

MAY 2020

Revealing the Toll of COVID-19: A Technical Package for Rapid Mortality Surveillance and Epidemic Response



Bloomberg
Philanthropies



Acronyms

ICD - International Classification of Diseases

CRVS - Civil Registration and Vital Statistics

DHS - Demographic Health Survey

PPE - Personal Protective Equipment

IDSR - Integrated Disease Surveillance and Response

ILI - Influenza-like Illness

MCCD - Medical Certificate of Cause of Death

MICS - Multiple Indicators Cluster Surveys

MLDI - Medical Legal Death Investigation

PCVA - Physician-coded Verbal Autopsy

RMS - Rapid Mortality Surveillance

SARI - Severe Acute Respiratory Infection

Contents

i	Acknowledgements
ii	List of Contributors
iii	Preface
<hr/>	
1	Why Implement Rapid Mortality Surveillance?
1	Why Total Mortality?
4	The Rapid Mortality Surveillance (RMS) Concept
5	Facility-Based Surveillance
10	Community-Based Surveillance
13	Data Quality
14	Deriving Estimates of Historical Mortality for Community-Based Surveillance
16	Graphing Excess Mortality
16	Analysis and Interpretation
18	Use of Rapid Mortality Surveillance Data
20	Checklist for Establishing Rapid Mortality Surveillance
<hr/>	
22	Annex 1: Infection Prevention and Control for Surveillance Workers
23	Annex 2: Including Manner and Cause of Death
23	Grouping mortality by manner of death and suspected COVID-19
24	Using medical certification of cause of death and ICD mortality coding
25	Investigation of suspected cases postmortem through medical autopsy
26	Use of verbal autopsy
28	References

Acknowledgements

This publication is, in part, an output of the Bloomberg Philanthropies Data for Health Initiative (www.Bloomberg.org). This publication was produced with support from Resolve to Save Lives, an initiative of Vital Strategies.” Resolve to Save Lives is a five-year, \$225 million initiative funded by Bloomberg Philanthropies, the Bill & Melinda Gates Foundation, and Gates Philanthropy Partners, which is funded with support from the Chan Zuckerberg Foundation. Resolve received additional funding from Bloomberg Philanthropies, CDC Foundation and Stavros Niarchos Foundation for the COVID-19 response.

The views expressed are not necessarily those of the Philanthropies. The views expressed in the documents on this platform are solely the responsibility of the authors and do not necessarily represent the views of the World Health Organization.

You may view and/or print pages from PreventEpidemics.org for your own personal or professional use and you may download any materials offered on the website for personal or professional non-commercial use. If you intend to use these materials in any other way you must first obtain written permission from Vital Strategies.

Suggested citation: Vital Strategies, World Health Organization (2020). Revealing the Toll of COVID-19: A Technical Package for Rapid Mortality Surveillance and Epidemic Response. New York: Vital Strategies

© Vital Strategies and World Health Organization 2020 CC BY-NC-SA 3.0 IGO



List of Contributors

Africa Centres for Disease Control and Prevention Mortality Surveillance Programme	Emily B Atuheire Akhona Tshangela	
African Center for Statistics United Nations Economic Commission for Africa	Oliver Chinganya William Muhwava	
US Centers for Disease Control and Prevention National Center for Health Statistics	Brian Munkombwe Erin Nichols	
CDC Foundation	Emily Cercone Olga Joos	
Department of Sociology The Ohio State University	Samuel J Clark	
World Health Organization Division of Data, Analytics and Delivery for Impact	Carine Alsokhn Samira Asma Somnath Chatterji	Robert Jakob Doris Ma Fat WHO Verbal Autopsy Reference Group
World Health Organization Regional Offices	Adrienne Cox Monica Alonso Gonzalez Enrique Perez-Gutierrez Nathalie El Omeiri Andrea Vicari (AMRO/PAHO) Humphrey Cyprian Karamagi (AFRO)	Eman Abdelkreem Aly Azza Mohamed Badr Arash Rashidian (EMRO) Mark Landry (SEARO) Jun Gao (WPRO)
Statistics Division, United Nations Economic and Social Commission for Asia and the Pacific	Petra Nahmias David Rausis Tanja Sejersen	
Department of Epidemiology and Global Health Umeå University	Peter Byass, Advisor to WHO, Division of Data, Analytics and Delivery for Impact	
Swiss Tropical and Public Health Institute University of Basel	Don de Savigny	
Nuffield Department of Population Health University of Oxford	Ben Lacey	
Vital Strategies	Martin Bratschi Benjamin Clapham Carlie Congdon Cynthia Driver Ruxana Jina Adam Karpati Farnaz Malik	Anushka Mangharam Tom Matte Robert Mswia James Mwanza Elizabeth M. Ortiz Philip Setel

“Know your epidemic, know your system, know your response.”

— UNAIDS, 2008

“No country is really sure how many people it has lost in the [COVID-19] pandemic”

— New York Times, 2020

Preface

On Jan. 30, 2020 the World Health Organization (WHO) declared the outbreak of coronavirus disease 2019 (COVID-19) a Public Health Emergency of International Concern.^A Even before this declaration, counts of deaths and cases were a primary means of tracking the growth and trajectory of the pandemic. In particular, graphs depicting excess total mortality by week from countries around the world have been an increasingly common and powerful way to capture and present the impact of the COVID-19 pandemic.

The purpose of this document is to provide practical guidance to implement rapid mortality surveillance (RMS) and measure excess mortality in the context of the COVID-19 pandemic, with a focus on implementation in low-resource settings. This includes settings with largely paper-based systems of data collection.

We define RMS as “a system for generating daily or weekly counts of total mortality by age, sex, date of death, place of death, and place of usual residence.” Excess mortality is the degree to which currently measured mortality exceeds historically established levels. In the context of COVID-19, increases in total mortality are attributed to direct and indirect effects of the pandemic.

While this guidance is COVID-19 specific, the basic concept of rapid mortality surveillance adds to the international architecture of population health surveillance and civil registration and vital statistics (CRVS) systems.

A [https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-\(2005\)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-\(2019-ncov\)](https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov))

At one end of the spectrum, CRVS systems are fully functional, with digitization speeding up the recording of deaths and causes of death in near real-time. In these circumstances there is no distinction between RMS and CRVS. At the other end of the spectrum are settings in which CRVS systems are fragmented, have low completeness and coverage and are partially digitized, and are not yet able to report weekly mortality in a timely fashion. In these contexts, RMS can play important functions – particularly where restrictions on movement may be depressing death registration during the epidemic. These functions include: I) providing more timely weekly counts of death than would otherwise be possible; and II) obtaining and retaining the information sufficient for the later official registration of each death in the CRVS system.

In this document we provide:

- The rationale for and conceptual model of RMS
- Guidance for facility- and community-based surveillance
- Guidance for the analysis, visualization and use of the data
- A checklist for establishing a rapid mortality surveillance system

In addition to data collection for total mortality, we also discuss integration with other surveillance systems and the inclusion of information on the manner or cause of death. The guiding principles of RMS should be those that pertain to any system innovation: country ownership and leadership; capacity building; adaptability; and sustainability. Furthermore, it should be stressed that RMS should, wherever possible, be integrated into the national CRVS system—the essential nature of which, even under pandemic conditions, has been made clear by the United Nations.^B

This Technical Package is one of several global resources developed and supported by WHO and partners, including those of the Bloomberg Philanthropies Data for Health Initiative. In addition to this document, these global resources include:

- A technical note on Medically Certifying, International Classification of Diseases (ICD) mortality coding, and reporting mortality associated with COVID-19
- Technical guidance on COVID-19 coding in ICD-10^C
- A web portal where countries are being requested by WHO to report weekly mortality based on aggregate data from official cause-of-death death certification, where possible.

According to Article 64 of its constitution, WHO is mandated to request each Member State to provide statistics on mortality. Furthermore, the WHO Nomenclature Regulations of 1967 affirms the importance of compiling and publishing statistics of mortality and morbidity in comparable form. Member States started to report mortality data to WHO since the early fifties and this reporting activity is continuing until today. Every year WHO issues an annual call for data on mortality and causes of death and those data have driven major global health policies and research.

B <https://unstats.un.org/legal-identity-agenda/COVID-19/>

C <https://www.who.int/classifications/icd/COVID-19-coding-icd10.pdf?ua=1>

Why Implement Rapid Mortality Surveillance?

The slogan “Know your epidemic. Know your response” is as relevant today as it was when first coined to link evidence to action in the face of AIDS [1]. How then do we “know” the epidemic? How do we measure it? In the current context, two key indicators of impact are the number of COVID-19 cases and the number of COVID-19 deaths as reported on global dashboards.^D Yet these indicators are challenging to measure and reflect only part of the burden and distribution of the outbreak. Existing data from routine, and particularly syndromic, surveillance systems may address some of the shortfalls by serving as an early signal of undiagnosed COVID-19 cases [2]. However, understanding the true impact of COVID-19 on mortality requires reliable data that are not always available in a timely manner in many low-resource settings. Rapid mortality surveillance (RMS) can fill this gap where existing civil registration and vital statistics (CRVS) systems are unable to meet the need.

There are many approaches to mortality surveillance, involving all-cause and cause-specific mortality systems in the health sector, as well as civil registration systems and medicolegal death investigation systems. Ideally, countries have a digitized, unified death notification and registration system with high levels of coverage and completeness that captures all deaths from all causes in all settings (e.g. hospitals; care facilities; homes; or prisons) and can, therefore, be used to generate all necessary mortality data promptly.

However, in many low- and middle-income countries, the coverage and completeness of civil registration of deaths is often below 20%. Hospitals, as the main source of cause-of-death data, are frequently not integrated into the civil registration system, and many systems are only partially digitized, leading to significant lag times in reporting. Furthermore, not all countries use the international standard form of the medical certificate of cause of death and hence are unable to apply the International Classification of Diseases (ICD) rules of mortality coding. This makes it difficult to statistically analyze cause-of-death data over time and to compare between jurisdictions—even where deaths are carefully certified.

Perhaps more importantly, a focus on total mortality encourages the measurement of deaths occurring outside of a health facility, which can be the norm in many low- and middle-income countries. In some countries up to 70% of deaths may occur in the community, and therefore out of the reach of any likely COVID-19 testing or clinical case detection.

^D See e.g. World Health Organization (<https://covid19.who.int/>); Johns Hopkins (<https://coronavirus.jhu.edu/map.html>); Google (<https://www.google.com/covid19-map/>)

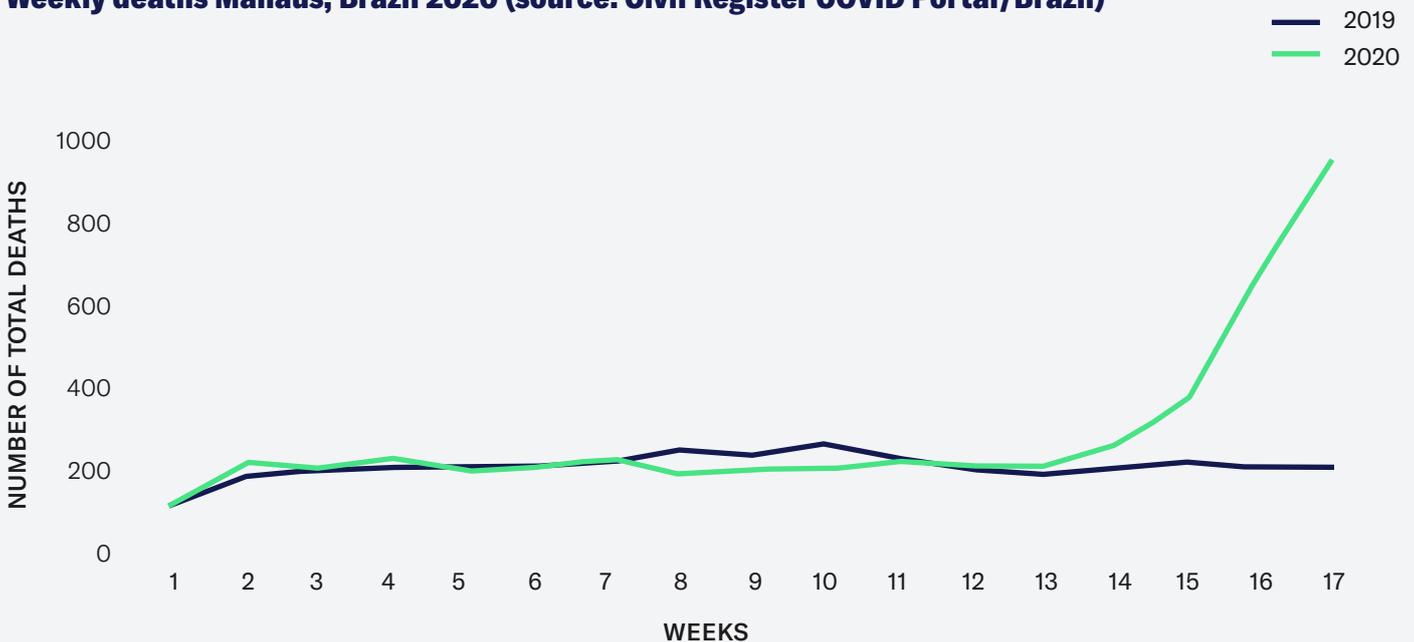
Why Total Mortality?

Identifying COVID-19-specific mortality is a challenge across the globe. In many countries, limits on test availability have led to restrictive criteria for access and use, even for people with symptoms. This makes the generalization of testing results impossible and counts of COVID-19 “cases” and “deaths” extremely difficult to interpret.

Without the testing of all suspected cases, health care providers, medical examiners and coroners are left to rely on evolving knowledge of the signs and symptoms associated with COVID-19 deaths. Our ability or inability to differentiate these from other causes of death may result in misclassification. Furthermore, due to societal and health system disruptions, the epidemic contributes to deaths from other causes.

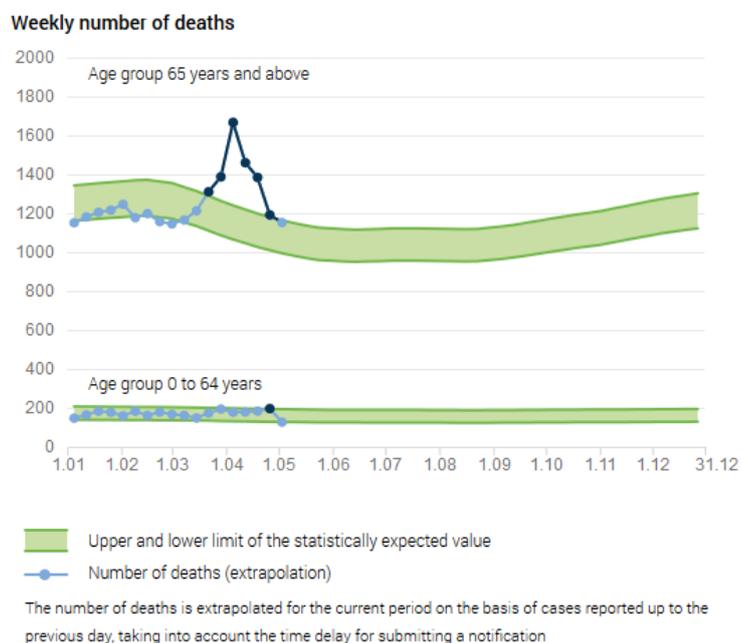
Given these challenges, WHO is calling on all governments to report weekly total mortality based on registration data where available in a timely manner, and other RMS data sources. Aggregated data can be uploaded to WHO via a global portal. Particularly if begun early enough in the epidemic, visualizations of total mortality even without age and sex disaggregation are readily interpretable. For example, Figure 1 was produced using publicly available data for a large city Brazil. It clearly shows the weekly excess mortality in 2020 compared to 2019 starting in week 14. Even without the historical comparison, the conclusions would be stark. Figure 2 shows a historically expected range of deaths by week, a preferred way to display the historical range if data are available.

FIGURE 1
Weekly deaths Manaus, Brazil 2020 (source: Civil Register COVID Portal/Brazil)^A



A <https://transparencia.registrocivil.org.br/registral-covid>

FIGURE 2
Weekly deaths in 2020 by age group, Switzerland (source [3])



Source: FSO – Cause of death statistics

© FSO 2020

Data status: 12.05.2020

The purpose of rapid mortality surveillance is to inform decision-makers about the scale and direction of the epidemic with a straightforward focus on excess mortality. It provides insights into the full magnitude of the health consequences of the epidemic (beyond case counts and mortality counts based on lab diagnosis), and into disparities in disease burden across geographic and demographic groups. Also, despite mortality being a lagging indicator of infections, it provides insight into ongoing population transmission patterns. Nevertheless, countries must also rely on many other indicators for decision-making during the COVID-19 pandemic.

Weekly counts of total deaths to achieve this purpose have been available in high-income countries [3-6] but are rarely published from low- and middle-income countries. At present there are no clear standards and protocols for reporting on all deaths specifically under epidemic conditions, regardless of cause [7, 8]. Some middle-income countries, for example in Latin America, have the data and are analyzing it for the first time in an epidemic context.^E In South Africa, where data are obtained from a digitized population register, the rapid mortality surveillance system has provided the timeliness of data production needed [9].

This technical guide addresses how rapid mortality surveillance can be applied for both facility- and community-based deaths where resources are constrained. This includes contexts with little or no digitization and connectivity. The guidance provided will enable health authorities to compile data so they can detect and monitor mortality, which will in turn inform decision-making over the course of the epidemic. The guidance has been kept as simple and fit-for-purpose as possible, bearing in mind that implementation will take place under challenging conditions.

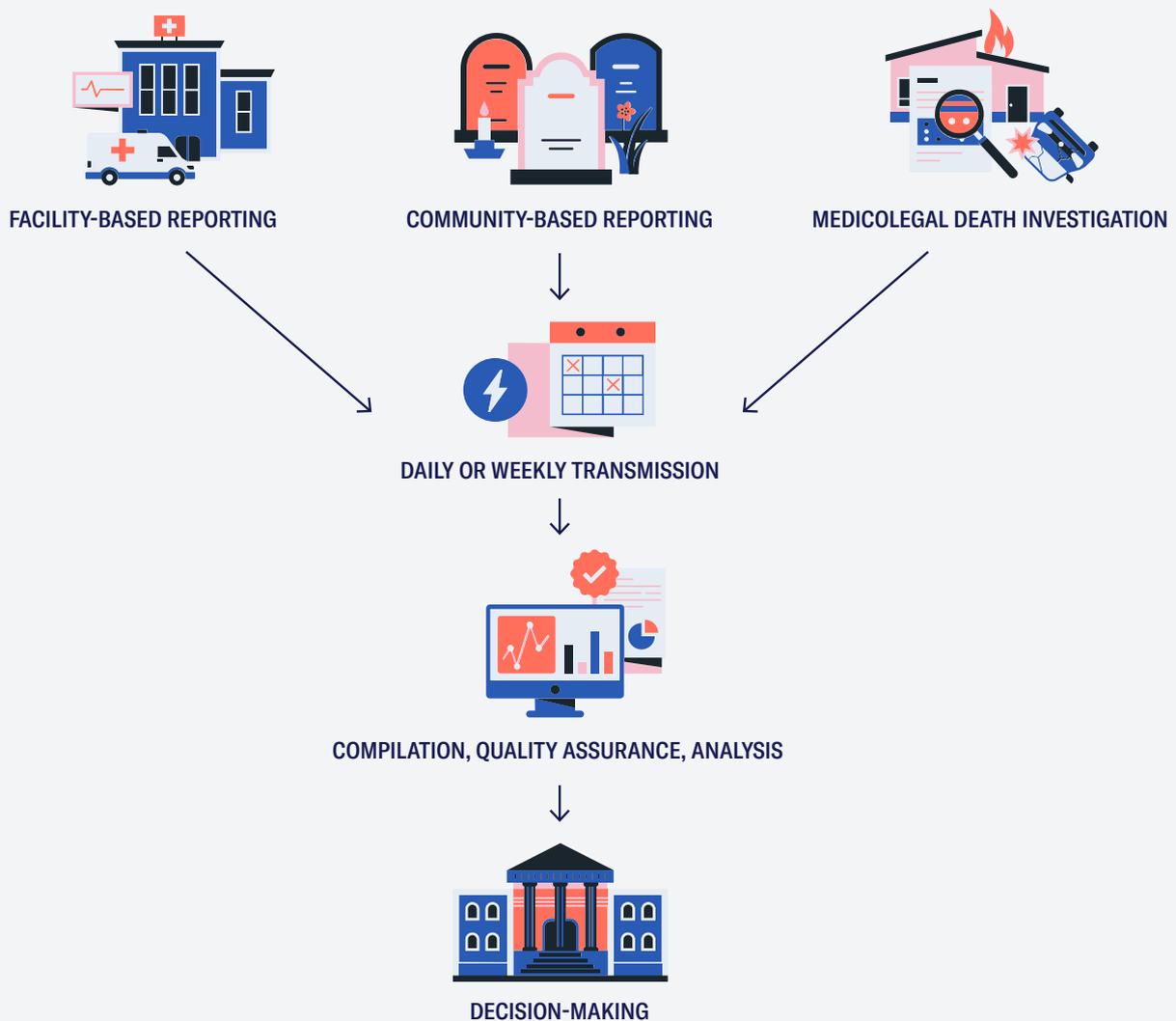
E See for example: <https://transparencia.registrocivil.org.br/registral-covid>

The Rapid Mortality Surveillance (RMS) Concept

The function of rapid mortality surveillance is to generate the data needed to analyze excess mortality by age and sex on a weekly basis. At its simplest level, the system should be capable of generating a visualization of mortality trends or excess mortality similar to the ones in Figures 1 and 2. To do this, there must be: i) a source of rapidly and routinely reported deaths by age, sex and location; and ii) some means to establish a baseline of pre-epidemic mortality levels by age and sex against which to compare the current reports.

The RMS concept has two main components—facility-based surveillance and community-based surveillance—as shown in Figure 3. Community-based surveillance is important where a significant number of deaths are either known or suspected to be occurring at home or otherwise outside of a health facility. In countries where a significant proportion of deaths are captured only by coroners or medical examiners as part of the medicolegal death investigation system (MLDI), this system should also be included.

FIGURE 3
Rapid Mortality Surveillance System



The minimum set of data elements recommended for collection across all the components of an RMS system (i.e. facility, community, and MLDI where necessary) are as follows:

- **Age**—decedent's age at death
- **Sex**
- **Place of usual residence**—geographic location (e.g. region or district) where the deceased usually resided
- **Date of occurrence**—the date (day, month and year) the death occurred
- **Site of occurrence**—whether in a health facility, at home or elsewhere (e.g. roadway)

The system should primarily operate without the need for close physical proximity and interaction between data collectors and respondents, particularly under the most severe epidemic conditions. That said, to the extent that any surveillance activity requires field or facility-based work, the guidance contained in Annex 1 may be used to enable protection of surveillance workers under different epidemiologic scenarios.

Given the strains on the systems under pandemic conditions, existing reporting processes are likely the best basis for rapid mortality surveillance—and may possibly be outside the usual flow of data from CRVS systems. Furthermore, to allow for the timely dissemination of real-time mortality estimates, surveillance system modifications may be required, including temporarily altering or reducing the amount of data collected; shortening reporting timelines; simplifying data flow; deploying faster means of data transmission; or abbreviating validation processes.

Such changes may be needed because of the demands of weekly reporting and the effect of public health and social measures on the operation of routine systems. Nevertheless, care should be taken wherever possible to actively collect and retain the minimum data elements necessary to contact families and complete an official death notification to the civil registrar. Collecting, storing and sharing these data with registrars will permit the CRVS system to complete the death registration process at a later date.

Any rapid mortality surveillance processes established should consider existing infrastructure and business processes for data collection and transmission, existing human resources and responsibilities, protocols or standard operating procedures for all stakeholders involved, and communications technology solutions for the data collection.

For community-based surveillance, a rapid initial assessment should be done of the existing surveillance or reporting options that may be leveraged for RMS or into which RMS might be integrated. This review should consider the coverage or completeness of the system, as well as its timeliness in reporting and its likely ability to detect all mortality events occurring in a representative manner. This assessment should lead to one or two candidate systems for integration. For example, many countries implement syndromic mortality surveillance on severe acute respiratory infections (SARI) or influenza-like illness (ILI) [8]. Elsewhere, the integrated disease surveillance and response (IDSR) strategy is used [10]. Any of these systems may present opportunities for integration of RMS. Community health workers, particularly if there is full coverage of a part or whole of a country, are a useful resource to consider as reporters of deaths.

Facility-Based Surveillance

Facility-based all-cause mortality surveillance aims to collect information regarding all deaths occurring at a health facility, with the optional collection of cause-of-death information where feasible. Many countries will want to include cause of death—particularly COVID-19-specific mortality—in their reports. Where manner or cause of death is also collected, cause-specific mortality fractions—that is, the proportions of all deaths due to broad or specific causes—can be calculated. The means to do so are addressed in Annex 2: Including Manner and Cause of Death.

Observed hospital mortality data can be compared to historical deaths from the same facility. Observed versus baseline facility-level mortality data would ideally be compared relative to the number of hospital admissions; deaths on arrival; and deaths occurring between arrival and admission, to account for changes in facility utilization. Baseline and current hospital admission data should therefore also be collected. The admissions data is recommended to assist with the interpretation of trends to account for any change in utilization.

A facility-based all-cause mortality surveillance system can build on existing networks of sentinel hospitals, or hospitals identified or sampled in some other manner. Health facilities worldwide collect information on total inpatient deaths and report this data, typically on a monthly basis, either as aggregated counts or patient-level records. They may also collect disease-specific or age-specific death counts through routine health information systems or program-specific surveillance tools. Some health facilities maintain a mortality register where all inpatient deaths are documented.

If certain hospitals are to be selected as sentinel sites, they should be chosen to be geographically representative, whether through a formal sampling exercise or a systematic consultative process with health experts. Given the dynamics of the COVID-19 pandemic, there should also be an effort to select health facilities serving areas of high population density, communities with close living conditions, and high-risk populations (e.g. older people, socially vulnerable people, people with comorbidities, etc.).

Some countries have established temporary hospitals or isolation camps for COVID-19. These should be included.

Sites that report only aggregated data can continue to do so, while taking steps to reduce the reporting time frames and processing times, and moving to disaggregate data by age and sex. Several countries that rely heavily on paper-based systems are devising ways of rapidly relaying daily information from health facilities on several priority indicators (e.g. personal protective equipment supplies; patient volume; bed capacity; drug supplies, etc.). Due to the time-sensitive nature of data collection, some are deploying interactive SMS systems using mobile phones to obtain this data, bypassing routine paper-based processes. Total mortality counts could be added to such systems.

Figure 4 shows a simplified business process map to produce data from facility-based surveillance (map shown is for total mortality analysis; cause-of-death analysis can be added as applicable.)

FIGURE 4
Simplified business process for facility-based surveillance

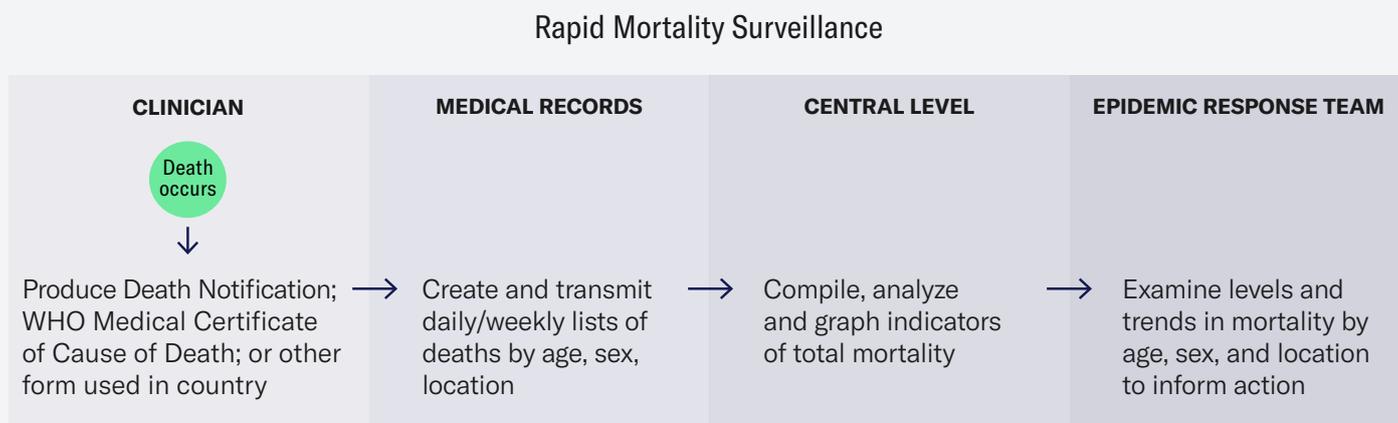


FIGURE 5
Sample weekly listing sheet: health facility

Date for week ending/week number:				
Facility name:				
Date of completion:				
Name of person completing this form:				
Death #	Patient ID [do not transmit]	Sex	Age at Death	Date of Death
1	XX-XXXXX	M	82	15-04-2020
2	XX-XXXXX	F	55	15-04-2020
3	XX-XXXXX	M	35	16-04-2020
...

Figure 5 shows a proposed template for data collection.

Figures 4 and 5 have been kept as simple as possible to account for application even in paper-based systems backed up by limited or no connectivity from the periphery. In such situations, the business process described in Figure 4 should still be applicable. In the facility setting, the RMS reporting routine may be integrated into the existing pathways for handling medical certificates of cause of death. Early experience with actors such as the Department of Health have shown that medical records staff and front-line health workers all contribute to compiling RMS data. Furthermore, it should still be possible to complete weekly listing sheets in Figure 5 and, if necessary, report them over a phone line to the central level. The central level authority may be an Epidemiology unit of the Ministry of Health or a specially created Epidemiology Intelligence Unit. Aggregation, tabulation, and analysis and graphing of excess mortality for policy-makers takes place at this level. Data use and interpretation is the responsibility of the government authority charged with epidemic response. The degree, trajectory, and slope of excess mortality revealed should be a central input into the deliberations of this entity.

It is of great importance that even during the pandemic and while running an RMS system, countries should continue documentation and secure storage of cases with medical records and an ICD-compliant medical certificate of cause of death (MCCD). In addition, it is critically important that efforts to register deaths with the civil registry continue. Nevertheless, fact-of-death reporting should not be delayed by the certification and registration process when doing so would significantly affect the timeliness of reporting. The United Nations Legal Identity Agenda has declared that civil registration should be considered an essential government service.^F However, some public health and social measures may make immediate registration challenging. If immediate civil registration of deaths is not possible, completed MCCD forms and/or other death notification forms can be stored until civil registration becomes possible again. Ultimately, the legal documentation provided by the civil registration system will be essential for people, so any backlogs in registration that occur during the pandemic must be cleared as soon as practical.

During pandemic or public health emergency conditions, daily reports of COVID-19-related deaths may be required. It may, therefore, be most straightforward to report all deaths daily. Compiling and transmitting data to the central level should be done by a designated person at each sentinel site—ideally someone in a non-clinical role such as medical records staff. Electronic systems may facilitate real-time data transmission, while paper-based systems will require processing time.

It is also critical to report the absence of any deaths recorded for the day (zero reporting), when applicable. This is to distinguish the fact that zero deaths occurred from a missed reporting cycle.

For the transmission of data from the hospitals to the central level (likely a unit at the central office of the ministry of health), various options are possible. Currently implemented electronic health information systems such as DHIS-2^G and electronic medical record systems such as Peru's SINADEF should be evaluated to determine if the suggested data about deaths is already being collected or if data collection systems that are in place can be easily modified to ensure the rapid collection of the recommended data. SINADEF is the Peruvian Ministry of Health's online cause-of-death system, which has been functional and operating widely in Peru since 2016. Capitalizing on its use early in the COVID-19 pandemic has been critical to providing a clear picture of all-cause and cause-specific mortality in Peru. Death certification in Peru can be done in online electronic formats or the traditional paper format, where internet access remains a challenge. A total of 70% of all deaths nationally are registered online within the first 24 hours.

If there is no existing electronic data collection system, a system can be established specifically for the collection of RMS data. Systems such as RapidPro^H (leveraging interactive SMS messaging) or Open Data Kit (ODK)^I could be considered. If required, information can also be shared by telephone, email or simple messaging services.

Available human resources, required hardware, and financial resources should be considered closely when deciding on the system to use for the transmission of data from the health facilities to the central level. Public-

F See <https://unstats.un.org/legal-identity-agenda/COVID-19/>

G <https://www.dhis2.org/>

H <https://rapidpro.io/>

I <https://opendatakit.org/>

private partnerships with telecommunications companies may allow for free or reduced cost services, as is the case in Colombia. In all cases, national policies regarding patient privacy and security should be adhered to.

At the central level, the designated unit at the ministry of health should compile reports from the facilities. This central data aggregation unit should also monitor reporting from the facilities and follow up with facilities that are not reporting on time. Following aggregation of reports from the facilities, the central level staff can proceed to analyze the data (see below).

Establishing pre-epidemic levels of mortality is another task related to setting up rapid mortality surveillance. Specifically, comparison data from the previous one to five years from the reporting facilities—ideally with details of deaths by age and sex, cause-of-death information, and total facility admissions for the reporting periods—will need to be compiled for analysis.

Community-Based Surveillance

Given its purpose of illuminating the impact and trajectory of the epidemic, rapid community surveillance of total mortality is crucially important in countries where a significant proportion of deaths occur outside of a formal health care setting and levels of civil registration of deaths are low. It may also be important for inclusion of remote geographic locations or marginalized populations with limited access to health care.

The proportion of deaths occurring outside of health facilities may increase during an epidemic if hospital capacity is exceeded. As with facility-based surveillance, the focus should be on total, all-cause mortality measurement with the addition of cause-of-death inquiry only where feasible.

Where CRVS systems are digitized and functioning, as in Peru, Brazil and South Africa, they may be a ready source of data to display excess mortality [9]. More commonly in low- and middle-income countries, other surveillance systems or strategies such as integrated disease surveillance and response (IDSR), which is designed to accommodate novel pathogens and other unanticipated outbreaks, or the severe acute respiratory infections (SARI) sentinel surveillance system, may be leveraged to achieve rapid mortality surveillance. Should this be the case, rapid mortality surveillance activities should be carefully integrated with any existing surveillance and reporting frameworks.

To the extent possible, community site selection should provide a representative picture at a national (or sub-national) level and follow some standards with regard to sampling [11]. Governments may want to augment representative samples with sentinel sites reflecting high-risk or vulnerable populations such as, displaced people, people who reside in slums/informal settlements, food-insecure people, etc. Existing community systems that monitor deaths may also be incorporated, such as health and demographic surveillance systems.^J

As discussed below, the sites should be selected as complete administrative units with available estimated population figures (e.g. sub-districts, wards, counties), and for which numbers of expected deaths can be generated. This will enable the calculation of pre-epidemic mortality levels needed to determine excess mortality. In practice, time and financial resource constraints may necessitate selection based on other considerations.

Regardless of how sentinel community sites for RMS are selected, certain conditions favor the success of the effort including:

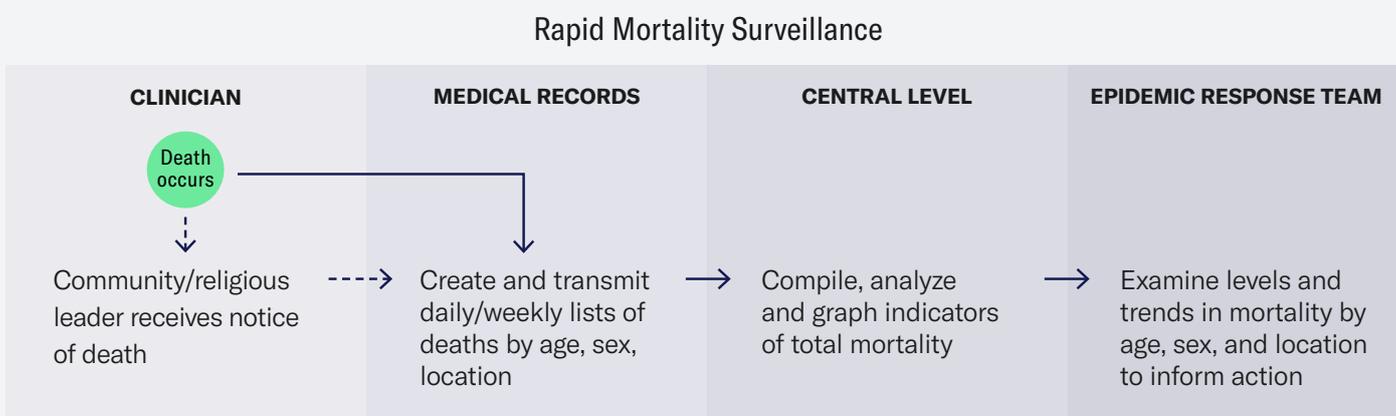
- The presence of a community health or development worker cadre whose routine duties include identifying and reporting incident births and deaths; other community actors may be considered for supporting the death reporting processes, including faith-based organizations, funeral homes or mortuaries, private sector, research institutions, or civil society;
- Established or pandemic-related death management processes that involve contact (remote or direct) with the family (e.g., burial teams or regulated burial or mortuary processes);
- Presence of a mobile communications platform that facilitates reliable remote connectivity to the community for reporting events; and/or

^J See <http://www.indepth-network.org/>

- Existing alternative health care structures, for example mobile clinics and outreach, which provide alternative avenues for care seeking, mortality data capture and reporting.

Figure 6 shows a simplified generic business process for community-based surveillance. As in the case of facility-based surveillance (Figure 4), the identification of deaths as part of RMS should serve the purpose of notification for the civil registration system where possible. This can be ensured by creating—at the point where the death is detected by the RMS reporting structure—a notification for each death with unique identification information, which is then stored safely for eventual civil registration.

FIGURE 6
Simplified business process for community-based surveillance



When a death occurs in the community, the community reporter (often a frontline health worker) will receive notice from members of the community via established channels or channels created for the purposes of RMS. The Africa CDC’s guidance on event-based surveillance may be of assistance with this [12].

Information on each death should be recorded using a listing form such as that in Figure 7 below.

FIGURE 7
Sample listing sheet: community-based surveillance

Date for week ending/week number:							
Site name:							
Date form completed:							
Name of person completing form:							
DO NOT TRANSMIT							
Death #	Family Contact Name	Telephone or Other Contact Information	Name of Deceased	Sex	Age at Death	Date of Death	Died in Health Facility [Y/N]
1	Abdi Michael	+(XX) XXX XXXX	Baby boy	M	0	06-04-2020	N
2	Rahema Machui	+(XX) XXX XXXX	Pendo Machui	F	68	06-04-2020	N
3	Juma Muhammed	+(XX) XXX XXXX	Aziz Aziz	M	81	09-04-2020	Y
...

As in the case of facility-based surveillance, many countries will want to explore causes in community deaths occurring during the pandemic. Guidance on how to do this is provided in Annex 2: Including Manner and Cause of Death.

It is recommended that the list of all deaths be completed as reports come in and be transmitted daily or weekly. Although collected for the purposes of later follow-up for death registration, the name of the family contact, telephone or other contact information, and the name of the deceased should be retained confidentially by surveillance system supervisors at each surveillance site. For the transmission of data from the community to the central level, it is preferred that data collection is set up using existing infrastructure, ensuring the proper role of local and sub-national levels to ensure timeliness and quality of data. If there is no existing electronic data collection system, a system specifically for the collection of data as part of RMS can be established. To ensure smooth operation and sustainability, available human resources, required hardware, and financial resources should be considered carefully when deciding on the system to use for the transmission of data from the community to the central level.

As in the case of facility-based surveillance, the business process described in Figure 6 and listing sheet shown in Figure 7 should be suitable even where digitization and connectivity of systems is extremely limited.

At the central level, the designated unit at the ministry of health should compile reports from the community sites. This central data aggregation unit should also monitor reporting from the different sites and follow up with sites that are not reporting on time. Following aggregation of reports, the central level staff can proceed to analyze the data.

Data Quality

For both community- and facility-based collection, continuous monitoring of the quality of data being collected will need to be established. Quality concerns include: accuracy; completeness; timeliness; consistency; coverage; smooth flow of data; and data management and processing at the central level. For example, the number of sites and reporting rates could vary, especially when the RMS system is being established, and this would need to be considered when analyzing and interpreting the data. Existing systems should be evaluated to ensure that data quality strategies are in place and used to continuously monitor the data.

For aggregated data, each report on numbers of death by age groups and sex should be checked to ensure that the reports are plausible (for example, compared to the report from the previous reporting period) and any anomalies (for example, if the number of reported deaths in one age group or of one sex suddenly increases or decreases substantially) should be confirmed with the person who submitted the report. Built-in components in the data collection workflow (such as skip logic, inconsistency checks, automated calculations, data validations, and instructional prompts) should be evaluated to ensure quality of data and to increase the accuracy and completeness in data collection and processing. In countries where the adaptation of existing systems or addition of data collection systems may be necessary, the adaptations and additions must be well-designed to include necessary data quality checks and formatting for simplicity and rapid application.

It may be necessary for the central level to provide remote data quality assistance to field teams to ensure that RMS is operating effectively and as intended. Remote support will be necessary where restrictions on movement and meetings would prevent in-person visits for data quality checks. A tool like WhatsApp mobile messaging could be used, for example, to facilitate more real-time communication and feedback among stakeholders, data managers at central level, and community or facility teams to ensure quality of data, and as way to send frequent reminders to all implementing teams to follow data quality and accountability protocols. These could include measures to ensure deaths are not double counted from either facilities or communities; ensuring reporting even if there were zero deaths; and taking measures to smooth the impact of missing reports by averaging where necessary.

Deriving Estimates of Historical Mortality for Community-Based Surveillance

The task of establishing historical mortality levels for community surveillance sites is challenging in settings where CRVS systems have had historically low levels of death registration completeness and coverage. Accurate data on population size and expected deaths in sentinel areas are needed to measure excess mortality.

For many low- and middle-income countries, the challenge will be specifying the expected numbers of deaths prior to COVID-19, especially for local areas and settings where large numbers of deaths occur outside health facilities.

To address this issue, we propose using the following crude indirect demographic methods to estimate the expected number of deaths using country-specific: I) population estimates and II) mortality data from the U.N. World Population Prospects 2019.^K

The key assumption with this approach is that sentinel site boundaries match those of administrative units for which there are estimated population figures (e.g. sub-districts; wards; counties). If this is not the case and the boundaries of community reporting sites cut across multiple administrative units, the construction of a baseline is particularly challenging. Under these circumstances, it is recommended to use the early RMS mortality counts as a baseline, and track levels and trends from that point forward.

It is also assumed the sentinel population structure (in terms of age and sex distribution) is similar to the national population as estimated in the U.N. World Population Prospects 2019 data.

The method proposed here involves applying age-specific death rates derived from the U.N. World Population Prospects to the sentinel population, and applying them separately for males and females and age categories. We use this indirect demographic approach because it is easy to implement and because primary historic data on the number of deaths in the sentinel population and/or sex- and age-specific death rates from sentinel sites may not otherwise be available.

^K See: <https://population.un.org/wpp/Download/Standard/>

Below are the steps to follow:

- From the most recent U.N. World Population Prospects 2019,^L obtain population size by age group for males and females for each year from 2015 to 2020^M for the country of interest. Use the downloadable spreadsheet files “Annual Population by Age Groups - Male” and “Annual Population by Age Groups - Female”.
- For the same country of interest, from the U.N. World Population Prospects 2019, obtain number of deaths by age group for males and females from 2015 to 2020.^N Use the downloadable spreadsheet files “Deaths by Age Groups—Male” and “Deaths by Age Groups—Female.”
- Calculate age-specific mortality rates (ASMR) based on the reference population figures and number of deaths obtained from the U.N. World Population Prospects for males and females for each of the years of interest (2015-2019). ASMR is obtained by dividing total number of deaths in an age group for the year of interest (numerator) by the midyear population for the same age group in that particular year (denominator).
- Obtain population sizes of sentinel sites, by age groups (0-59 years; 60+ years) and sex, from available sources such as the national census projections.
- Apply the age-specific mortality rates derived from the U.N. World Population Prospects 2019 data to the sentinel population to obtain expected number of deaths in the sentinel sites for each year of interest (2015-2019). This is done by multiplying the number of people in each age group of the sentinel population by the age-specific mortality rate in the comparable age group of the reference population for males and females.
- From the annual expected number of deaths in the sentinel sites by age group and sex for the years 2015-2019, the average weekly number of deaths over these years can be calculated, taking note of disasters or outbreaks with high death tolls in prior years (both to ensure data is not skewed, and to use those periods as a point of reference). Measures of deviation around the average in these recent years can also be computed.

The approach described above is relatively easy to implement. With the described method, there is no need to know the age-specific mortality rates of the sentinel population (only the population distribution by age group and sex), as these rates may be difficult to obtain. This method will not, however, account for sub-national variation in mortality, which may be substantial in some settings (for example, urban versus rural). If such variation is known to exist for the particular country or the selected sentinel sites, more elaborate methodologies to estimate baseline levels of mortality could be considered. Additional sources of data on mortality such as, for example, from Demographic and Health Surveys (DHS) or Multiple Indicator Cluster Surveys (MICS), could be considered to understand and account for sub-national variations in mortality. Estimating baseline levels of mortality for the sentinel sites of the RMS system taking into account these sources of information will be considerably more complex.

L <https://www.un.org/en/development/desa/population/publications/manual/estimate/demographic-estimation.as>

M See: <https://population.un.org/wpp/Download/Standard/Population/>

N See: <https://population.un.org/wpp/Download/Standard/Mortality/>

Another option is to use the central age-specific probability of death, column (${}_n m_x$) in the abridged life table for the 2015-2020 period, which can also be obtained from the U.N. World Population Prospects 2019. However, doing so will not permit calculation of annual age-specific mortality rates. Finally, it may be possible to use census data to derive expected numbers of deaths if data are considered recent enough.

As noted above, where it is not possible to determine a baseline, it will be necessary to use the first sets of observations as a contemporary baseline and track subsequent trends.

Graphing Excess Mortality

With the two data sources (i.e. weekly mortality reports of current mortality and comparison data), a graph of excess mortality such as that in Figure 1 can be created. This can be achieved by creating a line graph in a spreadsheet or statistical software program plotting the total number of deaths per week against the baseline (historical or estimated) data. Where desired, more detailed analyses of excess mortality can be carried out by age group, sex or location. As shown in the example from Switzerland in Figure 2, the number of deaths per week was plotted from January of 2020 against the upper and lower limit of the statistically expected value for two age groups: 0-64 and 65+. Displaying the data in this manner clearly pinpoints at least one population sub-group (those over about age 60) known to be especially vulnerable to COVID-19.

Accompanying this document is an Excess Mortality Calculator spreadsheet template, which may be freely downloaded and used to aid in these visualizations.⁹

Analysis and Interpretation

Once all-cause mortality data have been collected through either facility- or community-based surveillance, and historical data has been compiled or estimates of expected deaths have been calculated, the data can be compared to determine the extent to which observed deaths exceed baseline deaths, as an indicator of the overall COVID-19 mortality burden. This can be presented as one of the following measures:

- The absolute number and/or percentage above or below the limit of the 95% confidence interval derived from the historic number of deaths from at least four years of data; or
- The absolute number and/or percentage above or below the historic average number of deaths during each of the reporting periods.

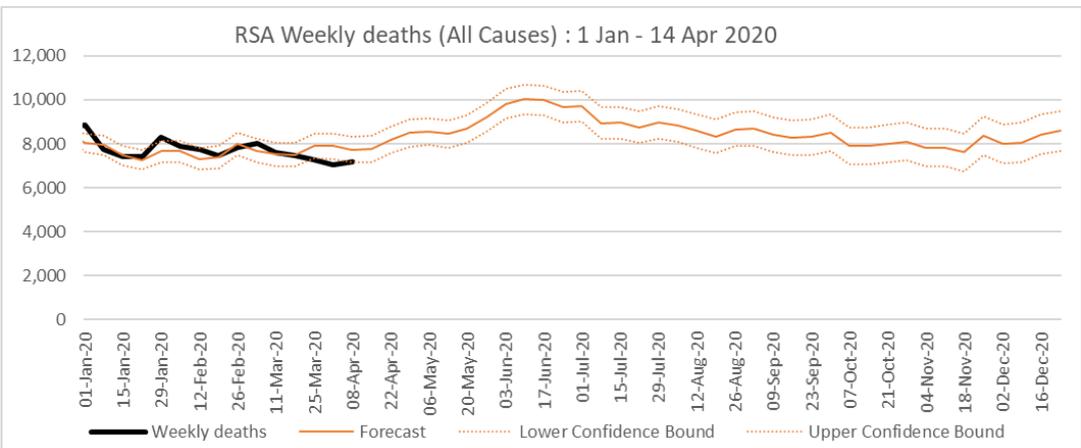
⁹ Available from: <https://vital.box.com/v/ExcessMortalityCalculator>

The following points need to be considered in interpreting the excess of observed mortality:

- When it is not possible to calculate the 95% confidence interval due to limited historical data, the absolute number and percentage above or below a baseline from the previous year(s) can be calculated. The latter may also be more understandable for decision-makers.
- For facility-based surveillance, excess mortality should preferably be calculated per 10,000 admissions, if possible, to account for potential changes in facility admissions over time. Where historical data are available in facilities, and if estimates are only available for the year, the annual estimate would need to be divided by 12 to obtain the monthly average or by 52 to obtain a weekly average to provide a crude baseline.

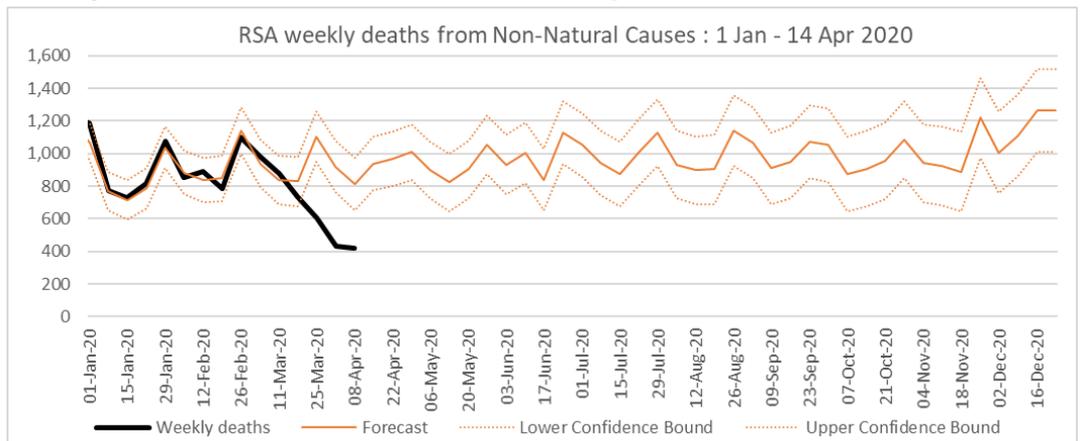
This information can be compared to data from previous years to further understand the burden of the pandemic. For example, as Figure 8 shows, the weekly number of deaths in South Africa had not exceeded the expected historical values by April 2020. It should be noted, however, as Figure 9 indicates, declines in deaths due to non-natural causes over the same period may be an offsetting factor. These figures serve as a reminder that no excess mortality may be detected: an important finding for policy makers in its own right.

FIGURE 8
Weekly deaths in 2020, Republic of South Africa (source [9])



Number for the last week has been adjusted for delayed registrations.

FIGURE 9
Weekly deaths from non-natural causes, Republic of South Africa (source [9])



Number for the last week has been adjusted for delayed registrations.

If cause-of-death data are available, the excess mortality measures can also be calculated for specific causes. Based on available cause-of-death data, it would be possible to determine the percentage of excess deaths related to COVID-19 using the two emergency ICD-10 codes, U07.1 and U07.2. Cause-of-death data can also be used to visualize the excess deaths due to influenza-like illness (ILI), severe acute respiratory infections (SARI), pneumonia, other acute respiratory conditions, or any other cause.

To the extent analyses are based on preliminary or incomplete data, this should be noted and reports updated accordingly.

Total excess mortality during the epidemic period can also be expressed to indicate the extent (proportional increase) to which excess deaths would increase the total expected mortality rate, within a time period, in the relevant area or country. For later analysis, excess mortality can be calculated using crude mortality rates per year.

It should be stated, however, that the lag between exposure, infection, death, reporting, analysis, and publication means that users need to be cautious about using mortality data to make inferences about the trajectory of the outbreak in real time. Mortality can be used to assess the trajectory, but it must be acknowledged that it reflects infections that occurred several weeks earlier.

In general, site data should be analyzed discretely. The statistical challenges in combining data from multiple sentinel sites are significant, and users should consult an expert demographer or epidemiologist about particular country situations.

Use of Rapid Mortality Surveillance Data

Comparing the current number of deaths to historical levels and patterns (e.g. from prior years, but even with the immediate pre-epidemic period) can provide understanding of the impact of COVID-19 on the population and on the health care system. The difference between the historical and current mortality burden is the excess that is presumed to be related to the COVID-19 pandemic. Further, the data produced by RMS systems can be used to measure burden and impact of the pandemic with resolution to geographic areas, demographic groups or vulnerable populations.

Examining excess mortality burden in comparison to laboratory-confirmed COVID-19 deaths or deaths with a COVID-related cause can provide insights into gaps in disease surveillance and the performance of other surveillance systems—for example, by detecting areas or populations where case reporting is low or absent. Conversely, where robust disease-specific mortality measurement is available, all-cause mortality provides a complementary indication of the indirect impact of the epidemic, due to societal and health care system disruptions.

RMS data can also provide information about the impact of public health and social measures and trends in community transmission—especially where health care utilization and testing data are scarce. Because RMS reflects both direct and indirect effects, it is also essential to evaluating the impact not only of COVID-19 itself but of the response and its consequences, such as social measures and interruptions in essential services. Where location of residence correlates with the distribution of social disadvantage, examining all-cause mortality at the local or subnational levels can illuminate disparities in disease impact.

The insights provided by measuring total mortality, rather than disease-specific mortality or case counts, will likely present governments with dismaying and difficult conclusions about the broader scope of the outbreak. Surveillance staff must be prepared to clearly explain the data and to help leaders and non-technical audiences understand and communicate the results. It is a common but difficult problem in public health surveillance, whereby improvements or enhancements to data collection systems produce larger estimates of disease burden. It is critical that government leaders be prepared to receive and integrate these data into their public communication and internal decision-making processes.

Checklist for Establishing Rapid Mortality Surveillance

The following checklist is an aid to setting up rapid mortality surveillance. Country conditions will vary greatly, so adaptation is encouraged.

	ACTIVITY	
	Community-based Mortality Surveillance	Facility-based Mortality Surveillance
Obtain buy-in from relevant stakeholders	<ul style="list-style-type: none"> <input type="checkbox"/> Emphasize the importance of total and excess mortality data and understanding the full mortality impact of the COVID-19 pandemic to gather consensus from stakeholders, including non-technical leadership <input type="checkbox"/> Identify a working group to oversee and coordinate rapid mortality surveillance, most likely stemming from an existing mortality surveillance technical working group or similar body <input type="checkbox"/> Design and approve process for routine integration of RMS results into overall surveillance system for COVID-19 response 	
Assess existing mortality data sources and do a gap analysis	<ul style="list-style-type: none"> <input type="checkbox"/> Collect information about existing mortality data systems and disease surveillance systems that may be suitable to collect mortality data <input type="checkbox"/> Identify the mortality data that is currently available and what data is desired and feasible to monitor the epidemic <input type="checkbox"/> Select existing system/s into which RMS can most readily and feasibly be integrated at facility and/or community level <input type="checkbox"/> Discuss implementation options and determine resources required for each (including workforce, financial, equipment, etc.) <input type="checkbox"/> Select a feasible and cost-effective method and develop a strategy and plan to establish rapid mortality surveillance 	
Identify surveillance sites and communicate importance of surveillance work	<ul style="list-style-type: none"> <input type="checkbox"/> Identify community agents who can report deaths and can do so safely during the epidemic <input type="checkbox"/> Select surveillance sites at which to engage the community agents 	<ul style="list-style-type: none"> <input type="checkbox"/> Identify selected hospitals to report based on existing health information and surveillance systems, or engage with all hospitals
Establish data collection tools, process and standard operating procedures	<ul style="list-style-type: none"> <input type="checkbox"/> Determine any changes that need to be made to existing systems to obtain the data required to monitor all-cause mortality during the epidemic <input type="checkbox"/> Include information about manner or cause of death where these can feasibly be collected without compromising total mortality reporting <input type="checkbox"/> Design/modify data collection tool for the required variables <input type="checkbox"/> Develop/modify system, business processes, and standard operating procedures, building on existing data collection platforms (e.g. DHIS2) <input type="checkbox"/> Ensure adequate health and safety protections for data collection staff, including infection control 	
Determine baseline level of mortality*	<ul style="list-style-type: none"> <input type="checkbox"/> Collect historical data on number of deaths in the applicable administrative areas (if available) <input type="checkbox"/> Estimate number of deaths in the applicable administrative areas if historical data are not available (e.g. using U.N. World Population Prospects) 	<ul style="list-style-type: none"> <input type="checkbox"/> Collect historic data on number of deaths at the facilities with, as applicable, cause of death <input type="checkbox"/> Collect historical data on facility admissions where feasible <input type="checkbox"/> As applicable, determine baseline level of cause-of-death distribution from facility, national or other level
Continuously collect data and report on daily/weekly basis*	<ul style="list-style-type: none"> <input type="checkbox"/> Collect and transmit data ensuring that every death is captured and not double counted <input type="checkbox"/> Ensure zero reporting 	
Continuously manage data	<ul style="list-style-type: none"> <input type="checkbox"/> Monitor reporting rate from facilities or community agents <input type="checkbox"/> Actively follow up with facilities or community agents to request data if not reported <input type="checkbox"/> Aggregate individual-level data from facilities and community agents 	
Continuously interpret and use data	<ul style="list-style-type: none"> <input type="checkbox"/> Calculate excess mortality, including any required sub-group analysis (age group, sex, location) <input type="checkbox"/> Plot graph or draw map showing excess mortality <input type="checkbox"/> Create short (1-2 page), standardized, routine reports that present, summarize and interpret the data <input type="checkbox"/> Ensure that RMS data is integrated and used in overall COVID-19 surveillance and response system 	

* These steps can take place in parallel

Annex 1: Infection Prevention and Control for Surveillance Workers^P

	ISOLATED CASES: Sporadic imported cases in the country	CLUSTER OF CASES: Localized clusters in the country, but not yet in the specific health facility or community of work	COMMUNITY TRANSMISSION: Known community transmission in the country or identified cases in the health facility or community of work
Administrative controls	<p>Do not come to work when showing any symptom including fever, cough or sore throat</p> <p>Disinfect or wipe off any materials that you bring home</p>	<p>Do not come to work when showing any symptom including fever, cough or sore throat</p> <p>Disinfect or wipe off any materials that you bring home</p>	<p>Do not come to work when showing any symptom including fever, cough or sore throat</p> <p>Suspend non-essential work in any office or health facility; use virtual or telephone communication with existing health facility staff to collect data if needed</p> <p>If surveillance workers must do essential work in health facilities, do not enter patient care areas</p> <p>Maintain distance of 1-2 meters and conduct discussion outside in the open air (if possible) if interviewing health facility worker to obtain data or explain the RMS process</p>
Hand hygiene	Wash hands frequently, including after being in any patient care area, touching any possible contaminated surface, before touching the face, and after using the restroom; use soap and water or an alcohol-based disinfectant gel (minimum 60% alcohol concentration)		
Respiratory hygiene	Cover your face when sneezing or coughing; use a tissue or the bend of your elbow	Use a surgical face mask (N95 respirator not required) in health facilities, particularly in patient care areas	If surveillance workers must do essential work in health facilities, use a surgical face mask (N95 respirator not required) but do not enter patient care areas

Annex 2: Including Manner and Cause of Death

Including manner and cause of death is an optional component of RMS. There are four levels at which data on manner and cause of death can be obtained as part of the system:

1. Grouping mortality by manner of death and suspected COVID-19
2. Using medical certification of cause of death and ICD mortality coding
3. Investigation of suspected cases postmortem through medical autopsy
4. Use of verbal autopsy

GROUPING MORTALITY BY MANNER OF DEATH AND SUSPECTED COVID-19

Grouping mortality by manner of death and suspected COVID-19 provides a broad picture or breakdown of total mortality. Relative to more detailed cause-of-death investigation, determining manner and suspected COVID-19 status requires much less time and resources, and can be done without delaying reporting of total mortality.

The questions to be answered for each death are based on the WHO's May 2020 guidance from an ad-hoc meeting of the WHO Verbal Autopsy Reference Group.^Q These questions will also all appear in a special augmentation of the 2016 WHO standard verbal autopsy form. Figure A1 shows the additional variables to be collected.

FIGURE A1

Screening questions to determine deaths due to suspected COVID-19, other natural, and non-natural causes

To be answered by the data collector:

- A. Are local social distancing/stay-at-home measures in place? [Y/N]

To be asked of the family:

1. In the **two weeks before death**, did the deceased suffer an injury or accident that led to death? [Y/N]
 - If yes → TERMINATE INTERVIEW
 - If no → continue: "In the **two weeks before death**, did the deceased:
 2. Test **positive** for COVID-19 on a test administered by a health professional? [Y/N]
 3. Have high fever lasting at least three days? [Y/N]
 4. Have extreme fatigue? [Y/N]
 5. Have a cough? [Y/N]
 6. Report newly losing or having decreased sense of smell or taste? [Y/N]
 7. Have difficulty breathing? [Y/N]
 8. Live with, visit, or care for someone who had any of these symptoms or a positive COVID-19 test? [Y/N]
 9. Travel to an area where COVID-19 was known to be present? [Y/N]

Guidance and resources for administration and interpretation of responses to these screening questions is available and can be freely downloaded.^R

USING MEDICAL CERTIFICATION OF CAUSE OF DEATH AND ICD MORTALITY CODING

With high quality medical certification of cause of death (MCCD) and ICD mortality coding, it would be possible to produce information similar to that produced by the U.S. Centers for Disease Control and Prevention (Figure A2).

FIGURE A2
Deaths by selected causes (Source: US CDC)

Week ending date in which the death occurred	COVID-19 Deaths (U07.1) ¹	Deaths from All Causes	Percent of Expected Deaths ²	Pneumonia Deaths (J12.0–J18.9) ³	Deaths with Pneumonia and COVID-19 (J12.0–J18.9 and U07.1) ³	Influenza Deaths (J09–J11) ⁴	Population ⁵
Total Deaths	11,356	569,403	90	43,358	5,171	5,055	327,167,434
2/1/2020	0	56,569	95	3,637	0	454	327,167,434
2/8/2020	0	57,094	96	3,632	0	488	327,167,434
2/15/2020	0	56,114	95	3,638	0	499	327,167,434
2/22/2020	0	55,646	96	3,488	0	516	327,167,434
2/29/2020	5	54,968	96	3,510	3	584	327,167,434
3/7/2020	19	54,333	94	3,601	11	564	327,167,434
3/14/2020	44	52,381	92	3,564	22	555	327,167,434
3/21/2020	449	51,785	91	3,966	206	475	327,167,434
3/28/2020	2,285	52,569	94	5,053	1,056	357	327,167,434
4/4/2020	5,012	49,770	89	6,110	2,429	346	327,167,434
4/11/2020	3,542	28,174	50	3,159	1,444	217	327,167,434

The necessary guidance for medical certification of cause of death for COVID-19 has been published by WHO [13] and should be consulted for the most current technical advice about how to correctly certify causes of death due to COVID-19.^T

Where cause of death is readily available from routine MCCD, lists could be expanded to include cause information, as shown in Figure A3. If ICD coding is done on site in a facility, ICD codes for the final underlying cause of death may be reported for each death. If ICD coding is not done on site, then facilities may consider indicating the tentative underlying cause of death (the lowest line listed [a-d] within the international medical certificate of cause of death) in their report as a preliminary cause, with the final underlying cause of death (determined through ICD coding) assigned at a later date.

S See: <https://www.cdc.gov/nchs/nvss/vsrr/covid19/index.htm>

T Available at: <https://www.who.int/classifications/icd/covid19/en/>

FIGURE A3

Sample list for deaths by age, sex and cause-of-death information

Date for week ending/week number:					
Facility name:					
Date of completion:					
Name of person completing this form:					
Death #	Patient ID [do not transmit]	Sex	Age at Death	Date of Death	Provisional Underlying Cause of Death According to MCCD
1	XX-XXXXX	M	82	15-04-2020	COVID-19 suspected
2	XX-XXXXX	F	55	15-04-2020	Breast cancer
3	XX-XXXXX	M	35	16-04-2020	Motor vehicle crash
...

Where the WHO standard international medical certificate of cause of death is used, care should be taken by medical records staff to ensure that a correctly completed MCCD is written by the attending physician. The form of the MCCD should conform to the 2016 revision published by WHO.^U Following the completion of the MCCD form, the collected data can be coded according to ICD.

INVESTIGATION OF SUSPECTED CASES POSTMORTEM THROUGH MEDICAL AUTOPSY

The medicolegal death investigation (MLDI) system should be prepared to manage confirmed and suspected COVID-19 cases to correctly certify the causes of death and protect the health of MLDI staff members. Current research on exposure risk in postmortem settings is limited and the guidance on biosafety, infection control, and autopsy practices may evolve.^V In countries with community transmission of COVID-19, physicians in the MLDI system should complete a case-based reporting form^W for decedents without a confirmed COVID-19 result. A physician can use results from this form along with the decedent's medical history and circumstances of death to determine if COVID-19 is suspected.

If COVID-19 is suspected and an autopsy is not conducted, the physician in the MLDI system should collect a postmortem nasopharyngeal swab if postmortem testing is available. If COVID-19 is suspected and an autopsy is conducted, physicians with access to postmortem COVID-19 testing should take swabs from three sites: nasopharyngeal and one swab from each lung. Ideally, postmortem COVID-19 testing should be done within three days of death as the sensitivity of the test may be affected after longer postmortem periods.^X In countries where postmortem testing is not possible, MLDI physicians should be familiar with clinical, pathological, histological and laboratory findings of

U See Section 7.1 in https://icd.who.int/browse10/Content/statichtml/ICD10Volume2_en_2016.pdf

V <https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-postmortem-specimens.html>

W <https://www.who.int/publications-detail/case-based-reporting-form>

X <https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-postmortem-specimens.html>

COVID-19 cases to guide their certification of deaths where COVID-19 is suspected.^Y Physicians in the MLDI system should report confirmed and suspected COVID-19 deaths according to WHO guidelines.^Z

In cases of confirmed or suspected COVID-19, the physician in the MLDI system will determine the need for an autopsy based on the legal framework, facility environmental controls, availability of personal protective equipment (PPE), and family and cultural practices. When conducting an autopsy in a suspected or confirmed COVID-19 decedent, the physician in the MLDI system should follow standard contact and airborne precautions with eye protection^{AA} and correct donning and doffing procedures for PPE.^{AB}

USE OF VERBAL AUTOPSY

The use of verbal autopsy is the only option for determining the percentage of community deaths likely due to COVID-19 for deaths occurring where no medical certification of cause of death or medical autopsy is possible. Verbal autopsy is also used in several countries in Latin America and Africa in conjunction with investigations into undetermined causes of some facility deaths, and for bodies brought in dead (also referred to as dead on arrival) at emergency rooms or mortuaries.

There are extensive resources available for implementing a verbal autopsy according to WHO guidelines.^{AC} The WHO VA Reference Group is recommending a set of COVID-19-specific questions to add to the most current version of the verbal autopsy questionnaire. Until the verbal autopsy questionnaire and corresponding automated algorithms are fully updated to include COVID-19, the COVID-19 questions can be captured in the open narrative, and the verbal autopsies can be coded by physician review, known as “physician-coded verbal autopsy” or PCVA.

The challenges of conducting verbal autopsy should not be understated. High quality verbal autopsy requires extensive training and can be expensive and time-consuming to arrange and conduct. In the context of the epidemic, traditional face-to-face data collection may be difficult, unsafe or impossible (although in some situations it may be possible to arrange for verbal autopsy to be conducted by phone). Nevertheless, where MCCD is not available, verbal autopsy is the only way to describe population-level cause-of-death patterns in the community.

For these reasons, weekly reports of total mortality should not be delayed by efforts to obtain a cause of death. Verbal autopsy findings can be reported with a lag without delaying the provision of other important data about the epidemic.

Y Oklahoma, Nature, and AJFMP publications

Z <https://www.who.int/publications-detail/global-surveillance-for-covid-19-caused-by-human-infection-with-covid-19-virus-interim-guidance>

AA https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Finfection-control%2Fcontrol-recommendations.html

AB <https://www.cdc.gov/niosh/npptl/pdfs/PPE-Sequence-508.pdf>

AC <https://www.who.int/healthinfo/statistics/verbalautopsystandards/en/>; <https://www.swisstph.ch/en/about/eph/household-economics-and-health-systems-research/whova/>

References

1. Wilson, D. and D.T. Halperin, "Know your epidemic, know your response": a useful approach, if we get it right. *Lancet*, 2008. 372(9637): p. 423-6.
2. Vital Strategies and Resolve to Save Lives, *Guide for Analysis of Respiratory Syndromic Surveillance Data to Supplement COVID-19 Surveillance*. 2020, Vital Strategies: New York.
3. Federal Statistical Office. *Mortality, causes of death*. 2020 [cited 2020 April 4]; Available from: <https://www.bfs.admin.ch/bfs/en/home/statistics/health/state-health/mortality-causes-death.html>.
4. European monitoring of excess mortality for public health action. *EuroMO-MO. Maps 2017-2020*. 2020 [cited 2020 April 4]; Available from: <https://www.euromomo.eu/graphs-and-maps/#map-of-z-scores>.
1. Nogueira, P.J., et al., *The new automated daily mortality surveillance system in Portugal*. *Euro Surveill*, 2010. 15(13).
1. Michelozzi, P., et al., [On the increase in mortality in Italy in 2015: analysis of seasonal mortality in the 32 municipalities included in the Surveillance system of daily mortality]. *Epidemiol Prev*, 2016. 40(1): p. 22-8.
2. World Health Organization and US Centers for Disease Control and Prevention, *Technical Guidelines for Integrated Disease Surveillance and Response in the African Region. 2nd edition*. 2010, World Health Organization Regional Office for Africa: Brazzaville.
3. World Health Organization, *Global epidemiological surveillance standards for influenza*. 2013, World Health Organization: Geneva.
4. Bradshaw, D., et al., *Report on Weekly Deaths in South Africa 1 January - 7 April 2020*. 2019, Burden of Disease Research Unit, South African Medical Research Council: Cape Town.
5. World Health Organization Regional Office for Africa, *Integrated Disease Surveillance and Response Technical Guidelines*. 2019: Brazzaville.
1. Begg, S., C. Rao, and A.D. Lopez, *Design options for sample-based mortality surveillance*. *Int J Epidemiol*, 2005. 34(5): p. 1080-7.
2. Africa CDC, *Event-based Surveillance Framework*. 2018, Africa Centers for Disease Control and Prevention: Addis Ababa.
3. World Health Organization, *Mortality associated with coronavirus disease (COVID-19). Technical note*. 2020, World Health Organization: Geneva.