entry and coding, and improves procedures for timely feedback and supervision in the field. At the same time, electronic data collection using handheld devices connected to automated diagnostic software will facilitate linking the COD information with other electronic data collected in the health system, thus improving the comprehensiveness, timeliness and accuracy of the health information system and its role in policy support.

Considering the rapid development that has taken place in VA methods, countries that already use VA in some form should seriously consider the benefits of these new automated methods and how best to integrate them into their routine CRVS systems. At a minimum, countries should try to periodically evaluate the accuracy of the VA data as part of the periodic COD data quality assessment recommended earlier (15, 16).

Conclusions

Recent developments in VA methods have removed the three main obstacles to routine application of VA in countries, namely: the length of the questionnaires, reliance on physicians, and uncertainty about the accuracy of the VA diagnosis. In parallel, the application of objective item-reduction methods has led to a validated questionnaire for which the performance characteristics (i.e. accuracy) are known and which can be applied in 20-25 minutes without a significant decline in the ability to get the COD right. Research comparing the accuracy of existing methods has confirmed that these automated methods significantly outperform physicians' ability to correctly certify the COD.

Even with standard training manuals for the application of the automated VA methods and questionnaire, each country will still have to translate and adapt these to suit cultural, epidemiological and administrative environments before introducing them and initiating training. Local human resources are required to help with these technical issues, and institutional arrangements for data collection, data storage, data use and ownership all have to be agreed before wide scale introduction of the available VA technology described here is possible. Finally, the same ethical considerations associated with medical data should be observed to guarantee the confidentiality of the data and respect the rights of the informants. While these implementation issues must be given careful consideration, experience with the use of automated VA methods and associated technology such as *SmartVA* strongly suggests that they are ready for widespread application and that they can substantially reduce ignorance about community deaths and relatively rapidly lead to significant improvements in cause-specific mortality data.



III. Conclusions and recommendations

The above analyses of the quality of the region's COD data suggest that more than half of the countries in the Asia Pacific Region cannot count on their civil registration and vital statistics systems to deliver the data they require for planning their health systems and maximizing health outcomes for their populations. Based on our analysis and other systematic reviews of the region's vital statistics, we propose a framework for policy action consisting of three different pathways according to CRVS system development in countries. The group with the least developed systems, labelled Group 1 in Table 4, comprises some of the largest populations in the region with the most deaths; thus the particular priority on improving the status quo. A second group of countries, labelled Group 2, also have weak civil registration systems but some, such as China, have sample registration systems that function well and are nationally representative. Group 3 consists of countries that have functioning systems but suffer continuing problems with the quality of their COD data or whose data dissemination policies need to be improved to make more detailed and timely data available for public use.

For each of the three groups, we recommend a different development pathway with strategic priorities and specific actions, all of which are explained in detail in the working paper. For Group 1 we recommend a pathway that prioritizes recording all deaths by age, sex and current residence as a minimum. Death reporting must first be made a legal obligation both for individuals and for institutions where deaths occur, if that is not already the case. Its implementation can then be achieved through collaboration between the health, justice and civil registration services using incentives and information campaigns for registering all vital events. Tools to help countries achieve this are already available, and a forum to exchange experiences is provided under the auspices of UN ESCAP's Regional Plan. At the same time that these countries build up their formal registration systems, they will need to rapidly establish or continue to use interim data collection sources (SRS, DHS, etc. – see section 1 of the working paper) to

generate essential vital statistics on their populations until the CRVS system reaches an acceptable level of completeness. Moreover, these data collection mechanisms can provide critical information on causes of death in addition to total deaths and births, by carrying out a verbal autopsy on all identified deaths. Countries that currently have no death registration system, as an interim measure, should consider establishing a sample registration system covering 1–2% of the population and collect causes of death using VA on all deaths reported via these systems. In parallel, it is recommended that they implement ICD certification and coding practices in all hospitals and at the same time begin to strengthen their medical records departments by training staff and coders. If ICD is already being used in hospitals, countries should, as a priority, begin compiling the COD data to generate national datasets with medically-certified COD. If not already in use, countries should immediately adopt the International Form of Medical Certificate of Cause of Death.

For countries in Group 2 that already have civil registration systems that succeed in recording most deaths, but where a high proportion do not have a medically certified cause, we recommend the routine integration of VA into their registration systems for all out-of-hospital deaths that do not have a valid death certificate. By using a short VA questionnaire on tablets or smartphones to collect information from families, and by using automated methods, it is now possible to reliably and efficiently identify the cause of death and avoid the high proportion of ill-defined causes which previously plagued such systems. Once evaluated by applying existing mortality data tools, the tabulated VA data can be amalgamated with other data to form a national COD dataset. For those countries that do not yet have a civil registration system with national coverage but have some form of mortality surveillance, the recommended strategy is to apply VA to the deaths they record in their SRS or DHS systems and to use automated VA methods to cost-effectively and efficiently obtain nationally representative COD data. Countries in this group must also monitor the quality of their hospital COD data to ensure that these data can be trusted and used for their intended purposes.

For Group 3 countries, the goals of completeness and coverage of the COD data have mostly been reached but there are residual problems with the quality of the data, particularly when tabulated for detailed causes. The pathway we recommend focuses on capacity building and the use of existing tools (13, 15, 38, 79) for better medical certification and ICD coding. All the actions described in this paper regarding hospital statistics should be considered by countries in this group, in particular those related to routinely checking the quality of hospital certification to verify whether there is serious misdiagnosis of common diseases or whether poor coding is to blame. In

countries with remote populations for whom medical certification of deaths is difficult, automated VA methods should be applied to those cases who die at home without contact with the medical system.

Countries in the Asia Pacific region with good CRVS policies and processes and well-functioning systems (Australia, Japan, New Zealand and Republic of Korea) are not discussed in this paper. Nonetheless, even in these countries, mortality registration systems can improve and become more efficient though continued vigilance. For example, just because all deaths are medically certified, one should not assume that the data on causes of death are correct. Hospital mortality patterns need to be compared regularly with expected regional COD distributions for deviance and if some differences in mortality cannot be explained, a medical records review should be carried out. This and other quality control methods for medical records will likely become increasingly common in systems where case mix is used to determine budget allocations and will be easier to undertake as more hospitals complete the computerization of their medical records and integrate their systems across services.

Within each of the three proposed pathways for COD data development, each country will need to assess their own situation, decide on priorities and develop an implementation plan with detailed steps for each action selected. Further explanation of the suggested actions/interventions can be found in sections 3 and 4 of the working paper and in the referenced literature. The WHO and UQ resource kit (2) in particular will be a critical resource for supporting country-specific improvement plans.

Table 4: Suggested framework and pathways for strengthening cause of death data in countries of the Region

Actions	Group 1 pathway	Group 2 pathway	Group 3 pathway
Review legal and regulatory framework for COD registration	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Establish coordination mechanism between involved ministries	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Build awareness of registration obligation and introduce incentives for registration	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Train staff in civil registration methods	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Expand registration facilities outside main urban areas	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Facilitate registration in hospitals and through mobile registration points	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Use verbal autopsy in SRS and HDSS to generate cause- specific data for deaths outside medical facilities	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Train staff in verbal autopsy methods	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Strengthen medical records departments in hospitals	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Train medical records and coding staff	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Review policies and mechanisms for collection of hospital data	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Integrate verbal autopsy methods into civil registration for deaths without a medically certified COD	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Use medical records reviews to verify hospital certification	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Train doctors in ICD certification	Very weak CRVS systems	Medium CRVS systems	Medium CRVS systems
Train staff in data verification and monitoring methods	Medium CRVS systems	Medium CRVS systems	Medium CRVS systems

Very weak CRVS systems

Weak CRVS systems

Medium CRVS systems



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Annex 1: Misclassification pattern observed in Sri Lanka

Gold standard diagnosis	Certain infectious and parasitic diseases	Cancers of the GI tract	Liver cancer	Trachea, bronchus and lung cancer	All other neoplasms	Blood and immune disorders	Diabetes mellitus	Other diseases of the nervous system	Hypertensive diseases	Ischaemic heart diseases	Cerebrovascular diseases	Other heart diseases	Pneumonia	Chronic lower respiratory diseases	Other diseases of the respiratory system	Diseases of the liver	Diseases of the skin	Genitourinary diseases	Perinatal conditions	Congenital malformations	Symptoms and ill-defined conditions	External causes	All other codes	Total	
Certain infectious / parasitic diseases	9		1	1	1	1	1					2		1		1						1	2	2	23
Cancers of the GI tract		4			1																		1	1	6
Liver cancer			4													2							1	1	7
Trachea, bronchus and lung cancer	1			2		1					1														5
All other neoplasms				1	22	1				2	2			4											32
Blood and immune disorders	1				2	1				2		1													7
Diabetes mellitus	3				3	34	1	4	22	9	1	3	2			3	1					1	7	94	
Other diseases of the nervous system	2					3	3	2		2			1		1	2									11
Hypertensive diseases	4					2	12	9	10	1	3		1	3		1		1					1	1	44
Ischaemic heart diseases	2					9	2	54	5	3	1	5		5		4				1		1	2	89	
Cerebrovascular diseases					1	1	1	2	1	17	1			1	1	1									28
Other heart diseases	1	1	1	1	2	3	2	17	4	21	1	4	1	4	1	3	1	1	1	2		1	3	70	
Pneumonia				1	1	1	2			1	1		9	2								2	3	23	
Chronic lower respiratory diseases	1					1	1	7	1	1	1	1	13							1			1	1	28
Other diseases of the respiratory system				1		1	1	1	1	1	1			3	2	2						1	1	1	15
Diseases of the liver	4		2			2	1	2	2	3		3	1	1		39	1	1					2	2	60
Diseases of the skin		1								1						1							1	1	4
Diseases of the genitourinary system											1														1
Perinatal conditions																		4							4
Congenital malformations	1																		4	3					4
Symptoms and ill-defined conditions																1									1
External causes of mortality	3		1	1	2	3	2	3		1		1		1		2		1		1		1	3	3	24
All other causes	1	1	1	1	1	2	2	1	3	2	1	1	1	1	1	2	2	1	1				4	4	22
Total	32	7	8	7	34	6	62	11	27	127	54	35	19	38	6	64	3	7	5	8	4	6	32	602	

Source: Rampatige et al (80)

The Asia Pacific Observatory on Health Systems and Policies is a collaborative partnership which supports and promotes evidence-based health policy making in the Asia Pacific Region. Based in WHO's Regional Office for the Western Pacific, it brings together governments, international agencies, foundations, civil society and the research community with the aim of linking systematic and scientific analysis of health systems in the Asia Pacific Region with the decision-makers who shape policy and practice.



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