A novel approach to support rapid data collection, management and visualization during COVID-19 outbreak response in WHO African Region

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Abstract

Background: The coronavirus disease 2019 (COVID-19) pandemic has created unprecedented challenges to systematic and timely sharing of COVID-19 field data collection and management. WHO is working with health partners on the rollout and implementation of the robust electronic field data collection platform. The delay in deployment and rollout of this electronic platform in the WHO African region as a consequence of the application of large-scale public health and social measures including movement restrictions and geographical area quarantine left a gap between data collection and management. This gave rise to the need to develop interim data management solutions in order to accurately monitor the evolution of the pandemic and support the deployment of appropriate public health interventions.

Objective: To review the design, development and implementation of the COVID-19 Data Summarization and Visualization (DSV) tool as a rapidly deployable solution to fill this critical data collection gap as an interim solution.

Methods: This paper reviews the processes undertaken to research and develop a tool to bridge the data collection gap between the onset of a COVID-19 outbreak and the start of data collection using a prioritized electronic platform such as Go.Data in WHO African region.

Results: In anticipation of the implementation of a prioritized tool for field data collection, the DSV tool was deployed in eighteen (18) Member States for COVID-19 outbreak data management. We highlight preliminary findings and lessons learned from the DSV tool deployment in the WHO African region.

Conclusions: We developed a rapidly deployable tool for COVID-19 data collection and visualization in the WHO African region. The lessons drawn on this experience offer an opportunity to learn and apply these to improve future similar public health informatics initiatives in an outbreak or similar humanitarian setting, particularly in low and middle-income countries.

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Keywords: COVID-19; Data Management; Data Collection; Visualization; EWARS, WHO African region; Go.Data; Outbreak; Pandemic; Health Emergencies

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INTRODUCTION

In December 2019, a cluster of cases emerged in China caused by a novel coronavirus disease, officially known as COVID-19 by the World Health Organization (WHO) [1]. Since then, COVID-19 has spread widely with a rapid global spread in just a few months [2]. WHO’s Director-General declared COVID-19 a Public Health Event of International

Concern on 30 January 2020, and later as a pandemic on 11 March 2020, urging all countries to take urgent and aggressive actions for detecting, tracing, isolating and treating active cases, and for preventing transmission to reduce COVID-19 related morbidities and mortalities [3]. As of 19 May 2020, there have been around 4.7 million laboratory confirmed cases of COVID-19 reported across the globe [4]. This novel coronavirus first arrived on the African continent in February, with the first few cases detected in Egypt and Algeria [5]. As of 19 May 2020, all WHO African Region Member States are affected with 47,953 confirmed cases and 1,488 reported deaths with a case fatality ratio of 3.1% [6].

During any disease outbreak or health emergency, timely access to validated data and its translation into evidence to support swift public health actions and decision-making is one of the biggest challenges faced by many public health experts, especially in resource poor settings. This is especially true for settings where routine public health surveillance systems are under-performing or non-existent or may be disrupted during the COVID-19 crisis. Such delays in outbreak control during emergency response results in delayed case detection and public health actions to mitigate onward transmission. Consequently, higher mortalities with higher rates of disease transmission in communities are inevitable. To address such delays, the WHO recommends implementation of a disease early warning system, known as Early Warning and Response System (EWARS), within three to ten days of onset of an acute phase of an emergency as one of the priority interventions to mitigate the negative health consequences resulting from the acute emergency or humanitarian event [7].

The EWARS system supports any existing health system and facilitates collection of essential, minimal data on prioritized epidemic prone or selected diseases with significant public health consequences to enable rapid analysis of trends for outbreak or emergency response in humanitarian settings. Enhancing the EWARS system using robust electronic data systems could be harnessed as a powerful tool by outbreak response teams in collecting vital epidemiological data to support appropriate and timely action during emergencies. WHO has developed various electronic tools and platforms, such as electronic Disease Early Warning System (eDEWS) and Early Warning and Response System (EWARS-in-a-box), to support EWARS surveillance data collection, management and analysis to inform timely public health actions and evidence-based decision making in humanitarian settings. Furthermore, these electronic systems have been adapted to

support an electronic surveillance component of Integrated Disease Surveillance and Response (eIDSR) and to facilitate early detection of prioritized epidemic-prone diseases [8-10].

COVID-19 disease is a current focus of surveillance, contact tracing and outbreak response strategies globally. These strategies seek to ensure early and timely identification of cases, their effective isolation and rapid contact tracing to break the chain of transmission lines [11]. For this purpose, WHO African Regional Office has prioritized use of Go.Data among existing WHO's electronic data collection platforms in the COVID-19 outbreak context. This tool has been recently developed by WHO in collaboration with partners in the Global Outbreak Alert and Response Network (GOARN) [12].

Go.Data is an outbreak investigation tool designed for flexibility in field data collection during public health emergencies. This tool provides functionality for case investigation, contact tracing, and visualization of chains of transmission. It facilitates data collection about an outbreak of an infectious disease including cases associated with that outbreak, events at which transmission of disease may have occurred, contacts that have been at risk of infection through exposure to a case or event, and contact tracing to monitor their health following an exposure [12, 13]. This electronic platform assists responders to choose the right interventions to stop the disease from spreading and to work smarter [14]. The key difference between Go.Data and other existing WHO electronic systems in WHO African region is that the Go.Data tool has been designed primarily to improve contact-tracing activities to break disease transmission. It also has functionality for visualization of transmission hierarchies. This is in contrast to other existing WHO electronic surveillance systems that have the primary focus to support EWARS functions as part of routine IDSR activities [8, 9, 15].

The complete roll out of an electronic field data collection platform ranges from a couple of weeks to a month for planning, deployment, training and support including regular technical advice in WHO African region. Potentially this may leave a critical gap between the declaration of onset of a COVID-19 outbreak and the start of data collection that is in line with operationalization delays reported with existing electronic platforms for EWARS [8, 16-18]. Few earlier studies have highlighted a need to use an interim and rapidly deployable

solution that could bridge the gap between outbreak onset and full implementation of electronic data systems. Studies also suggest considering poor technical capacity and issues with access and resources when implementing such interventions in resource poor settings [8, 17].

This paper discusses the process our team undertook to research and develop a tool that would bridge the data collection gap between the onset of an outbreak and the start of data collection using a prioritized electronic data collection platform (PEDCP). We developed the COVID-19 Data Summarization and Visualization (DSV) tool for this purpose. Currently, this DSV tool is used in the eighteen countries of the WHO African region to support the current COVID-19 outbreak response. Additionally, we highlight preliminary findings and lessons learned from DSV tool deployment in the eighteen countries in the WHO African region.

METHODS

To inform prioritized development of the COVID-19 DSV tool and better understand functions of existing tools against targeted needs, we reviewed the use of existing WHO electronic platforms and software for EWARS, case-based surveillance, contact tracing and other eIDSR related surveillance activities, during various outbreaks and health emergencies in the WHO African region. These included EWARS-in-a-Box, eDEWS and Go.Data. The purpose of the review was also: to identify any existing minimum data system standards aligned with COVID-19 regional and global surveillance guidelines & protocols; to prioritize information needs for effective COVID-19 outbreak response, planning and decision-making; and to inform the design of the interim DSV solution to facilitate smooth transitioning to implementation and full deployment of a PEDCP [19, 20].

The review was conducted through (1) an online literature search for technical guidance documents and published data in PubMed/MEDLINE, and Google Scholar databases, including the WHO library database, (2) directly approaching WHO teams through phone call or emails or in-person involved in designing and implementing these platforms in WHO African region, and (3) informal focused group discussions with WHO operational staff, including members of field teams, managers and leaders involved in field data collection and contact tracing during health emergencies such as EVD in DRC and West Africa and

other outbreaks in the WHO African region.

DSV Tool Design

As a result of our review, we identified the following seven key considerations essential in the development of the tool.

1) Inclusion of WHO standard data needs and priorities for COVID-19 response in the African region
2) Challenges around field data collection, management, analysis and visualization during the COVID-19 outbreak in member states
3) Reporting requirements under WHO International Health Regulations (2005), namely data flow from the field to country to regional office
4) Facilitate smooth deployment of robust data collection and contact tracing solution for case-based reporting,
5) Challenges around frequent staff turnover and training needs
6) Lack of basic infrastructure with key technical, political and financial considerations
7) Ease of use, sustainability and local ownership.

We also concluded that the tool must be specifically designed for interim use, have the ability to be rapidly deployed, be cost effective and time efficient.

The DSV tool was developed as part of the WHO Regional Office for Africa (AFRO) initiative, “Outbreak Toolkits”, available publicly at WHO outbreak toolkit web portal [21], that was adapted later at the WHO Global level for replication in global perspective in other WHO regions across the globe [22, 23], figures 1 and 2.

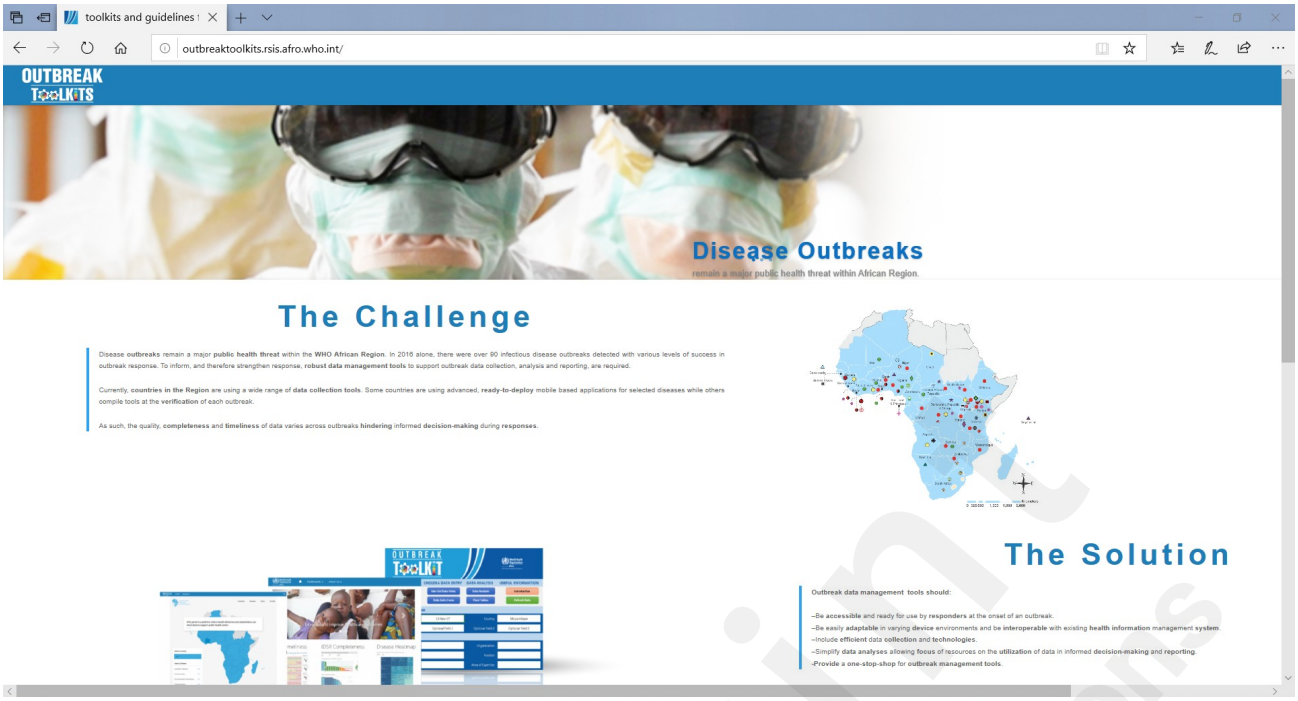


Figure 1. Screenshot of publicly available web portal of WHO AFRO Toolkit Project

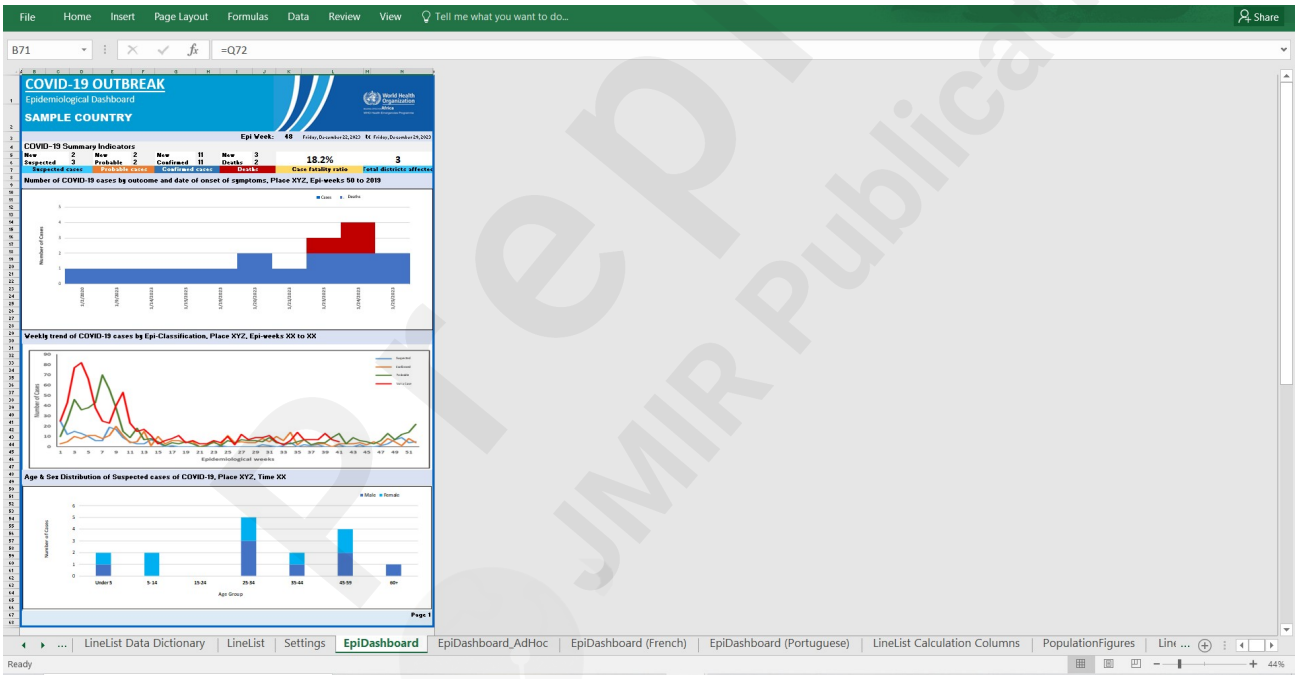


Figure 2. Screenshot of publicly available DSV tool showing automated printable data visualization

RESULTS

We concluded based on our review that the DSV tool must be specifically designed for interim use, have the ability to be rapidly deployed, be cost effective and time efficient. The

DSV tool was developed in line with WHO Global COVID-19 Surveillance Guidelines and Protocols and adapted to WHO African Region requirements. It assists member states in the collection, reporting, analysis and interpretation of data 'immediately' upon onset of any COVID-19 outbreak. The tool is simple, customizable, adaptable and easy to implement for interim use.

We developed the DSV tool using MS Excel. This tool uses pre-formatted pivot tables with automation that is simple to use, requiring basic MS Excel skills at the end user level. In phase two of DSV tool deployment, we built automation processes to support export and integration of multiple COVID-19 data files for sharing by member states and to be merged into one central COVID-19 database for use at the WHO regional level. This DSV tool is located on a publicly available web portal for COVID-19 WHO AFRO Outbreak Toolkit [13].

Description of DSV tool modules

The DSV tool consists of modules for data collection, automated data management and analytics, and visualization. A brief description of each module follows.

Data collection module: **We created the data collection tool using MS Excel spreadsheet in linelisting format. We also created optional XLSForms for use in KoBoCollect, ODK or other similar platforms for settings with prior XLSForm user experience and existing resources to use such platforms immediately. This allows flexibility for users either to enter data directly into formatted MS Excel worksheets with validation checks and conditional rules, or to use XLSForms with recommended ODK or KoBoCollect platforms for data entry using electronic devices as an option.**

Automated data management and analytics module: We created pre-formatted pivot tables with functionality to automatically extract the significance from a large, detailed dataset, summarize it into tables and then used canned pivot analysis for rapid multidimensional and meaningful high-level analysis of data. We kept flexibility to allow ad-hoc type of data handling and analysis as needed.

One click spreadsheet visualization – COVID-19 Dashboard: To help with data analysis and interpretation, we created pre-formatted single click visualizations and locked layout of

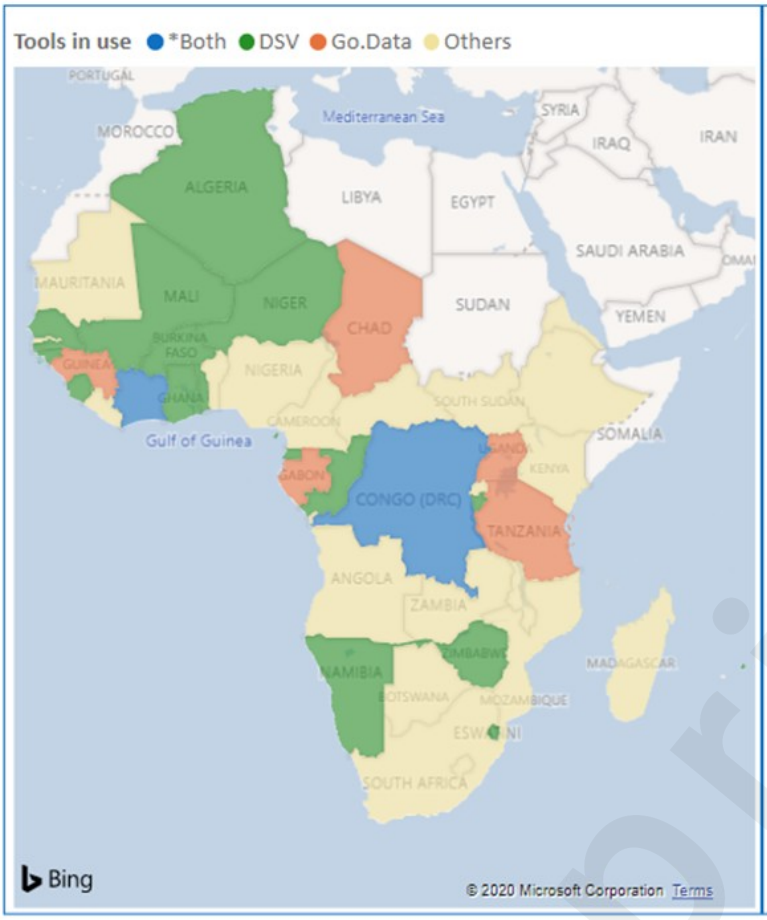
COVID-19 dashboard to facilitate printing of dashboard in PDF format to quickly share initial and high level summary with health emergency managers, leadership and other stakeholders in the WHO African region.

Multilingual support: This includes templates in three languages English, French and Portuguese to address the priority languages used in the WHO African region.

Using the DSV tool as an immediate response for COVID-19 outbreaks

It is specifically recommended that the DSV tool is immediately deployed upon confirmation of the first COVID-19 case within the African region. Rapid deployment will support the roll out of a prioritized electronic tool, which is currently facing delays due to country applied public health and social measures including movement restrictions and geographical area quarantine, in settings lacking basic infrastructure and necessary resources. To facilitate immediate reporting with DSV tool, we have also developed preconfigured XLSForms in multiple languages to be used with KoBoCollect, ODK or any other platform that support XLSForm configurations to facilitate real-time collection of data from the field using electronic devices but kept as an optional feature for use.

The main objective of developing the DSV tool was to provide an interim solution for immediate deployment during COVID-19 outbreak response for field data collection, contact tracing follow up, and to generate epidemiological information for decision makers in a timely manner. As shown in Figure 3, as at 10 May 2020 the DSV tool has been deployed in eighteen Member States in the WHO African Region and has been shared with other member states as part of a readiness and preparedness package. The interim use of the DSV tool is recommended to avoid delays in settings where technical infrastructure and constraints on resources remain major barriers to launching any electronic data collection platform for COVID-19 case-based surveillance.



Country	Tool
Algeria	DSV
Burkina Faso	DSV
Burundi	DSV
Chad	Go.Data
Congo, Brazzaville	DSV
Cote d'Ivoire	*Both
Democratic Republic of Congo	*Both
Equatorial Guinea	DSV
Eswatini	DSV
Gabon	Go.Data
Ghana	DSV
Guinea	Go.Data
Guinea Bissau	DSV
Mali	DSV
Mauritius	DSV
Namibia	DSV
Niger	DSV
Senegal	DSV
Sierra Leone	DSV
Tanzania	Go.Data
Togo	DSV
Uganda	Go.Data
Zimbabwe	DSV

**Both = DSV transitioning in progress to the Go.Data tool*

Figure 3: Map showing status of COVID-19 data collection tools deployed by WHO African Regional Office in the Member States, as of April 2020

Automation for COVID-19 Data Management for Decision Making

Figure 4 shows how data extracted using the DSV tool flows from Member States to the WHO AFRO office. At the WHO AFRO office, all COVID-19 data in MS Excel files are received via email, after the data validation process at the WHO country offices are completed and stored using an automated document management platform. At the WHO AFRO office, the COVID-19 data files are merged, compiled and shared with the data analytics teams. The data are then translated into information using R analysis for evaluation, synthesized into evidence, and stored in an online-integrated data warehouse with front-end web portal and COVID-19 dashboard. At this stage, synthesized information on the COVID-19 outbreak is translated into knowledge and shared with stakeholders (WHO global and regional offices, international partners and Member States) using

authoritative products such as AFRO COVID-19 daily updates, weekly situation reports, weekly epidemiological updates, GIS maps and COVID-19 Pandemic Dashboards.

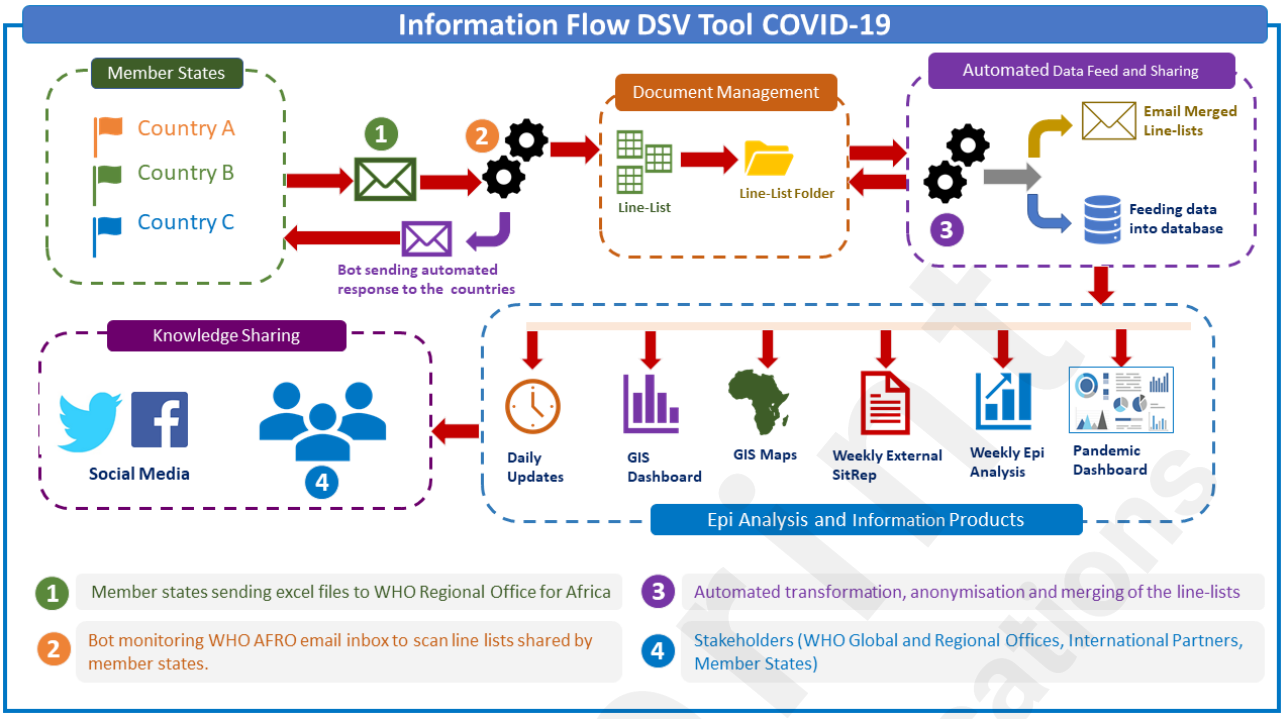


Figure 4: Automation workflow showing management of COVID-19 data in the WHO African Region

Transitioning Timeline

For a PEDCP, the planning, procurement, deployment, training and support activities required resulted in delayed rollout during the recent deployments in the WHO African region. The planning phase usually includes pre-deployment reviews, requirement analysis, procurements, testing and software configurations. This phase is followed by a software deployment, which includes infrastructure provisioning, software installation support, training of trainers (TOT), and customization and adaptation of data collection forms after which the system goes live. The last phase is end-user training and maintenance with sustained software support to start data collection and maintain the system.

For the DSV tool, the simple pre-formatted MS Excel tool was shared with all Member States in WHO African Region as part of a readiness and preparedness package for the COVID-19 pandemic. The DSV tool comes with a quick user guide and takes 24 to 48 hours to customize for any additional requirements, with or without technical support from

the WHO AFRO, and it is available for immediate data entry and visualization. The pre-formatted built-in automated analytics and visualization modules generate tables and charts in PDF printable format. The deployment timeline comparison shows the major benefit of DSV tool is that it shortens tool deployment time and can be used to bridge the gap between data collection and contact tracing between the time of onset of outbreak and complete rollout of a robust electronic data collection software, figure 5.

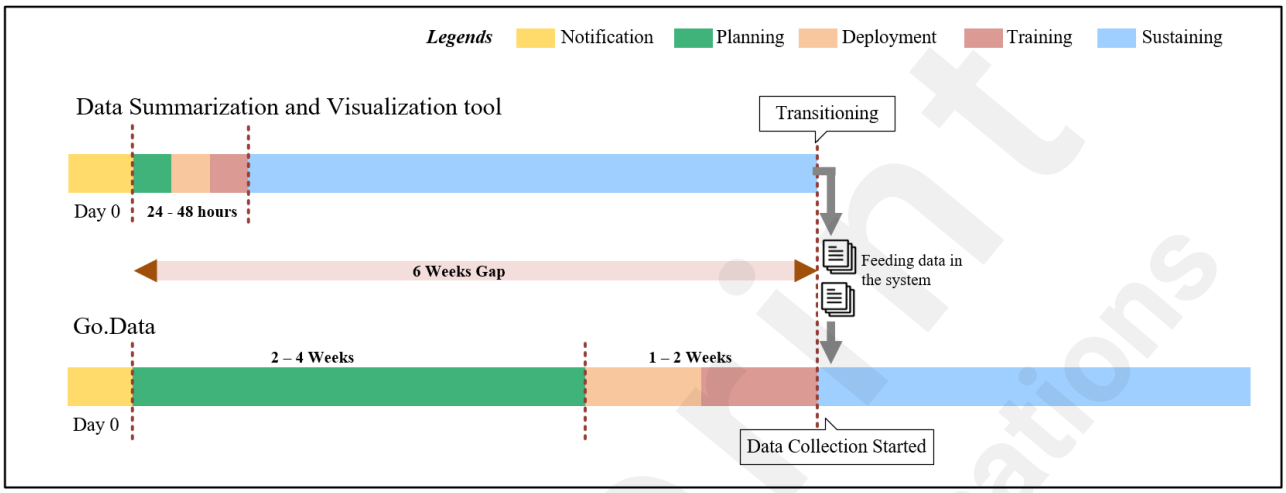


Figure 5: Timeline showing transitioning of DSV tool to Go.Data prioritized by WHO AFRO for COVID-19 field data collection in WHO African Region

DISCUSSION

The DSV tool is not a replacement for a robust electronic data collection platform. However, this tool provides outbreak investigation and response teams with a means to start collection of COVID-19 case, laboratory, hospitalization and contacts data immediately upon confirmation of a COVID-19 outbreak. In addition, it generates analytical data and visualizations in a timely manner using an automated process that shows the COVID-19 outbreak situation for emergency health managers and decision makers. As an MS Excel-based tool, it is specifically recommended as an interim solution for short-term outbreak needs and not for use in protracted outbreaks or emergencies. The Go.Data tool has been deployed in some Member States of WHO African Region, where it took several weeks for implementation and complete rollout since technical support was not possible on ground due to country applied public health and social measures including movement restrictions and geographical area quarantine. WHO AFRO is working closely with partners on a range of similar activities, and finding ways to work around limitations imposed by travel

restrictions and on site presence.

Deployment of PEDCP needs time for preparations, planning (requirement analysis, budget, and action plan), procurements, customizations, configurations, training and support. This increases the inevitable time delay between onset of COVID-19 outbreak and complete rollout, especially in unprepared settings where electronic tools deployment has not been considered as part of a WHO AFRO country readiness and preparedness plan for COVID-19 outbreak. This paper presents preliminary findings of this work and evaluation is planned, under the framework for the health emergency information management in the WHO African region, to assess how well this intervention achieved its goals (simplicity, cost effectiveness, time efficiency etc), what worked well, what didn't and how to improve effectiveness of operations.

As part of preparedness and response, WHO AFRO Health Information Management & Risk Assessment Program developed the DSV tool as an interim solution to support immediate collection of case and contact data during the initial phase of a COVID-19 outbreak response. The main purpose of this tool was to bridge the critical time delay between COVID-19 outbreak onset and PEDCT deployment for field data collection and contact tracing. To date, the DSV tool has been successfully implemented in 18 Member States as an interim approach in parallel to planning for Go.Data roll out as a prioritized electronic platform.

There are three main official languages (English, French and Portuguese) spoken in the WHO African Region, where the DSV tool was deployed. We developed a built-in multilingual support in the DSV tool by including templates in these three official languages as a standard approach for the region. We have kept flexibility in the tool to add more language templates so other spoken local languages can be easily configured in the tool and facilitate immediate availability of translated text in the tool. This functionality has been reported to be very useful in overcoming the language barrier with implementation in the WHO African region.

A workflow has been developed using an automated tools at the WHO regional office to support merging of multiple COVID-19 data files coming from the Member States into one

master dataset. Information management teams then use this master dataset to perform analysis on COVID-19 outbreak situation in the WHO African Region and produce authoritative information products. Additionally, this data is further integrated with other relevant information coming from other health pillars and evaluated in terms of broader stakeholders' needs and issues confronting the health emergency.

In the past few years, WHO has developed and deployed multiple electronic data systems to support EWARS functions and routine disease surveillance, and these tools have been found to be very effective and efficient informatics solutions in those settings. However, limitations have been reported, in addressing some specific case-based surveillance and contact tracing needs [8, 16]. We learned during the literature review and informed discussions that EWARS-in-a-Box and eDEWS platforms were developed by WHO with the objective of early detection and response to disease outbreaks during health emergencies. These platforms produced encouraging results with scaling up to other countries for EWARS and IDSR programs. However, both systems were not designed to support collection and management of complex contact tracing data to break the community disease transmission [8, 9, 15, 18]. On the contrary, Go.Data has been designed to address this critical gap along with a focus on collecting and managing complex contact tracing data efficiently with visualization tools to support response efforts more effectively during outbreaks and emergencies [12].

Finally, the DSV tool provides an innovative and low cost simple analytical and visualization interim solution for data collection and management. The cost was low because this project was developed and implemented without dedicated funds and only used existing infrastructure and resources at WHO regional office, WHO country offices and health authorities in the Member States. The DSV tool successfully bridges the critical gap between COVID-19 outbreak onset and PEDCT operationalization to avoid delays in getting critical COVID-19 data in timely manner during this period, facilitate timely access to validated COVID-19 data, and to enable translation of data into actionable information to support swift public health response and decision-making both at the country level and the WHO African regional office. The DSV tool is easily and immediately deployable in practice using existing infrastructure and resources, and has been developed using time efficient MS Excel pivot table technique that requires basic MS Excel skills at end user level and tool

standardization using WHO regional and Global guidelines and protocols makes it usable across all member states in WHO African region. We avoided the use of Visual Basic for Applications (VBA) macros to address possible tool performance issues and made it compatible with multiple versions ranging from MS Excel 2013 to MS Excel for Office 365, including compatibility with multiple operating systems. The built-in visualization module generates automated epidemiological reports on a timely and ad-hoc basis, an important public health informatics approach to perform well during COVID-19 emergency. Building local capacity to use the DSV tool for complete data analysis, visualization and reporting is easy using remote webinar sessions where basic MS Excel knowledge is considered essential for health staff participation. The DSV approach also improved timeliness of information sharing on epidemiological trends and feedback to field teams and key stakeholders involved in the outbreak response.

LESSONS LEARNED

Drawing on the WHO AFRO team's experience in planning and conducting DSV tool deployment activities in eighteen Member States, we describe following critical lessons learned and offer an opportunity to learn and apply these lessons to improve future similar public health informatics initiatives, including COVID-19 (but not limited to COVID-19), at any outbreak or similar humanitarian setting.

The deployment of the DSV tool was smooth since most of the data managers in the WHO African region are familiar with MS Excel-based tools and quickly adapted DSV tool using technical guidance guidelines provided for local COVID-19 outbreak context. The main concern shared by the data management team was that a reasonable number of variables be collected by the tool in considering the impact on staff workload, and that more than 50 variables were proposed in COVID-19 surveillance guidelines presented a challenge. Another challenge was to identifying minimum standard variables in the WHO African regional context from the list of 87 variables recommended for COVID-19 surveillance in the WHO technical guidance document [24]. The tool was then designed to ease workload for data entry, where we identified 22 minimum standard variables as required inputs and kept other variables as optional, based on feedback provided during the deployment in Member States.

During the planning phase, our technical staff experienced in field data collection in the WHO African Region suggested to limit end-user exposure with VBA enabled functions to avoid potential tool performance issues since, based on experience, it is not reliable. However, use of macro-enabled workbooks can give better result when adapted in small scale only. Another notable observation to highlight here is that when considering bulk data entry, users expressed a preference for spreadsheet applications over form-based data entry applications. Spreadsheets are quick and flexible to establish and adapt and they allow faster data entry through the use of copy/paste and drag-and-drop functionalities to facilitate data entry and manipulation. Despite offering benefits such as more robust data validation, form-based data entry applications require more technical skills to establish, and typically only allow working on a single observation at a time and thus take considerably longer when manipulating large volumes of data.

A common technical issue with the DSV tool was experienced by some Member States. It was reported that there were problems handling date systems (1904 and 1900) compatibility between operating systems Macintosh, iOS and Windows. This compatibility issue did not affect data entry processes using the DSV tool but required careful processing when compiling workbooks generated from different operating systems. To resolve this issue permanently, we developed a VBA based plug-in and installed it in DSV tool as an update.

The adoption of the DSV tool was smoother in countries where WHO Country Office data management teams had stronger relationships with their Ministry of Health counterparts. Building on existing working relationships enabled faster collaboration and decision-making on the selection of data collection tools and establishment of data collection processes and reporting channels. Furthermore, Member States that are stronger in surveillance have tended to require less support for establishing data collection platforms and are better able to leverage and integrate existing investments in IDSR towards outbreak response. Therefore, there is a need for strengthening data management capacity in Member States with weak surveillance mechanisms. The team observed limitations within some countries for establishing data collection systems, defining and documenting data management processes, integrating data from multiple sources, and management of the line lists. Some of these challenges manifested from limited expertise, lack of well-defined standard

operating procedures for data management in the context of outbreaks, lack of clearly defined roles and responsibilities within and across teams, and slow activation and repurposing of existing staff onto the COVID-19 response.

LIMITATIONS

Two slightly different naming approaches have been used in past for the same concept of WHO's early warning and response (EWAR), a component of an integrated disease surveillance during various health emergencies across the globe. These names are early warning and response system (EWARS), Disease Early Warning System (DEWS) and early warning and response network (EWARN). To keep consistency across paper, we have used the term 'EWARS' from the most recent naming convention in the WHO's Emergency Reforms Framework, but the concept of EWARN is same as EWARS and should not be confused when referring to other earlier papers.

CONCLUSION

In conclusion, we developed an innovative tool for time efficient COVID-19 data collection, management, summarization and visualization for immediate deployment in COVID-19 outbreak settings of Member States in the WHO African region. The automation process was introduced to facilitate timely knowledge sharing with response teams and decision makers, who rely on timely and accurate information for evidence-based decision-making. The approach and processes used in, and lessons learned from, this work are generalizable to other health emergencies and need to be considered as an interim solution for rapid deployment and immediate field data collection needs while deployment of an electronic platforms or software like Go.Data, EWARS-in-a-Box or eDEWS is planned for the next health emergency.

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CONFLICT OF INTEREST

We do not have any conflict of interest to declare, financial or otherwise.

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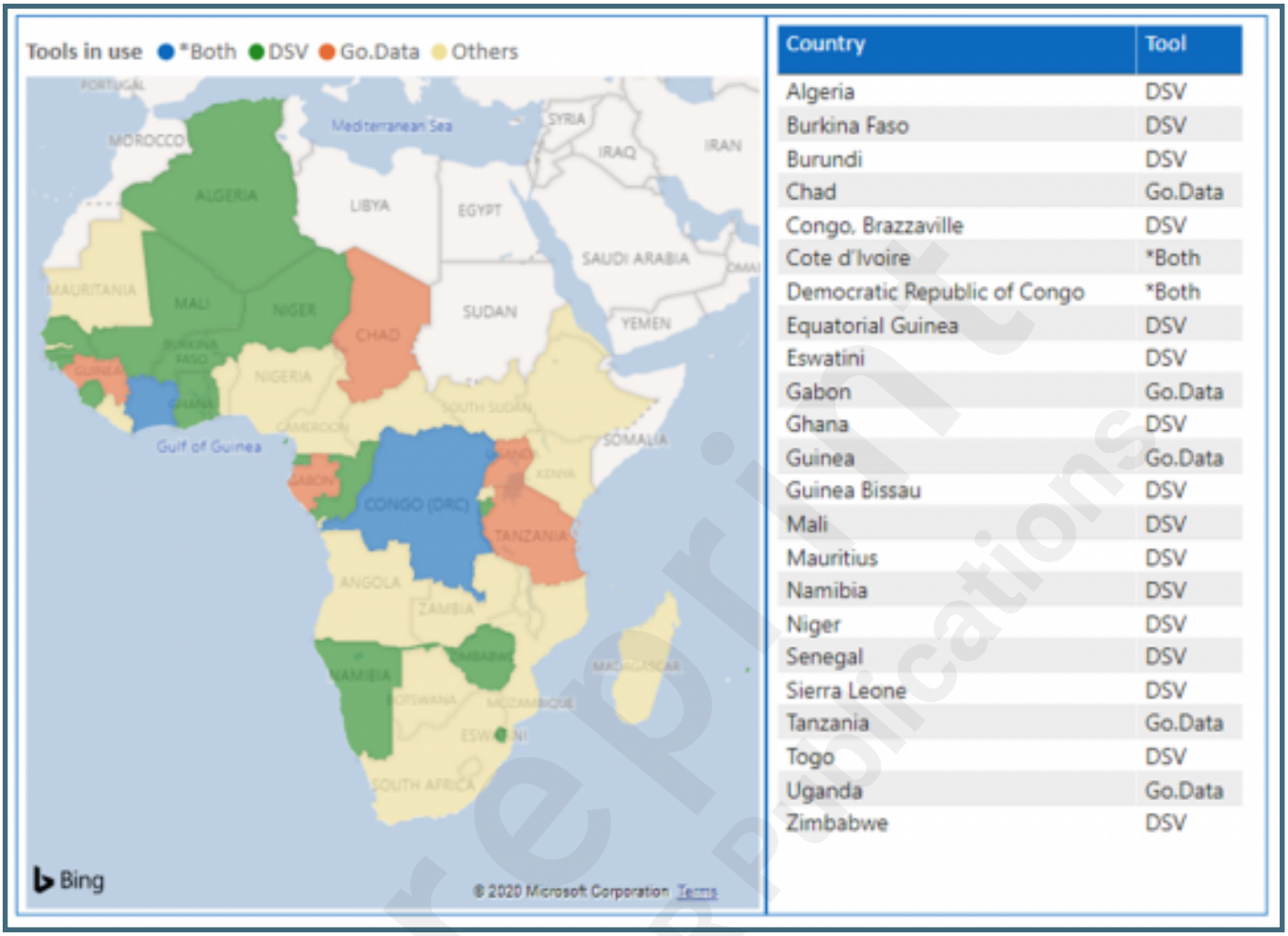
Supplementary Files

Figures

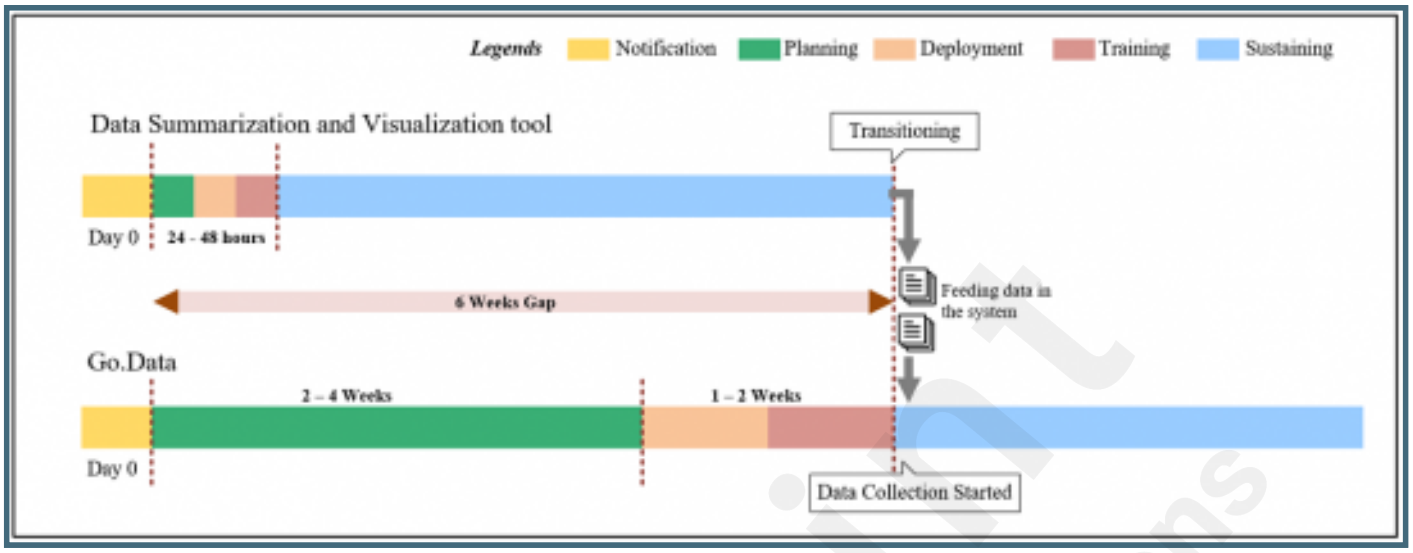
Screenshot of publicly available web Portal of WHO AFRO Toolkit Project.

Map showing status of COVID-19 data collection tools deployed by WHO African Regional Office in the Member States, as of April, 2020.

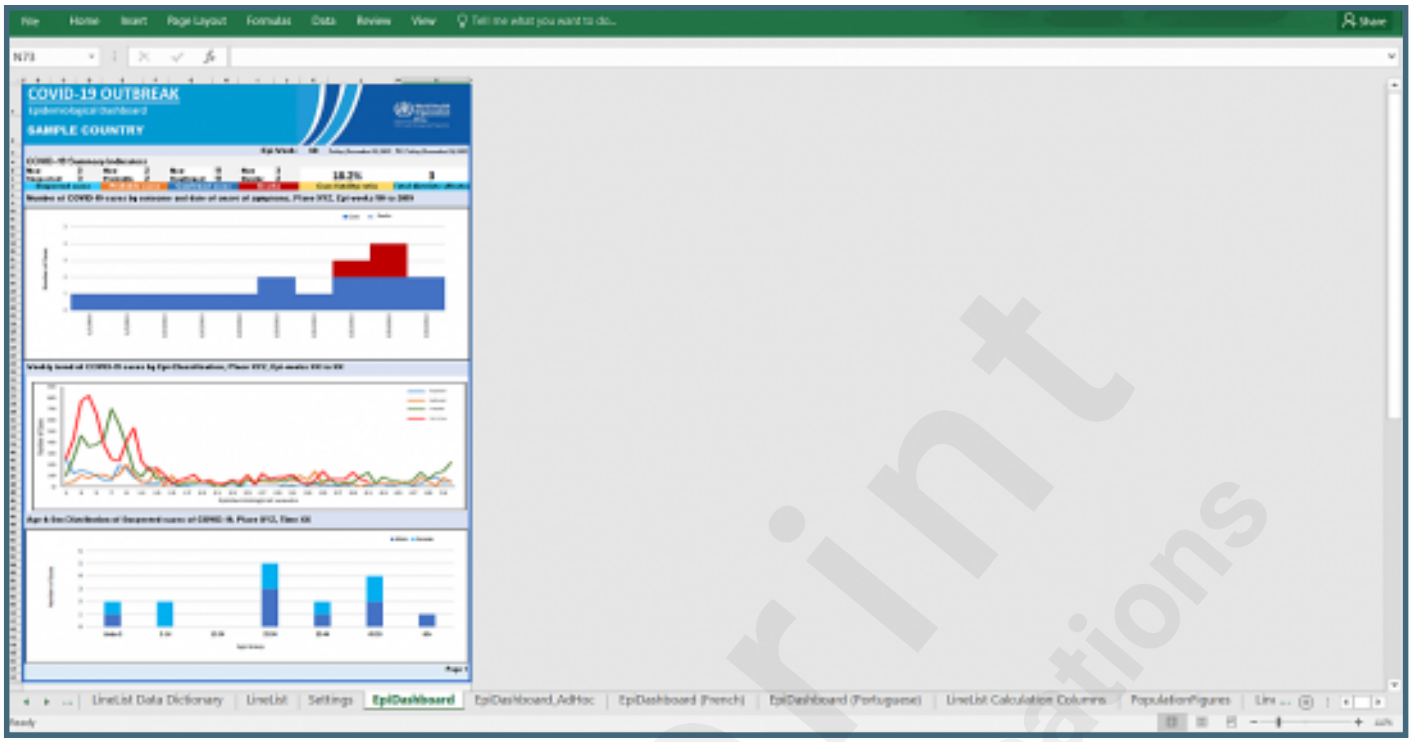


Country	Tool
Algeria	DSV
Burkina Faso	DSV
Burundi	DSV
Chad	Go.Data
Congo, Brazzaville	DSV
Cote d'Ivoire	*Both
Democratic Republic of Congo	*Both
Equatorial Guinea	DSV
Eswatini	DSV
Gabon	Go.Data
Ghana	DSV
Guinea	Go.Data
Guinea Bissau	DSV
Mali	DSV
Mauritius	DSV
Namibia	DSV
Niger	DSV
Senegal	DSV
Sierra Leone	DSV
Tanzania	Go.Data
Togo	DSV
Uganda	Go.Data
Zimbabwe	DSV

Timeline showing transitioning of DSV tool to Go.Data prioritized by WHO AFRO for COVID-19 field data collection in WHO African Region.



Screenshot of publicly available DSV tool showing automated printable data visualization.



Automation workflow showing management of COVID-19 data in the WHO African Region.