Appropriately integrating digital technologies into epidemic and/or pandemic responses can drive efficiencies in the health system and enable more rapid data exchange of information to inform evidence-based responses. Adaptations of existing tools tailored to different phases of a response can be the most strategic use of digital interventions, as long as they are coupled with a systematic approach to adapt, use, and scale data from deployments.

Digital Square designed Version 1 of the Digital Applications and Tools Across an Epidemiological Curve (DATEC) as a strategic framework for governments, investors, implementing organizations, and the digital health community at large to better understand how existing digital tools can be adapted and used during different phases of an outbreak. This framework is meant to highlight how digital technologies, which should already be present in a country, can most strategically be leveraged to augment response during an epidemic and/or pandemic.

Funded by United States Agency for International Development (USAID), Digital Square developed this framework in the context of the COVID-19 pandemic in partnership with USAID, the Centers for Disease Control and Prevention (CDC), the Bill & Melinda Gates Foundation, the German Corporation for International Cooperation (GIZ), the World Bank, and other investors.

The basis for the framework, shown on page 2, visualizes the DATEC and depicts how 13 use cases intersect at different points of a pandemic. Digital Square identified, aligned, and prioritized these use cases with USAID and GIZ as ones that deserve heavy emphasis during a pandemic. The DATEC has an accompanying table that includes descriptions of why a use case is highlighted in the DATEC during each phase, and how countries should plan to adapt and use digital health tools to address these use cases at points in time across the pandemic.

To further examine how to use the DATEC, this resource includes a deep dive into the utilization of outbreak tools, the need for strong data and digital health foundations within a health system, and a matrix to facilitate investor coordination in digital tools.

Governments, investors, implementing organizations, and the digital health community at large can use this framework as a guide to enable identification and adaptation of tools for quick deployment during an epidemic and/or pandemic. This framework can also be used outside of a pandemic to aid in planning implementation of digital tools where there are gaps in use cases.
Use cases across DATEC

Digital tools should already be in place in countries, aiding support to clients, health workers, and health system managers and strengthening data services. When a country is facing a disease outbreak or pandemic, existing digital tools can be adapted to meet emerging needs to efficiently and effectively support the response to the epidemic and/or pandemic. The DATEC illustrates the phases of an outbreak overlaid with use cases, or possible opportunities for interventions. The curve itself reflects the prevalence of the disease, with the chronological phases labeled across the bottom. Use cases, shown intersecting with the curve, vary throughout the course of an outbreak and offer opportunities for digital tools to be deployed. Use cases refer to the specific type of information collected, stored, tracked, analyzed, or visualized as it relates to the functional response to an epidemiological event.
Use case explanations

The table below includes information about the 13 use cases visualized in the DATEC graphic in the order in which they are introduced from top to bottom. The use cases are grouped by the color gradient that mirrors at which phase of the pandemic they enter the DATEC. Text in blue indicates the most strategic opportunities to adapt digital tools recommended at different phases of a pandemic.

<table>
<thead>
<tr>
<th>Use case</th>
<th>Objective</th>
<th>Functional description</th>
<th>Initial detection of disease</th>
<th>Early outbreak # of confirmed cases</th>
<th>National scale/rise in # of confirmed cases</th>
<th>Completion of initial outbreak wave</th>
<th>Resurgence of cases nationally</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coordination and operation</strong></td>
<td></td>
<td>Support emergency operations centers and other health facilities to improve rapid response efforts that make decisions about disease outbreaks.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Streamline data collection and analysis to inform disease preparedness</strong></td>
<td></td>
<td>When large numbers of cases are confirmed in a country, emergency operations centers (EOCs) should have robust digital tools to better understand where cases are concentrated and impacts of treatment at community, district, and national levels when a surge in cases occurs. National coordination and government officials can rapidly use the information to inform action including where to unlock funding, types of messaging to share with the public, and where local health workers and care teams can bolster health assets on the ground.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Digital Applications and Tools Across an Epidemiological Curve</strong></td>
<td></td>
<td>Digital tools for coordination and operation should continue to be used to better understand impacts on health systems and populations and improve intersectoral coordination. Use cases that are critical to detecting cases at the community or national levels can be identified and modeled to inform national decisions that may restrict travel from certain countries or regions. Data can also show where surges are anticipated and what interventions are most needed to mitigate further spread. At this point, interoperable tools are critical to help countries plan next steps for addressing the outbreak and prioritize measures to continue reduction of case numbers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Completion of initial outbreak wave</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resurgence of cases nationally</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Support allocation of resources to maximally mitigate outbreaks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Preventive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Epidemic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Disaster</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Emergency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Case management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Systematic processing of suspected/confirmed patients</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System for documenting patient details and clinical interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Digital Applications and Tools Across an Epidemiological Curve</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Completion of initial outbreak wave</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resurgence of cases nationally</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Support allocation of resources to maximally mitigate outbreaks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Preventive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Epidemic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Disaster</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Emergency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Case management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Systematic processing of suspected/confirmed patients</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System for documenting patient details and clinical interactions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Digital Applications and Tools Across an Epidemiological Curve</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Completion of initial outbreak wave</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resurgence of cases nationally</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Support allocation of resources to maximally mitigate outbreaks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Preventive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Epidemic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Disaster</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Emergency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Case management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Objective

Improve efficiency in clinical care and laboratory services.

Resurgence of cases nationally

Functional description

Use case

Health facility

Risk

Clients and health workers.

Initial detection of confirmed cases

Early detection and containment mechanisms to reduce spread of disease.

National surveillance of confirmed cases

Regional and national scale of outbreaks of confirmed cases

Completion of initial outbreak wave

Resurgence of cases nationally

Context/tracing

Tracking individuals to manage and reduce spread of disease.

Identification and follow-up of people that have had high-risk interactions with infected persons.

As cases rise in a country, it is essential to deploy contact tracing tools to trace the patient and anyone who has been exposed to the disease by that patient. Digital contact tracing tools deployed in health facilities can support the process of contact tracing by speeding up the detection of infected persons and ensuring the contact tracing is conducted effectively.

As with case management tools, as cases rise, health care providers can use technologies that support coordination with clients in the health system. In treatment planning, these tools inform the health system on cases and contacts by enabling automatic contact notification and follow-ups, and by showing patients and contacts to electronically self-report medical information and services along with contacts.

Contact tracing tools should ideally be deployed to exchange data with other systems including those outside of a national health system. As cases rise across country borders, deploying tools to track and trace anyone that is exposed is essential to curb further outbreaks of the disease.

Health facility and provider administration

Robust organizational underpinning for a functional response.

System for managing health facility accounting and human resources.

Health facilities play an important role in providing care to suspected and confirmed patients. Ensuring these tools are in place can help facilitate the smooth running of health providers such as tracking increased fluid intake, providing medication, and monitoring treatment. System for managing health care workers early, in an outbreak signal a support to health facility and result in physical and mental well-being.

As cases rise across the country, the health workforce may need to be resourced and task shifting may need to be realized for health facility or to manage essential health services. Digital tools can aid in providing information and the flow of health workers, including community health workers.

Health provider motivation and satisfaction is important to health workforce strengthening, especially as countries engage community health workers who are likely to significantly impact health worker physical and mental health. These tools can be used in task shifting and can improve their physical and mental well-being.

As cases rise, the use of digital tools to curb infections becomes much more important. Digital contact tracing systems (CTS) technologies are used for detecting the initial cases in a country to guide emergency response efforts.

Contact tracing tools should ideally be deployed to exchange data with other systems including those outside of a national health system. As cases rise across country borders, deploying tools to track and trace anyone that is exposed is essential to curb further outbreaks of the disease.

Risk communication and community engagement

Enhanced community awareness for disease prevention.

System for sharing information and encouraging early warning.

As countries identify disease outbreaks, SMS and other digital tools can be used to share information on critical guidance for disease prevention or removed outbreak of a disease in a common language through health communication tools.

As cases rise, the use of digital tools to curb infections becomes much more important. Digital contact tracing systems (CTS) technologies are used for detecting the initial cases in a country to guide emergency response efforts.

Digital tools can be harnessed for mapping locations of outbreaks in countries including border regions, supporting cross-border data sharing and analysis to inform responses.

As cases rise, often higher than during initial outbreak phases, contact tracing tools are a priority for countries to contain outbreaks before they become large. Contact tracing tools should ideally be deployed in countries to contain outbreaks before they become large.

Diagnostic tools

Enhanced efficiency in clinical diagnosis and collection of high quality data from diagnostic tests.

Diagnostics tools with digital interfaces and reporting of diagnostic tools.

Digital tools are used to support diagnosis and report through the entire EHR and are responsible for delivering essential care and treatment. As cases are detected, countries should prioritize development of diagnostics and ensure health care providers are informed on how to use them and capture data of diagnostic results.

As cases rise, rapid diagnostic tools may need to be included in health facilities and pipelines and be deployed to the point of care. Digital tools can improve the rapid deployment of diagnostic tools and can be used to gather information, communicate with patients, and inform response.

Digital tools can be used to improve data quality, correct for non-robust algorithms and ensure accurate diagnoses.

Digital tools can be used to improve data quality, correct for non-robust algorithms and ensure accurate diagnoses.

Diagnostic tools should continue to be used, even when vaccine coverage is high, as a way to ensure surveillance and early detection. Diagnostic tools should continue to be used, even when vaccine coverage is high, as a way to ensure surveillance and early detection.

Regional and global outbreaks of confirmed cases

Health worker motivation and satisfaction is important to health workforce strengthening, especially as countries engage community health workers who are likely to significantly impact health worker physical and mental health. These tools can aid in supporting community health workers and can improve their physical and mental well-being.

Health worker motivation and satisfaction is important to health workforce strengthening, especially as countries engage community health workers who are likely to significantly impact health worker physical and mental health. These tools can aid in supporting community health workers and can improve their physical and mental well-being.

Digital tools and data can promote continuous outbreak localization and help direct appropriate measures to reduce pockets of the virus, including by protecting health workers.

Digital tools and data should continue to inform approaches including interventions for high risk health workers.

Health facility and provider administration

Robust organizational underpinning for a functional response.

System for managing health facility accounting and human resources.

Health facilities play an important role in providing care to suspected and confirmed patients. Ensuring these tools are in place can help facilitate the smooth running of health providers such as tracking increased fluid intake, providing medication, and monitoring treatment. System for managing health care workers early, in an outbreak signal a support to health facility and result in physical and mental well-being.

As cases rise across the country, the health workforce may need to be resourced and task shifting may need to be realized for health facility or to manage essential health services. Digital tools can aid in providing information and the flow of health workers, including community health workers.

Health provider motivation and satisfaction is important to health workforce strengthening, especially as countries engage community health workers who are likely to significantly impact health worker physical and mental health. These tools can aid in supporting community health workers and can improve their physical and mental well-being.

As cases rise, the use of digital tools to curb infections becomes much more important. Digital contact tracing systems (CTS) technologies are used for detecting the initial cases in a country to guide emergency response efforts.

Digital tools can be harnessed for mapping locations of outbreaks in countries including border regions, supporting cross-border data sharing and analysis to inform responses.

As cases rise, often higher than during initial outbreak phases, contact tracing tools are a priority for countries to contain outbreaks before they become large. Contact tracing tools should ideally be deployed in countries to contain outbreaks before they become large.

Diagnostic tools

Enhanced efficiency in clinical diagnosis and collection of high quality data from diagnostic tests.

Diagnostics tools with digital interfaces and reporting of diagnostic tools.

Digital tools are used to support diagnosis and report through the entire EHR and are responsible for delivering essential care and treatment. As cases are detected, countries should prioritize development of diagnostics and ensure health care providers are informed on how to use them and capture data of diagnostic results.

As cases rise, rapid diagnostic tools may need to be included in health facilities and pipelines and be deployed to the point of care. Digital tools can improve the rapid deployment of diagnostic tools and can be used to gather information, communicate with patients, and inform response.

Digital tools can be used to improve data quality, correct for non-robust algorithms and ensure accurate diagnoses.

Digital tools can be used to improve data quality, correct for non-robust algorithms and ensure accurate diagnoses.

Diagnostic tools should continue to be used, even when vaccine coverage is high, as a way to ensure surveillance and early detection. Diagnostic tools should continue to be used, even when vaccine coverage is high, as a way to ensure surveillance and early detection.

Regional and global outbreaks of confirmed cases

Health worker motivation and satisfaction is important to health workforce strengthening, especially as countries engage community health workers who are likely to significantly impact health worker physical and mental health. These tools can aid in supporting community health workers and can improve their physical and mental well-being.

Health provider motivation and satisfaction is important to health workforce strengthening, especially as countries engage community health workers who are likely to significantly impact health worker physical and mental health. These tools can aid in supporting community health workers and can improve their physical and mental well-being.
Objective

Functional description

Initial detection of disease

Early outbreak analytics of confirmed cases

National surveillance of confirmed cases

Regional/global scale of outbreak/peak of confirmed cases

Completion of initial outbreak wave

Relevance of cases nationally

Event-based surveillance

Early detection of outbreaks and zoonoses, case investigation, and surveillance, and national and international capacity-building initiatives that are dependent or aligned to rapid deployment of digital disease surveillance.

System with functionality or applications that are needed to detect an outbreak and to reduce the risk of disease emergence.

Routine surveillance and event-based public health surveillance systems look at reports, stories, and other information about health events that could lead to a serious risk to public health. These systems are part of a country’s national surveillance tool box and rely on coordination of various responding agencies, including veterinary, human health, and environmental agencies.

As cases rise, countries should prioritize timeliness and completeness of their surveillance tools. Many of the surveillance tools are aggregate tools that track a single component and timely updates. For new virologists, deploying these case or other tools often provide the first digital touchpoints signaling a disease outbreak.

As cases expand globally, surveillance tools set not only the impetus for case management at the country level but also provide indicative information, informing where resources and needs are greatest across an region. Tools with functional or event-based surveillance continue to be emphasized here to promote a robust One Health engagement and use of digital tools across human and animal health.

Event-based surveillance should continue to be used even as a cases decline. This is in order to maintain timeliness and completeness of data as well as to perform data quality checks to ensure processes are functioning as intended or a resurgence of the disease that emerged.

During a resurgence, surveillance tools can continue to be used to report and case management at the country level and internationally. Multiple dimensions of analysis and various workflows can signal how the outbreak might evolve to make informed decisions.

Validation of infectious disease outbreaks.

System with functionality or tools that can be used to track confirmed cases with consistent, reliable, and accurate data.

Laboratory information systems have the capacity to improve clinical decision-making and quality of care at an early stage. These systems should be in place to connect with national surveillance laboratories and link testing and information of client samples.

Agile lab systems should be adapted to capture data consistently, these systems can also alleviate the burden on health workers and clients.

Information from laboratory information systems can be leveraged to make decisions, population-level public health decisions. As cases rise in a country, high-quality laboratory data can be used in a sentinel point in concert with disease surveillance data and other risk factors to detect an outbreak.

Information from laboratory information systems can be leveraged to make decisions, population-level public health decisions. As cases rise in a country, high-quality laboratory data can be used to assist in case detection and public health action.

Information from laboratory information systems can be leveraged to make decisions, population-level public health decisions. As cases rise in a country, high-quality laboratory data can be used to assist in case detection and public health action.

Information from laboratory information systems can be leveraged to make decisions, population-level public health decisions. As cases rise in a country, high-quality laboratory data can be used to assist in case detection and public health action.

Information from laboratory information systems can be leveraged to make decisions, population-level public health decisions. As cases rise in a country, high-quality laboratory data can be used to assist in case detection and public health action.

Learning and training

Specific health worker needs, including improved count data collection and case management.

Disseminate digital information or tools to improve learning and engagement.

Digital platforms, such as online learning and mobile apps, can help to improve learning and engagement.

As cases are confirmed, training health workers on their national or international platforms using digital tools can equip providers with essential information about the outbreak, symptoms, treatment, and how to protect themselves.

Wherever vaccines are ready to be deployed, digital tools can educate frontline health care workers about administration, side effects, and other essential information about vaccine delivery as well as caregiving training.

Scientists will identify more information about co-evolution, side effects, and new vaccine technologies in response to the disease. As the cases potentially rise again with this new evidence, training health care workers and supportive ecosystems will need to be validated information about the disease si more is known about the impact on patients.

Digital tools exist to identify and tracking potential new cases of COVID, recommending protective measures, and longitudinal testing.

Digital Health tools can identify a case is confirmed through the following data points of entry, for viral population to provide important data on disease spread.

Digital Applications and Tools Across an Epidemiological Curve

One Health

Detect zoonotic disease outbreaks.

Digital systems supporting One Health can identify the detection of human, animal, or zoonotic outbreaks, through integrated platforms allowing for real-time analysis of disease emergence prior to emergence of human cases. These systems will help to identify potential disease threats and overall impact of outbreaks.

As detection of a disease is initially identified, integrated platforms can be used to confirm the identity of the disease.

High-quality zoonotic disease surveillance should be tracked in-country and data shared among relevant stakeholders, including human health and animal health surveillance can be integrated for One Health surveillance.

As cases rise in a country, data should be reviewed with a One Health approach, including inputs from human health and animal health under the same surveillance system. Digital One Health tools can identify a case is confirmed through the following data points of entry, for viral population to provide important data on disease spread.

Digital platforms, such as online learning and mobile apps, can help to improve learning and engagement.

Digital Applications and Tools Across an Epidemiological Curve

Digital systems supporting One Health can identify the detection of human, animal, or zoonotic outbreaks, through integrated platforms allowing for real-time analysis of disease emergence prior to emergence of human cases. These systems will help to identify potential disease threats and overall impact of outbreaks.

As detection of a disease is initially identified, integrated platforms can be used to confirm the identity of the disease.

High-quality zoonotic disease surveillance should be tracked in-country and data shared among relevant stakeholders, including human health and animal health surveillance can be integrated for One Health surveillance.

As cases rise in a country, data should be reviewed with a One Health approach, including inputs from human health and animal health under the same surveillance system. Digital One Health tools can identify a case is confirmed through the following data points of entry, for viral population to provide important data on disease spread.

Digital platforms, such as online learning and mobile apps, can help to improve learning and engagement.

Digital Applications and Tools Across an Epidemiological Curve

Digital systems supporting One Health can identify the detection of human, animal, or zoonotic outbreaks, through integrated platforms allowing for real-time analysis of disease emergence prior to emergence of human cases. These systems will help to identify potential disease threats and overall impact of outbreaks.

As detection of a disease is initially identified, integrated platforms can be used to confirm the identity of the disease.

High-quality zoonotic disease surveillance should be tracked in-country and data shared among relevant stakeholders, including human health and animal health surveillance can be integrated for One Health surveillance.

As cases rise in a country, data should be reviewed with a One Health approach, including inputs from human health and animal health under the same surveillance system. Digital One Health tools can identify a case is confirmed through the following data points of entry, for viral population to provide important data on disease spread.

Digital platforms, such as online learning and mobile apps, can help to improve learning and engagement.

Digital Applications and Tools Across an Epidemiological Curve

Digital systems supporting One Health can identify the detection of human, animal, or zoonotic outbreaks, through integrated platforms allowing for real-time analysis of disease emergence prior to emergence of human cases. These systems will help to identify potential disease threats and overall impact of outbreaks.

As detection of a disease is initially identified, integrated platforms can be used to confirm the identity of the disease.

High-quality zoonotic disease surveillance should be tracked in-country and data shared among relevant stakeholders, including human health and animal health surveillance can be integrated for One Health surveillance.

As cases rise in a country, data should be reviewed with a One Health approach, including inputs from human health and animal health under the same surveillance system. Digital One Health tools can identify a case is confirmed through the following data points of entry, for viral population to provide important data on disease spread.

Digital platforms, such as online learning and mobile apps, can help to improve learning and engagement.

Digital Applications and Tools Across an Epidemiological Curve

Digital systems supporting One Health can identify the detection of human, animal, or zoonotic outbreaks, through integrated platforms allowing for real-time analysis of disease emergence prior to emergence of human cases. These systems will help to identify potential disease threats and overall impact of outbreaks.

As detection of a disease is initially identified, integrated platforms can be used to confirm the identity of the disease.

High-quality zoonotic disease surveillance should be tracked in-country and data shared among relevant stakeholders, including human health and animal health surveillance can be integrated for One Health surveillance.

As cases rise in a country, data should be reviewed with a One Health approach, including inputs from human health and animal health under the same surveillance system. Digital One Health tools can identify a case is confirmed through the following data points of entry, for viral population to provide important data on disease spread.

Digital platforms, such as online learning and mobile apps, can help to improve learning and engagement.

Digital Applications and Tools Across an Epidemiological Curve

Digital systems supporting One Health can identify the detection of human, animal, or zoonotic outbreaks, through integrated platforms allowing for real-time analysis of disease emergence prior to emergence of human cases. These systems will help to identify potential disease threats and overall impact of outbreaks.

As detection of a disease is initially identified, integrated platforms can be used to confirm the identity of the disease.

High-quality zoonotic disease surveillance should be tracked in-country and data shared among relevant stakeholders, including human health and animal health surveillance can be integrated for One Health surveillance.

As cases rise in a country, data should be reviewed with a One Health approach, including inputs from human health and animal health under the same surveillance system. Digital One Health tools can identify a case is confirmed through the following data points of entry, for viral population to provide important data on disease spread.

Digital platforms, such as online learning and mobile apps, can help to improve learning and engagement.
Digital tools that should be in place to support a well-functioning health system

What digital health systems and tools should be in place prior to a pandemic?

A mix of digital health tools should be in place prior to a pandemic, allowing for a "steady state" of the use of a tool and its data. Institutionalized tools are more easily and strategically adapted during a crisis like a pandemic.

"Steady state" activities to strengthen a country’s prevention, preparedness, and response in an epidemiological crisis

- Ensure digital health systems are equipped to collect, analyze, and synthesize high-quality scientific data.
- Develop and operationalize National Digital Health Strategies as a key component of health systems policies/strategies that articulate how and what types of digital tools should be harnessed for prevention, detection, and treatment of communicable diseases.
- Prioritize use of digital tools that use open data standards enabling data exchange.
- Deploy national data exchange repositories (e.g., product registries, facility registries, and client registries) to improve data quality and tool interoperability.
- Integrate predictive and early warning capabilities including signaling to improve health system responsiveness at the national and subnational level.
- Employ digital health tools to increase community and individual engagement in disease prevention efforts (e.g., risk communication and community engagement tools).
- Utilize digital health tools to strengthen cross-border surveillance and data sharing.
- Deploy digital health tools to promote One Health approaches to prevent emergence and spread of zoonotic diseases.
- Have in place the following: strong governance, legal frameworks, standardized infrastructure, interoperability, partnerships and coordination, and sustained financing.
- Strengthen the health system to produce reliable routine health data, fortify the vital registration and census data, and map capacity and laboratory equipment of health facilities.
Rebuilding and strengthening health systems

What should countries do post-pandemic to assess and strengthen the resiliency of a health system?

To rebuild and strengthen health systems post-pandemic, countries should assess and improve the utility of their tools deployed across health services. Strategies to strengthen health systems include conducting data quality assessments, improving systems interoperability, performing software upgrades, strengthening sustainable financing, modeling for digital health systems, and prioritizing improvements in digital infrastructure. Governments should also revisit national strategies and policies, making updates where needed. Emphasis should be on institutionalizing governance capacity to continue digital transformation.

To help assess and plan for improving digital health systems, countries can use stakeholder-vetted maturity models and toolkits such as the Health Information System Stages of Continuous Improvement Toolkit, the Health Information Systems Interoperability Maturity Toolkit, or the Digital Health Tools for Community Health Worker Programs Maturity Model and Toolkit. These resources can help countries assess, plan, and prioritize interventions and investments to strengthen their HIS.
Data from surveillance systems are routinely analyzed, visualized, and reviewed to detect disease. Data collection tools are adapted to capture case data about the disease and analytics used to tailor response efforts by geography. Case data combined with location data and/or satellite imagery helps identify and target “hot spots.” Data blending tools and hosting services are necessary to combine data across systems. Use existing data to create predictive models for who is at highest risk of infection in the next disease wave. Utilize data analysis and visualization to target outbreak response and resources in “hot spots.”

The table to the right provides examples of data science assets overlaid onto the DATEC to demonstrate how they cut across all pandemic phases and describes why it is important to analyze, visualize, and act on the data that exist throughout each phase.

Data science assets

Data science assets are the tools, resources, and approaches that support the intentional and integrated use of data to produce actionable insights that strengthen health systems. Data science assets are vital to prevent and manage current and future outbreaks throughout all phases of the pandemic.

Data science asset examples

- Analytics training materials
- Automated SMS communication
- Automated workflow
- Cloud-based data services
- Custom algorithms
- Data blending tools
- Data insights
- Data management/business processes
- Data use tools
- Data visualization
- Database management system
- Decision support tool
- Hosting services
- In-memory analytics
- Location data
- Mobile data collection tool
- Predictive models
- Research methods
- Research protocols
- Satellite imagery
- User-centered/people-centered design

The table to the right provides examples of data science assets overlaid onto the DATEC to demonstrate how they cut across all pandemic phases and describes why it is important to analyze, visualize, and act on the data that exist throughout each phase.

Data science assets

Foundational focus

Data science assets

Data science assets are the tools, resources, and approaches that support the intentional and integrated use of data to produce actionable insights that strengthen health systems. Data science assets are vital to prevent and manage current and future outbreaks throughout all phases of the pandemic.

Data science asset examples

- Analytics training materials
- Automated SMS communication
- Automated workflow
- Cloud-based data services
- Custom algorithms
- Data blending tools
- Data insights
- Data management/business processes
- Data use tools
- Data visualization
- Database management system
- Decision support tool
- Hosting services
- In-memory analytics
- Location data
- Mobile data collection tool
- Predictive models
- Research methods
- Research protocols
- Satellite imagery
- User-centered/people-centered design

The table to the right provides examples of data science assets overlaid onto the DATEC to demonstrate how they cut across all pandemic phases and describes why it is important to analyze, visualize, and act on the data that exist throughout each phase.

Data science assets

This relates to the need for a strong foundation of eHealth building blocks to underpin ability to analyze data, e.g.:
- Infrastructure (electricity, connectivity) to support data analytics at all levels of the health system.
- Workforce trained in data analytics.
- Data governance promotes data use at each level of the health system.

Pre-pandemic health systems

Initial detection of disease

Early outbreak/low # of confirmed cases

National scale/rise in # of confirmed cases

Regional/global scale of outbreak/high # of confirmed cases

Completion of initial outbreak wave

Resurgence of cases nationally

Rebuilding and strengthening health systems post-pandemic

Prevent

Detect

Respond

Prevent

Digital Applications and Tools Across an Epidemiological Curve
Foundational focus
Interoperability

Interoperability of systems allows harmonized data exchange between digital health information systems. Interoperability allows countries to leverage existing infrastructure to rapidly adapt to new needs that arise during a pandemic. It enhances views of data, allows rapid uptake of tools deployed for emergency response across the epidemiological curve, and improves overall decision-making for health interventions.

Interoperability is facilitated by a well-designed architecture allowing exchange of data. Terminology services allow for comparable naming across systems, which enables homogenization of data and can allow for rapid mapping of data from different systems to register and identify patients, for example. Health data standards such as the Fast Healthcare Interoperability Resources (FHIR) also facilitate interoperability and reduce the need for governments or partners to build connections of systems, rather allowing innovators to adopt existing standards and not re-create solutions.

The visualization to the right shows that interoperability cuts across all phases of the DATEC and all systems within the health space. The descriptions in the table provide examples of how interoperability facilitates function in each phase.

OpenHIE is an example of a global community of practice that enables large-scale health information interoperability. During COVID-19, the World Health Organization and Digital Square established the OpenHIE COVID-19 task force in response to the interoperability and data sharing needs of the global community. The task force is working to:

- Identify and collate information relating to data standards and exchange.
- Identify gaps in and establish standards for data exchange priorities.
- Provide documentation and guidance (for open source software tools managed by the global good community and proprietary software tools) to improve adherence to these standards.
- Ensure that rapidly deployed solutions can be integrated into national digital health architectures.
**Foundational focus**

**Routine surveillance**

Routine surveillance is critical to protect communities on national, regional, and global scales. Digital tools and applications enable countries to more efficiently and quickly target resources and evaluate programs. Digital health tools collect patient-level and aggregate surveillance data daily, weekly, monthly, and/or quarterly. Surveillance systems are integral to global health security.

Health system managers and leaders who use public health surveillance as a management tool must recognize that political support and human and financial resources are essential to the sustainability of strong routine surveillance systems.

It is important for the national governments and the digital health community to:

- Modernize infectious disease surveillance tools to drive public health action.
- Strengthen routine information available on the population (e.g., accurate census data, vital registration data, mapping of health facilities and their services).
- Integrate animal and human health data, particularly information on livestock.
- Train the health workforce on how to capture and use routine surveillance for disease control and prevention.
- Use digital health tools to analyze, visualize, and share surveillance data with stakeholders.
- Ensure surveillance systems across public and private sectors routinely share health information and use it for decision-making.
- Utilize surveillance information to optimize health system performance and resource use.

---

**Digital Applications and Tools Across an Epidemiological Curve**

**Pre-pandemic health systems**

**Initial detection of disease**

**Early outbreak/low # of confirmed cases**

**National scale/rise in # of confirmed cases**

**Regional/global scale of outbreak/high # of confirmed cases**

**Completion of initial outbreak wave**

**Resurgence of cases nationally**

**Rebuilding and strengthening health systems post-pandemic**

---

**Routine surveillance**

Continue routine surveillance of notifiable diseases.
Support reporting officers to improve data quality.
Utilization of outbreak control tools across DATEC

This visual depicts how three categories of outbreak control tools are developed, deployed, distributed, and scaled throughout the phases of the epidemic, namely: diagnostics, therapeutics, and vaccines. The three top rows depict categories of outbreak control tools and describe at a high level how digital health tools can bolster pandemic response efforts during each phase.

**Vaccines**
(e.g., preparation for vaccine deployment and tools to support scale-up through phased distribution)

**Therapeutics**
(e.g., supplemental oxygen, emergency use antivirals, convalescent plasma/antibody treatments)

**Diagnostics**
(e.g., nucleic acid tests, direct antigen tests, serologic/antibody tests, biorepository)

**Pre-pandemic health systems**

- Conduct research and development (R&D).
- Use digital tools for data collection and analysis.

**Therapeutics**

- Accelerate interoperability of diagnostic tools including new diagnostics that enter the market.
- Continue to accelerate interoperability of diagnostic tools including new diagnostics that enter the market.
- Use data from digital tools to prioritize deployment such as health workers and monitor early deployment of vaccine, including clinical trial cohorts.
- Harness digital case management tools to track administration and side effects; enable interoperability with electronic medical records and other tools.

**Diagnostics**

- Manage data while vaccine development is underway; begin prioritizing phase 1 recipients of vaccine.
- Harness data science tools used to manage large amounts of testing data of vaccine efficacy.
- Allow case management systems to include various treatment options; scale data collection of side effects as therapeutic interventions scale.
- Harness digital case management systems to include various treatment options; scale data collection of side effects as therapeutic interventions scale.
- Capture data in case management, wearables (e.g., smartwatches), and other relevant systems for treatment interventions including side effects.
- Add new therapeutic interventions to case management systems; utilize robust analytics on treatment.
- Allow case management systems to include various treatment options; scale data collection of side effects as therapeutic interventions scale.
- Harness data science tools used to manage large amounts of testing data of vaccine efficacy.

**Vaccines**

- Use digital tools to prioritize deployment such as health workers and monitor early deployment of vaccine, including clinical trial cohorts.
- Deploy digital tools such as supply chain, electronic registries, client communication tools, etc. Ensure interoperability of data for efficient distribution and tracking of vaccine administration.
- Monitor, deploy, and follow up to ensure safe, fair deployment of vaccines to all communities.

**Digital Applications and Tools Across an Epidemiological Curve**
### Impacts on health systems during a pandemic

This visual details examples of impacts on health systems at different phases of a pandemic. Digital tools can be used to mitigate these impacts. This is not an exhaustive list, yet this part of the framework can guide investments in digital tools to alleviate health system challenges. Below are broad categories of challenges on health systems and examples of approaches that can be taken to overcome them.

<table>
<thead>
<tr>
<th>Category</th>
<th>Example Approach</th>
<th>Example</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand on facilities, equipment, and supplies</td>
<td>Example approach: Demand on health facilities can be felt at all times during a pandemic, especially as confirmed cases increase nationally and regionally. Logistics management information systems can help ensure facilities plan ahead to have sufficient stock of supplies to meet the increased demand in services.</td>
<td>Health workers may be unfamiliar with symptoms or testing protocols for new and emerging diseases.</td>
<td>Laboratories may not be equipped to handle specimen testing for a new disease or disease variant.</td>
</tr>
<tr>
<td>Health workers and clients</td>
<td>Example approach: Health worker shortages, especially in areas where there are already insufficient numbers of qualified health workers, can be felt more intensely during an outbreak as health workers are lost to sickness, are overburdened by increased workload, and are faced with burnout. Digital learning and training tools can support task-shifting and also provide strategies for health workers to cope with workload and task management and to address mental health.</td>
<td>Increased financial burdens for clients and growing need for financial support that can be facilitated through digital financial services for health.</td>
<td>Surge in anxiety, mental health issues, and violence that affects health workforce and general population.</td>
</tr>
<tr>
<td>Outbreak control tools (diagnostics, therapeutics, vaccines)</td>
<td>Example approach: Therapeutics can often be costly for clients, especially in regions where there are already insufficient numbers of qualified health workers, can be felt more intensely during an outbreak as health workers are lost to sickness, are overburdened by increased workload, and are faced with burnout. Digital learning and training tools can support task-shifting and also provide strategies for health workers to cope with workload and task management and to address mental health.</td>
<td>Disruption to primary health care services and testing and treatment for HIV/AIDS, malaria, and other communicable diseases.</td>
<td>Surge in demand for psychosocial support (e.g., helplines, call centers, mental health chatbots).</td>
</tr>
<tr>
<td>Public health communication/policy</td>
<td>Example approach: Where vaccines are ready to be deployed later in an outbreak, electronic immunization registries are existing digital tools that can be adapted and scaled to support distribution to clients.</td>
<td>Regulatory agencies (e.g., national) communicate normative guidelines to minimize risk of disease transmission.</td>
<td>Governments enact policies (e.g., travel bans).</td>
</tr>
<tr>
<td>Other</td>
<td>Example approach: Some digital tools, especially those used at community level, have tasking prioritization features to help adapt delivery both for primary health care and response to an outbreak. These tools can be used especially as outbreaks begin significant disruption to primary health services like antenatal care and immunization.</td>
<td>Increased need for management of misinformation coupled with tailored and targeted public health information.</td>
<td>Surge requests for therapeutics disrupting the supply chain.</td>
</tr>
</tbody>
</table>

### Table: Impacts on health systems during a pandemic

<table>
<thead>
<tr>
<th>Phase</th>
<th>Impact</th>
<th>Example Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial detection of disease</td>
<td>Surge of testing could impact availability of staff and supplies at health facilities.</td>
<td>Surge requests for facilities (e.g., hospital beds), equipment (e.g., ventilators), and supplies (e.g., protective equipment).</td>
</tr>
<tr>
<td>Early outbreak/low # of confirmed cases</td>
<td>Health workers may be unfamiliar with symptoms or testing protocols for new and emerging diseases.</td>
<td>Reduced availability of health workers.</td>
</tr>
<tr>
<td>National scale/rise in # of confirmed cases</td>
<td>Compromised safety of health workers.</td>
<td>Surge requests for therapeutics disrupting the supply chain.</td>
</tr>
<tr>
<td>Regional/global scale of outbreak/peak in # of confirmed cases</td>
<td>Demand for facilities (e.g., emergency rooms, inpatient beds), equipment, and supplies exceeds supply.</td>
<td>Increased health worker burnout, mental health issues, and anxiety.</td>
</tr>
<tr>
<td>Completion of initial outbreak wave</td>
<td>Health workforce shortages exacerbated as health worker attrition increases.</td>
<td>Increased mental health needs for general population.</td>
</tr>
<tr>
<td>Resurgence of cases nationally</td>
<td>Demand for facilities (e.g., emergency rooms, inpatient beds), equipment, and supplies threatens to exceed supply.</td>
<td>Pandemic fatigue results in need to reinvigorate public to prevent disease transmission.</td>
</tr>
</tbody>
</table>

**Digital Applications and Tools Across an Epidemiological Curve**
### Investor coordination across DATEC

<table>
<thead>
<tr>
<th>USE CASE</th>
<th>CDC</th>
<th>DFID</th>
<th>Gates Foundation</th>
<th>Gavi</th>
<th>GIZ</th>
<th>Global Fund</th>
<th>Norad</th>
<th>Rockefeller Foundation</th>
<th>USAID</th>
<th>World Bank</th>
<th>WHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination and operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point of entry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply chain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact tracing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health facility and provider administration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection prevention control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk communication and community engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnostic tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Event-based surveillance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning and training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Health</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** CDC: Centers for Disease Control and Prevention, DFID: UK Department for International Development, GIZ: German Corporation for International Cooperation, USAID: United States Agency for International Development, WHO: World Health Organization.
## References


Digital Square is a PATH-led initiative funded and designed by the United States Agency for International Development, the Bill & Melinda Gates Foundation, and a consortium of other donors.

Digital Applications and Tools Across an Epidemiological Curve