

UNAIDS/WHO Working Group
on Global HIV/AIDS and STI Surveillance

Guidelines for HIV mortality measurement



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UNAIDS



**World Health
Organization**

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Contents

Acknowledgements	ii
Abbreviations	2
Introduction	3
1. Obtaining cause-of-death information for HIV/AIDS	6
1.1 Medical certification in line with the International Classification of Diseases	6
1.2 Verbal autopsy	18
2. Measuring HIV-associated mortality: data sources	23
2.1 Civil registration and vital statistics systems	23
2.2 Sample and local demographic surveillance systems	25
2.3 Household surveys with mortality modules	29
2.4 Hospital data on cause-specific mortality	29
2.5 Burial systems and clinical autopsies	33
3. Measuring HIV/AIDS-associated mortality: analytical techniques	35
3.1 Cause of death	35
3.2 Age–sex patterns of mortality	36
3.3 Modelled Estimates	37
References	38
Annex 1: Toolkits/resources for country mortality surveillance systems	41
1. Data collection	41
2. Death registration tools (forms, variables and specifications of data elements)	41
3. Automated data-collection and analysis tools	41
4. ICD-10: training tools, electronic version, manuals	42
5. Tools for cause-of-death ascertainment	44
6. Editing, analysing and presenting/communicating data on causes of death	44
7. Principles and recommendations for a vital statistics system	44
Annex 2: ICD-10 codes related to HIV	45

Abbreviations

ART	antiretroviral therapy
CCVA	computerized coding of verbal autopsy
CRVS	civil registration and vital statistics
DSP	Demographic Surveillance Programme (China)
HDSS	health and demographic surveillance system
ICD	International Classification of Diseases
ICD-10	<i>International statistical classification of diseases and related health problems tenth revision</i>
MMDS	Mortality Medical Data System
PCVA	physician-certified verbal autopsy
SAVVY	sample registration with verbal autopsy
SVR	sample vital registration
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNGASS	United Nations General Assembly Special Session
USA	United States of America
WHO	World Health Organization

Introduction

Mortality statistics, including causes of death, are the foundation of public health planning, monitoring and evaluation of interventions. Yet, the overwhelming majority of low- and middle-income countries do not have reliable mortality statistics. Out of 119 countries reporting causes of death to the World Health Organization (WHO), only 34 countries – representing 15% of the world population – produce high-quality cause-of-death data, and almost all of these countries are in Europe and the Americas. A further 85 countries – representing 65% of the world population – produce lower-quality cause-of-death data, while 74 countries, mostly in sub-Saharan Africa, lack such data altogether (1). This information paradox – where information is lacking where it is needed most – has critically hindered the ability of governments and country programmes to track progress in addressing the HIV epidemic.

A well-functioning civil registration system is the best way to monitor mortality and causes of death. Civil registration systems aim to register all the births, deaths with cause of death, and marriages. Many countries do not have civil registration systems that produce reliable vital statistics, as coverage tends to be low, especially for deaths, and information on causes unreliable. Even though there is increasing awareness and commitment to strengthening civil registration and vital statistics (CRVS) systems, it will take considerable time before these systems can produce reliable mortality statistics. Therefore, alternative methods to collect information on causes of death, including HIV, need to be considered. Such methods include sample registration systems, household surveys, hospital data, burial systems, clinical autopsy, analytical methods and others.

The Second Generation HIV Surveillance (2) provides a framework for the collection of data, starting with tracking the initiation of potential exposure to HIV through to reporting death from HIV-related causes. While its latest update includes recommendations to improve the collection of data on HIV/AIDS mortality (2, 3), the framework provides no formal suggestions for collecting mortality data, and there are currently no comprehensive data-collection guidelines for HIV mortality. Efforts to measure HIV/AIDS mortality are increasing in number and scope. Many of these efforts can serve as the foundation for civil registration systems, but much work remains to be done.

In the absence of quality CRVS data, global and regional estimation methods are used to obtain a general idea of the leading causes of death. This is done to obtain the overall picture and to assess the importance of specific diseases. In 2012, an estimated 1.6 million (range 1.4 to 1.9 million) people died from HIV-related causes, including 1.2 million (range 1.1 to 1.3 million) in sub-Saharan Africa (4). These estimates are based on country data that have been analysed in statistical models, using standard methods developed to estimate the course of the HIV/AIDS epidemic. The main input is HIV-prevalence data from a given population, depending on the kind of epidemic. HIV/AIDS mortality is estimated from an epidemiological model like Spectrum (5), using different parameters and assumptions and taking into account the number of people on antiretroviral therapy (ART) and its survival rates. Therefore, no direct HIV/AIDS mortality data are used to obtain global, regional and country estimates of HIV/AIDS mortality. In countries with reliable mortality registration data, it is necessary to compare the plausibility of the model-based mortality estimates with results from death registration.

The measurement of cause-specific mortality becomes even more important when monitoring progress and evaluating large-scale interventions. In response to the United Nations General Assembly Special Session (UNGASS) on HIV and other commitments, national HIV/AIDS programmes have developed national strategic plans to scale up prevention, treatment and care. It is critical to know how effective these programmes are. One of the clearest indicators of success is a decrease in mortality due to HIV-related causes. Therefore,

for most countries there is a need to collect the best possible HIV-related mortality data, to evaluate the impact of scaled-up HIV/AIDS programmes. However, it is not easy to collect accurate and reliable cause-of-death information. First, many deaths occur at home without medical certification. For deaths in health institutions, there are also challenges. Proper medical certification of cause of death requires use of the International Classification of Diseases (ICD) (6), currently in its 10th revision (ICD-10) (7), which involves intricate knowledge and commitment of the certifier (often the physician) and coder. The certifier often does not have accurate and complete knowledge of the circumstances that led to the death, especially if diagnostic opportunities are limited. Furthermore, the basic rules of establishing a cause of death are frequently not well known or applied properly. Certification and coding for HIV is more complicated than for many other conditions, as it is a complex disease that is characterized by many signs and symptoms that are easily confused with other illnesses. Additionally, the disease is associated with considerable stigma, which may affect the practices of the certifier or coder.

There are multiple ways in which programmes can invest in obtaining better information on HIV/AIDS mortality. It is, however, important that these investments are made in a way that contributes to the development of CRVS and strengthens the information for all causes of death, and, if possible, levels and trends of mortality. This document provides practical guidance on ways to improve measurement of HIV/AIDS mortality within this context. The best strategies and preferred methods will differ according to the type of HIV epidemic. Box 1 describes the most common categories of HIV epidemics, though it is important to recognize that several different types of epidemics may exist across subpopulations or geographical locations within a country. This document focuses primarily on generalized epidemics, and therefore sub-Saharan Africa, which has the overwhelming majority of countries with generalized epidemics and represents about 68% of the total global HIV/AIDS mortality (4).

Box 1. Types of HIV epidemics (4)

Generalized epidemics are those where the prevalence of HIV is consistently over 1% in pregnant women attending antenatal clinics, indicating that HIV infection is present among the general population at sufficient levels to enable sexual networking to drive the epidemic. Given the long duration of HIV epidemics in most countries classified as generalized, HIV/AIDS mortality is higher. Some data may be available, but the information may not be centralized. These data should be identified, evaluated for a potential contribution to HIV/AIDS mortality reporting, and then used to contribute to HIV surveillance statistics.

Concentrated epidemics are those where HIV prevalence is high in one or more subpopulations at higher risk (i.e. >5%), but the virus is not circulating in the general population.

Low-level epidemics are those where recorded infection is largely confined to members of subpopulations at higher risk of acquiring HIV (e.g. sex workers, drug injectors, men who have sex with men), with HIV prevalence levels below 1% and where HIV has not spread to significant levels within any subpopulation group.

Countries with low-level and concentrated epidemics present unique challenges for HIV/AIDS mortality surveillance, as for general epidemiological surveillance. Those responsible for conducting surveillance often have limited access to higher-risk populations. The key issue to remember in relation to HIV/AIDS mortality in these epidemic contexts is that HIV has not spread to the general population. General population data cannot therefore be relied upon to provide useful information.

With a focus on HIV/AIDS, Chapter 1 describes the different tools currently available to determine cause of death. These tools include medical certification of the cause of death using the ICD-10 (7) for deaths in health institutions, and verbal autopsy when medical certification is absent. For medical certification, special attention is paid to the diagnosis of HIV, by itself and in conjunction with maternal mortality and tuberculosis (TB).

Chapter 2 focuses on the data sources that can be used to measure HIV/AIDS-associated mortality. The ideal source is a comprehensive, high-quality CRVS system, and such systems have been established in many high-income countries. Some countries have well-established sample registration systems to monitor mortality and causes of death. More recently, an increasing number of countries are embarking on sample registration with verbal autopsy (SAVVY). In addition, the potential of other sources such as household surveys, hospital data, burial systems and clinical autopsy are discussed.

In Chapter 3, different analytical techniques to assess HIV/AIDS mortality trends in situations where data are incomplete or inaccurate are presented.

Finally, Annex 1 includes a toolkit comprising several resources for improving country mortality surveillance systems, and ICD-10 codes related to HIV are listed in Annex 2.

1. Obtaining cause-of-death information for HIV/AIDS

This chapter describes the standard procedures required for medical certification of the cause of death and specifically addresses issues related to the correct coding of HIV-related mortality, using the *International Statistical Classification of Diseases and Related Health Problems tenth revision* (ICD-10) (7). The second part of this chapter presents methods to ascertain the cause of death when medical certification is not possible. This is the case for the majority of deaths in sub-Saharan Africa, as they occur at home without the presence of a medical doctor before or after death. Reporting of HIV/AIDS-related deaths should follow the reporting and coding rules of the ICD-10, to ensure comparability of the data. If this rule is also followed in surveillance sites, the data on frequencies of deaths will be more comparable with vital registration data. In addition, the surveillance sites can continue to record more information and analyse cases using other criteria, as desired.

1.1 Medical certification in line with the International Classification of Diseases

International Classification of Diseases

The International Classification of Diseases (ICD) is a classification system developed by WHO that provides codes to classify diseases and a wide range of signs and symptoms, abnormal findings and external causes of injury or disease (6). It is the standard diagnostic tool for epidemiology, health management and clinical purposes. It contains about 14 000 different categories and is used to classify diseases and other health problems recorded on many types of health and vital records, including death certificates, and the reasons for primary, secondary and tertiary health-care encounters. Use of the ICD allows comparability of morbidity and mortality statistics across countries and contributes to a better understanding of the health of nations over time.

The ICD is revised periodically and is currently in its tenth edition (ICD-10) (7), which has been implemented or is in the process of being implemented in most countries. The 11th revision is currently being developed and is scheduled to be presented at the World Health Assembly in 2017.

The ICD includes coding rules for causes of death. These rules allow a coder to identify the single condition on the death certificate that is considered most informative from a public health point of view, called the “underlying cause of death”. The coding rules also play the important role of compensating for errors in the cause-of-death statement.

The ICD-10 includes:

- definitions such as “underlying cause of death”, “live birth”, “maternal death” and many others;
- “tabulation” lists, which indicate the cause-of-death groupings that countries should use to present mortality data that can be compared among countries;
- a prescribed format for the medical certification of death in the “international form of medical certificate of cause of death”, which is reflected in a two-part section on medical certification of death that should be part of every death certificate (see Box 2);
- rules regarding the compilation and publication of statistics on diseases and causes of death. These regulations require, for example, that member states use the ICD-10 for compiling mortality, including collecting, coding, age grouping and definitions, and in other statistics systems.

An index to the ICD-10 contains terms as they are reported on death certificates or medical records. It allows identification of the appropriate ICD category. A set of rules regulates the selection of the single underlying cause of death, in order to uniformly identify the single underlying cause of death for public health purposes. The single underlying cause of death is defined as “the disease or injury which initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury”, in accordance with the rules of the ICD-10.

The single underlying cause of death should be used for primary tabulation of public health statistics. From the public health perspective, it is necessary to specify the chain of events, distinguishing the precipitating or underlying cause from consequences of the condition. For example, for someone who suffered from gangrene, vision loss and diabetes and died subsequently, the underlying cause of death is diabetes.

Death rarely results from only one cause, and it can be caused by a variety of factors. Multiple cause-of-death statistics refer to statistics that include both underlying and associated causes of death. Multiple cause statistics provide complete information about conditions that frequently appear as a multiple cause of death, but that rarely appear as an underlying cause. Statistics on multiple causes of death can provide a more comprehensive and ultimately insightful view of mortality patterns than single underlying cause-of-death statistics. Analysis of data on multiple causes of death can provide information on associations between causes of death, revealing common combinations of events or conditions that lead to death. Multiple-cause-of-death data files can list as many as 20 contributing causes of death in addition to the reported underlying cause of death.

The presentation of multiple causes of death in tables depends on the purpose of such a tabulation. It is fundamental to show, for each cause or grouping of causes, the frequency of being selected as an underlying cause. Additional tabulations may show other relationships between sets of selected causes. Multiple cause-of-death analysis requires full electronic records of death certificates that allow access to the multiple coded causes that were reported, by case. However, standardization of the process is only in the early stages.

Box 2. International form of medical certificate of cause of death

The ICD's mechanisms for standardizing the procedures around causes of death include a medical certificate of cause of death form, which is described in volume 2 of the ICD-10 (7). A properly completed death certificate shows clearly why and how the death occurred. Entries on the form are coded and a single underlying cause is selected, following the rules specified in the ICD-10. The medical certificate of cause of death form is usually complemented with additional administrative information, as recommended by the United Nations or required by the relevant legislation.

It is the responsibility of the certifier, ideally a medical practitioner, filling in the death certificate to indicate which morbid condition(s) led directly to death and to state any antecedent condition(s) giving rise to this cause. The medical certificate is designed to facilitate selection of the underlying cause of death when two or more causes are recorded.

In completing the certificate, the medical practitioner or other qualified certifier should use his or her clinical judgement to report any disease, abnormality, injury or external cause that is believed to have contributed to the death. The medical part of the form is split into two parts: part I is for diseases related to the train of events leading directly to death, and part II is for unrelated but contributory conditions. In addition, there is a section to record the time interval between the onset of each condition and the date of death. Modes of dying – such as respiratory failure, heart failure, or brain death – should not be considered causes of death and therefore should not be listed on the certificate. Automated systems or paper forms must not include lists or other prompts that suggest selection of causes or codes, as they limit the range of diagnoses and therefore have an adverse effect on the accuracy and usefulness of the report. The example form shown in Fig. 1 includes the core medical certificate and indicates the additional information that should be collected. In order to align the way this information is collected internationally, the form should be followed as closely as possible.

Part I of the certificate

Part I of the certificate provides four lines on which the sequence of events leading to death are recorded. This space is used for diseases that are related to the sequence of events leading to death. The direct or immediate cause of death is entered on the first line, i.e. I(a). There must always be an entry on line I(a). The entry on this line may be the only condition reported in Part I. Where two or more conditions must be recorded, the sequence of events leading to death should be entered. Each event in the sequence should be recorded on a separate line.

The condition recorded on the lowest used line of Part I of the certificate is usually the underlying cause of death used for tabulation. However, the procedures for selection of the underlying cause of death outlined below may result in selection of another condition as the underlying cause of death. To differentiate between these two possibilities, the expression "originating antecedent cause" (originating cause) is used to refer to the condition proper to the last used line of Part I of the certificate, and the expression "underlying cause of death" will be used to identify the cause selected for tabulation.

If there is only one step in the chain of events leading to death, a single entry on line I(a) is sufficient. If there is more than one step, the direct (immediate) cause is entered on line I(a) and the originating antecedent cause is entered on the lowest line, with any intervening cause entered on line (b) or on lines (b) and (c). An example of a death certificate with four steps in the chain of events leading directly to death is:

- I(a) Pulmonary embolism – line (a) disease or condition immediately (directly) leading to death;
- I(b) Pathological fracture – line (b) disease or condition, if any, leading to (a);
- I(c) Secondary carcinoma of femur – line (c) records the other disease or condition, if any, leading to (b);
- I(d) Carcinoma of breast – line (d) records the other disease or condition, if any, leading to (c).

Occasionally, two independent diseases may be thought to have contributed equally to the sequence at a particular point. In such circumstances, they may be entered on the same line.

Part II of the certificate

Part II of the certificate is used to record conditions that have had no direct connection with the events leading to death but that, by their nature, contributed to the death.

Reporting the duration of conditions

The duration of the disease or condition is the interval between the onset of each condition entered on the certificate (not the time of the diagnosis of the condition) and the date of death; the interval is recorded in the column to the right of the disease or condition. The best estimate of the interval should be recorded when the time or date of onset is not known. The unit of time should be entered for each diagnosis – whether it is years, months, days, hours, minutes, or unknown. In a correctly completed certificate, the duration entered on each line will not exceed the duration entered for the condition on the line underneath (the condition that preceded it), since the causal sequence requires that antecedent conditions are reported in reverse order of their occurrence. On the form, this means conditions are reported in an ascending sequence (see Fig. 1). The information on duration is useful in coding certain diseases and provides a check on the accuracy of the reported sequence of conditions.

Fig. 1. Medical certificate of cause of death form

Core – Part I and Part II

Administrative data (can be further specified by country)			
Sex <input type="checkbox"/> Female <input type="checkbox"/> Male <input type="checkbox"/> Unknown		Age under 24 hours <input type="checkbox"/>	
Date of birth DD / MM / YYYY		Date of birth DD / MM / YYYY	
Medical data: Part I and Part II			
I. 1. Report disease or condition directly leading to death on line a 2. Report chain of events in due to order (if applicable) 3. State the underlying cause on the lowest used line	Due to	Cause of death	Time interval from onset to death
	a		
	b		
	c		
II. Other significant conditions contributing to death (time intervals can be included in brackets after the condition)			

This shows the core part of the medical certificate of cause of death. This format is essential, in order to be able to apply the rules for the selection of the single underlying cause of death.

Additional information

Was surgery performed within the last 4 weeks? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown
If yes please specify date of surgery DD / MM / YYYY
If yes please specify reason for surgery (disease or condition)
Was an autopsy requested? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown
If yes were the findings used in the certification? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown

Manner of death		
<input type="checkbox"/> Disease	<input type="checkbox"/> Assault	<input type="checkbox"/> Could not be determined
<input type="checkbox"/> Accident	<input type="checkbox"/> Legal intervention	<input type="checkbox"/> Pending investigation
<input type="checkbox"/> Intentional self-harm	<input type="checkbox"/> War	<input type="checkbox"/> Unknown

If external cause or poisoning
Date of injury DD / MM / YYYY
Please describe how external cause occurred (if poisoning, please specify poisoning agent)

Place of occurrence of the external cause			
<input type="checkbox"/> At home	<input type="checkbox"/> Residential institution	<input type="checkbox"/> School, other institution, public administrative area	<input type="checkbox"/> Sports and athletics area
<input type="checkbox"/> Street and highway	<input type="checkbox"/> Trade and service area	<input type="checkbox"/> Industrial and construction area	<input type="checkbox"/> Farm
<input type="checkbox"/> Other place (please specify):			<input type="checkbox"/> Unknown

For women, was the deceased pregnant? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown	
<input type="checkbox"/> At time of death	<input type="checkbox"/> Within 42 days before the death
<input type="checkbox"/> Between 43 days up to 1 year before death	<input type="checkbox"/> Unknown
Did the pregnancy contribute to the death? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown	

This additional section of a death certificate asks for information that is frequently omitted when filling in the certificate. This information is essential to accurate coding of the cause of death.

Detail for stillbirths and liveborn infants dying within 168 hours (1 week) from birth

Identifying particulars		
Child was born live on	DD / MM / YYYY at hh:mm	hours
and died on	DD / MM / YYYY at hh:mm	hours
This child was stillborn on <input type="checkbox"/> and died before labour <input type="checkbox"/> during labour <input type="checkbox"/> not known	DD / MM / YYYY at hh:mm	hours
Mother		
Date of birth DD / MM / YYYY	or, if unknown, age (years) YYYY	
Number of previous pregnancies		
Livebirths:	Stillbirths:	Abortions:
Date of last pregnancy		
DD / MM / YYYY		
Outcome of last previous pregnancy		
<input type="checkbox"/> Live birth	<input type="checkbox"/> Stillbirth	<input type="checkbox"/> Abortion
1st day of last menstrual period		
DD / MM / YYYY	or, if unknown, estimated duration of pregnancy (completed weeks)	
Delivery:		
<input type="checkbox"/> Normal spontaneous vertex	<input type="checkbox"/> Other (specify)	
Antenatal care, two or more visits:		
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Not known
Attendant at birth		
<input type="checkbox"/> Physician	<input type="checkbox"/> Trained midwife	
<input type="checkbox"/> Other trained person	<input type="checkbox"/> Other	
Specify	Specify	
Child		
Birth weight (grams)		
<input type="checkbox"/> Single birth	<input type="checkbox"/> First twin	<input type="checkbox"/> Second twin
<input type="checkbox"/> Other multiple (specify)		
Conditions of the mother affecting the child		

This additional section of a death certificate asks for information that is relevant in the assessment of perinatal deaths.

Ensuring good-quality information on cause-of-death information

In order to ensure good-quality cause-of-death information from medical certification, all involved staff need to be trained, and work and data flows should be clearly specified (see Box 3). Further, the international form of medical certificate of cause of death of the ICD-10 (see Box 2) should be used as prescribed, to ensure that ICD rules can be applied.

Box 3. Death certification

An experienced medical practitioner should provide the information on a death certificate. This practitioner should be well informed about the medical history of the deceased person and should carefully carry out a postmortem examination. In some jurisdictions, another official (who may not be medically trained) is responsible for completion of the medical certificate of cause of death.

In all settings, the medical practitioner, or other qualified certifier, should use their clinical judgment in completing the medical certificate of cause of death.

All entries should be typed or written legibly in black ink, without the use of abbreviations, alterations or erasures. As much detail as possible should be recorded, so that it can be used to assign complete and specific codes from the ICD-10.

In the case of accidents, injuries or poisonings, the external cause should be reported as the underlying cause. The mode of dying, such as cardiac arrest or respiratory failure, should not be reported as the direct (immediate) cause of death.

If the cause of death is unknown, even after investigation, it is correct to record it as "unknown". Alternatively, and particularly in the case of accidents, unexpected deaths or violent deaths, a coroner or some other legal authority, in addition to the staff mentioned previously, may provide the information on the death certificate.

Training

A routine training programme should be established, to ensure that reporting physicians understand the purpose of and correct methods for medical certification of cause of death. Staff that code the reported diagnoses need to be trained in the use of the ICD and how to apply the rules for selection of the single underlying cause of death. International training materials are listed in Annex 1.

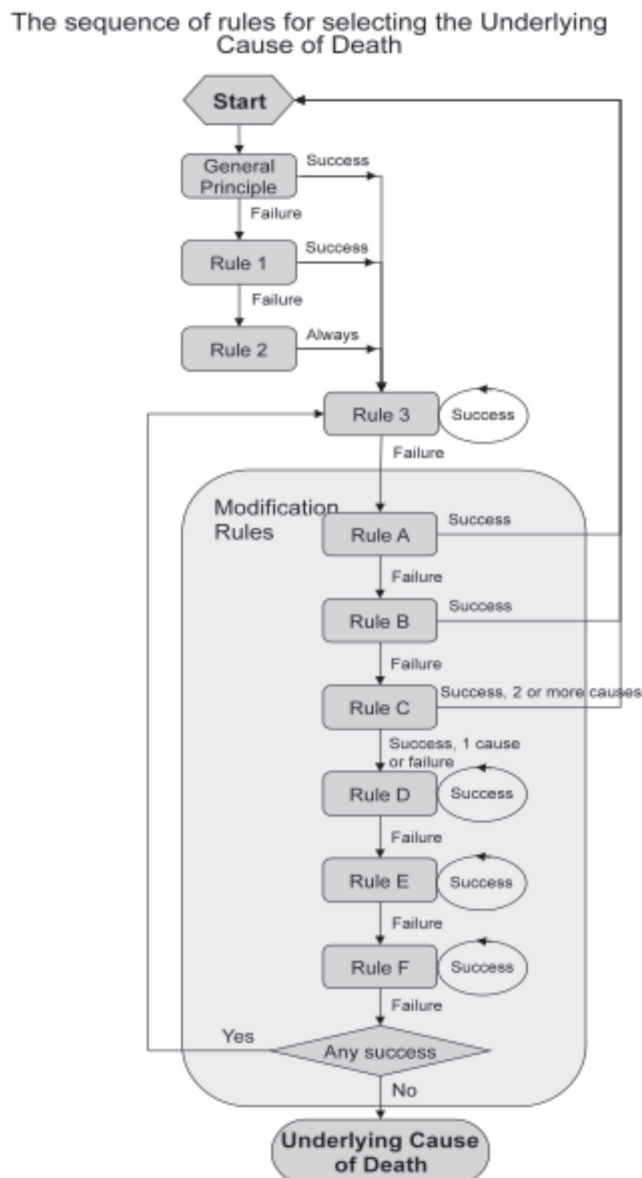
Structure

Cause-of-death reporting is ideally linked to death-certification processes, to ensure timeliness in reporting and a seamless feedback loop. Accordingly, the workflow must clearly define coordination between death notification processes, timely attendance of the deceased by a physician, and routing of the information contained in the death certificate to authorities in charge of civil registration. Workflows should ensure that staff at all levels have enough time assigned for reporting and coding. Centralization of coding processes is recommended, to ensure that the coding staff receive and process a sufficient number of deaths to maintain their skills, and that there is a large enough pool of staff to compensate for staff leave or job changes. Written arrangements and interagency agreements between the relevant authorities, at a high level, will lay the foundations for seamless technical collaboration.

Storage and processing of cause-of-death data and selection of underlying causes of death

Ideally, the death certificates should be stored electronically. The datasets would include age, sex, causes and durations and their position on the death certificate. Appropriate mechanisms should ensure confidentiality, authenticity and authorization prior to access to the data; that the information stored is based on the international form of medical certificate of cause of death; that the reported diagnoses are coded; and that a standard set of ICD rules (see Fig. 2) is applied for selection of the single underlying cause of death. Such mechanisms serve to eliminate reporting errors and to select the single underlying cause of death in a standardized way, for international comparison.

Fig. 2. The steps involved in selection of the single underlying cause of death*



*Application of these steps requires considerable training; use of automated systems is ideal.

The process for coding and selecting the single underlying cause of death is complicated and is best assisted by software for automated coding of the cause of death. Full details on coding procedures are beyond the scope of this guidance document, but can be found in the ICD-10, volume 2, instruction manual (see Annex 1) (8). Some countries have designed their own automated systems. However, Iris¹ is the only international automated system for coding causes of death and selection of the underlying cause of death (9). Aiming to improve international comparability, Iris provides a system in which the language-dependent aspects are not included in the software itself but rather are stored in separate database tables that can easily be modified. Iris can be used in batch mode or interactively and requires reporting with the international form of medical certificate of cause of death. The causes of death are then coded according to the ICD rules. Iris can be used in two modes. In the code-entry mode, the user enters ICD-10 codes corresponding to the conditions reported on the death certificates. Iris then selects the underlying cause of death. In this mode, Iris is ready for use as soon as it is installed. In the text-entry mode, the user enters the causes of death in

1 Iris refers to the Greek goddess of the same name.

free text, as they are reported on the death certificate. For text-entry coding, a dictionary that translates text into ICD-10 codes is required. The advantage of including a dictionary is that once a decision has been made on which ICD-10 code to use for a specific diagnostic expression, the expression will be coded in the same way each time it occurs on a death certificate. Iris also provides means for language standardization (regular expressions as part of its dictionaries), which considerably reduces the size of the dictionary.

A formerly widely used automated system for selection of underlying cause of death is the United States of America (USA) Mortality Medical Data System (MMDS). Iris decision rules for selecting the underlying cause of death were originally based on the MMDS; however, the international components of MMDS are no longer maintained, and the future of MMDS is uncertain.

Quality assurance

Information from cause-of-death certification is used for policy-making, determining need for prevention programmes, resource allocation, and monitoring trends indicating the level of success of a health system. Therefore, local feedback about causes of death, and training of physicians on certification of causes of death, are the most efficient mechanisms to ensure the quality of the reported causes of death. Plausibility checks by sex and age, and feedback of the statistics on causes of death to the reporting physicians, will ensure that errors in the data can be identified and corrected. Local feedback also increases the motivation to invest time in accurate examination of deaths and reporting of the causes.

Causes of death collected from medical certification, as prescribed by the ICD-10, are the most reliable source of mortality data. All steps are standardized, from reporting to the selection of a single underlying cause of death. Deaths need to be reported in order to be able to register them and to mobilize a physician to assess the cause of death. However, physician availability in a given population may not be sufficient to ensure attendance by a physician to examine the deceased and to report the cause(s) of death. Local traditions (e.g. a requirement to incinerate a deceased person within 24 hours) may greatly reduce the time available for examining and certifying death. Government commitment is required to allocate resources for a well-functioning system of death reporting, registration and certification of cause of death. Linkages between the health sector and formal death-registration processes require national regulations and carefully coordinated workflows that ensure the availability of skilled physicians to assess the cause of death. Options for getting cause-of-death information in the absence of medical certification are discussed in Section 1.2 on verbal autopsy.

Regarding HIV, reported frequencies suggest that there is underreporting. This may be because of structural issues, as well as limited understanding of death certification. Physicians and other certifiers are frequently reluctant to enter HIV infection as the underlying cause of death, owing to issues of stigma and/or the potential for legal consequences. Furthermore, some insurance policies may not pay out for HIV/AIDS-related deaths, and doctors may avoid listing HIV infection, in an attempt to protect the confidentiality of their patients' information. Transparent legal regulations and mechanisms that safeguard confidentiality, and related training of certifiers and relatives about confidentiality, will help to overcome this source of underreporting.

In summary, the level of medical certification of the cause of death globally is heterogeneous. For good-quality cause-of-death information, countries need to have appropriate legislation and data-collection mechanisms in place and to ensure that adequate resources are allocated to this activity. Physicians need to be trained – ideally repeatedly – on postmortem examination and cause-of-death reporting. Software-supported reporting and coding will facilitate the coding, application of rules and timely production of data. Electronic storage of whole death certificates will also enable multiple cause analysis – helping to solve, for example, issues of reporting cases of maternal HIV/AIDS, or cases of both TB and HIV/AIDS.

Coding HIV/AIDS mortality with the ICD

This section addresses coding of HIV reported in combination with frequent and otherwise important conditions. In order to improve HIV/AIDS mortality surveillance, both certifying medical staff and coding staff should be fully trained on the specific situations described in this section (see Annex 1, for ICD-10 interactive self-learning tool). The ICD-10 codes involved are presented in Annex 2; additional information on general ICD-10 coding procedures can be found in the ICD-10 volume 2 (8) (see Annex 1). For all deaths,

the medical certificate of cause of death must be filled in completely; the certifier should never select or guess one single condition out of a set that affected the deceased, even if, in some instances there is a temptation to do so (see also the earlier sections detailing how to fill in a death certificate).

HIV and encephalopathy or dementia

The B22.0 code for cause of death is used when there is a history of confusion, dementia and loss of consciousness lasting more than 1 day, or where there are other central nervous system manifestations, such as stroke associated with HIV.

HIV and neoplasms

A malignant neoplasm should not be accepted as “due to” any other disease, except HIV.

Kaposi sarcoma, Burkitt lymphoma and any other malignant neoplasm of lymphoid, haematopoietic and related tissue, classifiable to C46.– or C81 to C96, should be considered to be a direct consequence of HIV, where this is reported. No such assumption should be made for other types of malignant neoplasm.

Where HIV presents with Kaposi sarcoma and an infection, this complication is not coded separately but is included in the multiple-infection category. In cases where Kaposi sarcoma is the sole complication of HIV, the appropriate ICD-10 code is B21.0.

Example

I(a) Kaposi sarcoma

(b) AIDS

(c)

(d)

II

Select HIV resulting in Kaposi sarcoma (B21.0).

Example

I(a) Cancer of ovary

(b)

(c)

(d)

II HIV

Select malignant neoplasm of ovary (C56).

Paediatric HIV

The ICD-10 does not provide specific codes for classifying cause of death from HIV in children. Owing to difficulties in diagnosing HIV in children in clinical practice, let alone during verbal autopsy, the following guidelines should be used to assign a cause of death in children who had HIV.

HIV should be assigned as a cause of death in cases in which there were:

- clinical symptoms suggesting HIV in the child, in the absence of other obvious causes of immune suppression (for example, malnutrition);
- clinical symptoms suggesting HIV and a family and social history suggesting HIV (for example, parental death due to HIV), including cases where the child’s mother was sick at the time the child died; or
- clinical symptoms suggesting HIV and the attending physician had requested an HIV test to confirm the diagnosis.

Maternal HIV: pregnancy, childbirth and puerperium

Maternal deaths are the most frequent cause of death among women of reproductive age in most low- and middle-income countries. It is important that those who certify and code deaths are clear about what constitutes a maternal death and what constitute the direct and indirect causes of the death. The definitions related to maternal deaths are provided in volume 2 of the ICD-10 (8) and, for uniformity, should always be used.

A death is classified as a “maternal death” if a woman dies while she is pregnant, or within 42 days of terminating a pregnancy, irrespective of the duration or site of pregnancy; maternal deaths may result from any cause related to pregnancy – but not from accidental or incidental causes. “Late maternal death” refers to a death occurring from 42 days to 1 year after the termination of a pregnancy.

A “pregnancy-related death” is one that occurs during pregnancy or within 42 days of delivery, irrespective of the cause of death.

HIV patients may die “from AIDS”, or “with HIV”. Temporal to pregnancy, it is useful to distinguish those deaths of HIV-infected women that should be considered maternal deaths.

Women may die from obstetric causes, for example, incomplete abortion, complicated by haemorrhage or tetanus, or an ectopic pregnancy. These deaths are considered direct maternal deaths. In these cases, their HIV infection or AIDS may have coexisted with their death, but it is not considered as the underlying cause of death.

In contrast, “indirect maternal HIV deaths” are deaths of HIV-infected women who die because of the mutually aggravating effect of pregnancy and HIV. These cases are coded as O98.7. Only the certifying physician can assess the mutual aggravation, and only proper reporting of the mutual influence of HIV or AIDS and pregnancy in Part I of the certificate will guide the coders. The certifying physician should assess all these cases carefully. Only selected cases should be coded to O98.7.

A woman with HIV may die of one of the fatal complications of HIV or AIDS while pregnant. This is a rare event, since such severe illness makes pregnancy unlikely. An example may be when a woman who is HIV-positive and is in early pregnancy dies as a result of HIV wasting syndrome. Here the pregnancy is incidental to her cause of death, which is HIV wasting syndrome. In these rare cases, HIV or AIDS is selected as the underlying cause of death, and the appropriate code in block B20 to B24 of the ICD-10 selected. These are termed “HIV-related deaths to women during pregnancy, delivery or puerperium” and are not considered maternal deaths.

Classifying each and every case in terms of HIV status will give a clearer picture of the role of HIV and AIDS in maternal deaths. The convention of using O98.7 to describe indirect maternal deaths, and appropriate B codes to describe deaths of women when HIV or AIDS is the underlying cause and where pregnancy is incidental, will reduce confusion and standardize statistical tabulation.

HIV and infections

Besides the exceptions mentioned below, any infectious disease classifiable to A00–B19, B25–B49, B58–B64, B99 or J12–J18 should be considered to be a direct consequence of reported HIV.

Typhoid and paratyphoid fevers, other *Salmonella* infections, shigellosis (A01–A03) and TB (A15–A19) may be accepted as “due to” HIV disease, if so reported. In such cases, a code from the range B20–B24 would be selected.

However, the following infectious and parasitic diseases should not be accepted as “due to” HIV (or any other disease or condition, including malignant neoplasms or immunosuppression):

- cholera (A00)
- botulism (A05.1)
- plague, tularaemia, anthrax, brucellosis (A20–A23)
- leptospirosis (A27)
- tetanus, diphtheria, whooping cough, scarlet fever, meningococcal disease (A33–A39)
- diseases due to *Chlamydia psittaci* (A70)
- rickettsioses (A75–A79)
- acute poliomyelitis (A80)
- Creutzfeldt–Jakob disease (A81.0)
- subacute sclerosing panencephalitis (A81.1)
- rabies, mosquito-borne viral encephalitis, tick-borne viral encephalitis, unspecified viral encephalitis (A82–A86)

- dengue haemorrhagic and other mosquito-borne viral fevers (A91–A92)
- yellow fever (A95)
- Junin and Machupo haemorrhagic fevers, Lassa fever (A96.0–A96.2)
- other viral haemorrhagic fevers (A98)
- smallpox, monkeypox, measles, rubella (B03–B06)
- acute hepatitis B and C (B16–B17.1)
- mumps (B26)
- malaria, leishmaniasis, trypanosomiasis, Chagas disease (B50–B57)
- sequelae of tuberculosis (B90)
- sequelae of poliomyelitis (B91)
- sequelae of leprosy (B92)
- sequelae of trachoma (B94.0)
- sequelae of viral encephalitis (B94.1)
- sequelae of viral hepatitis (B94.2).

Malaria

Malaria that has been clinically diagnosed (or suggested by verbal autopsy) is coded B54. For cerebral malaria, the physician should seek to exclude other sources of encephalopathy, including HIV. When a sequence of conditions that is reported on a death certificate is examined in order to identify the single underlying cause of death, malaria should not be accepted or reported as being “due to” HIV.

HIV and tuberculosis

HIV may present with many complications and infections, each with its own unique cause of death, from B20 (Human immunodeficiency virus [HIV] disease resulting in infectious and parasitic diseases) to B24 (Unspecified human immunodeficiency virus [HIV] disease). Even though the fourth-character subcategories of B20–B23 in the ICD-10 are provided for optional use, it is important to differentiate between TB with HIV and TB alone, when possible.

The clinical picture may not always allow differentiation between an HIV infection and TB. It is only possible to be certain about the diagnosis with evidence from HIV serology testing and sputum smear testing for TB bacilli – a patient with symptoms and signs suggestive of HIV or TB, but who has a negative HIV serology test and a positive bacteriological sputum culture, has TB but not HIV. In many cases, the two conditions coexist, and in such cases – mostly – TB is caused by HIV and thus “HIV resulting in mycobacterial disease” is the single underlying cause of death.

A definitive diagnosis of TB can be made only in cases where an acid-fast bacillus smear identifies the disease, typically from sputum. In low-income countries, such information is rarely available in the medical records of the deceased. When deciding whether TB is an appropriate diagnosis, the physician should interpret the clinical signs and the history with caution, and try to find out whether the deceased:

- was sputum positive for acid-fast bacillus;
- had a chest X-ray that suggested pulmonary TB;
- had been taking anti-TB drugs;
- had a history suggestive of TB, for example, a cough lasting longer than 1 month, wasting, or prolonged fever (in cases in which the deceased had fevers, it is difficult to differentiate between TB and HIV).

Considering the public health importance of TB, and in order to maintain uniformity in assigning causes of death, the following four-character categories should be used for HIV with TB in cases where neither the sequence can be identified nor a single cause selected.

Example

- I(a) Tuberculosis
- (b) HIV
- (c)
- (d)
- II HIV

Correctly filled in certificate; HIV resulting in mycobacterial infection (B20.0) is selected as single underlying cause of death.

Example

- I(a) Tuberculosis
- (b)
- (c)
- (d)
- II HIV

The certificate is probably not correctly filled in; ICD-10 coding and selection rules ensure that HIV resulting in mycobacterial infection (B20.0) is selected as the single underlying cause of death.

HIV disease resulting in multiple diseases classified elsewhere (B22.7)

This subcategory should be used when conditions classifiable to two or more categories from B20 to B22 are listed on the death certificate. If desired, additional codes from within the block B20–B24 may be used to specify the individual conditions listed.

HIV resulting in multiple infections

The B20.7 code, “HIV disease resulting in multiple infections”, for cause of death should be used where there is evidence of more than a single infection occurring in a patient with HIV; these infections may include candidiasis, mycoses or parasitic diseases.

Using this code for the cause of death when there is more than one infection helps to avoid assigning several causes of death (one for each type of associated infection), builds uniformity and facilitates a consensus among coders.

Where there is evidence of TB or other disease in addition to HIV, the cause of death B20.0 (HIV disease resulting in tuberculosis) is used. In cases of HIV where only one infection has been identified, such as candidiasis, then the cause of death assigned is B20.4 “HIV disease resulting in candidiasis”. See the next section for information about coding for Kaposi sarcoma.

Example

- I(a) Cerebral toxoplasmosis and herpes zoster
- (b) Burkitt lymphoma, HIV
- (c)
- (d)
- II

In this death certificate, HIV disease resulting in multiple diseases classified elsewhere (B22.7) is selected as the single underlying cause of death. Cerebral toxoplasmosis, selected by some of the additional rules in the algorithm shown in Fig. 2 (rule 2 – see ICD-10 volume 2 (8)), is considered a direct consequence of HIV.

Blood transfusion

When a blood transfusion is given as treatment for any condition (e.g. a haematological disorder) and an infected blood supply results in an HIV infection, then HIV should be coded as the underlying cause and not the treated condition.

Also, diseases of the blood and blood-forming organs, and certain disorders involving the immune mechanism (D50–D89), may be reported on a death certificate as the cause of Human immunodeficiency virus [HIV] disease (B20–B24) and the certificate indicates that the HIV is a result of a blood transfusion given as treatment for the originating condition. In this case, the code should be HIV (B20–B24).

Example

- I(a) Kaposi sarcoma, 1 year
 - (b) HIV, 3 years
 - (c) Blood transfusion, 5 years
 - (d) Haemophilia, since birth
- ICD-10 rules will select as the underlying cause HIV (B20–24).

Example

(a) Pneumocystis carinii [jirovecii], 6 months

(b) HIV, 5 years

(c) Ruptured spleen, 7 years

(d) Assault – fist fight, 7 years

ICD-10 rules will select as the underlying cause HIV (B20–24).

Antiretroviral therapy

ART may have undesired effects. In such cases, the ICD-10 has categories in more or less every organ system to identify the effects of acute or chronic toxicity of substances. Some examples are given in Annex 2 for most known frequent chronic or acute side-effects of ART – though the ICD-10 has many more categories. Coding in such cases would identify the kind of organ problem, allowing use of an additional code (if desired or possible) to identify the drug. For selection of the underlying cause of death, this means that unless there has been an anaphylactic reaction, cases of death from chronic complications of ART would still be coded to HIV (B20–B24).

1.2 Verbal autopsy

Verbal autopsy has become an important source of information about causes of death in populations lacking civil registration and medical certification. Verbal autopsy is an interview carried out with family members and/or caregivers of the deceased, using a structured questionnaire to elicit signs and symptoms and other pertinent information that can later be used to assign a probable underlying cause of death.

Verbal autopsy is now carried out in many settings around the world. In some countries, it is used to complement medical certification. Verbal autopsy is also used in health and demographic surveillance sites (longitudinal community studies), sample or sentinel registration systems, and censuses or national household surveys.

Verbal autopsy is applied in three main ways:

1. as a research tool in the context of longitudinal population studies, intervention research or epidemiological studies, usually in children or to determine maternal cause(s) of death;
2. as a source of cause-of-death statistics to meet the demand for population-level estimates of disease burden, to be used in policy, planning, priority-setting and benchmarking (as in global burden of disease studies);
3. as a source of cause-of-death statistics, to be used for monitoring progress and measuring programme impact.

It is important to note that while verbal autopsy can be an essential public health tool for obtaining a reasonable direct estimation of the cause structure of mortality at a community or population level, it may not be an accurate method for attributing causes of death at the individual level.

Data collection

In order to achieve comparability over time, WHO has designed standardized verbal autopsy instruments that serve different purposes. An extensive, detailed instrument was published in 2007 and focuses more on research. The 2007 WHO set of verbal autopsy standards were based on a comprehensive review of all instruments in use at the time (10). A separate questionnaire is used for neonate deaths (under 28 days old), for deaths of children aged 28 days to 14 years, and for deaths of adults age 15 years and above. This standard instrument has been applied in many research settings, including the INDEPTH health and demographic surveillance sites (11).

In 2012, a simplified instrument derived from the 2007 version for routine use was released (12), and this is being updated in 2014 to allow the use of different analytical software systems that assess the cause of death (including InterVA and the Population Health Metrics Research Consortium's Tariff method). This simplified instrument reduces the number of questions and the interview time by 30–40% and has been designed for routine use in non-research settings such as civil registration systems. The format of the

source questionnaires allows easy implementation on mobile devices, using tablets or cellphones, to collect and transmit the data. Further information on this instrument and the manual is available in Annex 1.

The quality of information recorded during a verbal autopsy depends on the memory of the respondents and the skills of the interviewers. Questions must be locally adapted in each setting, to account for the effect of culture and language on participants' understanding of and response to questions. While this adaptation can be readily achieved, it must be done with caution, in order to maintain the comparability of verbal autopsy results over time and across populations.

Attributing cause of death

The 2007 WHO verbal autopsy standards (10) expect that up to three physicians trained in verbal autopsy coding would independently review individual questionnaire data; this is known as physician-certified verbal autopsy (PCVA). However, this method is time consuming and expensive.

The 2012 instrument addresses recent developments in computerized coding of verbal autopsy (CCVA) methods for interpreting verbal autopsy data and hence reduces the time and effort necessary to determine the cause of death. In this way, CCVA becomes feasible for routine use and an acceptable alternative to PCVA. Validation studies suggest that automated methods provide results that are just as good as, or better than, physician coding (13, 14).

Box 4 provides an overview of current verbal autopsy analysis software tools for attributing cause of death.

Box 4. Computerized ascertainment of cause of death using coding of verbal autopsy data

CCVA methods can be algorithmic or probabilistic. Algorithmic methods follow a set of predefined diagnostic criteria that can be expert or data derived, resulting in binary outcomes (yes or no) for a single cause of death; probabilistic methods use predefined probabilities to determine the probability of a range of causes.

The development of validated, reliable and accurate CCVA methods remains an active area of research, and multiple methods exist and are regularly being revised and improved. Currently, InterVA is the most widely used CCVA method. Available since 2006, InterVA has been applied in different settings, including in the INDEPTH Network of health and demographic surveillance sites (11). InterVA is based on a set of expert-derived indicators and uses Bayesian probabilistic modelling with a set of predefined probabilities for a specific cause-of-death list. It is currently in its fourth version (14). An application for mobile data collection using the 2012 WHO verbal autopsy instrument (12) is in development.

Other methods have been based on a large standard dataset from a multicountry study conducted by the Population Health Metrics Research Consortium (13). The dataset comprises hospital deaths, where good-quality diagnostic information was available to inform the cause of death with reasonable certainty. Only a small proportion of the deaths in the standard dataset are from Africa, where HIV and malaria are much more common compared to any of the other study sites. Among a variety of proposed analytical methods, the tariff method is one of the most attractive options that has been tested with the standard dataset. This method uses an additive algorithm based on "tariff" scores that reflect the relative contribution of each symptom to each cause of death. Therefore, the tariff method allows the user to assess the appropriateness of the weights assigned to each symptom associated with a cause of death.

It is important to note that the list of causes of death that can be assessed by verbal autopsy is only a small sample of the list of causes used on medical certificates. Large cause categories such as "rash disease" or "diarrhoeal diseases" have little value when more specific information is needed to plan appropriate public health interventions (e.g. targeting interventions for measles versus chickenpox, or for cholera or dysentery versus acute watery diarrhoea or chronic diarrhoea).

Another consideration for attributing cause of death for verbal autopsy is how the overall cause-specific mortality fraction is constructed. Some projects use a probabilistic approach to distribute a single death to several causes, which prohibits comparisons with other studies. Furthermore, some projects distribute deaths of “other” and “unknown” cause among the causes already assessed, which may bias results.

Methods used to ascertain the cause of death for verbal autopsy should be fully and clearly documented. Finally, cause-of-death information resulting from verbal autopsy should always be analysed separately from cause-of-death information resulting from medical certification of the cause of death.

HIV and AIDS

The performance of a verbal autopsy instrument depends on the sensitivity and specificity of the key symptoms for the diagnosis of a given cause of death, with consideration to the specific epidemiologic profile of a given setting. While verbal autopsy works well for some diseases of high public health importance with specific symptoms (such as measles, whooping cough, tetanus, cholera and dysentery), as well as for accident and violence, the use of verbal autopsy is more problematic with diseases that have less specific symptoms but that are equally important (such as HIV in children, malaria in adults, TB and cancers).

As is the case in clinical practice, where a positive HIV serology test and positive TB bacilli sputum test are required to diagnose these conditions with any degree of accuracy, it can be very difficult to differentiate between HIV and TB using verbal autopsy. In many cases, the two conditions can coexist, but it is difficult to determine which condition is the underlying cause of death. Furthermore, determining the cause of death for these cases is further complicated by the limited information collected by verbal autopsy.

However, recent research has provided guidance for the application of verbal autopsy for assessment of HIV/AIDS mortality. An analysis of verbal autopsy data from Manicaland, Zimbabwe and Kisesa, United Republic of Tanzania aimed to identify the best set of symptoms to identify probable HIV deaths (15). The best symptoms were those with the highest sensitivity and specificity in identifying the gold standard deaths – those with known HIV status. Table 1 shows the 10 symptoms and the ways in which these symptoms are identified in the verbal autopsy instrument, and Box 5 shows the outcomes for the evaluation of AIDS symptoms.²

Table 1. Symptoms to identify probable HIV deaths, with questions in the verbal autopsy instrument

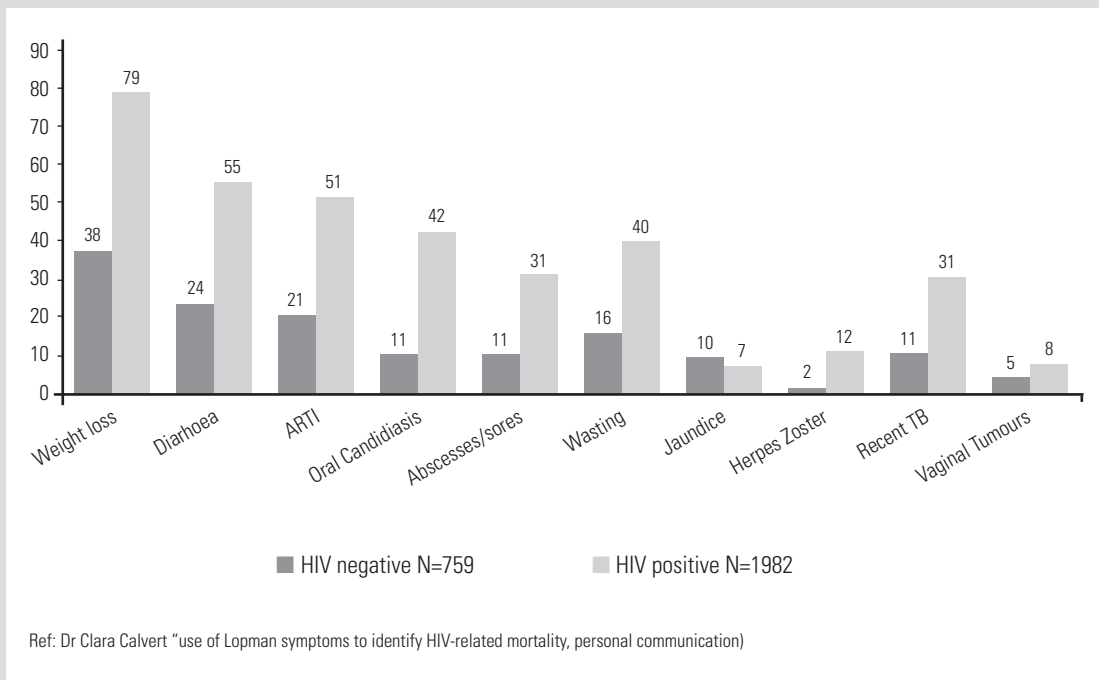
Symptom	How the symptom can be identified with questions in the verbal autopsy instrument
Weight loss	Direct verbal autopsy question
Diarrhoea	Diarrhoea with blood or diarrhoea lasting longer than 1 week
Acute respiratory tract infection	Cough and chronic pain or difficulty breathing
Oral candidiasis	Direct verbal autopsy question
Abscesses/sores	Verbal autopsy question “any skin lesions or ulcers?”
Wasting	Direct verbal autopsy question
Jaundice	Diagnosed with liver disease or any observed yellowness
Herpes zoster	Direct verbal autopsy question
Recent TB	Diagnosed with TB or (cough with blood and night sweats)
Vaginal tumours	Swollen genitals and female death

² This section is based on a presentation by Clara Calvert, “Use of Lopman symptoms to identify HIV-related mortality”, presented at a WHO meeting on “Improving cause of death and AIDS mortality measurement in Africa”, Cape Town, 15–16 November 2013.

Box 5. Evaluation of AIDS symptoms (15)

Fig. 3 shows the prevalence of symptoms for the pooled data that were collected through verbal autopsy in five health and demographic surveillance (HDSS) sites (Karonga, Malawi; Kisesa, United Republic of Tanzania; Manicaland, Zimbabwe; Masaka, Uganda; and Umkhanyakude, South Africa), by HIV status among adults aged 15–49 years. The prevalence of reported symptoms among deaths of HIV-positive individuals ranges from 79% for weight loss, 55% for diarrhoea, and 51% for acute respiratory tract infection, to just 7% for reporting herpes zoster and 8% for vaginal tumors. Among deaths of HIV-negative individuals, weight loss (38%), followed by diarrhoea (24%) and acute respiratory tract infection (21%) were the most commonly reported symptoms during the disease preceding death.

Fig. 3. Prevalence of key symptoms in adults aged 15–49 years (%; pooled data from five HDSS sites)



The sensitivity (percentage of deaths among HIV-positive individuals who had the symptom) ranges from 7.3% for jaundice to 78.6% for weight loss, shown in Table 2. The specificity (percentage of deaths among HIV-positive individuals who did not have the symptom) varies from 98.3% for herpes zoster to 62.5% for weight loss. The likelihood ratio (sensitivity divided by [100 – specificity]) is used to measure the association of a given symptom with HIV; a likelihood ratio above/below one suggests that the symptom is/is not associated with HIV. In this study, the likelihood ratio was highest for herpes zoster and oral candidiasis. Jaundice and vaginal tumours had the two lowest likelihood ratios.

Table 2. Sensitivity, specificity, and likelihood ratio for AIDS symptoms in verbal autopsy (pooled data from five HDSS sites)

Symptom	Sensitivity	Specificity	Likelihood ratio
Weight loss	78.6	62.5	2.10
Diarrhoea	55.1	76.3	2.32
Acute respiratory tract infection (ARTI)	51.2	79.1	2.45
Oral candidiasis	42.4	89.2	3.93
Abscesses/sores	31.2	88.8	2.79
Wasting	39.6	84.2	2.51
Jaundice	7.3	90.1	0.74
Herpes zoster	11.6	98.3	6.82
Recent TB	30.7	89.3	2.87
Vaginal tumours	8.0	95.3	1.70

Overall, 89% of deaths among HIV-positive individuals had at least two symptoms. Therefore, it can be concluded that, based on the symptoms indicative of AIDS-defining illnesses from verbal autopsy, 89% of deaths among HIV-positive individuals are attributable to HIV. However, the study noted that 50% of deaths among HIV-negative individuals have one or more of these symptoms.

Limitations occur, especially in high-malaria regions, for identification of cases of HIV cases and in the distinction between TB and HIV. Obviously, the presence of an HIV test result greatly improves the accuracy of the cause of death.

Conclusions

Data from verbal autopsy are traditionally used to estimate the burden of diseases of a particular age, sex or disease group. Verbal autopsy allows the causes of death to be described at the community level or population level, in instances where medical certification of the cause of death is not feasible, and it facilitates the identification of major health problems; comparisons of local and national differences in mortality ratios; monitoring of trends over time; and evaluation of interventions and health programmes.

While verbal autopsy procedures that are routinely carried are growing in importance as a source of data for populations lacking other reliable sources of routine mortality information, the usefulness of verbal autopsy depends greatly on quality and standardization. If poorly conducted, verbal autopsy can produce misleading results. The process for verbal autopsy must be standardized as much as possible – from the interview and questionnaire to the ascertainment of the diagnosis – in order to minimize and appropriately describe sources of bias. The issues of quality assurance and systematic coding are the main hurdles to overcome before universal use of verbal autopsy can be recommended. While it is still under an active and dynamic state of research and development, verbal autopsy remains the best source of mortality information in the absence of a well-functioning civil registration system and proper medical certification of the cause of death.

2. Measuring HIV-associated mortality: data sources

This chapter describes the vehicles for collection of cause-of-death information, whether this is from medical certification or verbal autopsy. This includes CRVS systems, sample and local demographic surveillance systems, household surveys with mortality modules (and verbal autopsy), hospital data on cause-specific mortality, burial systems and clinical autopsies. Often a combination of data sources is used to obtain the best picture of the patterns of cause of death in a country or specific population.

2.1 Civil registration and vital statistics systems

Civil registration is the continuous, permanent, compulsory and universal recording of the occurrence and characteristics of events, including vital events, pertaining to the population, as provided by decree or regulation, in accordance with the legal requirements of a country (16). While civil registration records are essential for administrative and legal purposes, they also provide a wealth of information for compiling vital statistics on a regular basis.

When properly functioning, CRVS systems are the most reliable source of continuous data on fertility, mortality and causes of death, allowing development of priorities for health (see Box 6). In countries that have a functioning CRVS system in place, generation of data on causes of death, including HIV/AIDS, is considered the “gold standard” for evaluating changes in mortality levels, as well as the impact of scaling up ART in reducing mortality from HIV/AIDS.

Although a CRVS system is considered the ideal system for generating such data, the reality is that only around one third of all deaths in the world are recorded in civil registries that include information on the cause of death (17, 18). There is a huge disparity in generating cause-of-death information across continents. In Asia and Africa, the continents with the largest number of deaths from HIV, capturing cause-of-death information remains a major challenge. In Africa, South Africa, Egypt, Mauritius and Seychelles are the only countries where all, or nearly all, deaths are counted with their respective cause-of-death information. Some countries in this continent have such data only for health facilities or a limited part of their population.

Box 6. CRVS operations

Civil registration is a core government function. While birth and death events are health outcomes, the systems are often implemented by agencies and ministries other than the ministry of health, such as the Registrar-General’s office. However, because cause-of-death information is a by-product of a CRVS system, the health sector has a determinant role in generating it. Furthermore, the health sector plays a key role in generating data on births and deaths.

The operations of CRVS systems are guided by government regulations, and such systems follow standard definitions of vital events. Such functional systems should, in principle, be able to record deaths as well as medically certified causes of death. Details and rules are described in a series of United Nations handbooks (see Annex 1).

The complexity of the legal and administrative framework in which cause-of-death statistics are routinely generated implies that government commitment is crucial. Inadequate or outdated legislation; lack of infrastructure; insufficient budget; lack of medically qualified certifiers; lack of training in certification and coding; and poor or non-existent collaboration among various public authorities are common problems that influence the quantity and quality of the data generated.

In health-care facilities, the presence of clinically trained personnel enables medical certification of the cause of death. The information on the cause of death is then coded according to the ICD-10 (7). Depending on the country, the coding could be done by a trained coder in the health facility, staff at the ministry of health, or another designated body. It is important to note that coding is best done by trained staff who are not physicians. Every record of the deceased is then compiled, including the ICD-10 codes. The chain of procedures involves several ministries and agencies, such as the civil registration authorities, the ministry of health, the ministry of justice, the ministry of the interior and the national statistical office. For monitoring of deaths associated with HIV, officers of the AIDS programme and ministry of health staff will need to develop collaborations to share data and improve systems.

The main strength of a fully functional CRVS system is its capacity to produce data on a continuous basis that are consistent and comparable over time and across areas. As the registration of vital events, including the cause of death, is established as a legal requirement, it obliges every citizen in a country to abide by it -- for instance, burials cannot take place if the death has not been registered. Events are thus registered as close as possible in time and place to where they happen, and facts are carefully checked because of their importance in producing legal documentation (19).

For the purposes of HIV/AIDS mortality surveillance, cause-of-death data from fully functional CRVS systems enable policy-makers to monitor the impact of ART on mortality and mortality trends over time, even in the smallest administrative areas. For example, data from Brazil show a real decline in mortality following free and universal access to ART in the mid-1990s (20); data from the USA for 1987 to 2008 show a change in the mortality pattern, as HIV is now more a chronic condition with deaths occurring at a later age (21).

South Africa is one of the few countries with a high HIV burden that have a well-functioning national CRVS system. However, a national CRVS system does not automatically imply that reliable information on HIV/AIDS as a cause of death is available. Incorrect application of the standard principles and rules on death certification and coding may result in underreporting of HIV/AIDS deaths, as is the case in South Africa, where the accuracy of death certification and HIV coding is of questionable quality (22, 23). Additional information is provided in Box 7.

Box 7. AIDS as a cause of death in CRVS – misclassification is common

The quality of cause-of-death information is highly reliant on what the certifiers write on the death certificates about the causes that have led to death. A recent retrospective study of deaths registered in the Brazilian Mortality System from 1985 to 2009 was conducted to quantify the extent of underreporting of HIV deaths and misclassification to AIDS-related conditions in the population of those aged 15–49 years. The study found that a total of 72 120 deaths were recoded as due to HIV, representing only 27% of all estimated HIV deaths in 1985–2009 (19).

While models are available from the Joint United Nations Programme on HIV/AIDS (UNAIDS) to assist countries to estimate several impact indicators related to HIV, including the number of HIV deaths, it is good practice for countries to analyse cause-of-death data from their civil registries, to identify the HIV deaths. The study in Brazil has allowed the country to gauge the level of HIV mortality from their own official data, as compared to the results from models.

In South Africa, the civil registration data for 2006 showed that only 2.4% of all registered deaths were recorded with HIV as the underlying cause of death. Modelling of trends in age-specific death rates strongly suggested that deaths attributable to HIV were often misclassified on the death-notification forms to HIV-related causes such as TB, pneumonia or diarrhoea. Overall, at least 61% of AIDS deaths were misclassified to other causes (23), owing to the way death certificates were filled in.

Potential for HIV /AIDS mortality surveillance

Available data on causes of death collected by WHO demonstrate good progress in obtaining mortality statistics from countries between 1950 and the mid-1980s. However, the situation has stagnated since then, with few new countries starting to produce reliable cause-of-death information. Most of the countries that do not report cause-of-death information are low- and lower-middle-income countries in sub-Saharan Africa, where most of the generalized HIV epidemics are. Countries should prioritize efforts into building or strengthening their CRVS system, because these systems are considered the best source of HIV-related mortality information. In the short term, alternative measures should be sought to provide needed mortality information, such as household surveys and sample registration systems, which may include a specific (verbal autopsy) module to capture information on specific causes including HIV/AIDS-related mortality. Population censuses are generally not suitable for verbal autopsy, unless the work is done in a special follow-up survey of households with reports of recent deaths, as was done in Mozambique (24).

There is a comprehensive framework for evaluation and improvement of CRVS systems (25), as well as a resource kit available to guide countries in assessing and strengthening their CRVS system (19). At the international level, more pressure to obtain information from individual countries on causes of death, in order to monitor internationally set goals, would help to raise awareness of the importance of obtaining such information from a routine system such as CRVS.

2.2 Sample and local demographic surveillance systems

When applied in conjunction with validated verbal autopsy procedures and implemented in a nationally representative sample of population clusters, sample vital registration (SVR) represents an affordable, cost-effective, and sustainable short- and medium-term solution for countries that do not have a well-functioning CRVS system. SVR complements other information sources by producing age-, sex-, and cause-specific mortality data that are more complete and continuous than those otherwise available. The tools and methods employed in an SVR system, however, are imperfect and require rigorous validation and continuous quality assurance. Nationally representative sample-based vital registration systems have been operating for decades in Bangladesh, China and India, to obtain mortality and cause-of-death information. Sample vital registration with verbal autopsy (SAVVY) systems have been established more recently in Pakistan and Zambia. Indonesia, Malawi and the United Republic of Tanzania are in the process of implementing SAVVY.

In addition, the last decade has seen considerable growth in longitudinal community studies, often called health and demographic surveillance system (HDSS) sites. The INDEPTH network (11) is a collaboration of such local studies, which are often driven by research funding and provide mortality and cause-of-death statistics.

Sample registration systems

India and China have long-established sample registration systems. Neither country has a generalized HIV epidemic, so the numbers of deaths due to HIV/AIDS constitute a relatively small proportion of the total deaths.

In China, death registration mostly takes place in the eastern and southern parts of the country and is higher in urban than in rural populations. In the vital registration data, which cover less than 10% of the country, only 0.06% of all deaths were coded as HIV. The China Demographic Surveillance Programme data are based on a national sample registration system (DSP) and include causes of death recorded from verbal autopsy, in addition to medical certification. The DSP is intended to be nationally representative and includes more rural areas. In 2010, 0.07% of all deaths detected through the DSP were coded as HIV.

In India, the Sample Registration System started in 1964 and expanded to cover the whole country by 1970 (26). In approximately 7000 sample areas (covering almost 1% of the population), part-time officials continuously record births and deaths. In addition, an independent survey team uses questionnaires to interview individuals twice a year. As part of this, a verbal autopsy study was conducted during 2001–2003 (27). Physicians coded the verbal autopsy interviews. Overall, 3.2% of all deaths among people aged 15–64

years were attributed to HIV infection, corresponding to about 100 000 deaths (99% confidence interval: 59 000 to 140 000). In comparison, the UNAIDS mortality estimates for the same period reported that the number of deaths caused by HIV infection in India was about 140 000 (99% confidence interval: 100 000 to 170 000; adults and children). This comparison suggests that verbal autopsy can give a good estimate of HIV/AIDS-related deaths.

SAVVY is a system of surveillance sites selected through probability sampling to be representative of the country. The foundation of SAVVY is demographic surveillance, yielding continuous collection of life events and prospective identification of births and deaths. Verbal autopsy is the tool employed for determining the probable causes of death. SAVVY is not a substitute for universal civil registration. However, its components can fill short- to medium-term needs for critical statistics on births, deaths and causes of death at the population level.

SAVVY is considered as a short- to medium-term option in countries lacking the resources to implement a high-quality civil registration system. As a sample-based system, SAVVY requires fewer resources for implementation and ongoing operation and represents a cost-effective alternative to full national civil registration. If planning is done carefully with a long-term view, SAVVY could benefit and accelerate the development of a CRVS system. Care should be taken to avoid any delay in the development of a full CRVS system, particularly in countries with little capacity. There is a set of principles and practices that need to be considered to ensure that SAVVY provides maximum benefits in relation to efforts to develop a CRVS system (for a report see *(28)*).

SAVVY yields data on the age and sex distribution of deaths, the leading causes of death by age groups and sex, and estimates of death rates by age and sex. SAVVY also produces estimates of maternal deaths and maternal mortality ratios by cause of death. Information on treatment received prior to death, and on the location of death, are also collected through the verbal autopsy. These data are critical to guide planning and priority-setting for health services, to identify emerging health problems, to monitor the progress of health initiatives, and to evaluate the effectiveness of health programmes (for more detail see Box 8).

Box 8. Setting up SAVVY

SAVVY implementation begins with the selection of sites throughout the country, based on probability sampling. The population covered in a given country and the total number of SAVVY sites depends on a number of factors, including total population, subnational variation in mortality rates, and available resources. SAVVY sites can be selected to be representative of subnational levels as well, such as urban/rural or provinces. A baseline or initial census is then conducted in the SAVVY sites, to determine the resident population and their demographic characteristics – age, sex, marital status and educational attainment. The data collected in the baseline census provide population denominators for calculating rates (e.g. mortality rates) within the SAVVY system.

Following the baseline census, a network of supervised key informants in the community continuously monitors and enumerates births, deaths and migration within the SAVVY sites. The key informants track and record all births, deaths and migrations. When a death occurs, the key informant notifies a verbal autopsy interviewer. The verbal autopsy interviewer then conducts a verbal autopsy interview at the household where the death occurred (within a locally appropriate time frame).

SAVVY has been aligned with the WHO 2007 international standardized verbal autopsy questionnaires *(10)*. Several methods are available to assign the causes of death from verbal autopsy questionnaires, including physician review, expert algorithms, and data-driven algorithms such as regression, neural networks and Bayesian approaches. In view of the software now available for assessing the cause of death, it might be an option to use the simplified 2012 WHO verbal autopsy instrument *(12)*.

Potential for HIV/AIDS mortality surveillance

In countries with generalized epidemics, SAVVY generates data on HIV/AIDS and HIV/AIDS-associated mortality. The percentage of all deaths that were HIV/AIDS deaths, by age group and sex; distribution of deaths due to HIV/AIDS, by age group and sex; percentage of HIV/AIDS deaths with and without TB, by age and sex; and indirect obstetric deaths with HIV/AIDS are all available from a SAVVY system. These data are essential for monitoring and evaluating HIV interventions and programmes.

If SAVVY is based on a national sample, the estimates can be considered representative. In the case of HDSS studies, the greatest value lies in documenting trends in mortality associated with HIV and other causes over time. In general, the limitations of verbal autopsy – a non-sampling error – apply to SAVVY and HDSS studies. This includes recall bias; that is, remembering events differently than they happened or remembering incompletely. Therefore, the ongoing surveillance of a SAVVY system minimizes the time lag between the death and administration of the verbal autopsy interview.

With less than one third of countries having a registration system that provides high-quality vital statistics, the need for alternative sources of vital statistics will continue for the near future. SAVVY is designed as an interim measure toward a fully functioning vital registration system and will continue to be an option for countries requiring mortality data for HIV/AIDS. For successful implementation of SAVVY, predictable funding support is critical, because it will take several years to fully deploy the system in all sampling points, and the quality of data is likely to improve gradually in the first year of implementation.

Box 9 presents preliminary results of SAVVY development in the United Republic of Tanzania and Zambia.

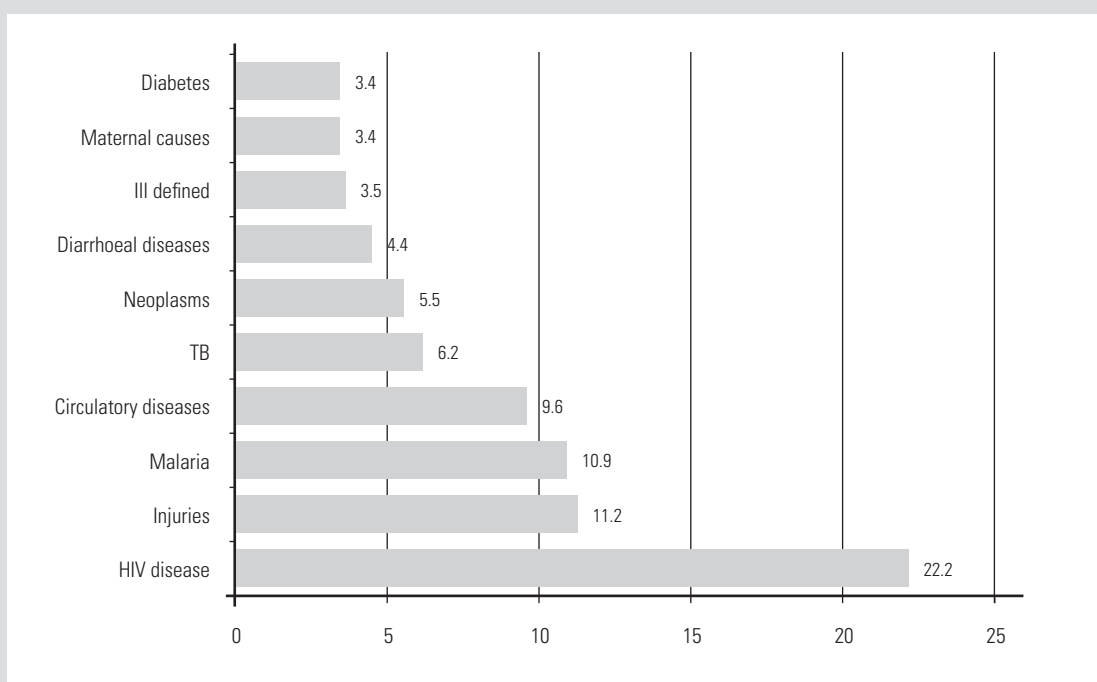
Local health and demographic surveillance (HDSS)

The INDEPTH Network is a collaboration of almost 50 HDSS sites in many countries (11). Most of these sites are local surveillance studies, with populations of from less than 10 000 to over 100 000 under surveillance. Some have been running for decades. They often include health interventions. The HDSS sites are valuable sources of data on long-term trends in mortality by age and sex, as well as fertility rates. Increasingly, verbal autopsy is used, which may provide insights into cause-specific mortality trends. Although the HDSS samples are not representative of the national population, and may also be exposed to additional research-linked interventions, they could be helpful in providing an idea of national trends. In the United Republic of Tanzania, for instance, the HDSS picked up child mortality trends well before this was documented in the national Demographic and Health Survey (29).

Box 9. Developing SAVVY in the United Republic of Tanzania and Zambia: the first results

In the mainland of the United Republic of Tanzania, 23 districts form the SAVVY sample, which is led by the Ifakara Health Institute in collaboration with the Ministry of Health and Social Welfare, the National Bureau of Statistics and the national registration authority (RITA).^{*} This includes 161 000 households in each of eight zones, or a population of 805 000 (which is about 2% of the mainland population). In each enumeration area, a key informant notifies the SAVVY district coordinator of vital events in the communities. The coordinator verifies the events, collects data and registers them at the village executive office, using government death registers. The coordinator also arranges and conducts a verbal autopsy interview using the WHO tools with households that have had a death. The verbal autopsy interviews are entered into the computer centrally, and physicians select the cause of death. Fig. 4 shows the results for adult deaths for 2012 when the system was operational in 13 districts.

Fig. 4. Main causes of death among people aged 15–59 years, SAVVY, United Republic of Tanzania, 2012 (%)



In Zambia, SAVVY is implemented and led by the Central Statistical Office, Ministry of Health, and the Department of National Registration. It was initiated in four provinces in 2010 and then expanded to 13, using the standard WHO verbal autopsy questionnaires. SAVVY is community based and implemented in a nationally representative cluster sample of 76 census supervisory areas, including 30 urban census supervisory areas.

In the baseline census, all households reporting a death in the last year were followed up with a verbal autopsy interview. Subsequently, community key informants were used to report verbal autopsy interviews. All causes of death were coded by physicians, using the ICD-10. In the preliminary results for 2012, HIV was the lead cause of death for males (19.4% of all deaths) and for females (22.4%). Mortality peaked at the age of 35–39 years for both sexes.

^{*} This section is based on a presentation by Gregory Kabadi "Monitoring HIV using sample vital registration with verbal autopsy (SAVVY) in Tanzania", and by Sheila Shimwambwa-Mudenda, "SAVVY design, implementation and results in Zambia", both presented at a WHO meeting on "Improving cause of death and AIDS mortality measurement in Africa", Cape Town, 15–16 November 2013.

2.3 Household surveys with mortality modules

Household surveys provide detailed demographic and socioeconomic data for households and individuals. Most countries now have systems of data collection for household surveys but with varying levels of experience and infrastructure. The surveys conducted by national statistical offices are generally multipurpose or integrated in nature and designed to provide reliable data on a range of demographic and socioeconomic characteristics of the various populations. For countries with an absence of routine medical certification of cause-of-death information, a variety of methods have been developed to incorporate verbal autopsy data into household surveys, in order to obtain a general idea of the leading causes of death in the population. About two decades ago, the Demographic and Health Surveys added a short, optional verbal autopsy module with questions about signs and symptoms during the illness preceding death in children aged under 5 years (30). Six countries included the verbal autopsy module. In subsequent years, much work was done to improve the verbal autopsy instrument. Verbal autopsy modules are now the most commonly used method of collecting information on cause of death in household surveys. This method and others are described next.

Verbal autopsy module in health or other survey

The full module is part of the health survey and asks for all deaths that have been identified in the household schedule (all ages) or in the birth history (children only). For HIV, deaths of all ages are the main interest. Currently, few surveys add a full verbal autopsy module (the WHO standard). It is a major burden on the interviewer and respondent and could be emotionally disrupting. An example of a recent survey with a full verbal autopsy module is the Nepal Demographic and Health Survey 2006 (475 child deaths) (31).

Follow-up survey

Deaths have been identified in a survey through the household schedule or birth history. A follow-up survey of households in which deaths occurred is conducted within a year of the survey, and the WHO verbal autopsy instrument is administered. An example of such a survey is the Uganda Child Verbal Autopsy Study 2007: the verbal autopsy interviews were conducted 5–11 months after the initial household survey; verbal autopsy interviews were completed for 86% of identified deaths, resulting in a sample of 641 deaths (32).

Mortality and causes-of-death survey

Mortality and causes of death

A special survey is conducted on mortality and causes of death. Deaths are identified in the household interview section of the questionnaire, using a fixed time reference, such as the last 12 months before the survey. For all deaths, the standard verbal autopsy instrument is applied. Other questions, such as a social autopsy, which aims to identify circumstances that may have affected the mortality risks, can be added. An example is the Afghanistan Mortality Survey 2010 (33). The recall period was 5 years, and over 3000 deaths were identified. HIV was, as expected, rare.

Post-census survey

This method is similar to a follow-up to a survey, but the deaths are identified in a census. Censuses often include a question on deaths in the household in the last 12 months. A sample of the households with deaths can be followed up. In Mozambique, a post-census survey with verbal autopsy was conducted among more than 10 000 deaths, with a response rate of 84% (24). HIV/AIDS was associated with 27% of all the deaths, and was the second most common cause, after malaria.

2.4 Hospital data on cause-specific mortality

Hospitals should routinely collect information on causes of death by age and sex, in addition to information on pregnancy status and treatment status. Such data can form a good basis for cause-specific mortality statistics, which can help identify needs for hospital treatment and allow related planning of resources (see Box 10). It is important to note that in countries where the majority of deaths take place outside of health facilities, hospital mortality data may not be representative of the mortality burden of the population as a whole. The guiding principles for hospital data on cause-specific mortality are:

- to record deaths individually by cause, age and sex, and by location of hospitals;

- to record death in line with ICD principles: causes of death are reported on the international form of medical certificate of cause of death and coded using the ICD-10. Where more than one cause is reported, ICD rules for selection of the underlying cause of death are applied;
- to maintain confidentiality, person-identifying data are kept in a separate database, but an identifier should ensure that a linkage to the relevant personal record could be made, if necessary;
- to motivate certifying doctors, local mortality statistics are always compiled and shared with the physicians.

The procedures and definitions related to full certification of causes of death are described in detail in Chapter 1.

Box 10. Hospital monitoring system

For a well-functioning hospital-based mortality monitoring system, all relevant staff need to be informed about the collection of cause-of-death information and what happens to the data that are entered into the system. The physicians need to be trained on filling in a death certificate. The training should include information on how to report diagnoses as specifically as possible and understanding the importance of reporting stigmatizing diseases. A locally adapted list of the most frequent diseases can facilitate the coding, but a local expert should also be available to properly code rare cases.

The rules for selecting the underlying cause of death are complicated. Using so-called “decision tables” or semi-automated systems like Iris (9), will be essential to properly carry out that task.

Data clerks should be trained about the processes and requirements for completeness of data.

The diagnosis is ascertained during the stay. Hospitals record at least the deaths that occurred in the hospital.

The death information should be collected in a dedicated office inside the hospital and ideally entered into an electronic database. The workflows need to be designed carefully and agreed upon with all involved staff. The data can be entered directly by the certifier, or the completed forms are collected centrally. Sufficient numbers of forms should be available on all wards. The central storage device should be secured against natural and human hazard.

Any new staff must be trained to assure continuous quality at every step of the information collection.

The hospital records in many countries with generalized HIV epidemics are of particularly limited use. Hospitals often lack a good system for identifying and recording all deaths and attributing a cause of death using all available information. The international form of medical certificate of cause of death is not used, and the standard ICD rules for selecting the underlying cause of death (see Chapter 1) are not applied. The lack of ICD-trained and motivated medical professionals contributes to poor coding, the absence of coders or poorly trained coders, or trained coders with no ICD manuals or electronic tools. Finally, comorbidity or a sequence of events is rarely included in death records in low- and middle-income countries.

These flaws have multiple consequences. For instance, the information recorded in hospital records typically shows the reason for treatment but not the cause of death. Where cause-of-death information is available, causes are frequently attributed to non-existing codes or ill-defined categories that are not useful for public health purposes. In general, only aggregated data are available for external use, which limits the ability to conduct more advanced analysis. Creating a local ICD coding index that includes the locally most frequent diagnoses (wrongly also called ICD shortlist) is a probate way to reduce the coding burden. The coding staff must be aware that conditions that are not on such list are coded using the full ICD-10. Failure to do so will greatly affect the comparability of information over time because only the diagnoses mentioned in the local index will be reported.

In spite of the various limitations, hospital data are demonstrating their value. In Mozambique, a major effort by the Ministry of Health resulted in a complete revision of the mortality surveillance system, which now produces regular reliable data (see Box 11). In Botswana, hospital morbidity and mortality statistics are an important source of short- and long-term trends related to HIV (see Box 12, p.xx).

Box 11. Causes of death in hospitals in Mozambique

In 2008, the Ministry of Health in Mozambique initiated a revision of the system for collection of mortality data in the health sector.* The nongovernmental organization Jembi worked with the Ministry of Health to assess and revise the system. In the first phase, an intra-hospital mortality register, including causes of death, was set up. In 2009, the death certificate was revised and included the following nine sections:

- identification of the issuing entity
- identification of the dead person
- residency of the dead person
- place of occurrence of death
- information for deaths in those <1 year of age
- information for maternal mortality
- causes of death (underlying, intermediate, direct)
- identification of signing doctor
- information on external causes of death.

An electronic tool for data management was introduced, comprising an individual electronic register, using the full ICD-10 list, with built-in data validation, and a reporting function. Hospital data flows were revised, and training materials were developed. By the end of 2012, the system had been installed in 28 hospitals and provincial directorates of health. During 2009–2011, HIV was associated with 28% of all deaths in 10 hospitals with data during that period. Hospital data can provide greater detail than verbal autopsy data, as is shown in Table 3.

Table 3. Hospital data on causes of death

Cause of death, HIV disease resulting in:	Number	%
Unspecified HIV disease	5870	72
HIV + mycobacterial infections	916	11
HIV + multiple infections	410	5
HIV + encephalopathy (HIV dementia)	339	4
HIV + other bacterial infections	238	3
HIV + Kaposi sarcoma	202	2
HIV + Pneumocystis pneumonia	86	1
HIV + candidiasis and other mycoses	36	0.4
HIV + wasting syndrome	29	0.4
HIV + other malignant neoplasms	22	0.3
HIV + Burkitt lymphoma	15	0.2
Total	8163	

* This section is based on a presentation by Cidalia Baloi and Roberta Pastore, "Cause of death data from hospitals in Mozambique", presented at a WHO meeting on "Improving cause of death and AIDS mortality measurement in Africa", Cape Town, 15–16 November 2013.

Hospital data on causes of death are likely to be biased for the pattern of causes reported, as there is differential use of health services by cause of death, and tertiary hospitals are usually referral hospitals for provinces. Overall, an estimated 4% of all deaths in Mozambique are captured by the hospital registration system. In 2007, a post-census survey was conducted to assess causes of death (see Table 4) in Mozambique through verbal autopsy. In terms of age distribution, compared to the verbal autopsy deaths, the hospital deaths included more neonatal deaths and more deaths in persons aged 15 years and older. Malaria was more common in the survey than in the hospital, but the proportions of deaths due to HIV were surprisingly similar. The differences in malaria may be due to people not reaching hospitals in acute circumstances or due to misclassification, most likely in the verbal autopsy.

Table 4. Causes of death ascertained by post-census survey in Mozambique

Deaths	Agency collecting data	
	INE/CDC (2007) ^a	SIS-ROH (2011) ^b
Crude mortality rate	14.6/1000	0.6/1000 (4%)
Deaths 0–27 days, %	8	20
Deaths 28 days to 4 years, %	35	14
Malaria	51	9
HIV	16	16
Deaths 5–14 years, %	7	4
Malaria	49	10
HIV	14	20
Deaths >14 years, %	50	61
HIV	40	49
Malaria	14	3.2
Total deaths, %		
HIV	27	30
Malaria	29	7

^aINE/CDC: National Statistical office/Centre for Disease Control Mozambique.

^bSIS-ROH: hospital information system in Mozambique.

Potential for HIV mortality surveillance

Using the cause-of-death information generated by hospitals is a feasible way to gather high-quality information. However, local decision-makers, IT providers and involved staff need to collaborate and be trained for their contribution to generating accurate data. Simplified coding lists need to be in line with the ICD-10; regional clearing houses could assist in coding where such lists do not suffice.

Trends in admissions/discharges and mortality/case-fatality data by diagnosis are useful to assess trends in HIV/AIDS mortality. Given the specific age pattern of HIV/AIDS, it is essential that the data available are disaggregated by age and sex. Appropriate reporting of stigmatizing causes, and lack of training in death certification may compromise the data quality and should always be taken into consideration.

2.5 Burial systems and clinical autopsies

Burial systems consist of monitoring the number of people who are buried, determining the cause of death, and calculating mortality trends using estimates about population sizes. There are several burial systems that may be used to estimate HIV/AIDS-related mortality. These include the use of records as part of cemetery surveillance, and burial societies, parish registries, and morgue surveillance with cadaver autopsy. Cadaver autopsy is most useful in settings where many people die in hospitals or morgue registration is high, and where medical expertise is available to conduct autopsies.

The term “autopsy” stems from the Greek and Latin “*autopsia*”, translating as “seeing for oneself”. Clinical or pathological autopsy (also known as postmortem examination or necropsy) denotes the surgical examination of a decedent’s body. Because they are labour intensive, autopsies are performed in hospitals and nowadays are applied routinely to only a fraction of all deaths (e.g. unexplained deaths that occur in the context of an otherwise successful therapy) received at the mortuary. Several types of autopsy are used. Needle-based autopsies rely on biopsies taken from key organs and tissues without opening of the body. Full autopsy refers to a comprehensive, open-body examination. Virtual autopsies refer to the examination of a body by imaging techniques such as magnetic resonance imaging or multislice computed tomography.

The primary strength of clinical autopsies is their usual high accuracy in ascertaining the cause of death. Clinical autopsies constitute the gold standard in ascertaining the cause of death. As such, they may serve as the reference for the validation of verbal autopsies; they have also been shown to frequently differ from clinical diagnoses made antemortem, indicating that physicians’ diagnoses also have imperfect accuracy. However, refusal by family members for autopsy of their next of kin (for religious or logistical reasons), especially for paediatric deaths, may lead to selection bias and smaller sample sizes – an issue that is now being addressed in higher-resource settings, where virtual autopsies using imaging techniques are available. Further, decedents’ bodies should be examined soon after death (e.g. within 12–24 hours); with this time restriction, people who die outside of a hospital or require quick burial for religious reasons may be less likely to be examined by autopsy, further compromising the representativeness of the sample.

Burial surveillance is conducted by cemetery clerks, who are regularly briefed in training workshops. The clerks collect information on the date of burial, age, name, sex, address, marital status, region of birth, ethnicity and religion, and a lay report of the cause of death from relatives or close friends while they arrange for burial. Missing values for age and sex are imputed using different methods. In theory, it would also be possible to conduct a standardized verbal autopsy interview with the relatives of the deceased, although this has not often been applied.

There are several morgue-based studies that have been used to make the diagnosis of HIV/AIDS through cadaver autopsy. The burial method has been used successfully in Côte d’Ivoire and Republic of Congo (34). The Addis Ababa Mortality Surveillance Program in Ethiopia, which has no civil registration requirements, established a cemetery surveillance system in 2001 and has conducted numerous evaluations of HIV/AIDS programming (35), though evaluation has been limited to Addis Ababa, the capital city, which conducts surveillance of burials at all cemeteries. With the exception of Namibia and a recent study in rural Malawi (34,35), few other countries, have published HIV/AIDS-related mortality findings using burial-system surveillance.

Potential for HIV /AIDS mortality surveillance

With the exception of morgue surveillance, which requires medical skill, burial-system surveillance is a relatively simple method for determining the number of deaths and characteristics of the deceased. The main advantage of using burial-system surveillance is that it builds on registration systems that already exist. However, there are a number of limitations to using burial systems for surveillance. There is no denominator of all deaths, because only buried deaths captured in the system are counted, a true denominator of all deaths is lacking, and the sample selection may be biased and not representative (nationally or otherwise).

Accordingly, burial systems may be most useful in urban areas that are most likely to have formal burial practices and more complete registration than in rural areas. Other sources of selection bias that restrict the representativeness of burial systems include the fact that in rural areas people often do not use cemeteries but rather are buried close to their homes. In many countries, people are buried in their place of origin. Undercounting of women and children may occur as a result of government efforts to collect taxes, such as burial registration fees that may not be affordable. Finally, the selection of deaths for which verbal autopsy can be conducted is often limited to those with complete address information.

With the strong presence of HDSS sites and Demographic and Health Surveys in numerous countries, and an increasing use of SAVVY, it is unlikely that burial-system surveillance will become a main method of measuring HIV/AIDS mortality. However, in countries with weak civil registration, low cremation rates and monitored burial systems, this method can provide HIV surveillance officers with additional HIV/AIDS-mortality measurements, which can, in turn, be shared with civil authorities. If such burial systems exist, and other data sources are lacking, HIV/AIDS-related mortality information should be collected from burial or morgue systems. When conducting HIV/AIDS mortality surveillance using burial systems, it is important to consider that the introduction of ART programmes has an effect on the overall mortality, especially in adults. Thus, comparing the patterns of mortality before and after the introduction of life-saving medications can provide evidence of its impact.

While clinical autopsies are performed in most countries, they are rarely performed as a tool for surveillance. However, clinical autopsies may provide valuable data for ascertaining the exact causes of death, and, performed over time, may provide data for trend observations. For HIV/AIDS-related mortality surveillance, autopsies may help to identify the proportion of undiagnosed HIV infection, describe the HIV/AIDS-related cause of death (opportunistic infections, AIDS-related cancers, etc.), help validate verbal autopsy instruments that distinguish HIV/AIDS- from non-HIV/AIDS-related deaths, and facilitate the detection of drug-resistant HIV.

3. Measuring HIV/AIDS-associated mortality: analytical techniques

As the previous chapter shows, multiple data sources can generate the relevant data on HIV/AIDS mortality, but all have data-quality issues. Such issues include incompleteness and misclassification and must be considered when interpreting any analysis conducted using these data. In addition to assessing the situation in terms of cause-specific mortality, there is great interest in evaluating key interventions such as ART and prevention of mother-to-child transmission of HIV, where the ultimate goal is reducing HIV/AIDS mortality. This chapter describes the methods that are available to ascertain levels and trends in HIV mortality, in order to measure the impact of such interventions.

3.1 Cause of death

A detailed description of ascertaining the cause of death is provided in Chapter 1. This section describes special considerations for analysing cause-of-death information. We recall that the standard method for determining cause of death is medical certification, where the certifying physician has information about the HIV status of the deceased and where the certifier and coder apply ICD rules. Where these rules are applied correctly, and where there is good coverage of death registration and medical certification, the proportion of deaths due to HIV/AIDS, as well as population mortality rates, should be reliable. However, several analyses of cause-of-death data that are generated as part of CRVS systems have shown that HIV/AIDS mortality is grossly underreported. This underreporting is predominantly thought to be due to stigma associated with the diagnosis of HIV. For instance, in South Africa, which has experienced a severe generalized epidemic since the early 1990s, only 2.0–2.5% of deaths were attributed to HIV/AIDS among all registered deaths during 1996–2006. The true cause-specific mortality fraction¹ is more likely to have been between 19% and 48% over that period (22). It was estimated that more than 90% of HIV/AIDS deaths were misattributed to other causes during 1996–2006.

Health and demographic studies may include diagnostic tests for determining HIV status, and thus can provide reliable data on trends of HIV/AIDS-associated mortality. These trends can be used to assess the impact of ART, with a reduction of the all-cause mortality indicating successful therapy, as was demonstrated in Malawi (38).

In the absence of data on HIV status, clinical diagnoses and verbal autopsy are the best methods for determining the cause of death. Verbal autopsy can provide a reasonable approximation of the proportion of deaths due to HIV/AIDS, as has been shown in several studies described in previous sections of this document. In Malawi, verbal autopsy data from a HDSS in Karonga district, from September 2004 to August 2009, showed a dramatic decline in HIV/AIDS mortality but not in mortality due to noncommunicable diseases (39). ART was introduced in mid-2005. Over the entire period, there were 905 deaths, the HIV/AIDS death rate fell from 505 to 160/100 000 person-years, and there was no evidence of an increase in rates of noncommunicable diseases. The proportion of total deaths attributable to HIV/AIDS fell from 42% to 17%; deaths attributable to noncommunicable diseases increased from 37% to 49%. It was concluded that, 4 years after the introduction of ART into HIV care in Karonga district, all-cause mortality had fallen dramatically, with no evidence of an increase in deaths due to noncommunicable diseases.

¹ Deaths in WHO's mortality database were distributed among 48 mutually exclusive causes. For each cause, age- and sex-specific global death rates were compared with the average rate among people aged 65–69, 70–74 and 75–79 years, to generate "relative" global death rates. Relative rates were also computed for South Africa alone. Differences between global and South African relative death rates were used to identify the causes to which deaths from HIV/AIDS were misattributed in South Africa, and to quantify the HIV/AIDS deaths misattributed to each. These deaths were then reattributed to HIV/AIDS.

3.2 Age–sex patterns of mortality

Mortality patterns according to age and sex can be used to assess the impact of interventions, as well as the quality of data. When there is no access to ART, HIV/AIDS mortality has a very specific pattern during adult ages, with peaks during the ages of 25–49 years. Mortality among women tends to peak a bit earlier than that among men. Because the prevalence of HIV is so high in countries with generalized epidemics, the impact of AIDS on all-cause age-specific mortality rates is often very large. This is the case for mortality statistics generated by national death registration systems or local HDSS sites. The age–sex patterns can also be observed in hospital data. Box 12 provides an example from Botswana where death registration and hospital data were used to assess HIV/AIDS mortality trends.

Deviations from the expected age- and sex-mortality patterns for HIV/AIDS can be used to identify potential underreporting of deaths, misclassification of cause of death, reporting bias due to stigma or other reasons, and coding errors. For such analysis, WHO, the University of Queensland, and the Health Metrics Network developed ANACOD (ANALysing mortality levels and Causes of Death), an Excel-based electronic tool for generating the age- and sex-specific patterns from mortality data (see Annex 1).

Box 12. Trends in age- and sex-specific mortality, Botswana*

In Botswana, the registry of births and deaths has much lower completeness than in South Africa (probably of the order of 50–60%), but trends by age and sex over time suggest very large changes in mortality. During 2003–2010, mortality at the ages of 15–64 years declined considerably for both sexes. However, mortality among people aged 65 years and over went up (see Fig. 5).

At the same time, hospital death rates (or case-fatality rates per 100 admissions increased until 2003 and then levelled off (see Fig. 6). The impact was greatest at ages above 25 years. The overall picture that emerges from the death registration data, partly supported by the hospital data, is that ART has a major impact on mortality in Botswana.

Fig. 5 shows data on death rates from the Registry of Births and Deaths, Ministry of Home Affairs, and Fig. 6 presents data from the Health Statistics Unit, Ministry of Health.

Fig. 5. Death rates for age 15–64 years versus age 65+ years, overall (tot) and by sex (M, F), Registry of Births and Deaths, 2003–2010

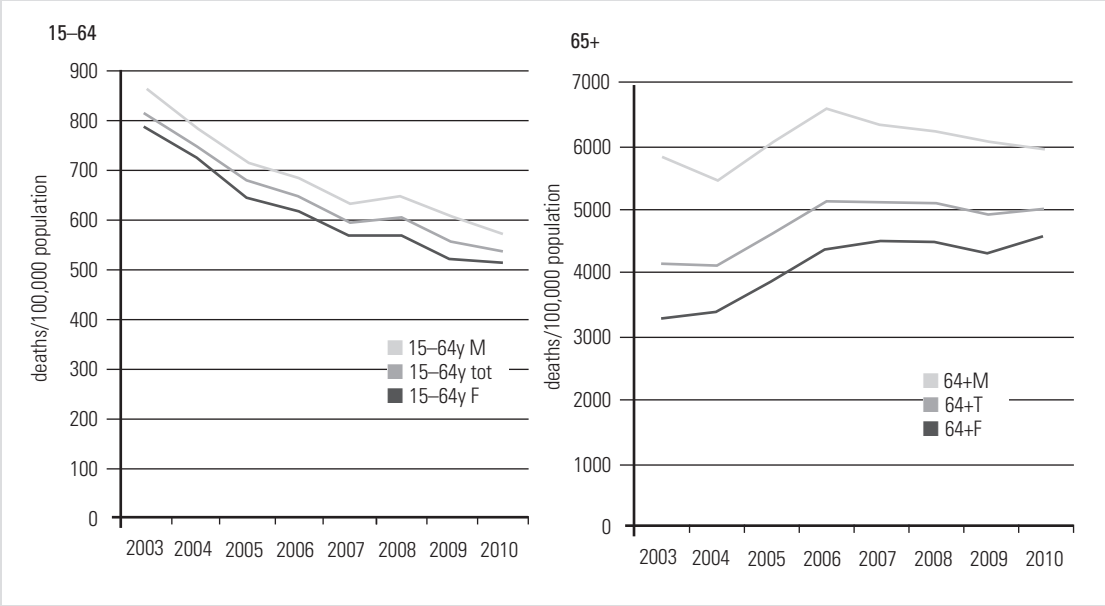
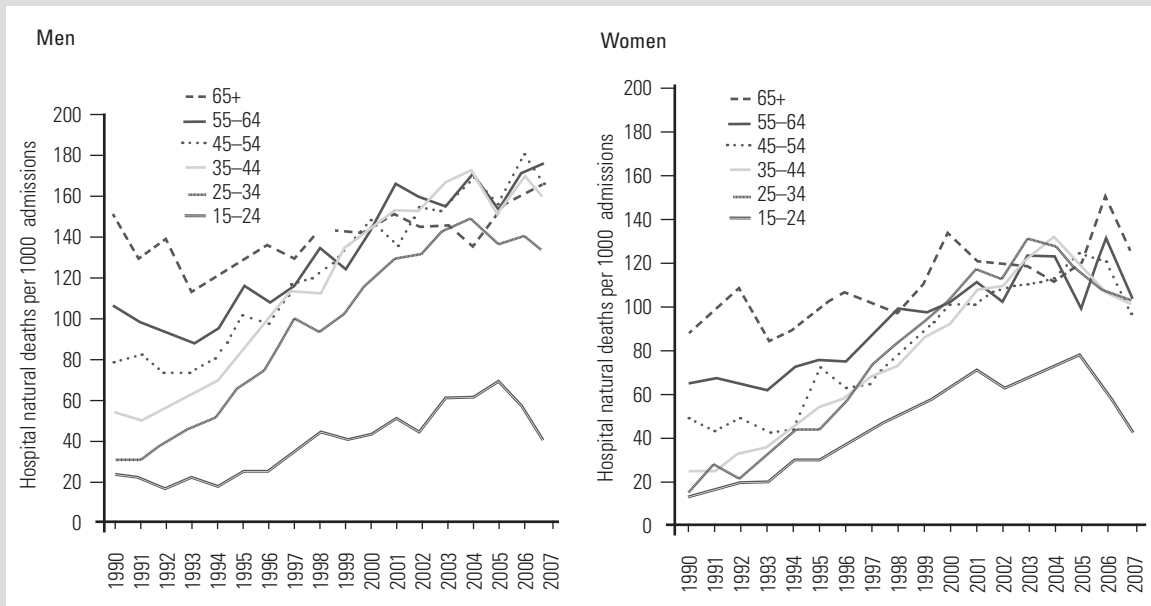


Fig. 6. Hospital death rates (deaths/admissions) by age group (years) and sex, Health Statistics Unit, 1990–2007



*This section is based on a presentation by Rand Stoneburner "Using hospital and civil registration data to assess the impact of antiretroviral treatment in Botswana", presented at a WHO meeting on "Improving cause of death and AIDS mortality measurement in Africa", Cape Town, 15–16 November 2013.

3.3 Modelled Estimates

In the absence of other good sources of cause-of-death data, statistical modelling can be used to estimate various HIV/AIDS-related indicators. The statistical model that is most commonly used to estimate HIV-related deaths is the AIDS impact module in Spectrum (5). The software development has been guided by the UNAIDS Reference Group on Estimates, Modelling and Projections. Demographic data, programme statistics, epidemic patterns, and surveillance and survey data are the inputs into demographic and epidemiological computations (in a child and adult model), which produces the number of HIV-infected people, new infections, AIDS deaths, eligibility for ART and need for prevention of mother-to-child transmission of HIV.

More information can be found on www.epidem.org and in supplements to the journal *Sexually transmitted Infections* in 2010 (http://sti.bmj.com/content/86/Suppl_2.toc) and 2012 (http://sti.bmj.com/content/88/Suppl_2/i3.abstract).

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Annex 1: Toolkits/resources for country mortality surveillance systems

1. Data collection

1.1 Improving the quality and use of birth, death and cause-of-death information: guidance for a standards-based review of country practices (http://www.who.int/healthinfo/tool_cod_2010.pdf)

This tool provides comprehensive guidance on how to systematically evaluate the quality and functioning of civil registration and vital statistics systems. The package consists of two components: a *detailed assessment tool*, plus a rapid assessment tool available as text or as a spreadsheet, for ease of compilation of data. The aim is to help responsible authorities obtain a clear and comprehensive understanding of the strengths and weaknesses of their civil registration and vital statistics systems, and generate the evidence base for corrective action.

1.2 Strengthening civil registration and vital statistics for births, deaths and causes of death. Resource kit (http://www.who.int/healthinfo/CRVS_ResourceKit_2012.pdf)

This resource kit is designed for use by all stakeholders who are engaged in strengthening the registration of births, deaths and causes of death within civil registration and vital statistics systems. It presents materials drawn from many sources, to enable users to identify, locate and make use of the core standards, tools and materials needed to build stronger and more efficient systems.

2. Death registration tools (forms, variables and specifications of data elements)

2.1 Principles and recommendations for a vital statistics system (<http://unstats.un.org/unsD/demographic/standmeth/principles/default.htm>)

This United Nations publication describes the variables to be collected in vital registration, including death registration for vital registration purposes.

2.2 ICD-10 volume 2 – Instruction manual (http://www.who.int/classifications/icd/ICD-10_2nd_ed_volume2.pdf)

This volume is the instruction manual for the ICD-10. It provides a basic description of the ICD-10, together with practical instructions for mortality and morbidity coders. It also contains guidelines for death certification and the reporting, presentation and interpretation of data.

3. Automated data-collection and analysis tools

3.1 Iris, interactive coding system for coding of causes of death (www.iris-institute.org)

Iris is an automated coding system that allows reporting of causes of death, selecting the underlying cause of death by applying the selection rules of the ICD-10. It can be used to enter causes as text, or to directly enter ICD-10 codes; rules for selection are then applied, in order to identify the underlying cause of death. Dictionaries of diagnoses are available in different languages. If a diagnosis is entered, Iris processes the text expressions and, if necessary, splits composite expressions into the constituent parts. Each term is then matched to the dictionary and Iris assigns an ICD-10 code.

3.2 WHO verbal autopsy instrument (<http://www.who.int/healthinfo/statistics/verbalautopsystandards>)

The WHO verbal autopsy instrument 2012 is designed to be suitable for routine use. An updated version that allows use of the currently available analytical software will be published in 2014. It is designed primarily for use with electronic data-collection tools. Traditional paper-based questionnaires can be derived. Sample questionnaires are provided with the instrument.

Compared to the 2007 instrument, the numbers of conditions and questions have been reduced, based on evidence from the field. Sets of questions address information relevant to vital registration, and information relevant to assessment of the cause of death and the context. The questions have been reformulated to allow for responses with a simple yes or no answer, or a duration in some instances. This approach makes the instrument suitable for use with software that assigns causes of death, as well as for physician assessment. The instrument is designed for all age groups, including maternal and perinatal deaths, and also deaths caused by injuries. The format of the source questionnaire allows easy implementation on all devices. See 4.6 for information on the manual for this instrument.

4. ICD-10: training tools, electronic version, manuals

4.1 WHO ICD-10 interactive self-learning tool (<http://apps.who.int/classifications/apps/icd/icd10training/>)

Offline, the following can be downloaded and run on a local computer:

<http://apps.who.int/classifications/apps/icd/ClassificationDownload/DLArea/OfflineTrainingPackage.zip>

The WHO electronic ICD-10-training tool allows users to learn how to use the ICD and to handle cause-of-death information in line with ICD guidelines. Electronic copies of the ICD-10 are embedded in the tool, so all the materials needed for the training are supplied.

The tool has sections for members of the general public who simply want some brief information about the ICD, and there are also detailed sections for coders.

The tool can be used online, or it can be downloaded and installed on a local computer, and shared with friends and colleagues, e.g. on a memory stick (see also the readme file included in the package).

The basic training on how to code with the ICD-10 and how to avoid major errors in coding requires approximately 2 hours' training time.

Trainees will understand the correct use of the international medical certificate of cause of death in about 40 minutes.

The full training package includes 28 sections, taking a total of approximately 40 hours' training time. Coders undertaking the full training will interactively learn about classification context, how to use the ICD-10 for morbidity and mortality coding, pitfalls in coding and analysis specific to individual chapters, basic medical science, statistical presentation of coded data, confidentiality and certification of causes of death.

Managers, epidemiologists, or others who will not need to code but require an understanding of the process, can gather a basic overview of the coding process and the ICD, by completing the introductory section of the tool and working through chapter summaries, in about 5 hours.

4.2 WHO ICD-10 interactive self-learning tool on completing the certificate of cause of death

A special version of the ICD-10 self-learning tool teaches certifiers how to fill in a death certificate and includes a pocket guide (see 4.3 below). This version is included in the download package, and it can also be accessed online at <http://apps.who.int/classifications/apps/icd/icd10training/ICD-10%20Death%20Certificate/html/index.html>.

4.3 WHO: Cause of death on the death certificate in line with ICD-10 – quick reference guide (http://apps.who.int/classifications/apps/icd/icd10training/ICD-10%20Death%20Certificate/html/ICD-10_Resources/causeofdeathflyer.pdf)

This pocket guide informs on how to fill in a death certificate, what happens to the data, and how to avoid typical and frequent errors. It has been designed to inform physicians at a glance and can be printed on any printer (settings: double sided, landscape) and folded become a small booklet

4.4 WHO-FIC Network Mortality Forum (<https://sites.google.com/site/mortalityforum/>)

The Mortality Forum is an international discussion network of more than 100 members representing more than 40 countries and organizations, which identifies and solves problems related to the interpretation and application of the ICD-10 to coding and classification of mortality (cause of death).

Problems are solved in the forum, or fed into specialist discussions at the WHO-FIC Network Mortality Reference Group, resulting in standardized application of mortality coding rules and guidelines, by making decisions regarding the interpretation of rules and guidelines for mortality, and deliberating on updates to the classification and the rules and guidelines.

4.5 International statistical classification of diseases and related health problems 10th revision (ICD-10), for online browsing, and Volume 2 for download (<http://www.who.int/classifications/icd/en/>)

The ICD is available for browsing online at the site above. Volume 2 (instruction manual) of the ICD can also be downloaded from there, free of charge.

4.6 Verbal autopsy standards: ascertaining and attributing causes of death (WHO short form, WHO research questionnaire) (<http://www.who.int/healthinfo/statistics/verbalautopsystandards/en/index.html>)

See 3.2 for information on the verbal autopsy instrument.

A manual informs users on how to use the 2012 WHO verbal autopsy instrument. The components of this manual include:

- background on verbal autopsy;
- sample verbal autopsy questionnaires for three age groups (<4 weeks, 4 weeks to 14 years, 15 years and above);
- the full matrix of questions, definitions and related skip patterns;
- instructions on how to use the matrix of questions;
- criteria for setting up an infrastructure for data collection and the related databases;
- information about available software for assessing a cause of death;
- instructions on how to design a localized questionnaire;
- general cause-of-death certification and coding guidelines for applying the ICD-10 to verbal autopsy;
- a simplified cause-of-death list for verbal autopsy, with corresponding ICD-10 codes.

All materials (questionnaires, table of indicators with skip patterns and this manual) are available separately for download.

This manual and its resources are the products of a one-year effort by an expert group led by the WHO, consisting of researchers, data users and government agencies, with support by the Health Metrics Network (HMN), the University of Queensland and the INDEPTH Network. The 2012 WHO verbal autopsy instrument is intended to allow for simple and inexpensive identification of causes of death in places where no other routine system is in place and will serve the needs of countries' CRVS systems. Independently, this instrument can also be used in research and disease-specific programmes. All materials are easily and widely accessible on the WHO website, in print, and are incorporated into diverse resource kits, intended for strengthening national vital statistics systems. Additional language versions will be made available through similar channels.

Experience from the field and publications on the most widely used and validated verbal autopsy instruments and procedures (WHO verbal autopsy standards, InterVA and Population Health Metrics Research Consortium [PHMRC] verbal autopsy instrument) were systematically reviewed and also assessed against experience in using software for assignment of cause of death (InterVA and PHMRC VA instrument). Verbal autopsy users were queried for use of verbal autopsy instruments and utility of verbal autopsy questions. This resulted in a simplified verbal autopsy instrument, with a reduced number of questions and causes of death. The systematic application of the 2012 WHO verbal autopsy instrument will facilitate the application of verbal autopsy in routine surveillance of vital events and introduce more consistency and cross-comparability

of mortality data derived from verbal autopsy. The correspondence table allows for easy conversion to and from the ICD-10. The application of a standardized international set of questions will facilitate the compilation of larger databases that would finally provide the evidence for stepwise improvement of verbal autopsy questionnaires internationally.

The 2007 version of the VA tool is still available for environments where resources allow more extensive interviews and assessment of cause of death.

5. Tools for cause-of-death ascertainment

5.1 InterVA (<http://www.interva.net/>)

InterVA is software to facilitate interpretation of verbal autopsies, and the latest versions and information are available freely online.

6. Editing, analysing and presenting/communicating data on causes of death

6.1 Analysing mortality level and cause-of-death data – ANACOD (http://www.who.int/healthinfo/topics_standards_tools_data_collection)

ANACOD is an automated tool, published by WHO, which builds analytical capacity to assess the quality of mortality statistics.

This electronic tool provides a step-by-step approach to quickly conducting a comprehensive analysis of data on mortality levels and causes of death. It automatically reviews the data for errors, tabulates the information, presents the results in the form of easy-to-use tables and charts, and provides the opportunity to compare the findings with those from other groups of countries. The tool is continuously improved by WHO, based on feedback from users and in consultation with experts.

6.2 CodEdit (http://www.who.int/healthinfo/civil_registration/en/)

CodEdit is an automated tool intended to help producers of cause-of-death statistics to strengthen their capacity in performing routine checks on their data, in order to minimize errors.

Its primary purpose is to flag and warn about basic gross errors, alert about possible misuse of codes, and finally provide a summary of the dataset. This tool provides relatively simple ways of checking for the validity of each data record that would enable data collectors to improve their data significantly. The tool will be available on the above website in 2014.

6.3 CodPresent

CodPresent is a tool that will provide steps to presenting cause-of-death data, particularly those of imperfect quality. Effective data presentation is necessary to ensure that cause-of-death data are used. Forthcoming on the above website.

7. Principles and recommendations for a vital statistics system

A series of United Nations handbooks describes all aspects of setting up a civil registration and vital statistics system (<http://unstats.un.org/unsD/demographic/standmeth/default.htm>).

Annex 2: ICD-10 codes related to HIV

ICD-10 codes for HIV

Human immunodeficiency virus [HIV] disease (B20–B24)	
Incl.:	perinatal HIV infection
Excl.:	asymptomatic human immunodeficiency virus [HIV] infection status (Z21) complicating pregnancy, childbirth and the puerperium (O98.7)
B20 Human immunodeficiency virus [HIV] disease resulting in infectious and parasitic diseases	
Excl.:	acute HIV infection syndrome (B23.0)
B20.0	HIV disease resulting in mycobacterial infection HIV disease resulting in tuberculosis
B20.1	HIV disease resulting in other bacterial infections
B20.2	HIV disease resulting in cytomegaloviral disease
B20.3	HIV disease resulting in other viral infections
B20.4	HIV disease resulting in candidiasis
B20.5	HIV disease resulting in other mycoses
B20.6	HIV disease resulting in <i>Pneumocystis jirovecii</i> pneumonia HIV disease resulting in <i>Pneumocystis carinii</i> pneumonia
B20.7	HIV disease resulting in multiple infections
B20.8	HIV disease resulting in other infectious and parasitic diseases
B20.9	HIV disease resulting in unspecified infectious or parasitic disease HIV disease resulting in infection NOS
B21 Human immunodeficiency virus [HIV] disease resulting in malignant neoplasms	
B21.0	HIV disease resulting in Kaposi sarcoma
B21.1	HIV disease resulting in Burkitt lymphoma
B21.2	HIV disease resulting in other types of non-Hodgkin lymphoma
B21.3	HIV disease resulting in other malignant neoplasms of lymphoid, haematopoietic and related tissue
B21.7	HIV disease resulting in multiple malignant neoplasms
B21.8	HIV disease resulting in other malignant neoplasms
B21.9	HIV disease resulting in unspecified malignant neoplasm
B22 Human immunodeficiency virus [HIV] disease resulting in other specified diseases	
B22.0	HIV disease resulting in encephalopathy HIV dementia
B22.1	HIV disease resulting in lymphoid interstitial pneumonitis
B22.2	HIV disease resulting in wasting syndrome HIV disease resulting in failure to thrive Slim disease
B22.7	HIV disease resulting in multiple diseases classified elsewhere
Note: For use of this category, reference should be made to the morbidity or mortality coding rules and guidelines in Volume 2.	
B23 Human immunodeficiency virus [HIV] disease resulting in other conditions	
B23.0	Acute HIV infection syndrome
B23.1	HIV disease resulting in (persistent) generalized lymphadenopathy
B23.2	HIV disease resulting in haematological and immunological abnormalities, not elsewhere classified

	B23.8	HIV disease resulting in other specified conditions
B24 Unspecified human immunodeficiency virus [HIV] disease		
Incl.:	acquired immunodeficiency syndrome [AIDS] NOS AIDS-related complex [ARC] NOS	
		Dementia in human immunodeficiency virus [HIV] disease (B22.0)
		Dementia developing in the course of HIV disease, in the absence of a concurrent illness or condition other than HIV infection that could explain the clinical features.
	O98.7	Human immunodeficiency [HIV] disease complicating pregnancy, childbirth and the puerperium
		Conditions classifiable to B20–B24
R75 Laboratory evidence of human immunodeficiency virus [HIV]		
Incl.:	nonconclusive HIV-test finding in infants	
Excl.:	asymptomatic human immunodeficiency virus [HIV] infection status (Z21) human immunodeficiency virus [HIV] disease (B20–B24) human immunodeficiency virus [HIV] disease complicating pregnancy, childbirth and the puerperium (O98.7)	
	Z11.4	Special screening examination for human immunodeficiency virus [HIV]
	Z20.6	Contact with and exposure to human immunodeficiency virus [HIV]
Excl.:	asymptomatic human immunodeficiency virus [HIV] infection status (Z21)	
Z21 Asymptomatic human immunodeficiency virus [HIV] infection status		
Incl.:	HIV positive NOS	
Excl.:	contact with or exposure to human immunodeficiency virus [HIV] (Z20.6) human immunodeficiency virus [HIV] disease (B20–B24) human immunodeficiency virus [HIV] disease complicating pregnancy, childbirth and the puerperium (O98.7) laboratory evidence of human immunodeficiency virus [HIV] (R75)	
	Z71.7	Human immunodeficiency virus [HIV] counselling
	Z83.0	Family history of human immunodeficiency virus [HIV] disease Conditions classifiable to B20–B24, O98.7

ICD-10 codes for frequent complications of antiretroviral therapy

Incl.:	perinatal HIV infection	
E88.1	Lipodystrophy, not elsewhere classified Lipodystrophy NOS	
Excl.:	Whipple disease (K90.8)	
L27 Dermatitis due to substances taken internally		
Excl.:	adverse: <ul style="list-style-type: none"> effect NOS of drugs (T88.7) food reaction, except dermatitis (T78.0–T78.1) 	
	allergy NOS (T78.4)	
	contact dermatitis (L23–L25)	
	drug: <ul style="list-style-type: none"> photoallergic response (L56.1) phototoxic response (L56.0) 	
	urticaria (L50.-)	
	L27.0	Generalized skin eruption due to drugs and medicaments Use additional external cause code (Chapter XX), if desired, to identify drug.
	L27.1	Localized skin eruption due to drugs and medicaments Use additional external cause code (Chapter XX), if desired, to identify drug.
K71 Toxic liver disease		
Incl.:	drug-induced: <ul style="list-style-type: none"> idiosyncratic (unpredictable) liver disease toxic (predictable) liver disease 	

Use additional external cause code (Chapter XX), if desired, to identify toxic agent.	
Excl.:	alcoholic liver disease (K70.-)
	Budd–Chiari syndrome (I82.0)
K71.0	Toxic liver disease with cholestasis Cholestasis with hepatocyte injury 'Pure' cholestasis
K71.1	Toxic liver disease with hepatic necrosis Hepatic failure (acute)(chronic) due to drugs
K71.2	Toxic liver disease with acute hepatitis
K71.3	Toxic liver disease with chronic persistent hepatitis
K71.4	Toxic liver disease with chronic lobular hepatitis
K71.5	Toxic liver disease with chronic active hepatitis Toxic liver disease with lupoid hepatitis
K71.6	Toxic liver disease with hepatitis, not elsewhere classified
K71.7	Toxic liver disease with fibrosis and cirrhosis of liver
K71.8	Toxic liver disease with other disorders of liver Toxic liver disease with: <ul style="list-style-type: none"> • focal nodular hyperplasia • hepatic granulomas • peliosis hepatis • veno-occlusive disease of liver
K71.9	Toxic liver disease, unspecified
I21 Acute myocardial infarction	
Incl.:	myocardial infarction specified as acute or with a stated duration of 4 weeks (28 days) or less from onset
Excl.:	certain current complications following acute myocardial infarction (I23.-) myocardial infarction: <ul style="list-style-type: none"> • old (I25.2) • specified as chronic or with a stated duration of more than 4 weeks (more than 28 days) from onset (I25.8) • subsequent (I22.-)
	postmyocardial infarction syndrome (I24.1)
I21.0	Acute transmural myocardial infarction of anterior wall
	Transmural infarction (acute)(of): <ul style="list-style-type: none"> • anterior (wall) NOS • anteroapical • anterolateral • anteroseptal
I21.1	Acute transmural myocardial infarction of inferior wall
	Transmural infarction (acute)(of): <ul style="list-style-type: none"> • diaphragmatic wall • inferior (wall) NOS • inferolateral • inferoposterior
I21.2	Acute transmural myocardial infarction of other sites
	Transmural infarction (acute)(of): <ul style="list-style-type: none"> • apical-lateral • basal-lateral • high lateral • lateral (wall) NOS • posterior (true) • posterobasal • posterolateral • posteroseptal • septal NOS
I21.3	Acute transmural myocardial infarction of unspecified site
	Transmural myocardial infarction NOS
I21.4	Acute subendocardial myocardial infarction

		Nontransmural myocardial infarction NOS
	I21.9	Acute myocardial infarction, unspecified
		Myocardial infarction (acute) NOS
I63 Cerebral infarction		
Incl.:	occlusion and stenosis of cerebral and precerebral arteries, resulting in cerebral infarction	
Excl.:	sequelae of cerebral infarction (I69.3)	
	I63.0	Cerebral infarction due to thrombosis of precerebral arteries
	I63.1	Cerebral infarction due to embolism of precerebral arteries
	I63.2	Cerebral infarction due to unspecified occlusion or stenosis of precerebral arteries
	I63.3	Cerebral infarction due to thrombosis of cerebral arteries
	I63.4	Cerebral infarction due to embolism of cerebral arteries
	I63.5	Cerebral infarction due to unspecified occlusion or stenosis of cerebral arteries
	I63.6	Cerebral infarction due to cerebral venous thrombosis, nonpyogenic
	I63.8	Other cerebral infarction
	I63.9	Cerebral infarction, unspecified
I64 Stroke, not specified as haemorrhage or infarction		
Incl.:	<ul style="list-style-type: none"> • embolism • narrowing • obstruction (complete)(partial) • thrombosis 	of basilar, carotid or vertebral arteries, not resulting in cerebral infarction
Excl.:	when causing cerebral infarction (I63.-)	
	I65.0	Occlusion and stenosis of vertebral artery
	I65.1	Occlusion and stenosis of basilar artery
	I65.2	Occlusion and stenosis of carotid artery
	I65.3	Occlusion and stenosis of multiple and bilateral precerebral arteries
	I65.8	Occlusion and stenosis of other precerebral artery
	I65.9	Occlusion and stenosis of unspecified precerebral artery Precerebral artery NOS
N14 Drug- and heavy-metal-induced tubulo-interstitial and tubular conditions		
Use additional external cause code (Chapter XX), if desired, to identify toxic agent.		
	N14.0	Analgesic nephropathy
	N14.1	Nephropathy induced by other drugs, medicaments and biological substances
	N14.2	Nephropathy induced by unspecified drug, medicament or biological substance
Renal failure (N17–N19)		
Use additional external cause code (Chapter XX), if desired, to identify external agent.		
Excl.:	<ul style="list-style-type: none"> • congenital renal failure (P96.0) • drug- and heavy-metal-induced tubulo-interstitial and tubular conditions (N14.-) • extrarenal uraemia (R39.2) • haemolytic-uraemic syndrome (D59.3) • hepatorenal syndrome (K76.7) • hepatorenal syndrome: <ul style="list-style-type: none"> • postpartum (O90.4) • prerenal uraemia (R39.2) • renal failure: <ul style="list-style-type: none"> • complicating abortion or ectopic or molar pregnancy (O00–O07, O08.4) • following labour and delivery (O90.4) • postprocedural (N99.0) 	
N17 Acute renal failure		
Incl.:	acute renal impairment	
	N17.0	Acute renal failure with tubular necrosis

		Tubular necrosis: <ul style="list-style-type: none"> • NOS • acute • renal
	N17.1	Acute renal failure with acute cortical necrosis
		Cortical necrosis: <ul style="list-style-type: none"> • NOS • acute • renal
	N17.2	Acute renal failure with medullary necrosis
		Medullary [papillary] necrosis: <ul style="list-style-type: none"> • NOS • acute • renal
	N17.8	Other acute renal failure
	N17.9	Acute renal failure, unspecified
N18 Chronic kidney disease		
Incl.:	chronic renal failure chronic uraemia diffuse sclerosing glomerulonephritis	
Use additional code, if desired, to identify underlying disease.		
Use additional code, if desired, to identify presence of hypertension.		
Excl.:	chronic renal failure with hypertension (I12.0)	
	N18.1	Chronic kidney disease, stage 1 Kidney damage with normal or increased GFR (> 90 mL/min)
	N18.2	Chronic kidney disease, stage 2 Kidney damage with mild decreased GFR (60–89 mL/min)
	N18.3	Chronic kidney disease, stage 3 Kidney damage with moderately decreased GFR (30–59 mL/min)
	N18.4	Chronic kidney disease, stage 4 Kidney damage with severely decreased GFR (15–29 mL/min)
	N18.5	Chronic kidney disease, stage 5 Chronic uraemia End stage kidney disease: in allograft failure <ul style="list-style-type: none"> • NOS • on dialysis • without dialysis or transplant Renal retinitis (H32.8) Uraemic: <ul style="list-style-type: none"> • apoplexia (I68.8) • dementia (F02.8) • neuropathy (G63.8) • paralysis (G99.8) • pericarditis (I32.8)
	N18.9	Chronic kidney disease, unspecified
N19 Unspecified kidney failure		
Incl.:	renal insufficiency NOS	
Excl.:	kidney failure with hypertension (I12.0) uraemia of newborn (P96.0)	
M80.4	Drug-induced osteoporosis with pathological fracture	
Use additional external cause code (Chapter XX), if desired, to identify drug.		
M81.4	Drug-induced osteoporosis without pathological fracture	
Use additional external cause code (Chapter XX), if desired, to identify drug.		
Poisoning by drugs, medicaments and biological substances (T36–T50)		
Incl.:	overdose of these substances wrong substance given or taken in error	

Excl.:	<p>abuse of non-dependence-producing substances (F55)</p> <p>adverse effects ['hypersensitivity', 'reaction', etc.] of correct substance properly administered; such cases are to be classified according to the nature of the adverse effect, such as:</p> <ul style="list-style-type: none"> • aspirin gastritis (K29.-) • blood disorders (D50–D76) • dermatitis: <ul style="list-style-type: none"> • contact (L23–L25) • due to substances taken internally (L27.-) • nephropathy (N14.0–N14.2) • unspecified adverse effect of drug (T88.7) <p>intoxication meaning inebriation (F10–F19)</p> <p>drug reaction and poisoning affecting the fetus and newborn (P00–P96)</p> <p>pathological drug intoxication (F10–F19)</p>
T37 Poisoning by other systemic anti-infectives and antiparasitics	
Excl.:	<p>anti-infectives:</p> <p>locally applied NEC (T49.0)</p> <ul style="list-style-type: none"> • topically used (for): <ul style="list-style-type: none"> • ear, nose and throat (T49.6) • eye (T49.5)
T37.5	Antiviral drugs (poisoning)
Excl.:	<p>amantadine (T42.8)</p> <p>cytarabine (T45.1)</p>
Complications of surgical and medical care, not elsewhere classified (T80–T88)	
Use additional external cause code (Chapter XX), if desired, to identify devices involved and details of circumstances.	
Use additional code (B95–B98), if desired, to identify infectious agent.	
Excl.:	<p>adverse effects of drugs and medicaments (A00–R99, T78.-)</p> <p>any encounters with medical care for postoperative conditions in which no complications are present, such as:</p> <ul style="list-style-type: none"> • artificial opening status (Z93.-) • closure of external stoma (Z43.-) • fitting and adjustment of external prosthetic device (Z44.-) <p>burns and corrosions from local applications and irradiation (T20–T32)</p> <p>complications of surgical procedures during pregnancy, childbirth and the puerperium (O00–O99)</p> <p>poisoning and toxic effects of drugs and chemicals (T36–T65)</p> <p>specified complications classified elsewhere, such as:</p> <ul style="list-style-type: none"> • cerebrospinal fluid leak from spinal puncture (G97.0) • colostomy malfunction (K91.4) • disorders of fluid and electrolyte balance (E86–E87) • functional disturbances following cardiac surgery (I97.0–I97.1) • postgastric surgery syndromes (K91.1) • postlaminectomy syndrome NEC (M96.1) • postmastectomy lymphoedema syndrome (I97.2) • postsurgical blind-loop syndrome (K91.2)
T88.6	Anaphylactic shock due to adverse effect of correct drug or medicament properly administered
Excl.:	anaphylactic shock due to serum (T80.5)
X44 Accidental poisoning by and exposure to other and unspecified drugs, medicaments and biological substances	
This covers accidental overdose of drug, wrong drug given or taken in error, and drug taken inadvertently, accidents in the use of drugs, medicaments and biological substances in medical and surgical procedures, (self-inflicted) poisoning, when not specified whether accidental or with intent to harm. Follow legal rulings when available (see note at Y10–Y34).	
Incl.:	<p>agents primarily acting on smooth and skeletal muscles and the respiratory system, anaesthetics (general)(local) drugs affecting the:</p> <ul style="list-style-type: none"> • cardiovascular system • gastrointestinal system <p>hormones and synthetic substitutes</p> <p>systemic and haematological agents</p> <p>systemic antibiotics and other anti-infectives</p> <p>therapeutic gases</p> <p>topical preparations</p> <p>vaccines</p> <p>water-balance agents and drugs affecting mineral and uric acid metabolism</p>

X64 Intentional self-poisoning by and exposure to other and unspecified drugs, medicaments and biological substances	
This covers purposely self-inflicted poisoning or injury or suicide (attempted)	
Incl.:	agents primarily acting on smooth and skeletal muscles and the respiratory system anaesthetics (general)(local)
	drugs affecting the: <ul style="list-style-type: none"> • cardiovascular system • gastrointestinal system hormones and synthetic substitutes systemic and haematological agents systemic antibiotics and other anti-infectives therapeutic gases topical preparations vaccines water-balance agents and drugs affecting mineral and uric acid metabolism
Y14 Poisoning by and exposure to other and unspecified drugs, medicaments and biological substances, undetermined intent	
This covers events where available information (after investigation) is insufficient to enable a medical or legal authority to make a distinction between accident, self-harm and assault. It includes self-inflicted injuries, but not poisoning, when not specified whether accidental or with intent to harm (X40–X49). Follow legal rulings when available.	
Incl.:	agents primarily acting on smooth and skeletal muscles and the respiratory system anaesthetics (general)(local)
	drugs affecting the: <ul style="list-style-type: none"> • cardiovascular system • gastrointestinal system hormones and synthetic substitutes systemic and haematological agents systemic antibiotics and other anti-infectives therapeutic gases topical preparations vaccines water-balance agents and drugs affecting mineral and uric acid metabolism
Drugs, medicaments and biological substances causing adverse effects in therapeutic use (Y40–Y59)	
Note:	For list of specific drugs classified under the fourth-character subdivisions, see Table of drugs and chemicals in Alphabetical Index [of the ICD-10].
Excl.:	accidents in the technique of administration of drugs, medicaments and biological substances in medical and surgical procedures (Y60–Y69)
	Y41.5 Antiviral drugs (adverse effects in therapeutic use); correct drug properly administered in therapeutic or prophylactic dosage as the cause of any adverse effect
Excl.:	amantadine (Y46.7) cytarabine (Y43.1)

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