Lessons from Rapid Mortality Surveillance

Findings of a multi-country qualitative process evaluation

Bloomberg Philanthropies
DATA FOR HEALTH INITIATIVE
RESOLVE TO SAVE LIVES
Vital Strategies

Table of Contents

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Executive Summary and Key Takeaways

The purpose of this qualitative report is to look back and summarize local views on the key success factors and barriers to establishing Rapid Mortality Surveillance (RMS) in 13 countries supported in these efforts by the Vital Strategies Civil Registration and Vital Statistics (CRVS) and Data Impact programs through the Bloomberg Philanthropies Data for Health Initiative, and the Resolve to Save Lives Initiative (the 'Initiatives'). Looking forward, we intend to carry forward lessons learned into further evolution of mortality surveillance models and platforms, particularly in Africa.

The **Introduction** reviews the problem of tracking the true human toll of the COVID-19 pandemic and the purpose and approaches to RMS employed by participating countries. The purpose and process of the evaluation are also presented, and the methodology is described.

The **Results** section covers local views on: Government Ownership and Buy-In; Data Sources and Digitization; Collaboration and Data Sharing; Integration of mortality surveillance with CRVS systems; and Data Use.

Key takeaways from Government Ownership and Buy-In

- Desire for sustainability led to sponsorship for systems integration
- Total/Excess Mortality seen as critical data for national authorities
- Government ownership & sponsorship translated into new or revised business processes, SOPs, or guidance
- Widespread uptake of commitment to establish mortality surveillance despite competing demands of the epidemic response
- Implementation challenges were greater in the pandemic context, making government buy-in and persistence even more essential
- Where sponsorship was weak or did not translate into concrete governance and accountability mechanisms, RMS was not institutionalized

Key takeaways from Data Sources and Digitization

- Few, if any, proven alternatives to well-functioning, digitized CRVS systems for use at scale on a sustainable basis
- Despite challenges, digitized CRVS systems with high completeness and coverage are the desired gold-standard
- At least three countries intend to integrate the capture of data on all deaths by age, sex, location and place of death into their national implementation of the Integrated Disease Surveillance and Response (IDSR) system
- In some countries, lockdowns extended to registration activities and services, making it impossible during those times to collect notification and registration data from the community. In others, lack of proper data sharing agreements hindered the effort

Key Takeaways from Collaboration and Data Sharing

- Where there are new relationships to be established among data producers and consumers, it is important to ensure necessary regulatory mechanisms are in place to promote data sharing and coordination (e.g., MOUs)

- Relevant stakeholder engagement necessary but not sufficient for success; also need coordination, collaboration, accountability and leadership mechanisms
- Ensuring that necessary MOUs and SOPs were in place helped enable coordination. Likewise, good coordination and collaboration are often required to establish inter-ministerial agreements

Key takeaways from CRVS Integration

- It is important to separate the form of a particular style surveillance system from its function to provide timely mortality data and absorb surveillance functions into the CRVS system over time
- In Colombia it was possible to add a component on cause of death to the RMS system, again due to the high degree of system digitization and integration

Key takeaways from Data Analysis and Interpretation

- Excess Mortality Calculator had wide uptake and use to track total and excess mortality[1]
- Involvement of those experienced at data analysis and triangulation is critical
- There should be more attention to users and use cases

Key takeaways from Data Use

- Dissemination mechanisms ranged from periodic reporting to ministries and Emergency Operations Centers to routine updating of public-facing dashboards and reports
- Uses ranged from public education and information to policies related to vaccine rollout and alert levels
- Results from mortality surveillance have illuminated the gaps in existing systems to record incident deaths, including through the CRVS system

[1] 'Excess mortality' is the difference in number of deaths between current mortality levels compared with historical averages for the same dates, locations and populations.

Introduction

Problem

COVID-19 has revealed that even in the 21st century, reliably measuring mortality in a timely manner remains challenging [1]. Accurate measurement of total mortality can quantify the human toll of the pandemic [2, 3]. Without these measures, countries' ability to define the scope, scale, or causes of excess mortality are constrained, thereby limiting the ability for public health officials and policymakers to develop and implement data-informed prevention and protection measures. To address this, global and regional partners of the Bloomberg Philanthropies Data for Health Initiative[2] developed a technical package [3] to support improvements in measuring and responding to excess mortality data in the context of the ongoing global pandemic. Implementation was supported in 13 Low- and Middle-Income Countries (LMIC).

Comparing current all-cause mortality to historical levels and patterns can provide an understanding of the impact of COVID-19 on the population and on the healthcare system. The difference between the historical and current mortality burden is the excess mortality that may be either directly or indirectly related to the pandemic. The additional deaths included in excess mortality analysis encompass confirmed and unconfirmed or undetected COVID-19 deaths in addition to deaths from other conditions that occur due to disruptions in health care services and/or changes in health behavior on the part of the population.

This report describes the results of a process evaluation that was conducted in quarter three of 2021 to understand local views on the barriers, facilitators, and overall experiences in thirteen of these countries in implementing the technical package to improve their surveillance of total and excess mortality.

In addition to diagnostic testing and case reports, counts of COVID-19 deaths have been a primary method for tracking the growth and trajectory of the pandemic.[3] Given the limited diagnostic testing availability in many LMIC and challenges in consistent diagnosis of confirmed and suspected COVID-19 cases, there are few other options aside from measuring total mortality to assess the population health impact and spread of the epidemic.

The task, however, is often not straightforward. The pandemic has illuminated the fact that simple counts of deaths by age, sex, location, and place of death can be extremely challenging in some contexts. In settings where many deaths may not be registered in a timely way or may go permanently unregistered by the civil registration system, it is difficult to accurately count total mortality [3]. Nevertheless, despite these challenges and the fact that mortality is a lagging indicator of COVID-19 infection, representative measures of total and excess deaths can provide insight into ongoing population transmission patterns and the overall impact of the pandemic.

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[2] The partners in the Data for Health Initiative contributing included CDC, CDC Foundation, WHO, UN Economic and Social Commission for Asia-Pacific.
[3] See e.g., https://coronavirus.jhu.edu/map.html; https://coronavirus.jhu.edu/map.html.

Rapid Mortality Surveillance (RMS) is defined as a system that can swiftly generate daily or weekly counts of total mortality by age, sex, date of death, place of death, and place of usual residence to inform action (2). Examples of RMS in the past have included facility and community reporting, as in the context of Ebola [4]; and ongoing surveillance for the detection and response to seasonal trends in excess mortality in Italy [5]. RMS uses either existing CRVS systems to establish a rapid surveillance process for retrieving, visualizing, and analyzing data or, where this is not possible, health facility and/or community data are obtained from other existing sources to accomplish the purpose. In some instances, i.e., where no mortality registration or surveillance system is in place, this has included primary data collection.

Community-based surveillance focuses on detecting and reporting deaths that occur outside of the health care setting – ideally by leveraging existing community channels for death notification (e.g., funeral services, traditional or religious leaders, and community surveillance lookouts or frontline workers). This is particularly important in LMIC where over 70% of deaths may occur in the community.

Both community- and facility-based mortality surveillance aim to strengthen and streamline reporting and improve accessibility of data for the Emergency Operations Center to inform pandemic response.

Objectives

The objective of this evaluation was to describe some of the successes and challenges in implementing RMS systems during the COVID-19 pandemic in a variety of country contexts and extract lessons learned. We are not aware of another cross-country process evaluation of establishing mortality surveillance systems in this midst of a pandemic, particularly in varying settings of CRVS system completeness and digitization.

The specific evaluation objectives were to (1) describe how some of the significant issues in establishing mortality surveillance were addressed in each country, (2) assess progress in institutionalization and sustainability, (3) describe the successes and challenges of the various RMS systems in terms of our ingoing assumptions and (4) identify facilitators and barriers to implementation. These findings are intended for use as a basis for countries to further evaluate and refine mortality surveillance systems and inform mortality surveillance efforts in other LMIC.

Approach

Through a qualitative process of key-informant interviews this report retrospectively assesses the hypothesis that RMS can provide timely and useful counts of deaths, even in settings lacking strong CRVS systems and even in the context of a massive response to the pandemic's first waves. In addition, we assess the following assumptions:

- In settings without digitized and nearly complete death registration, existing systems can be quickly augmented or leveraged to provide timely, useful data on the levels and trajectory of mortality by age, sex, and location on a national or representative basis.

- Demand for excess mortality data will be high, leading to strong ownership and use of RMS outputs (together with other sources) by Emergency Operations Committees (EOCs) in the COVID-19 response.

Materials & Methods

A semi-structured interview guide was utilized to conduct qualitative interviews with eighteen key informants from thirteen countries supported by the Bloomberg Philanthropies Data for Health and Resolve to Save Lives Initiatives ("the Initiatives"). Interviews were conducted between August and October 2021. Key informants included government officials, in-country technical partners, and Data for Health Initiative staff embedded in government departments. Key informants were purposively sampled based on their involvement in mortality surveillance in each country to allow for detailed exploration of factors related to the evaluation questions.

Interviews were transcribed, translated to English (if required), double-coded, and analyzed using Dedoose (https://www.dedoose.com/) qualitative analysis software. Where necessary, depending on country context, ethical clearance for conducting RMS work was obtained from the appropriate national research ethics bodies. Where ethical clearance was not sought, the activities were deemed by national governments to be exempt due to being 'public health surveillance' and the fact the data contained exclusively deceased individuals.

Setting

This evaluation took place across thirteen countries supported by the Initiatives: Bangladesh, Brazil, Burkina Faso, Colombia, Ethiopia, Ghana, Liberia, Malawi, Peru, Rwanda, Senegal, Sierra Leone, and Togo. Interviews were conducted with a key informant from each country, such as a government staff partner who was familiar with the RMS surveillance activities, or an in-country partner who has worked closely with the Data for Health Initiative.

Table 1 on the following page shows the key characteristics of these systems.

Table 1. Key characteristics of RMS systems

Country	Coverage	Using which existing surveillance system?	Reporting Cadre	Frequency	Number of deaths recorded through Feb '22
Bangladesh	National	CRVS system (BDRIS)	Registrars and Health Assistants at the sub-district level	Monthly with 3-month lag	
	Country-wide sample of 500 hospitals	DHIS2	Statisticians at each government hospital	Monthly totals reported with a 2–3-week lag	658,069
Brazil	National	Vital Statistics	Health officials - mortality system technical team	2 weeks delay	
	Sao Paolo State	Vital Statistics	Health officials - Director of Strategic Information with support of University of Sao Paulo	2 weeks delay	2,685,388
	National	Civil Registration and Ministry of Health Vital Statistics Systems	Civil Registration Offices	Real-time	
Burkina Faso	4 of 13 administrative regions of the country: Centre Region(Ouagadougou), Haut Bassin region (BoboDioulas), North Center and Sahel	Health facility/patient registers and community level informants	Trained data collection officers	Weekly	9,452

Country	Coverage	Using which existing surveillance system?	Reporting Cadre	Frequency	Number of deaths recorded through Feb '22
Colombia: All-Cause Mortality	National	Colombia Rural Vital	Community leaders with confirmation by local health officials	Real-time	531,565
Colombia: Cause of Death Investigation	National	RUAF-ND	Physicians, data managers	Weekly	
Ethiopia	23 woredas	PHEM (Public Health Emergency Management)	Health extension worker	weekly	100,698
	National	DHIS2	HIT	Monthly	
Ghana (AFENET)	National (a selection of health facilities across three geographic zones)	Health Facility District Health Information Management System, Community Data, Civil registration and vital statistics	Community-Based Surveillance Volunteers (CBSV)	Weekly	13,755
Liberia	National	Health facility medical records, Community database and informants, CRVS and local levels	trained data collection officers	Weekly	1,970
Peru: facility based	National	SINADEF: electronic medical certification of cause of death system capturing close to all death (completeness of above 70%) Epidemiology Unit: confirmed COVID-19 cases	Physicians, data managers	Weekly	354,753

Country	Coverage	Using which existing surveillance system?	Reporting Cadre	Frequency	Number of deaths recorded through Feb '22
Rwanda: community based	National: 70%	IDSR	Community health workers and health center data managers	Weekly	
Rwanda: facility based	National (all hospitals n=46 accounting for 30% of deaths pre-Covid)	MCCD form in SMoL Program in DHIS2	Physicians, and Hospital data managers	Real-time as data gets entered at the hospital	13,166
Senegal: facility based	National (all public hospitals (n=39; completeness unknown)	HMIS system	Physicians, data managers	Weekly	29,969
Sierra Leone	In four of the 16 districts across the three levels (tertiary, secondary, and primary) of the health care system	Health facility records/patient registers (COMSA), Child Health and Mortality Prevention Surveillance (CHAMPS), Maternal Mortality Surveillance (MMS) records, and community death registers	Project data collectors	Weekly	8,744
Togo	National (6 health regions – Grand Lomé, Maritime, Plateaux, Centrale, Kara and Savanes)	Existing health facility records; at the community level data will be prospectively collected using a community data collection tool.	Trained data collection officers and community informants	Weekly	12,364

Results

Several key themes emerged during the coding and analysis of interview transcripts. These were: i) government ownership and buy-in; ii) data sources and digitization; iii) collaboration and data sharing; iv) integration with CRVS; v) data analysis and interpretation, and vi) data use.

Each of these will be discussed in detail with supporting examples and quotations from the interviews. Across country context, success in these areas appeared to be directly tied to the successful production and use of all-cause mortality data and excess mortality data. Countries that experienced challenges or weaknesses in these areas referred to slowness and/or quality of their RMS outputs.

Of the thirteen countries that took part in the evaluation, two people were interviewed in three of the countries while for the other ten countries one interview took place. Five of the interviewees were Vital Strategies Country Coordinators or consultants, while eleven were government officials. All but three interviewees were male.

The number of excerpts coded among the five individuals (1M:4F) who assigned codes to the interview transcripts ranged from 103 to 245 with a mean of 156 and a median of 159. In sum 809 excerpts were coded. See Appendix A for a summary of code application.

Government Ownership and Buy-in

We defined ‘country ownership’ as a demand for RMS and excess mortality data by official bodies and individuals, such as a Ministries of Health (MoH), EOC, and the head of the Epidemiology Unit. With many competing health priorities during the pandemics first waves, government prioritization of the collection and use of RMS data were thought to signal the value that intended users placed on the functioning of the RMS system and its results.

Factors Favoring Country Ownership

Government ownership was identified as a key facilitator of success needed to build an RMS system and tackle obstacles to producing quality data. Lack of government ownership was also cited as a root cause of challenges and limitations to RMS where these existed. For many, previous experience working with mortality data and awareness of its benefits motivated key government officials to prioritize RMS work. Many country teams also saw RMS as part of the government’s responsibility to maintain awareness and contribute to saving lives.

> Mortality data reported on a weekly basis in real time would help us to plan and understand disease patterns, because if people are dying … then we want to go out and investigate why. Then we’re able to stop that epidemic from escalating into a nationwide epidemic or global

> pandemic… That is the reason the Director was very much interested in the RMS strategy. – Sierra Leone Respondent 1

In cases where key stakeholders did not already value accurate mortality data collection, highlighting what it could offer the COVID-19 pandemic response was the most frequently used method of obtaining buy-in and government ownership. Some also paired a sense of the intrinsic duty that governments feel to protect the health of their populations with the external motivation that came from a focus on RMS amongst international partners and stakeholders.

> The main element was the country making a case at the national level on the essence of RMS and making them appreciate what collecting RMS could bring on board in detecting excess mortality and to be able to analyze the impact of interventions that are made. – Ghana Respondent 1

> It is really the commitment to the country that one has. The government, in compliance with its international agendas, has a political motivation to be continually in contact with mortality data. –Colombia Respondent 1

Motivation for and ownership over RMS stemmed from both internal and external sources. Even though the concept of RMS was seen to originate externally, there appeared to be ready uptake by government stakeholders once awareness of the potential value and importance of mortality surveillance was created. In some cases, buy-in from even a single government stakeholder led to other key agencies and ministries getting onboard.

> The RMS activity was initiated externally and was able to get the buy in of government and then the health sector. The health sector has shown strong interest and has pushed for RMS to function. So, both ends have played a role in maintaining RMS. – Ghana Respondent 1

> At the beginning of the process [the Initiatives] gave us the idea. They came up with the idea of asking Senegal if they were interested in implementing a system of rapid surveillance of mortality. Then when we communicated it to the Ministry, we realized that it corresponded with a need that existed but that wasn't financed. – Senegal Respondent 2

Country Ownership and Implementation Success

The degree of country ownership and commitment of resources to the new undertaking of RMS even at the height of the pandemic response was reflected in part through the rapid development of manuals, standard operating procedures, and institutionalized processes for RMS. Another aspect of how country ownership was manifest in country action was the near universal commitment to its integration into existing systems. From the start there was an inherent reluctance to mount a parallel, un-institutionalized effort that would not be sustainable. This has even manifested in a desire to move away from the term 'rapid' mortality surveillance which, to some, implies a parallel and impermanent solution. Senegal, which elected to focus on complete mortality surveillance in health facilities and communities surrounding major hospitals, had no existing system into which RMS could be integrated and established a new reporting system for it.

Governments that were more successful in implementing RMS tended to assign clear roles and responsibilities within their ministries and made available staff and resources to conduct the work. The availability of these resources also led to quicker and more effective problem solving when challenges arose.

As in Latin America, RMS in Rwanda, was established from mortality data derived from the CRVS system. Registration records data along with cause of death data from facilities and the community are the main data elements of the CRVS system. Currently, the CRVS system in the country has an estimated death registration completeness of about 30%.[4] Therefore, to further strengthen mortality surveillance, the government has also integrated all-cause mortality reporting into the routine Integrated Disease Surveillance and Response system (IDSR) that includes events occurring in the community through a community-based surveillance system. This data will therefore not only be linked with civil registration records but will be reported on a weekly basis so that any future excess mortality can be quickly identified. In doing so, government also gave ownership and specific mandates to civil registration and health agents at all levels and sensitized them in the analysis and use of this additional data, which enhanced their sense of responsibility to ensure it was collected and reported.

> Another achievement is how the government bought into RMS. There is ownership from the government, and we are quite happy that all-cause mortality, or RMS data are integrated into the CRVS system. It will be easier to monitor the trend and the magnitude of any outbreak. So, from that, the ownership and integration, the registration of death and cause of death will increase. – Rwanda Respondent 1

In Colombia, RMS leveraged the existing government-owned digital registration system. The primary CRVS stakeholders – the Ministry of Health (MSPS) and National Statistics Administrative Department (DANE) – were motivated to build up RMS capacity in the country. With the high level of buy-in and existing channels of collaboration across government agencies, Colombia was able to successfully develop and utilize an RMS system to confront COVID-19.

In Peru, the online notification system for deaths that is owned and managed by the General Department of Information Technologies within the Ministry of Health, called SINADEF, also proved to be the best source of mortality data during the pandemic, lending itself to RMS. Because the government was already confident in this data source and the value of RMS, they were able to leverage the system quickly and efficiently for excess mortality analysis. This significantly shortened the time needed for system set up and allowed them to monitor changes in excess mortality as early as 2020.

In Senegal, the routine health and social information system information systems data is available at all levels of the health system. However, it previously did not include mortality. Government ownership was demonstrated through a ministerial order requiring ongoing data collection to facilitate mortality surveillance in the Ministry of Health. The RMS has made historical and contemporary mortality data available: data from 2016 to

[4] Bloomberg Philanthropies Data for Health Initiative CRVS progress monitoring data, 2022 (unpublished)

2019 were collected in health facilities and continued through 2020 to date. Data are regularly shared with the EOC, and there is regular monitoring and involvement from the Department of Planning, Research and Statistics (DPRS). Furthermore, there was a strong government push for the RMS system to be implemented and institutionalized into the national system, and a desire to integrate hospital staff into the ministry plan for mortality surveillance.

> An official memo was sent out to include this activity in the hospital routine activities, and there is a high demand from the ministry to extend this surveillance to health centers so that we can cover all public institutions that record deaths. These are all achievements of the system. There has previously been no system for mortality surveillance at the level of the community, as well for the civil status record and the hospital. It is the first initiative to do so beginning with areas surrounding major hospitals, and I believe that it's an achievement. – Senegal Respondent 2

Consequences of Inadequate Country Ownership

It also became apparent when a lack of country ownership, either broadly or in specific areas of the work, had negative implications on the outcomes of RMS. In some cases, lack of buy-in or resources resulted in a scope of the work that was insufficient to produce quality or useful data. In others, the lack of resources and allocated staff were reflective of lower investment in surveillance systems that resulted in implementation delays, lag, or discontinuation of the work. The overriding challenge, to be sure, was the pandemic itself. In some settings, it was clear that the key stakeholders needed to support RMS were heavily engaged with the pandemic response and unable to invest time or attention to the matter. Other reasons for lack of government buy-in can be ascribed to a few factors but were not probed in depth. In one country, the relevant authorities in the health sector did not prioritize establishing RMS sufficiently to ensure its success. This was primarily due to all relevant health sector staff being completely absorbed in the pandemic response, which government prioritized over establishing RMS. Additionally, government's awareness and appreciation of the utility of mortality data did not result in a suitable institutional owner and lead of the RMS system.

> Coordination of mortality surveillance is weak at all levels of the health system. There are no assigned persons responsible for mortality surveillance data reporting at the facility or community level. Ensuring that the purpose of institutionalizing mortality surveillance is understood by all relevant internal and external stakeholders is at the preliminary phase. And the country has not yet designed nor approved any process of routine integration of mortality data into surveillance system nor have cost estimates for the national mortality surveillance plan has been developed. –Respondent 1 from a West African Country

Key informants from a few countries also emphasized the importance of buy in and coordination at all levels of the government involved in RMS implementation, not just at the level of national directors or EOCs. Where this was not the case, the challenges of day-to-day implementation were greater and took longer to be resolved. Turning support and sponsorship into practice at the level of the system implementors proved to be complex. This included the identification of required or additional human resources.

> Mortality surveillance is considered a high priority in [the country] and statements have been made by senior officials in MOHS including Directors formally calling for implementation of National Mortality surveillance (NMS) in the country. However, work is still in progress to ensure NMS has leadership support from MOHS and buy in from all key stakeholders. – Respondent 1 from a West African Country

> There are institutions, hospitals where the data aren't rapidly updated, and sometimes there is just one person managing all hospital data. This has caused a lot of slowness in some hospitals despite the enthusiasm shown at the level of the Ministry. – Respondent 2 from a West African Country

Conclusion

The finding that political and technical sponsorship and buy-in is a key success factor to the sustainable outcome of an innovation, in this case, RMS is not novel. It does, however, bear stressing and nuancing in this context in terms of what sponsorship achieved.

RMS was an innovation that came late in the first wave of the pandemic. Thus, the COVID response was already demanding the urgent attention of many key stakeholders when RMS was introduced. Yet despite this, local actors in many countries successfully advocated and communicated the importance of counting deaths in either a comprehensive or representative manner.

It was clear that stakeholders were motivated by a commitment, if not a sense of duty, to improve local understanding of mortality. As part of this commitment, countries urged that nomenclature move away from referring to 'rapid' mortality surveillance just for the present pandemic, and toward a long-range commitment to mortality surveillance for the present and the future. Most countries approached the establishment of total mortality surveillance with an eye toward sustainability and integration into existing platforms. In at least two countries, however, the buy-in was minimal to absent.

Data Collection and Digitization

Rapid mortality surveillance was introduced to understand deaths attributed directly or indirectly to COVID-19 and to facilitate quick decision making in confronting the pandemic. For this reason, daily and weekly counts of death were needed to monitor the trends of deaths due to all-causes and to determine the effect of COVID-19 on all-cause excess mortality during the pandemic.

The approaches to data collection varied in their details, but they can broadly be categorized into three types:

1. Those that were positioned to obtain and make use of near real-time mortality and (often) cause of death data from well-functioning CRVS systems
2. Those where sub-optimal CRVS or other data systems have been leveraged
3. Those where mortality data were collected for the first time

For countries such as Peru with well-functioning CRVS systems as defined above, data were easily extracted from electronic systems in place for use in excess mortality calculations. Having readily available nationally representative data facilitated mortality estimation and generating reports countrywide to show mortality patterns nationally as well as by subgroups.

In countries without well-functioning and fully digitized CRVS systems, tallies based on civil registration records were nevertheless available and used in Bangladesh and Rwanda. The limitations of these data have been that reporting is severely lagged due to statutory grace-periods for death registration (>2 months), and their estimated completeness is not high (estimated at around 30% death registration).

For countries in these situations (i.e., strong political support, but absent a functional CRVS system) there were three basic issues to resolve regarding the generation of mortality surveillance data:

- How to sample for the purposes of demonstrating feasibility, deliverability, or scalability?
- How to detect and capture data on incident deaths by age, sex, location, and place of occurrence?
- What is the degree of digitization that can be introduced and fully and sustainably integrated into business processes and functions related to mortality surveillance?

In some cases, the disadvantages of integration with the CRVS system – at least for the present – versus an alternative path were starkly portrayed:

> There is a well-established and functional indicator-based integrated diseases surveillance system (IDSR) which provide timely and reliable morbidity data on priority diseases for action. Also, the country has been very successful in implementing electronic integrated diseases surveillance system (eIDSR) using DHIS2 (replacing a paper-based reporting) and electronic Case Based Disease Surveillance (eCBDS) system which has enhanced data accuracy, timeliness of reporting, analysis and storage of priority morbidity data in the country. However, there is very limited mortality surveillance system, and the overall mortality surveillance is not part of the system. The existing Health Information system, DHIS2 though suitable to collect mortality data does not collect mortality surveillance data. The Civil Registration and Vital Statistics (CRVS) systems is non-existent in the country.- [West Africa Country] Respondent 2

Variation in site selection and data collection for RMS

In several Latin American countries, there was no need for site selection because CRVS systems cover the entire population. For those countries without well-functioning CRVS, variation in site selection ranged from quota sampling at various levels of the health system (Burkina Faso, Ghana, Liberia, Sierra Leone, and Togo), to universal application at all public hospitals (Senegal). For example, in Liberia, sentinel sites were selected because of the lack of a well-functioning CRVS system. Although primarily facility-based, deaths from ‘catchment’ populations residing nearby health facilities were also included:

> We didn't have any structure or any functional [CRVS] system at the community level that would record deaths in the community and pass it on. So, what we have now are volunteers who are in the communities who pass on information on deaths that occur in their community. That was combined with deaths that would occur in the facility for that community. The facility would serve as a catchment facility for that community, and they would then pass it on to the next level, and then the next level after that. This would go to the next level and then after that to Monrovia. - Liberia Respondent 1

Sites were selected purposively to include each of the five regions of the country. Data were collected through hospital death record reviews (retrospectively, to determine a pre-pandemic baseline) and prospectively. A detailed standard operating procedure was worked out to cover the complete digital data journey, from reporting/capture to statistical output ready for dissemination. Another interviewee acknowledged the presence of a CRVS system which was not adaptable for use in RMS activity; referring to it as "weak." As a result, RMS was integrated into the Health Management Information System (HMIS) reporting functions.

> In terms of how it is related, we have tried to use the same personnel that run the existing surveillance system in the country, but RMS currently doesn't have the country's CRVS system [to rely on for data] because that particular system is quite weak. - Ghana Respondent 1

Challenges in Collection and Quality Assurance of Data

How deaths were reported and recorded impacted the quality of digitized data. In some situations, especially with community deaths, mortality data were spottily reported due to occasional lockdowns whilst in others, community data was not collected at all. It was apparent that in some locations there was little interest or incentive to register deaths to begin with – let alone during pandemic lockdowns. As one interviewee recounts,

> During the lockdown, people were not allowed to go for registration. Sometimes, also mortality [registration] is not an interesting activity. A mortality registration is not interesting for them. But they focus on the birth registration instead of mortality. - Rwanda Respondent 2

Cross-checking and validation of mortality data using other surveillance systems was deployed in some countries to enhance the quality of RMS data. This was possible because of the ability to triangulate different data sources at national and sub-national levels. in Colombia:

> Well, in terms of the most recent actions, there are comparisons of data on events of public health interest, not only COVID but also maternal mortality and perinatal mortality, with the databases of the surveillance system. Similarly, in terms of civil registration, there is also this cross-checking process involving the participation of the three entities: the Civil Registry, when it creates its databases; the Ministry of Public Health; and the National Administrative Department of Statistics, which is the one that carries out the cross-checking process and communicates about missing information. - Colombia, Respondent 1

In other countries, the ability to conduct cross-checking and validation of collected data were difficult even when mortality data had been previously collected. Lack of data sharing arrangements contributed to inaccessibility of available data for use in RMS. One interviewee recounted how they attempted to access available data for RMS to no avail.

> … at some point there were strides where through [the Initiative] they tried to link us with the Registration Bureau, with an objective that instead of taking more time getting data from data grids, we could get this data straight at, at one point from national Registration Bureau. But unfortunately, I think those efforts did not materialize. But that was the, one of the best options we could have taken, to align the data, which is already been collected by the Registration Bureau … All that had to be done was to put in place measures on how best we could share data. – Central African Country Respondent 1

The role of digitization

As stated, digitized CRVS systems facilitated the uptake and use of RMS data. This success also depended on how integrated the digitized CRVS system was with other existing systems. For example, Colombia relies on its digitized CRVS systems (RUAFND) for RMS. Created in 1998, the system was digitized in 2008, allowing for online certification of vital events, births, and deaths. An interviewee recounted:

> ".. in 2017, an automated data migration process began with internet, which allowed mortality information from the forensic system to migrate to RUAFND. This improved the timeliness of coverage of this information, making RUAFND the official mortality database in the country."

In rural areas with limited access to internet a parallel system was instituted and integrated with the RUAFND to improve coverage. One interviewee recounted the challenge and remedy as follows:

> "…we still have some difficulties, especially in places where there is little technology, where there is no easy access to the Internet; they still have manual certification, but it is a very small percentage compared to the total number of cases that are presented… We are working to close the gap through the Colombia Rural Vital strategy, which makes it possible to recover vital facts in ethnic populations or those that are difficult to access due to their geography... it is a matter of compiling information to upload it to RUAFND and have greater coverage."

> "…the Ministry led the health sphere, and they created and issued some resolutions to build what was called the SegCovid system, an information system where you could closely track every case and all the information related to health, to monitor the people infected with COVID. This information system where information about morbidity and mortality could be found, as well as travelers' sworn statements, medical appointments, and information, channels."

In Peru (which did not participate in the evaluation), a digitized health information system, SINADEF, facilitated mortality surveillance. SINADEF is a national computerized system of deaths with a database of medical death certificates issued by all physicians nationwide. While a parallel system (epidemiology center of the CDC Peru) exists, it

captured deaths that had diagnostic confirmation with laboratory tests. Whereas very few people had laboratory confirmatory tests.

> When SINADEF showed that the usual number of deaths was being exceeded, there was doubt about whether it was true…they soon realized that the information provided through SINADEF was the most appropriate for monitoring the severe impact that the pandemic caused in the country.

In Rwanda for example, the CRVS systems and data on community deaths from verbal autopsy are successfully linked into the DHIS2 HMIS platform. With the linked databases, it was easier to validate community deaths and to generate disaggregated mortality reports by any geographical unit. One interviewee described their system as follows:

> ...the government has finished the integration of civil registration system … which allows the entire birth/death registration, conducting verbal autopsies, and it provided the probable cause of deaths which is entered into DHIS2. The integration of different systems has already been completed to allow death notification, registration, certification, and to conduct the verbal autopsy. Rwanda Respondent 1

In some countries with digitized CRVS systems, but with inefficiencies in design or low levels of timeliness and completeness , CRVS-derived data was not taken up as a source of mortality surveillance. In other countries, such as Rwanda, there has been a willingness to use the data despite these shortcomings. Overall, well integrated digitized systems went hand in hand with proper leadership and a clear structure with defined responsibilities.

Conclusion

The section above focused on approaches used to select data collection systems in settings where CRVS systems were not capable of generating the desired data with the desired completeness and timeliness, and the implications of having access to digitized systems to conduct mortality surveillance. It also included some examples from countries where CRVS systems are used to measure excess mortality in a timely manner. Some countries (e.g., Rwanda) have been relying on semi-digitized CRVS systems with low to moderate completeness, and that employ more active mechanisms to detect incident deaths than in the past. Other countries (e.g., Rwanda and Ethiopia) have implemented mortality surveillance by leveraging national implementations of integrated disease surveillance and response (IDSR) systems. The approaches have been or are, as of this writing, being demonstrated in purposive and geographic samples.

Collaboration and Data Sharing

Strong collaboration, including data sharing, among key stakeholders and agencies, both local and international, was another factor pivotal to success. Where strong mechanisms for collaboration and data sharing existed, it helped facilitate quality data collection and use, and generated country ownership and institutionalization of RMS work.

The foundation for this was built in two ways: i) establishing or leveraging existing governance mechanisms and ii) ensuring that the necessary MOUs and SOPs for data

sharing and coordination were either already in place, or where needed, were developed for RMS.

The RMS Technical Package [3] recommends the use of CRVS committees and working groups to support the mortality surveillance system's uptake, quality, and use. Both CRVS and RMS activities are, by nature, multisectoral in that to be most effective they require interaction between Ministries of Health, National Statistics Offices, and the anchor ministry responsible for Civil Registration services, such as the Ministry of Interior or Home Affairs. Each of these entities, along with other government stakeholders, plays a crucial role in the collection and reporting of CRVS and disease surveillance data. RMS was no exception to this as evidenced by the involvement of multiple agencies in each country.

> Everyone participates: the National Institute of Health, the surveillance data; the physicians and the institutions, the death data; the ICT Office with the maintenance of all this programming of automated processes to integrate the different records and sources, and this is the result. – Colombia Respondent 2

> We have the director of the Ghana health service, and we have the director for the public health. We have the school of public health. We have the various regions where RMS is, and the hospitals. These are the persons involved. At the national level we use the EOC to get information and to share information to the national level – Ghana Respondent 1

With this number of agencies and departments involved, a clear need for governance structures related to RMS data production and use also emerged. These committees took the form primarily of working groups and technical committees with the purpose of coordination and technical oversight of the RMS system. Once the data collection strategy was identified, these governance structures were key to promoting good communication, information sharing, and coordination throughout implementation.

In some countries these already existed and were expanded to include RMS:

> At central level we have a National CRVS Steering Committee. From that again, we have a National Mortality Technical Committee, which reports to the steering committee. So, the National Mortality Technical Committee is composed of government institutions, the government partner members, and universities, and such institutions. RMS activities are now presented there. – Rwanda Respondent 1

> I believe that in this sense also, the inter-institutional commitment has been fundamental to creating this information system that will clearly have opportunities for improvement as with all the processes, but that does allow us to quickly obtain information on the COVID-19 situation. - Colombia Respondent 1

In others they were created or strengthened to meet the needs of RMS:

> There was frequent communication between the Ministry of Health and EPHI before, but specifically for this pandemic, and the mortality related events, there was not much frequent collaboration between these organizations. Even if they worked closely in other areas, I don't remember that they did for many of the health-related aspects, specifically for mortality

related events. So, I think it's great they got an opportunity to through this working group. - Ethiopia, 1

The hospital epidemiologic surveillance network is an important structure that worked with death data but was suspended and this weakened this work. However, we are currently trying to re-establish this alliance with a better infrastructure because this is going to profoundly contribute to our work. These are spaces where we work a lot together since we cannot always be inside hospitals, they help us in this battle for information – Brazil, Respondent 1

Another key function of these governance structures was to ensure the proper mechanisms were in place for sharing data with EOCs, Incident Management Teams (IMTs), other emergency or pandemic response authorities, Ministries of Health, or others. Therefore, the governance structures were also responsible for ensuring that SOPs and MOUs for data sharing were in place across all necessary agencies.

I think that to achieve this institutionalization, it is necessary to have a manual of procedures because it's something that is institutionalized. It is necessary that we have a manual describing the system that is implemented, so that it'll be shared and follow a standard expectation. –Senegal Respondent 2

Conclusion

Collaboration and coordination across government stakeholders was essential to success. This extended to ensuring or establishing the necessary data sharing agreements. In some cases, existing structures were leveraged to facilitate the necessary collaborations; in others new agreements were put in place.

Data Analysis and Interpretation

The analysis of RMS data involves comparing all-cause facility- or community-based mortality data to historical data on expected deaths, which have either been compiled or estimated. This comparison between historical and current mortality data measures the excess mortality, which can then be assessed over time and used to determine the true toll of the pandemic. By disaggregating this analysis by demographic factors, such as age, gender, or location, more can be learned about whether certain groups are experiencing more excess mortality due to COVID-19 than others. To facilitate this analysis, the D4H Initiative developed a Microsoft Excel-based excess mortality calculator (EMC) – available in English, Spanish, and French – which compares weekly, or monthly all-cause mortality data collected through facility or community surveillance against historical data [2]. The calculator produces metrics such as cumulative excess mortality, excess mortality by demographics, and deaths per hospital admissions if these data are available. It also outputs graphs that can be used for interpretation and reporting.

Excess mortality should be interpreted in conjunction with other COVID-19 data sources, such as data on public health and social measures or hospitalization data. By comparing excess mortality data to data on confirmed COVID-19 deaths, further insights on gaps in COVID-19 disease surveillance can be gained. With support from the D4H initiative, countries utilized the EMC to regularly input RMS data and report on weekly or monthly excess mortality, disaggregated by demographic data and cause of death if available.

Through this analysis, countries identified important factors to facilitate RMS and gaps in the system that should be addressed. For example, ideally countries could conduct the analysis at both national and subnational levels to understand the pandemic's impact geographically, but in some countries, all-cause mortality data were limited to certain areas where only subnational analysis could be conducted. For example, in Malawi, analysis was conducted at the district level, but due to a smaller sample size, it was noted that any trends or findings of excess mortality should be interpreted with caution.

> But the analysis will be at that level. At the district level. In terms of trends of mortality from 2019, if there have been excess mortality, 2019 and 2020, 2021. Why there was the sample, was quite small. So, I was saying… if we are to… to continue later, maybe it would be good also to scale up one in another district...and also in other in quite other facilities, which we need to have a bigger sample, so that we can …. know the trends of mortality, like in Malawi, or at the regional level. – Malawi Respondent 1

Another factor for successful analysis and interpretation of RMS data was having trained staff within government tasked with regularly analyzing and disseminating results. Institutionalization of processes, such as data collection, analysis, and interpretation, was vital to ensuring a high-functioning RMS system.

> So, we have taken initiative of extracting death registration data, and it will be weekly…and if not possible, we will go for the monthly extraction of data, from the BDRIS system. And then we will… examine it with rapid mortality calculator, and we will… compile, analyze, and will present before the policymaker regarding the excess mortality in our country. This is what we have decided, and we are trying to train the officials of [the] Office of the Registrar General and will provide training for one of our IT consultants. He will be trained up for compilation, analysis of data, and presenting data in the graphs." – Bangladesh Respondent 1

> I downloaded the data on a weekly basis, analyzed using Excel, and then entered on the excess mortality calculator shared with…the focal person and the designate for the Director of Health Security and Emergency, and then we look at issues like is the data talking to each other…are they corresponding…So on a weekly basis for the first phase, that is from November, to February, that is what we were doing on the first phase. – Sierra Leone Respondent 1

Results from excess mortality analysis should account for the current COVID-19 situation in a country and triangulated with other COVID-19 data sources. In Togo, RMS data in the EMC revealed a peak in excess deaths in March 2021, and by interpreting this finding in conjunction with healthcare center data, the government used this information to inform PHSM and lockdown. In Senegal, the team developed a data brief further exploring excess mortality outputs and concurrent events that could explain certain peaks in mortality. Additionally, the team is preparing a more detailed mortality report that is based on RMS data. This would be complemented by health center data registered in the DHIS2, data from the national statistics and demography agency using mortality projections in Senegal, and civil status data, which includes deaths from hospitals, health centers and communities for relevant years. All three data sources would serve for a better triangulation of RMS data.

> Now, with regard to the graphic expressed by the calculator, we analyze it in order to see how we can explain during the time we're living the decrease in mortality, the excess mortality on the graphic according to sex, age, and other categories…So, this first outbreak, apart from what the COVID-19 numbers showed, such as the increased number of cases—it is also true that at this time, the number of deaths weren't very high, but according to what we've collected in the rapid mortality surveillance, a peak in the healthcare centers was seen during the same time of these deaths…I think that it would in fact show us that apart from the official COVID-19 numbers that we have, there have been various other deaths in our communities, in our healthcare facilities, and they can be also connected to COVID-19. - Togo Respondent 1

Countries, such as Rwanda, also remarked on certain limitations of the analysis outputs, which are usually intended for a more technical audience, such as government officials and the EOC and less for the public or the media. Intended audience should be considered as countries develop reports and publications on COVID-19 excess mortality.

> What I do think is that sometimes graphs are not easy to be interpreted by some of journalists. And there are some terms that are not easy to be interpreted by journalists. What I think is can provide… a training on the, on journalists so that they, they know how to interpret the data. Sometimes still it is not easy to be, to interpret it, especially those graphs. – Rwanda Respondent 2

Regular analysis and evaluation of RMS data is critical to understanding gaps in the current system and who or where may have more excess mortality due to COVID-19. Although robust methods have been developed for estimating excess mortality,[5] the D4H calculator is a user-friendly tool for countries to record, analyze, and use their own data. Overall, countries have found the EMC useful for regularly tracking all-cause mortality data and using outputs from the analysis, such as excess mortality graphs, to share with decision-makers and publish in reports or media. In Burkina Faso, the calculator helps the Ministry of Health track reporting of deaths and follow-up with those site that did not report for the week.

> Now, as we regularly receive, we extract data to enter it onto the calculator. While we report the data, we enter it onto the calculator. The calculator is set up with graphs. So, we copy these graphs to write the report. But beyond those responsible, the focal point of the Ministry of Health obviously checks the data extraction each week to know if that site has reported many deaths that week; if that site has not reported deaths and they send that to the sites to see what they are doing. And this is a way of analyzing and it makes it possible to question the people who are at the sites about what is being done. What we do is the extractions with the calculator, with the graphs. When we do the report, we send it back to the sites so they can see it, too. So that's how we do data analysis and information dissemination. – Burkina Faso Respondent 1

> In addition, early on, proposals were made on how to analyze mortality as data to try to get the best out of it and to use it for decision-making—the tool of great quality that Vital Strategies offered us very early on, we adopted it and used it immediately. We also had

[5] See, e.g., https://www.who.int/data/stories/the-true-death-toll-of-covid-19-estimating-global-excess-mortality

> experience with this tool because we have used endemic channels as a tool for monitoring and analyzing surveillance data, but we had not used it for mortality; but here we saw that it was technically feasible, it was very well documented and, in fact, we were among the first to use the tool and we began to publish data from the processing of data in these templates. – Colombia Respondent 2

Data Use

During a pandemic, RMS data can provide valuable information to complement other epidemiological measures that guide response and public health and social measures. The data can be used to measure the burden and impact of the pandemic in geographic areas or demographic groups. It may also provide operational information on gaps in mortality or disease surveillance, so it is recommended that findings be shared with Emergency Operations Center (EOC) or national technical committees to guide pandemic response and government officials and policymakers to guide mortality surveillance system improvements. Interviews with key informants drew attention to how information from RMS has been used to inform response and decision-making and highlighted areas to improve in the CRVS system.

Disseminating data for decision-making

As expected, dissemination of RMS data varied by country. In some countries, findings from all-cause mortality/excess mortality analysis were disseminated in tools such as internal or external dashboards for decision-making. For example, in Peru a dashboard was created to present information on all excess mortality which was referenced during press briefings with health officials, and a commission was established to recategorize COVID-19 deaths providing a more accurate measure of the direct impact of COVID-19 on excess mortality [6]. The use of RMS data has resulted in further analysis of specific causes of death and on survival, strengthening the evidence for the impact of vaccination.

> This information on the open data platform has allowed independent citizens to use the information and improve the health of different population groups. Another significant achievement is the use of mortality information for several publications linked to suicide, from suicide, deaths from external causes to the comparison of survival or mortality between vaccinated and unvaccinated populations… - Peru Respondent 1

The Colombia team began building its RMS database using the Technical Package [3], including the excess mortality calculator [2] to establish a historical baseline as a benchmark to measure excess mortality for 2020 and 2021. After establishing standard operating procedures for calculating these values on an ongoing basis, the Colombia team was able to transfer these data to a publicly available dashboard, allowing citizens and journalists alike to track excess mortality by epidemiological weeks, disaggregated by municipality/district, age, and sex and informing government decisions related to COVID safety protocols. Main users of the data include ministers and deputy ministers who have found the data helpful in understanding mortality trends in the country.

> In terms of general mortality information, all entities have this information publicly available on the websites of each entity. For example, the monitoring carried out by the National Institute of Health can be checked directly on the [dashboard], and this monitoring is

> continually updated. In the specific case of the control panel, it is already within the Ministry's tools. – Colombia Respondent 1

To keep the public informed of COVID-19 in Rwanda, the Rwanda Biomedical Center (RBC) has been regularly producing weekly COVID-19 epidemiology bulletins, including information on cases, deaths, and public health and social measures (PHSM). All cause and excess mortality results based on data from civil registration records are regularly presented to the EOC and published in the weekly bulletin.

> We are requested biweekly to present RMS data or results to the EOC team, which is composed of...key technical people, including WHO and the CDC and other members...So we present to them and to the government...to take some policy decisions.... They see if after looking at the mortality trends, they say...many people are dying, so can't we put some...movement restriction measures, so that...we can reduce the number of deaths per day? So, we do present to them and am extremely happy that our results have been used in taking some decisions regarding prevention measures. – Rwanda Respondent 1

In some Data for Health countries where data were not shared digitally, outputs from excess mortality analysis were shared with policymakers. For example, in Togo, excess mortality outputs were presented to Regional Directors, who were briefed on how to use results for COVID-19 mitigation measures. All-cause mortality data revealed a peak in excess deaths in March 2021, information which the government used to institute public health and social measures and lockdowns. In Ethiopia, the team was preparing to share results from excess mortality analysis with the EOC within the Ethiopian Public Health Institute (EPHI) at the time of writing.

Using data to address gaps in the CRVS or mortality surveillance systems

Rapid mortality surveillance data have also been useful in helping countries identify gaps in the current mortality surveillance or CRVS systems. For example, in Burkina Faso, RMS data revealed timeliness issues in the current surveillance systems especially DHIS2, which is experiencing a six-month reporting lag, i.e., the time from death occurring to the inclusion of the death in the reported numbers. To address this, discussions are underway with the Ministry of Health to integrate mortality surveillance into the routine surveillance system, highlighting how data are used to improve the overall system. Furthermore, in Liberia, RMS data have helped expose significant gaps and insufficiencies in the country's disease and mortality surveillance system.

In Senegal, RMS data from health facilities are regularly entered and analyzed in the excess mortality calculator. Given that RMS has been a new initiative in Senegal, key informants mentioned that data use could still be improved. Nevertheless, findings from RMS have been presented in daily COVID-19 press conferences arranged by the Ministry of Health. Rapid mortality surveillance bulletins have been developed and shared with the Ministry of Health. The team went further to train hospitals to develop their own bulletins for finer interpretation and local decision-making with hospital directors. An RMS manual has also been written, which will facilitate the institutionalization of RMS. The manual reports all procedures were undertaken for mortality surveillance in Senegal including

data collection, recording in the RMS tracker hosted in DHIS2, monthly reports, the tracker, semi-annual reviews, newsletters.

While Senegal has not yet implemented community-based RMS, there is an interest among officials to expand the work to include community-based surveillance. Furthermore, key informants in Senegal reflected that although they reached 100% completeness in collecting data from health institutions, there were issues in timeliness, following implementation of a new data collection system and insufficient human resources to manage hospital data.

> Maybe the risk that we could encounter in the system is that the data that we have isn't complete at this time, because we've noticed with the rapid surveillance that the data at the community level has a lot of deaths that we haven't taken into taken into account, so I think that it might be a risk because if we don't pay attention, it is possible that some people tell us that the data doesn't reflect all of the mortality in Senegal, so that it only reflects the mortality at the hospital level, so this could be restricted. So, this gives us a great picture of hospital mortality, but it can't give us a full picture of mortality at a general level. – Senegal Respondent 2

Key informants from Sierra Leone, Ghana, and Malawi also noted the importance of having representative RMS data to achieve a true picture of the COVID-19 burden in a country. By assessing results from RMS, countries were able to determine what else should be done to make accurate inferences.

> In the discussion with the EOC, something that came up clearly was the representativeness of the data. From a technical point of view, from the EOC's point of view, this is like a very good… strategy going forward. If we could get [RMS] in every health facility, or in majority of health facilities now that we know accounts for let's say 90% of mortality in Sierra Leone. You know, that would be a very good tool to predict… to tell us exactly what we are, what we're experiencing as a, as a nation. But one thing that was, that came out very clearly, that if it was not… you know, if, if the selection was not detailing by statistical methods, then we could not just make an inference that this is exactly what is happening across the country. - Sierra Leone Respondent 1

> With utilization I think it has given some good information to the COVID-19 technical working group that has shown interest in us, mainly expanding it to capture more facilities. COVID-19 has been high because as I said we were just a pilot that was capturing data to be able to share with the technical working group on COVID…The scope is quite small for it to be able to scientifically predict what is actually happening so the scope needs to be funded for it to be a significant representation of what is happening in the country as far as mortality is concerned. - Ghana Respondent 1

Challenges to data use

Although RMS data can provide insight into the health data systems and inform response, challenges remain in using data that may not be complete or representative of the country's population. For example, in Colombia, the team has seen an undercounting of deaths for both rural and urban communities. In rural communities, this is due to a lack of connectivity and reliable cell phone service; in urban communities, during peaks in the pandemic, a decrease in care-seeking was observed. As a result, the data available are

an underestimate, and it may be impossible to know the true count of deaths. Rwanda experienced challenges in data managers being seconded to COVID-19 response, thus delaying death registration, resulting in incomplete data, which poses a challenge when assessing and interpreting excess mortality results. To address this, the mortality committee uses RMS results to track the reporting lag and data quality issues to then provide feedback to health facilities.

> The data [are] analyzed [on a] monthly basis. So [the Ethiopian Public Health Institute (EPHI)] already uses that data for them. But as I said before...they want some other supporting local [data] because the facility death all by itself might not be enough for the decisionmaker to present... and give them some conclusions. So, they need to get some community data that supports their findings in, in the previous period - Ethiopia Respondent 1

Conclusions

RMS data were disseminated through a variety of channels and used in ways that included public facing dashboards, sub-national analyses to inform vaccine rollout and alert levels, and the identification of areas for improvement in the timely measurement of mortality. Triangulation of RMS data with other data sources, such as COVID-specific data or survey data, can help provide a clearer picture of the total mortality burden and trends in mortality. Furthermore, although all-cause mortality data may be readily and regularly available for policymakers, it is important to create a culture of data use where government officials understand the value of data from mortality systems for both monitoring and response.

Summary and Discussion

The WHO estimates that there were 6.6 million deaths directly through November 2022 due to coronavirus,[6] and estimates that 14.9 million excess deaths directly and indirectly occurred due to the pandemic in two years (2020-2021). At the time this was a difference of 9.5 million.[7] Yet it must be stressed that data for *both* the direct and total excess mortality burdens of the pandemic are based largely on models for many, if not most, low- and middle-income countries. Without total mortality surveillance well-functioning CRVS systems, countries – particularly at the sub-national level – will struggle to understand the true scale of mortality in disease outbreaks. In view of the overriding need for these data at country level, regional efforts have been launched such as the Africa Centers for Disease Control's [1] "Continental Framework for Strengthening Surveillance Systems" to guide countries in the region toward functioning, timely, and representative mortality surveillance, thus bolstering the development of the CRVS system.

As a contribution to the collective learning in a rapidly expanding area of public health intelligence, this report retrospectively examined the hypothesis that RMS can provide timely and useful counts of deaths, even in settings lacking strong CRVS systems and

[6] https://covid19.who.int/
[7] https://www.who.int/data/stories/global-excess-deaths-associated-with-covid-19-january-2020-december-2021

even in the context of the competing demands of the pandemic's first waves. In addition, we assessed the following assumptions:

- In settings without digitized and nearly complete death registration, existing systems can be quickly augmented or leveraged to provide timely, useful data on the levels and trajectory of mortality by age, sex, and location on a national or representative basis.
- Demand for excess mortality data will be high, leading to strong ownership and use of RMS outputs (together with other sources) by Emergency Operations Committees (EOCs) in the COVID-19 response.

Investigating the evidence in support of these hypotheses illuminated two broad groups in terms of country experience: i) countries with 'mature,' largely complete, and highly digitized CRVS systems (Brazil, Colombia, and Peru); and ii) countries with partially digitized CRVS and health information systems, with low to medium completeness and significant lag in reporting (Bangladesh, Burkina Faso, Colombia, Ethiopia, Ghana, Liberia, Malawi, Rwanda, Senegal, Sierra Leone, and Togo). The former group largely succeeded in leveraging existing CRVS and cause of death data systems. The data produced were analyzed and communicated in a manner that influenced public discourse and government response.

The latter group had an uneven experience in terms of successfully establishing mortality surveillance. Challenges included: competing demands or lack of prioritizing mortality data, which led to insufficient ownership and demand by government; significant delays when new systems for data collection needed to be established or integrated into existing mechanisms; small sample sizes; issues of data lag when integrating with CRVS systems; and challenges in the use and interpretation of data produced under these conditions.

On the other hand, successes in the three Latin American countries resulted in a long-term sustainable commitment to develop and improve mortality surveillance beyond the initial 18 months of the pandemic. As of this report writing, three countries are integrating surveillance of total mortality into national Integrated Disease Surveillance and Response systems (Ethiopia, Rwanda, and Sierra Leone), with preliminary findings and lessons learned expected in late 2022. One country has used the demonstration RMS program supported by the Initiatives to leverage a 'Grand Challenges' innovation grant from the Bill and Melinda Gates Foundation, and to seek more significant long-term resources to support mortality surveillance. In addition, important improvements to the regulatory environment around data access and sharing were made in several countries. One country in this group (Rwanda) has embarked on integrating the monthly measurement of total and excess mortality based on the integrated and decentralized HMIS/VA/CRVS system, which is currently scaling nationally. While acknowledging the limitations on usability of lagged, incomplete, facility-only, or small sample data, countries nevertheless have triangulated mortality surveillance with other data to provide intelligence to EOCs and Ministries of Health. Analyses have also served to pinpoint areas in need of improvement. Lastly, the uptake and use of technical resources provided by the Initiatives, particularly the Excess Mortality Calculator, was notable.

Given that estimates of excess deaths can provide essential information on the burden of mortality related to the COVID-19 pandemic, regularly collecting, analyzing, disseminating, and using all-cause mortality data are crucial to understanding the true impact on populations, particularly when data are disaggregated by factors such as age, sex, and location. This process of reflecting on the first 18 months' experience of supporting RMS in combination with a rigorous review of data can inform strategies to improve data production and produce more accurate results.

In terms of our ingoing hypothesis and assumptions, we may conclude the following:

- Hypothesis: RMS can provide timely and useful counts of deaths, even in settings lacking strong CRVS systems and even in the context of the competing demands of the pandemic's first waves.
    - The evidence supporting this hypothesis was mixed. Three country cases the validity of this hypothesis.
    - In other countries, the hypothesis that RMS could be established in countries without strong CRVS systems and in the context of competing demands of the pandemic response was partially proven as demonstrated by the high degree of country ownership and leadership in countries such as Ethiopia, Rwanda, Senegal, Sierra Leone.
    - The failure to fully prove the hypothesis centered around issues including insufficient country ownership and leadership; timeliness/lag; and insufficient quality and quantity of data for policy uses.
- Assumption: In settings without digitized and nearly complete death registration, existing systems can be quickly augmented or leveraged to provide timely, useful data on the levels and trajectory of mortality by age, sex, and location on a national or representative basis.
    - We interpret 'quickly' to mean within three to six months. This assumption largely did not hold. At the time RMS was introduced and established, no countries were able to identify a suitable system that met the criteria above. Most countries either began with or stressed counting deaths in hospitals, and community data sources were either not identified or did not function in a timely or complete enough manner to provide a national or representative picture.
    - Since the evaluation interviews were conducted, however, three countries (Ethiopia, Rwanda, Sierra Leone) have sought to expand community-based surveillance of their IDSR systems and integrate total mortality surveillance into that platform. Or to make facility-based surveillance universal at facilities where deaths occur (Senegal).
- Assumption: Demand for excess mortality data will be high, leading to strong ownership and use of RMS outputs (together with other sources) by Emergency Operations Committees (EOCs) in the COVID-19 response.
    - Except for Bangladesh, this assumption held, particularly if we include system improvement as one important use of data.

Findings from this evaluation reveal the importance of improving the overall quality of mortality surveillance data – through digitization, timeliness, scale, accurate reporting, analysis/triangulation, and use – to enable data driven decision making and action.

In sum we found high need, high demand and varying capacity to implement based on the maturity of the CRVS system. One way forward to solving the apparent dichotomy of 'mortality surveillance vs CRVS development' would be to think about the point at which a CRVS system would be capable of absorbing and supporting mortality surveillance functions. Until that point is reached, some augmentation of CRVS death registration activities in representatively sampled areas will be needed to meet the demand. Parallel and unlinked mortality surveillance and CRVS systems are to be avoided.

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Annex 1: Summary of Code Application

Code Description	Number of coded passages
Community surveillance	31
Facility surveillance	32
Respondent characteristics	4
Respondent's role	20
Change in role since COVID	7
System characteristics	48
System name	12
System objectives	30
Scope of RMS system	24
Scale of RMS	28
Entities supporting RMS	32
Govt agencies supporting RMS	35
Individuals who support RMS	10
Coordination among stakeholders in RMS	37
Types of data produced by RMS	23
Timeliness of data reporting	29
Promptness of data production	10
Government ownership	63
Government demand for RMS	23
Lack of government demand for RMS	1
RMS strategy and objectives	20
Collaboration and data sharing among stakeholders	46
Examples of integration	26
Examples of successful implementation	26
Examples of unsuccessful integration	6
Examples of unsuccessful implementation	6
Increased government ownership of data	6
Sustainability	37
Connection and integration between RMS and CRVS system	36
Risks to sustainable RMS	31
Mitigating risks to sustainable RMS	12
Concerns for or about RMS system	4
Vision for future RMS activities	30
Future new or improved data sources	7
Future new or more robust analyses	3
RMS headline results	38
Use of data	43
RMS data users	34
Challenges to data use	19
Solutions to data use challenges	5
Opinions on scope of data collected	12
Opinions on scale for data use	6
Relationship between scope of data and decision-making	2
Examples of data utilization by government	21
Journalist and media use of RMS data	16
Public use of RMS data	18
Implementation	55
Implementation Challenges	39
Data collection process	43
Data analysis process	28

Code Description	Number of coded passages
Data interpretation process	7
Data quality assurance process	20
Data quality assurance activity results	7
Barriers to implementation of RMS	20
Specific gaps in the RMS system	21
Solutions to gaps in the RMS system	22
Total	**1,267**

Code Description	Number of coded passages
Government ownership	63
Implementation	55
System characteristics	48
Collaboration and data sharing among stakeholders	46
Use of data	43
Data collection process	43
Implementation Challenges	39
RMS headline results	38
Sustainability	37
Coordination among stakeholders in RMS	37
Connection and integration between RMS and CRVS system	36
Govt agencies supporting RMS	35
RMS data users	34
Facility surveillance	32
Entities supporting RMS	32
Risks to sustainable RMS	31
Community surveillance	31
Vision for future RMS activities	30
System objectives	30
Timeliness of data reporting	29
Scale of RMS	28
Data analysis process	28
Examples of successful implementation	26
Examples of integration	26
Scope of RMS system	24
Types of data produced by RMS	23
Government demand for RMS	23
Solutions to gaps in the RMS system	22
Specific gaps in the RMS system	21
Examples of data utilization by government	21
RMS strategy and objectives	20
Respondent's role	20
Data quality assurance process	20
Barriers to implementation of RMS	20
Challenges to data use	19
Public use of RMS data	18
Journalist and media use of RMS data	16
System name	12
Opinions on scope of data collected	12
Mitigating risks to sustainable RMS	12
Promptness of data production	10

Code Description	Number of coded passages
Individuals who support RMS	10
Future new or improved data sources	7
Data quality assurance activity results	7
Data interpretation process	7
Change in role since COVID	7
Opinions on scale for data use	6
Increased government ownership of data	6
Examples of unsuccessful integration	6
Examples of unsuccessful implementation	6
Solutions to data use challenges	5
Respondent characteristics	4
Concerns for or about RMS system	4
Future new or more robust analyses	3
Relationship between scope of data and decision-making	2
Lack of government demand for RMS	1
Total	**1,267**

Annex 2: Two Country Examples of Integration with CRVS

In this section we present two country examples of how CRVS systems were leveraged for mortality surveillances.

Rwanda

After deliberation, the Rwandan government decided that total mortality should be a natural output of the CRVS system and has attempted to prioritize increased frequency and timeliness of reporting from that system. Prior to the pandemic, significant efforts were underway to improve both community and facility death registration through systems improvements in the CRVS system. Historically, Rwanda did not have an integrated CRVS system where mortality data could be captured and utilized for surveillance purposes. Although there have been improvements in the system, completeness remains a concern and only a small percentage of deaths across the country are registered or assigned causes of death, particularly for community deaths.

CRVS integration with the RMS system was made possible through government buy-in and prioritization.

> So, during the COVID-19 and introduction of RMS, this is when the government realized that it needed a single source of mortality data to monitor the outbreak and to have a complete set of mortality data. That's why our RMS activities has awakened the government to establish and, to establish and view this from the mortality surveillance through CRVS system. – Rwanda Respondent 1

One key facilitator of CRVS system integration in Rwanda was their experience in implementing the DHIS2 system, which has been integrated with its CRVS system to capture birth and death information and to serve as a centralized data system. Building upon these existing capabilities allowed the Rwandan government to pull mortality surveillance data from a centralized source during the pandemic. Utilizing this digital database was a key factor in integrating RMS activities into Rwanda's CRVS system.

> That's why at the moment, the CRVS system integrated with DHIS2, is also integrated with the whole bigger central system and the other systems for promotion of data […] also it is integrated with the IED system, national registration of ID system, operation register. So, at the moment, the data we are capturing at national level, mortality database, it has unique ID across. So, for us we feel now at the moment, is another milestone and a highlight to have achieved, to be having a stronger mortality surveillance at the moment. Rwanda Respondent 1

The data, however, are used by government with caution in view of the previously noted low completeness of death registration and known obstacles to timeliness of reporting (i.e., the statutory registration window for a death).

Colombia

In Colombia, the CRVS system has high completeness and is more digitized compared to Rwanda. This eased integration between the CRVS and RMS systems. More than 80% of deaths are registered and assigned cause of death through the CRVS system, and data are shared across databases and government agencies.

Due to the close collaboration between the Ministry of Health, the National Institute of Legal Medicine, the National Registry of Civil Status and the National Statistics Department, Colombia's CRVS system and its data are streamlined across government agencies. This is also a major facilitator in improving the registration of vital events and interoperability of data systems. Regular data cross-checking and establishing interoperability of data systems has allowed Colombia to create its own public facing data dashboard demonstrating key indicators related to the COVID-19 pandemic, including excess mortality by week.

The excess mortality dashboard was the first product that Colombia developed to monitor the COVID-19 pandemic through CRVS-RMS system integration. It has increased the reporting of deaths and the dissemination and use of other information services available to the Ministry of Health.

Complementing the excess mortality dashboard, a process of reclassification of COVID-related deaths has been implemented. Through this process, it has been possible to measure COVID's contribution to the excess mortality measured across the country. This process is one step that contributes to the completeness of Colombia's excess mortality data, made possible again by the timeliness and interoperability between death registration systems and the digitization of death records.

Both countries demonstrated a great deal of operational success within their unique contexts and existing parameters of their CRVS systems, though issues of timeliness and completeness remain more acute in Rwanda, as noted above. The combination of timely death reporting, digitization of various components of the death registration system, and completeness of data all influence whether countries can seamlessly integrate routine mortality surveillance into their CRVS systems.

Conclusion

This section of the evaluation report explored two RMS systems and the similarities and differences in their approach to establish and use mortality surveillance data using CRVS data. While both countries have taken the same general approach of basing mortality surveillance on the CRVS system, the relative ease with which Colombia has established and used mortality surveillance during the pandemic has been greatly enhanced by its comparatively more complete and more fully digitized system that predated the pandemic.