dSTARR Project
digital Solutions To support COVID-19 Antigen RDT Rollout

Stakeholder and Market Needs Assessment

Understanding stakeholder and market needs to inform the development of digital solutions to support COVID-19 diagnostic testing

September 2021
1 Overview of the assessment
2 Summary and key themes
3 Country-specific findings
Digital Solutions to Support COVID-19 Antigen RDT Rollout (dSTARR) Project

- **Goal:** To advance digital health solutions to improve data collection and mitigate current pain points associated with COVID-19 diagnostic testing in low- and middle-income settings

- **Aim:** To develop standards and enhance interoperability of patient and diagnostic data-collection platforms, driving the incorporation of these standards into leading mobile health tools in low- and middle-income settings
As a first step in this project, a global **stakeholder and market needs assessment** was conducted in Q2 to Q3 of 2021.

### Objective

To understand stakeholder and market unmet needs associated with the current or future use of **COVID-19 antigen RDTs** (Ag RDTs) and identify opportunities to leverage digital solutions to address pain points.

### Outcomes

Findings of this assessment will be used to:

- **Align specifications** to unmet needs as defined by country stakeholders
- Identify **expanded use cases**, beyond data capture, for the digital solutions
- Inform the development of the **digital tool(s)** during subsequent project phases
Between May and August 2021, key informant interviews were conducted with **24 stakeholders** in **five countries**.

- Interviewees were selected based on role alignment with interview topics
- Interviews were between **30 and 90 minutes** in length
- Interviews conducted in **local languages where possible**, including French, Portuguese, Vietnamese, and English
- Qualitative **interview guide** developed to understand the current COVID-19 diagnostic testing environment and how a digital solution could support Ag RDT rollout
Interview guide

Interview questions related to the following themes:

- Status of COVID-19 diagnostic testing
- Patient testing process
- Provider procedure and training
- Data reporting
- Supply chains

Interviewees were also asked about their understanding of and experience with the country’s digital health infrastructure and usage which is reflected in analysis of *Digital ecosystem*
The following **expanded use cases** for COVID-19 Ag RDT data-capture solutions were explored during the stakeholder interviews:

### Referral support
Identifying and arranging nearby health facilities for follow-up or care

### Patient management
Communicating with patient before and after visit

### Overall clinical management
Monitoring patient, contact tracing, and offering care

### Digital record keeping, reporting, surveillance
Collecting, aggregating, and exchanging all data associated with patient COVID-19 management

### Capacity-strengthening
Supporting and training health care workers

### Supply chain support
Procuring supplies and managing inventory efficiently
## Summary of stakeholder participation

<table>
<thead>
<tr>
<th>Country</th>
<th>Brazil</th>
<th>India</th>
<th>Senegal</th>
<th>Vietnam</th>
<th>Zambia</th>
<th>Total</th>
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<tr>
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<td>Academia</td>
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<td>Industry</td>
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<td><strong>Total</strong></td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>7</td>
<td>2</td>
<td>24</td>
</tr>
</tbody>
</table>

- Rio de Janeiro’s Municipal Health Secretariat
- Department of Science and Technology, MOH
- University of Brasilia
- Tropical Medicine Foundation
- Pan American Health Organization
- B. J. Medical College
- Jalgaon Municipal Corporation
- PATH
- Bio24
- Health District of Thies
- St. Louis and Richard Toll Health District
- Pasteur Institute in Ho Chi Minh City
- Hospital for Tropical Diseases
- National Institute of Hygiene and Epidemiology
- Yen Bai Center for Disease Control
- Viettel Solutions
- Association of Public Health Laboratories
- Ministry of Health (MOH)
- Zambia National Public Health Reference Lab
- Zambia National Public Health Institute
- Clinton Health Access Initiative
1 Overview of the assessment
2 Summary and key themes
3 Country-specific findings
What’s working, what’s not?

<table>
<thead>
<tr>
<th></th>
<th>Brazil</th>
<th>India</th>
<th>Senegal</th>
<th>Vietnam</th>
<th>Zambia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Ag RDTs approved for use*</td>
<td>79</td>
<td>48</td>
<td>4</td>
<td>19</td>
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<tr>
<td>Referral support</td>
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<td>Patient management</td>
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<td>Digital record keeping, reporting, surveillance</td>
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*These numbers reflect the latest information that was publicly available or that PATH was able to solicit from country partners as of September 2021. The number of approved tests frequently changes as new data become available.
### What’s working, what’s not?

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Ag RDTs approved for use*</th>
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<th>Overall clinical management</th>
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<th>Capacity-strengthening</th>
<th>Supply chain support</th>
<th>Digital ecosystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>79</td>
<td>Facility referral sometimes through WhatsApp</td>
<td>Various mobile platforms for results reporting but contact tracing and patient management often informal</td>
<td>Expansive network of care</td>
<td>Robust data management and reporting systems but requires duplicate entry within disconnected systems initially using paper-based forms</td>
<td>Lacking centralized training and guidance</td>
<td>Centralized system for procurement</td>
<td>Strong usage of digital tools and information systems</td>
</tr>
<tr>
<td>India</td>
<td>48</td>
<td>Disconnect between types of facilities</td>
<td>Various mobile platforms for results reporting and contact tracing but prone to spread of misinformation</td>
<td>Robust clinical and community management</td>
<td>Centralized data management and reporting system but initially using paper-based forms</td>
<td>Centralized guidance exists but does not reach staff</td>
<td>Robust system for procurement but lacking demand forecasting</td>
<td>Strong usage of digital tools and information systems</td>
</tr>
<tr>
<td>Senegal</td>
<td>4</td>
<td>Strong referral system between public and private entities</td>
<td>Existing mobile systems for results reporting but difficult to utilize due to volume of tests</td>
<td>Reliant on polymerase chain reaction (PCR) confirmatory testing</td>
<td>Lack of standardized data to be collected and initially using paper-based forms</td>
<td>Lacking sufficient information in interviews</td>
<td>Lacking sufficient information in interviews</td>
<td>Centralized system in use</td>
</tr>
<tr>
<td>Vietnam</td>
<td>19</td>
<td>Sample transfer for referral to other facilities not centralized</td>
<td>Difficult to return test results with influx of cases and patients lack high-quality information or support</td>
<td>Differing data management systems across facilities</td>
<td>Disjointed lab management systems but lack consistent internet connectivity for use</td>
<td>Lacking centralized training and guidance</td>
<td>Supply estimation difficult and mandated bidding requirements</td>
<td>Lacking infrastructure and strong network connectivity</td>
</tr>
<tr>
<td>Zambia</td>
<td>2</td>
<td>Lacking linkages between various facilities for referral</td>
<td>Inconsistent communication of results through mobile or in person</td>
<td>Immediate contact tracing if complete patient data are captured</td>
<td>Multiple data collection tools and management systems but lacking data quality assurance</td>
<td>High turnover of staff and difficulty in adhering to guidance</td>
<td>Multiple procurement channels working well together</td>
<td>Lacking infrastructure and strong network connectivity</td>
</tr>
</tbody>
</table>

*These numbers reflect the latest information that was publicly available or that PATH was able to solicit from country partners as of September 2021. The number of approved tests frequently changes as new data become available.
<table>
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<tr>
<th>What’s working</th>
<th>Challenges</th>
<th>Opportunities to leverage a digital solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Referral support</strong></td>
<td>- Referral (often through WhatsApp) of patients with positive results</td>
<td>- Currently no digital platform for referral support</td>
</tr>
<tr>
<td><strong>Patient management</strong></td>
<td>- Using WhatsApp, telephone, and Conecte SUS to contact patients</td>
<td>- Misinformation on COVID-19 testing and treatment (e.g., early use of serological tests)</td>
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<tr>
<td></td>
<td>- Immediate reporting of Ag RDT results to patient at POC</td>
<td>- Poor monitoring of contacts and compliance with self-isolation</td>
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<tr>
<td><strong>Overall clinical management</strong></td>
<td>- Various levels of care available to citizens</td>
<td>- General population lack awareness regarding when to get tested</td>
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<tr>
<td></td>
<td></td>
<td>- Multiple tests conducted for the same infection may be reported as new cases</td>
</tr>
<tr>
<td><strong>Digital record keeping, reporting, surveillance</strong></td>
<td>- Healthcare workers (HCWs) can enter data into various systems to be aggregated</td>
<td>- Use of paper systems at local level</td>
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<td></td>
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<td>- Underreporting of cases</td>
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<td></td>
<td>- Parallel reporting, and non-standardized municipal systems</td>
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<td></td>
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<td>- Variable reporting rates depending on the level of the health care professional</td>
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<tr>
<td></td>
<td></td>
<td>- Incomplete information</td>
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<tr>
<td><strong>Capacity-strengthening</strong></td>
<td>- In general, Ag RDT use is being implemented as per WHO guidelines</td>
<td>- Limited time available for health professionals</td>
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<td></td>
<td></td>
<td>- Some HCW compliance challenges with testing guideline adherence</td>
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<tr>
<td><strong>Supply chain support</strong></td>
<td>- Centralized system for procurement of supplies</td>
<td>- Appropriate use and stock control</td>
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<td></td>
<td>- Waste mitigation and accurate ordering</td>
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<tr>
<td><strong>Digital ecosystem</strong></td>
<td>- General population own and use mobile technologies</td>
<td>- Lack of resources for data analysis</td>
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<tr>
<td></td>
<td>- Multiple data reporting systems exist</td>
<td>- Existing information systems not interoperable</td>
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<td></td>
<td>- Cloud services for internal information exchange (Microsoft Teams, OneDrive)</td>
<td>- Information systems have been adapted to fit local context hindering data sharing</td>
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</tbody>
</table>
Brazil: Key takeaways

The current status is

- Ag RDT usage has expanded capacity to allow for improved result turnover and contact tracing
- COVID-19 data reporting is mandated at the federal system (national e-SUS Notifica system) but inefficient due to parallel systems (primary health care and municipal systems) and overburdened HCWs

A new digital tool should

- Consider local specificities as opposed to national implementation, as information systems across municipalities are not standardized and inequities are context specific
- Be interoperable or able to interface with the many existing information and data management systems
- Allow for changing of content depending on local context

Digital tool developers should consider

- The structure of the numerous existing data management and information systems
- Focusing on HCWs at the primary health care level
- Innovative content within tools to allow for accurate and timely reporting of necessary information
## India: What’s working, what’s not?

<table>
<thead>
<tr>
<th>What's working</th>
<th>Challenges</th>
<th>Opportunities to leverage a digital solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Referral support</strong></td>
<td>Hospital patients with positive Ag RDT immediately taken to intensive care unit (ICU)</td>
<td>No data link between lab test results and admission to hospital</td>
</tr>
<tr>
<td><strong>Patient management</strong></td>
<td>Positive and negative results available to patients through phone, SMS, and/or online portal</td>
<td>Informing patients of results can be timelier and more streamlined</td>
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<tr>
<td></td>
<td></td>
<td>Spread of misinformation</td>
</tr>
<tr>
<td><strong>Overall clinical management</strong></td>
<td>Facility providers and community volunteers tend to patients and potentially affected contacts</td>
<td>Low rates of self-testing in part due to laypeople needing to report results centrally</td>
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<td></td>
<td></td>
<td>No unified system for hospital admissions or treatment protocols</td>
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<td></td>
<td></td>
<td>Sample collection methods and workflow need improvement</td>
</tr>
<tr>
<td><strong>Digital record keeping, reporting, surveillance</strong></td>
<td>Inputting information through Microsoft Excel</td>
<td>High volume of testing and granular patient information make paper-based forms difficult</td>
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<td></td>
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<td>Higher volumes at public vs. private facilities</td>
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<td>Difficult to bulk upload completed Excel data forms</td>
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<td></td>
<td>No single mechanism for data flow between facilities</td>
</tr>
<tr>
<td><strong>Capacity-strengthening</strong></td>
<td>Central portal with training materials and guidance</td>
<td>HCWs struggle to keep up with changing guidance</td>
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<td></td>
<td>Lacking demonstrations or trainings for new guidance</td>
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<td></td>
<td></td>
<td>Periodic reorientation to testing strategies</td>
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<tr>
<td><strong>Supply chain support</strong></td>
<td>—</td>
<td>Demand forecasting based on use rates not used</td>
</tr>
<tr>
<td><strong>Digital ecosystem</strong></td>
<td>Robust ICMR portal for centralized data management and reporting</td>
<td>Many facilities do not have access to a tablet to complete data entry</td>
</tr>
</tbody>
</table>
India: Key takeaways

The current status is

• Ag RDT capacity has rapidly expanded during India’s 2nd Wave
• A centralized reporting database (ICMR) exists, but lengthy data entry processes hold up large volumes at testing locations

A new digital tool should

• Be adaptable to varying volume of testing at different facilities
• Interface with existing centralized data reporting portal
• Allow HCWs to efficiently receive guidance and training updates

Digital tool developers should consider

• The effect large volumes of testing will have on the flexible development of a digital tool
• How to leverage centralized reporting and guidance portal to efficiently push out necessary information to HCWs
### Senegal: What’s working, what’s not?

<table>
<thead>
<tr>
<th>What’s working</th>
<th>Challenges</th>
<th>Opportunities to leverage a digital solution</th>
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</thead>
<tbody>
<tr>
<td><strong>Referral support</strong></td>
<td>- Patients who present at private facilities are referred to or have samples sent to <strong>public facilities to ensure technicians have proper training</strong> in Ag RDTs and PCR tests</td>
<td>- System to coordinate optimal transport of samples across long distances (up to 114 km)</td>
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<tr>
<td><strong>Patient management</strong></td>
<td>- Initiating symptom treatment while results are pending</td>
<td>- Digital hub where patients can return to a clinic or any computer to view results, regardless of whether they have a cell phone</td>
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<tr>
<td></td>
<td>- Confirmatory PCR testing, regardless of Ag RDT result, <strong>ensures fast and improved care of patients</strong></td>
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<tr>
<td><strong>Overall clinical management</strong></td>
<td>- Notification sheets of negative results shared with attending physician, chief physician, medical region lead, and MOH</td>
<td>- HCW concerns around Ag RDT test performance due to lack of trust in results</td>
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<td></td>
<td>- HCWs use WhatsApp to seek advice</td>
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<tr>
<td><strong>Digital record keeping, reporting, surveillance</strong></td>
<td>- Time required to transfer data from paper to Excel makes it difficult to generate real-time reports</td>
<td>- Central database for all forms to be used for generating useful reports</td>
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<td>- Missing data can make it difficult to conduct patient follow-up</td>
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<tr>
<td><strong>Capacity-strengthening</strong></td>
<td>- Private facilities cannot conduct Ag RDT or PCR testing due to lack of training and infrastructure</td>
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<tr>
<td><strong>Supply chain support</strong></td>
<td>- National Pharmacy allocates stock of Ag RDTs to medical regions, which allocate to facilities</td>
<td>- Facilities do not have control over supply stock</td>
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<td>- Ag RDT allocation based on notification reports about daily Ag RDT use in different regions</td>
<td>- Connection between facilities and district level for inventory management</td>
</tr>
<tr>
<td><strong>Digital ecosystem</strong></td>
<td>- DHIS2 for tracking patient information, sampling date, results, and contact tracing</td>
<td>- Internet connectivity and infrastructure challenges</td>
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<td></td>
<td>- Sharing reports via email in Excel sheets to inform stock allocation</td>
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</tbody>
</table>
Senegal: Key takeaways

The current status is

- MOH has strict guidelines to use Ag RDTs in public facilities only due to specified training and infrastructure requirements
- Data reporting and contact tracing are conducted through a centralized system, District Health Information System 2 (DHIS2)

A new digital tool should

- Provide data link between Ag RDT test results and confirmatory PCR testing
- Directly connect with DHIS2
- Standardize data collection and reporting forms

Digital tool developers should consider

- How to connect data collection between public and private facilities
- What kind of content would improve HCW confidence in Ag RDT test methods and results
### Vietnam: What’s working, what’s not?

<table>
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<tr>
<th>What’s working</th>
<th>Challenges</th>
<th>Opportunities to leverage a digital tool</th>
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</thead>
<tbody>
<tr>
<td><strong>Referral support</strong></td>
<td>- Viettel software for sample management and transfer between departments</td>
<td>- System to coordinate samples transport (as opposed to personal vehicles/public transportation)</td>
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<td>- Results sheets not provided for patients for potential referral</td>
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<td>- Lacking sample transfer mechanism</td>
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<tr>
<td><strong>Patient management</strong></td>
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<td></td>
<td>- Provide patients with information on COVID-19 and next step</td>
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<td>- Mental health support for those in need</td>
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<td>- Facilitation of contact tracing</td>
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<td>- Artificial intelligence or chat bot to connect with online clinical support</td>
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<tr>
<td><strong>Overall clinical management</strong></td>
<td>- Difficult to maintain social distancing at community screening sites during COVID-19 outbreaks</td>
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<td></td>
<td>- Negative results not delivered to patients</td>
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<tr>
<td></td>
<td>- System to coordinate samples transport (as opposed to personal vehicles/public transportation)</td>
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</tr>
<tr>
<td><strong>Digital record keeping, reporting, surveillance</strong></td>
<td>- Use of Ag RDT to screen in remote environments</td>
<td>- Operation system to ensure all patients are admitted and receive timely medical care</td>
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<td></td>
<td>- Different departments/organizations have different data management systems (e.g., epidemiology department vs. testing department)</td>
<td>- Management of at-home self-test results (e.g., use decision logic to provide consultation to people)</td>
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<td></td>
<td>- Concern about Ag RDT performance but unable to confirm with PCR</td>
<td>- Unique patient identification</td>
</tr>
<tr>
<td><strong>Capacity-strengthening</strong></td>
<td>- Excel is easy to use and adapt to different needs</td>
<td>- Ability to evaluate effectiveness of new software</td>
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<td></td>
<td>- Time to collect or transfer data</td>
<td>- Semi-automation of administrative processes</td>
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<td>- Incomplete data capture especially in outbreak settings</td>
<td>- Centralized data management outside of province level</td>
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<td></td>
<td>- Complicated administrative procedures and forms preparation associated with reporting</td>
<td>- Disseminating detailed regulations and requirements for software systems</td>
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<td>- Quality checks are difficult to implement due to lack of standardization</td>
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<tr>
<td><strong>Supply chain support</strong></td>
<td>- Use of group chats to seek guidance and advice from other HCWs</td>
<td>- Disseminate best practices for HCWs conducting Ag RDTs</td>
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<td></td>
<td>- Limited time available for health professionals</td>
<td>- Support in-person training with digital learning modules</td>
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<td>- Lack of time for training HCWs on new tools</td>
<td>- Moderated forum for HCWs to asynchronously support one another</td>
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<tr>
<td><strong>Digital ecosystem</strong></td>
<td></td>
<td>- Real-time supply and inventory management systems receiving data at facility level</td>
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<td></td>
<td>- Plans to develop overall health information management system</td>
<td>- Improve interoperability between existing information systems</td>
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<td></td>
<td>- Investment in infrastructure required to use many existing digital solutions (i.e., internet connection)</td>
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<td>- Need to pay extra cost to add on COVID-19-specific management modules to existing digital tools</td>
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<td></td>
<td>- Many regions do not have internet/3G or 4G</td>
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</tbody>
</table>
Vietnam: Key takeaways

The current status is

- Ag RDT capacity has expanded rapidly in response to major outbreaks across the country
- Disjointed data management systems between lab and health care facilities

A new digital tool should

- Be amenable to fluctuations in testing volume with a focus on outbreak management
- Allow for data input from various sources for higher-level reporting
- Be developed for use in a no- to low-network connectivity environment

Digital tool developers should consider

- Potential areas for automation, especially for use in high-volume testing areas
- Lack of widespread digital infrastructure
<table>
<thead>
<tr>
<th>Feature</th>
<th>What's working</th>
<th>Challenges</th>
<th>Opportunities to leverage a digital tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referral support</td>
<td>- HCWs follow up with patients who test positive either by phone or physically at the address they provided</td>
<td>- Missing or incorrect patient information (e.g., names, addresses)</td>
<td>- Data verification features for data entry</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Creating linkages between lab, surveillance, and clinical teams to share data</td>
</tr>
<tr>
<td>Patient management</td>
<td>- HCWs and surveillance team members reach patients either by phone or physically at the address they provided</td>
<td>- Inconsistent communication of results, especially for negative cases</td>
<td>- Inform patients of test result through mobile app</td>
</tr>
<tr>
<td>Overall clinical management</td>
<td>- Contact tracing initiated by surveillance team upon positive test result</td>
<td>- Misapplication of Ag RDT due to shorter turnaround time</td>
<td>- System focused on clerk or data personnel at sample-collection site to streamline data capture</td>
</tr>
<tr>
<td>Digital record keeping, reporting, surveillance</td>
<td>- Multiple data collection tools and management systems</td>
<td>- Incomplete information during data capture</td>
<td>- Mobile data collection tool focused on reducing transcription errors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Data transcription errors</td>
<td>- Require some minimum amount of data to improve data quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Underreporting especially due to digital infrastructure issues</td>
<td>- Provision for laypeople to input information into surveillance tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Variation across sites of data being captured</td>
<td></td>
</tr>
<tr>
<td>Capacity-strengthening</td>
<td>- Competency assessments for HCWs</td>
<td>- Poor adherence to guidelines</td>
<td>- Digitize and disseminate notifications and guidelines to HCWs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- High turnover of staff trained to conduct COVID-19 test often due to career advancement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- HCWs must take work home with them to ensure reporting</td>
<td></td>
</tr>
<tr>
<td>Supply chain support</td>
<td>- MOH and Zambia Medicines and Medical Supply Agency (ZAMMSA) work well together</td>
<td>- Multiple channels of procurement for different supplies</td>
<td>- Semi-automated inventory management to directly report usage to ZAMMSA</td>
</tr>
<tr>
<td>Digital ecosystem</td>
<td>- Effective access control for confidential health and testing data - Connectivity support to DisaLab</td>
<td>- Blackouts and connectivity/internet challenges</td>
<td>- APIs to integrate existing information systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Lack of computers and related infrastructure</td>
<td>- Build upon existing HIV notification program to inform patients and caregivers of test result</td>
</tr>
</tbody>
</table>
Zambia: Key takeaways

The current status is

- Ag RDTs are available, but due to fluctuating supply, guidance is changing for testing requirements
- Hub and spoke model of data reporting through labs (DisaLab system)

A new digital tool should

- Facilitate data completeness for returning and reporting results
- Interface with or build upon existing digital data collection tools in use
- Provide data linkage between sample collection sites and labs

Digital tool developers should consider

- What types of mobile functionalities would be appropriate for use in both facility and community-based interaction
- Methods to minimize transcription errors and time to collect data
## Potential opportunities for addressing challenges across geographies

<table>
<thead>
<tr>
<th>Referral support</th>
<th>Patient management</th>
<th>Clinical management</th>
<th>Digital record keeping, reporting, surveillance</th>
<th>Capacity-strengthening</th>
<th>Supply chain support</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient level</strong></td>
<td>✓ Viewing referrals in centralized mobile platform ✓ Referral reminders</td>
<td>✓ Centralized returning of results ✓ Two-way communication with provider</td>
<td>✓ Ag RDT self-test results reporting ✓ Chat bot for COVID-19 questions and concerns</td>
<td>✓ Storing all data associated with patient's COVID-19 management</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Provider level</strong></td>
<td>✓ Referral platform ✓ Ability to share patient information to facilities ✓ Follow-up on incomplete referrals</td>
<td>✓ Two-way communication with patient ✓ Patient dashboard</td>
<td>✓ Mobile platform for providers to connect ✓ Contact tracing platform linked to patient data ✓ Running Ag RDT</td>
<td>✓ Mobile data capture tool at point of care ✓ Access to stored patient records</td>
<td>✓ Training ✓ Automated updates and reminders for new guidance or training material</td>
</tr>
<tr>
<td><strong>District level</strong></td>
<td>✓ Identifying and locating nearby health facilities</td>
<td>✓ Mass communication of accurate COVID-19 testing information</td>
<td>✓ Patient linked to contact tracing ✓ Sample collection coordination</td>
<td>✓ Automatic reporting of point of care data ✓ Linking patient data across facilities</td>
<td>✓ Facilitation of in-person training and workshops</td>
</tr>
<tr>
<td><strong>Country level</strong></td>
<td>✓ Health facility registry for referrals</td>
<td></td>
<td>✓ Results and follow-up procedure recorded for country-level analysis</td>
<td>✓ Aggregation of point of care data to high-level dashboards ✓ Ability to connect distinct information systems</td>
<td>✓ Centralized online portal for all guidance and training</td>
</tr>
</tbody>
</table>

- **In scope vs out of scope for digital solution**
- **In scope** ✓
- **Out of scope** ✗
- **Potential opportunities for addressing challenges across geographies**

- **NA**
### Potential opportunities for addressing challenges across geographies

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<td></td>
<td>NA</td>
</tr>
</tbody>
</table>

| **Provider level** | Referral platform | ▶ Mobile platform for providers to connect | ▶ Mobile data capture tool at point of care | ▶ Training | ▶ Standardized inventory forms sent to district level |
|                    | ▶ Ability to share patient information to facilities | ▶ Contact tracing platform linked to patient data | ▶ Access to stored patient records | ▶ Automated updated and reminders for new guidance or training material | ▶ Semi-automated inventory reporting |
|                    | ▶ Follow-up on incomplete referrals | ▶ Patient dashboard | | | |

| **District level** | Identifying and locating nearby health facilities | ▶ Patient data linked to contact tracing | ▶ Automatic reporting of point of care data | ▶ Facilitation of in-person training and workshops | ▶ Inventory management |
|                    | ▶ Mass communication of accurate COVID-19 testing information | ▶ Sample collection coordination | ▶ Linking patient data across facilities | | ▶ Support in prevention of stockout and ordering |

| **Country level** | Health facility registry for referrals | ▶ Results and follow-up procedure recorded for country-level analysis | ▶ Aggregation of point of care data to high-level dashboards | ▶ Centralized online portal for all guidance and training | ▶ Demand planning based on aggregated Ag RDT utilization and results data |
|                   | NA | ▶ Ability to connect distinct information systems | ▶ Ability to connect different information systems | | |

- **Referral environment is currently limited by lack of facility registration data**

- **Greatest unmet need at current Ag RDT rollout phase will take place at the provider-level**

- **High potential for digital solution to mitigate record keeping, reporting, and surveillance challenges**

- **Patient level should be explored after provider level**

- **Country level should be explored after provider level**

### Feasibility of digital solution to support current Ag RDT rollout:

- **High**
- **Medium**
- **Low**

- **Need for training needs to be validated at provider-level**

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Given on this initial understanding of the Ag RDT environment, the following should be prioritized for the development of a digital solution:

- Based on the current phase of Ag RDT rollout, across geographies, **providers** have the highest burden and could benefit most from a streamlined, efficient digital solution
- **Digital record keeping, reporting, and surveillance** is an area where a digital solution could serve to connect providers to multiple areas of the health system

Next, based on **feedback from important stakeholders**, including users, FIND colleagues, potential vendors, and relevant external stakeholders in the Ag RDT space, a list of **narrowed down and specific functionalities** will be developed for a digital solution.
Limitations

- Small sample size of 24 stakeholders
- Highly evolving COVID-19 context
- Did not speak directly with healthcare providers or patients as part of this process
Next steps

- Disseminating information with key stakeholders to receive input and validation for proposed prioritization
- Discussing opportunities to address key challenges with global mHealth vendors
- Developing digital solution using human-centered design principles
- Implementation and testing of digital solution in one to two geographies
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>PCR</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Ag</td>
<td>antigen</td>
<td>PCR</td>
<td>polymerase chain reaction</td>
</tr>
<tr>
<td>API</td>
<td>application programming interface</td>
<td>POC</td>
<td>point of care</td>
</tr>
<tr>
<td>COVID-19</td>
<td>coronavirus disease 2019</td>
<td>Q</td>
<td>quarter (e.g., Q1=quarter 1)</td>
</tr>
<tr>
<td>DHIS2</td>
<td>District Health Information Software 2</td>
<td>rt-PCR</td>
<td>reverse transcription polymerase chain reaction</td>
</tr>
<tr>
<td>HCW</td>
<td>health care worker</td>
<td>RDT</td>
<td>rapid diagnostic test</td>
</tr>
<tr>
<td>ICU</td>
<td>intensive care unit</td>
<td>SMS</td>
<td>short message service</td>
</tr>
<tr>
<td>ID</td>
<td>identification code or number</td>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>MOH</td>
<td>Ministry of Health</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1 Overview of the assessment
2 Summary and key themes
3 Country-specific findings
Interview guide

Interview questions related to the following themes:

- Status of COVID-19 diagnostic testing
- Patient testing process
- Provider procedure and training
- Data reporting
- Supply chains
Interview guide

The following **expanded use cases** for COVID-19 Ag RDT data capture solutions were explored during stakeholder interviews:

- **Referral support**
  Identifying and arranging nearby health facilities for follow-up or care

- **Patient management**
  Communicating with patient before and after visit

- **Overall clinical management**
  Monitoring patient, contact tracing, and offering care

- **Digital record keeping, reporting, surveillance**
  Collecting, aggregating, and exchanging all data associated with patient COVID-19 management

- **Capacity-strengthening**
  Supporting and training health care workers

- **Supply chain support**
  Procuring supplies and inventory management
Country-specific findings

Brazil
India
Senegal
Vietnam
Zambia
Details of interviews conducted in Brazil

List of abbreviations used in this section:

CPF: National Person ID Number

e-SUS: electronic Unified Health System

GAL: Laboratory Environment Management System

LACENs: Central Laboratories of Public Health

PAHO: Pan American Health Organization

SIVEP: Epidemiological Surveillance Information System

UPA: Emergency care unit

Please note the following factors of interviews conducted in Brazil:

• Some interviewees (2 of 5) provided robust information specific to their local/regional contexts and, as such, their information/perceptions are not necessarily applicable to the broader national context—these points have been called out as state-level observations.

• Interviews were conducted by and analyzed in collaboration with partners at Global Health Strategies in Rio de Janeiro.
Since the onset of the pandemic, **testing capacity has advanced rapidly in Brazil**. Deployment of Ag RDTs marked an important advancement in improving capacity and detection of cases in early 2021, with support from PAHO.

**Who gets tested?**
- Symptomatic patients within 5-7 days of symptom onset only
- Prioritization of **severe** cases, patients with comorbidities, and contact tracing
- No asymptomatic patients at risk of false negative unless identified via contact tracing

**Where does testing occur?**
- Primary health units
- Emergency health units
- Public and private hospitals
- Drugstores within private health care system
- Central Laboratories of Public Health (LACENs)
- Biochemistry labs at public and private hospitals
- Private lab system

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“No self-testing is being conducted in Brazil at this time.”

“The main challenge is related to the general population’s understanding of what the appropriate moment and type of test for each case is. When the patient presents for testing, even if they are asymptomatic, it is hard for the professional to refuse testing. It is a challenge to have a population that is already mentally vulnerable in various forms to understand this.”
Patient testing process

Patient presents at public or private facility for testing

- PCR test samples sent to health unit with testing capabilities
- Ag RDT performed on-site

Patient receives results

- Patient recommended to isolate at home until results communicated within 48-72 hours
- Results reported by telephone, WhatsApp, email, or patient/family member picking up a report at the health unit (varies by municipality/team)
- Results available in 15 minutes at the point of care

Clinical management in the event of a positive result

- If Ag RDT only, **PCR conducted to confirm** quarantine, isolation, or medication
- Immediate referral based on clinical status
- The patient is **isolated** and informed that contacts should also be tested, usually with Ag RDT
- Surveillance is contacted for **contact tracing**
- Contacts are listed in municipal platform and patient sent home to self-isolate though self-isolation is **not always feasible**

*The biggest challenge for health professionals is to monitor contacts, as people who live with positive patients still have to go to work and usually can’t self-isolate. Many health units have separate tents to screen suspected and confirmed COVID-19 patients.*

These steps do not apply to drugstore Ag-RDT testing in the private sector where, though it is mandated, reporting of results into surveillance systems is not always followed, and no monitoring of or following up with patients is conducted

“The main challenge is for the patient information to be available for surveillance to track contacts. It would be good if systems were integrated.”
Facility and testing environment

- Initial data collection occurs on paper-based form
- Majority of clinics have internet access, though more limited in rural settings, for which paper reporting is key

Tracking different tests:

- For Ag RDT, patient’s initials are written on device
- For PCR, non-standard label with patient’s initials and reference number

<table>
<thead>
<tr>
<th>Data collection form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of health unit</td>
</tr>
<tr>
<td>National person ID number (CPF)</td>
</tr>
<tr>
<td>Date of birth</td>
</tr>
<tr>
<td>Mother’s name</td>
</tr>
<tr>
<td>Demographic data</td>
</tr>
<tr>
<td>Comorbidities and symptoms</td>
</tr>
<tr>
<td>Testing data and results</td>
</tr>
</tbody>
</table>

Trainings and support

- MOH provides training to State Surveillance and Laboratory units which are in turn responsible for training all other HCWs
- Since training and testing coordination is provided at the state level, fragmentation exists around type of training provided at the facility level
- Training materials developed for quality assurance (created by PAHO) and state-level units are used
- Informal training channels exist between state-level units. One State Surveillance organization developed a video, which ended up being so helpful, it was circulated to multiple units
- Drugstore and laboratory staff lacking adequate training

“The video helped a lot. It has been successfully used, thus, demystifying training and sample collection for testing. There is now an understanding that there is no more need for in-person training led by highly qualified health professionals, and it has become clear that the sample collection can even be performed by the patient [in the case of nasal swab].”

“It is consensus that the appropriate amount of information for COVID reporting should be the minimum, as a large form would not be compatible with the volume of data to be reported.”
Ag RDT data are first recorded on paper or spreadsheets and then separately reported through 3 different systems:

**A platform exclusive to municipality health units**
- States and municipalities have developed a level of autonomy from the MOH regarding information systems
- Does not integrate with other systems

**e-SUS AB**
- Primary health care data system
- Registration into this platform is made per primary health care units
- Data within system managed by municipality health department, but broader database managed by MOH

**e-SUS Notifica**
- Federal system for reporting cases
- Any health professional can report through this platform, including the private sector
- Data on mild symptoms is exported and managed by the municipality’s surveillance area
- Many COVID-19 cases initially are put into SIVEP, which is for severe acute respiratory infections
- Recent launch of monitoring module but no centralization efforts yet

**GAL**
- Laboratory environment manager
- Molecular PCR results are input into this platform
- There is no space for reporting of Ag RDT results in this platform
- No link exists between Ag RDT and PCR data

**Conecte SUS**
- Patient-facing portal
- Allows citizens to view clinical history through mobile device or web browser
- Integrated with e-SUS Notifica, from which data is automatically transferred
- Not linked to private healthcare system
- Is helpful for vaccine tracking and test result reporting, but not contact tracing

"This triple data entry poses a challenge to knowing where antigen test data lies."

These 4 systems are robust at a national level but lack flexibility which makes contact tracing difficult.
**Uses for reported data**

- **OpenData SUS** contains data for MOH including confirmation of case, state, epidemiological, and demographic data from e-SUS Notifica
- TabNet tool within OpenData SUS **updated daily** with aggregated data made available by MOH
- MOH makes data available to municipalities, restricted to **in-house servers**
- Municipality’s Institute of Informatics works with servers and has data center to make data from OpenData SUS available to public
- Municipality has a **COVID-19 data dashboard** automated for use by the press and health managers

**Redundancies and inefficiencies**

- Systems are **not integrated**, causing duplicative entry
- **Transcription of data** from paper to electronic systems is a key challenge, particularly when COVID-19 case volume is high
- There are many local nuances because municipalities are using a **wide variety of tools** and each state has their own approach for reporting results into required systems
- At emergency care units (UPAs) data is reported on paper only, and pharmacies do not report at all, causing underreporting
- Unequal access to technologies with **significant local and regional inequities**

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“It is hard work and time consuming to report several times on several different platforms.”

“A tool that could integrate the databases used by health professionals would be very useful.”

“The biggest challenge is to maintain the quality of the database, as, for this, it has to be done for several other databases.”
**Supply chain**

### Supporting organizations
- In early 2021, PAHO donated many Ag RDTs to Brazil
- At the state level, there may be health surveillance foundations to lead procurement process

### Procurement systems
- MOH manages procurement at the central level
- **States** have a strategic input system to qualify usage of medication, tests, and other supplies
- Each **municipality** also has their own supply management systems within the health units and must report to the state to receive supplies. This is managed by the Sub-Secretariat
- Emergency procurements and biddings also exist

### Supply security issues
- Appropriate use and stock control
- Distribution and allocation of resources appropriately to **avoid waste**
- Managing distribution to health units with low volumes of patients

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"[Tracking supplies for COVID-19 testing] is managed through the central system that also distributes it to the health units. The health units must report their needs/consumption to receive more batches."
<table>
<thead>
<tr>
<th>What’s working</th>
<th>Challenges</th>
<th>Opportunities to leverage a digital solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Referral support</strong></td>
<td>- Referral (often through WhatsApp) of patients with positive results</td>
<td>- Currently no digital platform for referral support</td>
</tr>
<tr>
<td><strong>Patient management</strong></td>
<td>- Using WhatsApp, telephone, and Conecte SUS to contact patients&lt;br&gt;- Immediate reporting of Ag RDT results to patient at POC</td>
<td>- Misinformation on COVID-19 testing and treatment (e.g., early use of serological tests)&lt;br&gt;- Poor monitoring of contacts and compliance with self-isolation</td>
</tr>
<tr>
<td><strong>Overall clinical management</strong></td>
<td>- Various levels of care available to citizens</td>
<td>- General population lack awareness regarding when to get tested&lt;br&gt;- Multiple tests conducted for the same infection may be reported as new cases</td>
</tr>
<tr>
<td><strong>Digital record keeping, reporting, surveillance</strong></td>
<td>- Healthcare workers (HCWs) can enter data into various systems to be aggregated</td>
<td>- Use of paper systems at local level&lt;br&gt;- Underreporting of cases&lt;br&gt;- Parallel reporting, and non-standardized municipal systems&lt;br&gt;- Variable reporting rates depending on the level of the health care professional&lt;br&gt;- Incomplete information</td>
</tr>
<tr>
<td><strong>Capacity-strengthening</strong></td>
<td>- In general, Ag RDT use is being implemented as per WHO guidelines</td>
<td>- Limited time available for health professionals&lt;br&gt;- Some HCW compliance challenges with testing guideline adherence</td>
</tr>
<tr>
<td><strong>Supply chain support</strong></td>
<td>- Centralized system for procurement of supplies</td>
<td>- Appropriate use and stock control&lt;br&gt;- Waste mitigation and accurate ordering</td>
</tr>
<tr>
<td><strong>Digital ecosystem</strong></td>
<td>- General population own and use mobile technologies&lt;br&gt;- Multiple data reporting systems exist&lt;br&gt;- Cloud services for internal information exchange (Microsoft Teams, OneDrive)</td>
<td>- Lack of resources for data analysis&lt;br&gt;- Existing information systems not interoperable&lt;br&gt;- Information systems have been adapted to fit local context hindering data sharing</td>
</tr>
</tbody>
</table>
Country-specific findings

Brazil
India
Senegal
Vietnam
Zambia
Details of interviews conducted in India

List of abbreviations used in this section:

HMIS: Health management information system

ICMR: Indian Council of Medical Research (within Department of Health Research, Ministry of Health and Family Welfare, Government of India)

iGOT: Integrated Government Online Training

MOHFW: Ministry of Health and Family Welfare

SRF: Sample registration form

Please note the following factors of interviews conducted in India:

• The 5 stakeholder interviews in India were conducted in July and August 2021

• Ag RDT implementation rapidly expanded during the 2nd Wave
Status of COVID-19 diagnostic testing

During the 1st Wave, testing was dependent on rt-PCR due to inadequate Ag RDT performance. When the 2nd Wave occurred, Ag RDT capacity rapidly expanded with high-quality Ag RDTs.

Who set minimum standards of how many should be testing per million population but in India it is hard to test ~300,000 people per million people.

Who gets tested?

- Anyone who walks into testing center should first be screened with Ag RDT
- Random testing at municipal corporation buildings with high traffic (e.g., bus, train station)
- District hospitals (accumulate samples from public and community health centers)
- National laboratories
- COVID-19 care centers for high-risk or symptomatic patients
- Anyone who walks into testing center should first be screened with Ag RDT
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- Random testing at municipal corporation buildings with high traffic (e.g., bus, train station)
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Mass testing
- Testing centers
- Sample collection centers within health system
- Public and community health centers

Targeted testing
- District hospitals
- COVID-19 care centers for high-risk or symptomatic patients

Self-testing with COVID-19 Ag RDT kits has begun, but there is hesitance, and few are proactively buying kits.

Digital solution can help – potentially as a software at central level that can push to mobiles of doctors and give overview of revisions and encourage to follow them.

Central portal for updated guidelines exists but it is still difficult for users to keep up to date with new or changing guidelines.

“WHO set minimum standards of how many should be testing per million population but in India it is hard to test ~300,000 people per million people.”

Where does testing occur?

Ag RDT

rt-PCR

Ag RDT

rt-PCR

Ag RDT

rt-PCR

Ag RDT

rt-PCR

Ag RDT

rt-PCR

Ag RDT

rt-PCR

Ag RDT

rt-PCR

Ag RDT

rt-PCR

Ag RDT

rt-PCR

Ag RDT

rt-PCR

Ag RDT

rt-PCR
Patient presents for testing at sample collection center

- Patient is registered, information is captured, and lab tech collects sample
- rt-PCR
- Ag RDT

Patient receives results whether positive of negative

- rt-PCR
  - Test results uploaded to ICMR
  - Lab notifies patient of result through phone and SMS with ability to check report online

- Ag RDT
  - Test results uploaded to ICMR and HMIS (depending on facility)
  - Lab notifies patient of result verbally and with printed leaflet
  - Government officials notified of any positive results

Clinical management in the event of a positive result

- Guidance has changed since 1st Wave because strict quarantine mandates kept people from testing
- In 2nd Wave, government will provide basic supplies to a household that has a positive COVID-19 case to help care for individual
- HCWs track family members and contacts of positive cases to provide further testing guidance and track symptoms
- Community health volunteers may visit homes to promote quarantine and provide public health notifications

"Antigen test is happening at collection center which is carried out now in most of the states, test results uploaded by collection center to the ICMR portal. Whatever report result comes out, lab notifies the patient of test result"

"When Antigen test result is positive, we load the result on our HMIS system as well as the ICMR website. This is usually done within the first half an hour of the result. We upload the negative antigen report in the system [later] as well."

"Community health volunteers may sanitize building premises and put a notification up in building that this building has COVID-19 cases."
Facility and testing environment

- At collection site, patient information is collected on paper and copied onto sample tube. This information is then manually transferred into ICMR portal to automatically create and assign a SRF ID to each sample.

- Each lab has a different login for access to ICMR platform with varying permissions based on operator access level. Specific details such as operator ID and kit type must be entered.

- Many collection centers do not have access to a tablet.

Trainings and support

- MOHFW central portal has specific section for guidance, documents and webinars for training, and Integrated Government Online Training (iGOT) modules.

- HCWs check MOHFW central portal for updated guidelines but struggle to keep up with changes (e.g., some HCWs in the field are using 3-month-old guidelines).

- Staff could benefit from additional demonstrations and trainings around new guidelines.

Data collection form

- Unique SRF ID created for each sample
- Name
- National ID number
- Address
- Symptoms
- Vaccination status
- Reason for testing
- Known COVID-19 positive contacts

"In places where information isn't clearly written, when lab staff compares against the line list and can't make out what is written, they have to discard the samples."

"Jalgaon Municipal Corporation testing center in Maharashtra will ask for all information and use antigen testing first, the person is asked to enter name, address, contact, alternative contact number and primary contacts they have been in touch with in an excel sheet. We maintain a physical copy of the details to mitigate any potential system failure."
Data reporting

## Existing systems

<table>
<thead>
<tr>
<th>ICMR Portal</th>
<th>Microsoft Excel</th>
<th>WhatsApp</th>
<th>Cloud Pathology software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab information management system</td>
<td></td>
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<tr>
<td>- Data is collected on either on paper-based or Excel forms</td>
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<tr>
<td>- Once patient registration and information gathering is complete, paper-based data is <strong>manually transferred</strong> into ICMR portal by health facility staff</td>
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<tr>
<td>- All lab testing results are reported into ICMR portal</td>
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<tr>
<td>- For collection centers without testing capacity: lab staff set up <strong>WhatsApp groups</strong> to send results and reports</td>
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<tr>
<td>Data collection tool</td>
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<tr>
<td>- <strong>Data collection forms</strong> have been developed to be used in Excel across numerous health facilities</td>
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<tr>
<td>- Excel forms must be manually input into ICMR portal (unless using Cloud Pathology software)</td>
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<tr>
<td>Lab communication tool</td>
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<tr>
<td>- Labs use a closely monitored WhatsApp group to share <strong>COVID-19 reports and status summaries</strong></td>
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<tr>
<td>- Collated lists of all test results shared for easier reference and faster sharing</td>
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<tr>
<td>Private sector labs</td>
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<tr>
<td>- Developed in Maharashtra as a <strong>digital solution</strong> for private sector labs</td>
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<tr>
<td>- District commissioner enquired about how public labs could leverage system for <strong>bulk upload</strong> of rt-PCR Excel data sheets</td>
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<tr>
<td>- System has simplified data entry by connecting patient and test <strong>data flowing from initial point of contact</strong> at collection centers to <strong>result notification</strong> through ICMR portal</td>
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<tr>
<td>- Has been implemented in <strong>Punjab</strong></td>
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</tbody>
</table>
Uses for reported data

- Collection center and labs input all data into ICMR portal
- Both negative and positive results are recorded
- Government officials are notified of positive test results
- MOHFW provides data to public through online portal

Redundancies and inefficiencies

- **Duplication of work** due to paper-based data collection and online reporting
- Delays and long wait times at collection centers due to **time required to input data**
- Lab staff must manually **re-verify samples** against information digitally provided by collection center staff
- HCWs **manually** looking up new guidance rolled out by ICMR

"The re-verification of samples at lab manually against info given to clear digital format [is] another challenge [that] could be eliminated if you have seamless mechanism for digitizing data at the entry point."
Supply chain

Supporting organizations

- ICMR
- UNICEF

Procurement systems

- Procurement processes differ between state and municipal corporations
- State-level: each state procures supplies to meet testing needs which are supplied to regional warehouses, then to district-level storage, and finally to discrete collection centers.
- Municipal corporation: procure test kits through different mechanism

Supply security issues

- Stock outs from collection centers and labs occurred, but frequency of occurrence lessened throughout the 2nd Wave
- No mechanism to forecast demand by collection center
- Utilization rates are not considered when allocating supply, instead a fixed number of Ag RDTs are provided to each site

"For the Ag RDT kits, our corporation does the procurement at the local level. During the 2nd Wave, the kits were not easily available due to high demand and prices also escalated. The standardization of the kits is important because the performance of each kit varies. We only buy kits that are listed on the ICMR portal."
## What’s working, what’s not?

<table>
<thead>
<tr>
<th></th>
<th>What’s working</th>
<th>Challenges</th>
<th>Opportunities to leverage a digital solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Referral support</strong></td>
<td>Hospital patients with positive Ag RDT immediately taken to intensive care unit (ICU)</td>
<td>No data link between lab test results and admission to hospital</td>
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</tr>
<tr>
<td><strong>Patient management</strong></td>
<td>Positive and negative results available to patients through phone, SMS, and/or online portal</td>
<td>Informing patients of results can be timelier and more streamlined</td>
<td>Promotion of testing of patients, family members, and contacts</td>
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<td></td>
<td></td>
<td>Spread of misinformation</td>
<td>Dissemination of high-quality, streamlined information and guidance</td>
</tr>
<tr>
<td><strong>Overall clinical management</strong></td>
<td>Facility providers and community volunteers tend to patients and potentially affected contacts</td>
<td>Low rates of self-testing in part due to laypeople needing to report results centrally</td>
<td>Platform for easy reporting of Ag RDT self-testing results</td>
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<tr>
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<td></td>
<td>No unified system for hospital admissions or treatment protocols</td>
<td>QR code usage to verify samples between point of collection and lab testing</td>
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<tr>
<td></td>
<td></td>
<td>Sample collection methods and workflow need improvement</td>
<td>Mobile operations management platform for sample collection centers</td>
</tr>
<tr>
<td><strong>Digital record keeping, reporting, surveillance</strong></td>
<td>Inputting information through Microsoft Excel</td>
<td>High volume of testing and granular patient information make paper-based forms difficult</td>
<td>Digitization of data collection at initial point of contact with patient</td>
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<tr>
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<td>Higher volumes at public vs. private facilities</td>
<td>Connection of patient information through national ID when being tested multiple times</td>
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<td>Difficult to bulk upload completed Excel data forms</td>
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<tr>
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<td>No single mechanism for data flow between facilities</td>
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</tr>
<tr>
<td><strong>Capacity-strengthening</strong></td>
<td>Central portal with training materials and guidance</td>
<td>HCWs struggle to keep up with changing guidance</td>
<td>Centralized software that pushes out guidance updates and revisions to HCWs to encourage compliance</td>
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<tr>
<td></td>
<td></td>
<td>Lacking demonstrations or trainings for new guidance</td>
<td>Digitization of information so it can be automatically updated and disseminated</td>
</tr>
<tr>
<td><strong>Supply chain support</strong></td>
<td></td>
<td>Demand forecasting based on use rates not used</td>
<td>Inventory management system for collection centers, which can automatically track use for state-level procurement</td>
</tr>
<tr>
<td><strong>Digital ecosystem</strong></td>
<td>Robust ICMR portal for centralized data management and reporting</td>
<td>Many facilities do not have access to a tablet to complete data entry</td>
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</tr>
</tbody>
</table>
Country-specific findings

Brazil
India
Senegal
Vietnam
Zambia
Details of interviews conducted in Senegal

List of abbreviations used in this section:

IMF/MFI: Infirmier Médecin Chef [Chief Nurse]
IPD: Institut Pasteur de Dakar
IRESSEF: Institut de Recherche en Sante, de Surveillance Epidemiologique, et de Formation
(Institute for Health Research, Epidemiological Surveillance, and Training)

Please note the following factors of interviews conducted in Senegal:

• The 3 stakeholder interviews in Senegal were conducted in June and July 2021; additional interviews were unable to be scheduled due to high stakeholder involvement in and prioritization of the COVID-19 response

• Interviewees included those working at public and private health facilities
Since it is a border area, at least 400 tests were done. The MoH provided the team with a machine for PCR testing but very difficult compared to the results because the whole region of St Louis was directed to the district of Richard Toll. Fortunately, RDT is available.

MOH guidelines only permit Ag RDT and PCR testing at public health facilities due to training requirements and lack of infrastructure at private facilities. Private facilities must refer patients to public facilities for Ag RDT or PCR tests.

**Patient testing process**

**Who gets tested?**
- Patients suspected of having COVID-19
- Confirmation of Ag RDT tests
- Travelers

**Where does testing occur?**
- Border areas
- Hospitals and health facilities
- Public health facilities (not in private facilities)
- Point of care settings
- Some occupational settings (i.e., agribusinesses)

IPD, a private lab, is an exception to this mandate. At the beginning of the pandemic, all public health districts sent samples to IPD for testing.

"Since it is a border area, at least 400 tests were done. The MoH provided the team with a machine for PCR testing but very difficult compared to the results because the whole region of St Louis was directed to the district of Richard Toll. Fortunately, RDT is available."
Patient’s testing process

Many health care workers are not confident in the performance on Ag RDTs and often send all patients, regardless of result, for PCR confirmatory testing.

**Patient presents for Ag RDT testing**
- Private facility
  - Sample collected at private facility and sent to public facility for testing
- Public facility
  - Doctors conduct Ag RDT directly with patient

**Patient receives Ag RDT and confirmatory PCR results in 3-4 days**
- Whether positive or negative, patient is referred to public health district facility for confirmatory PCR testing
  - Patient receives results and follow-up via phone or WhatsApp
- If positive, patient is sent to health district for confirmatory PCR testing
  - Patient receives results and follow-up via phone or WhatsApp
- If negative, result is recorded on notification sheet and patient receives confirmatory PCR testing
  - Patient receives results and follow-up via phone or WhatsApp

**Clinical management in the event of a positive result or suspected case**

- Hospitalized patients receive results from attending physician
- If results are negative, but patient is hospitalized and has COVID-19 symptoms, they will be referred to a specialist
- Patient receives advice based on MOH guidelines, such as remaining at home and limiting contact with others. Follow-up is conducted via phone or WhatsApp
- If a positive patient’s symptoms are severe, and there is space in the health facilities, the patient will be hospitalized

“Before, if it was the doctor who sent the patient, symptomatic treatment is requested while pending the result. Guidance is also provided. And after result, the information is given directly to the person tested, advice is provided, how to behave at home, procedures to follow. It also depends on MoH recommendations/guidelines that change over time.”

Many health care workers are not confident in the performance on Ag RDTs and often send all patients, regardless of result, for PCR confirmatory testing.
Facility and testing environment

- At the beginning of the pandemic, healthcare workers would visit community members to conduct sample collection for testing. Now, **the samples are taken in a healthcare setting**, unless the patient is unable to move.

- An Ag RDT can be done by public doctors at the point of care, but samples for PCR testing often must be transported to a location with necessary equipment.

- **Private facilities** can collect samples, but cannot conduct Ag RDT or PCR testing, as per MOH guidelines.

- Patient data is collected **during registration at the health care facility’s reception**.

- Patient data is recorded **on paper form**, then transferred into Excel.

Trainings and support

- **IPD** initially supported sample testing, but it is now done by **IRESSEF and the national lab**.

- **MOH supports training** of IPD, IRESSEF, and other permitted facilities on how to run Ag RDT and PCR tests, as well as training on health information systems.

Data collection form

| Demographics (patient and household information) | Patient ID number |
| Symptomatic data (checkbox of symptoms + timing of symptoms) | Recent entry into country |
| Sampling location | Previous diagnoses |
| Medical region, district, and post. | Risk factors and medical history |

**"The difficulty lies in the delivery of the sample and compliance with the transport conditions at the level of the health centre concerned, which can go up to 114km away."

**"At the beginning of COVID-19, it was just demographic aspect. The information requested is now (surname, first name, date of birth, address, symptoms, clinical signs, anticipation (prior tests, vaccinated, other chronic diseases [such as] diabetes...)"**
### Existing systems

<table>
<thead>
<tr>
<th><strong>DHIS 2</strong></th>
<th><strong>Microsoft Excel</strong></th>
<th><strong>WhatsApp &amp; Email</strong></th>
<th><strong>Alert Cell</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data reporting tool</strong></td>
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<tr>
<td><strong>Data collection tool</strong></td>
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<tr>
<td><strong>Patient and HCW communication</strong></td>
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<tr>
<td><strong>Patient contact tool</strong></td>
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</tbody>
</table>

- **MOH** digital tool for patient data and contact tracing
- Includes clinical information and test results, patient contacts, screening date, and more
- **Districts** also have access to this system

- Data **transcribed** from paper registration forms and results cards into Excel sheets
- Shared with IPD **every 15 days**
- Excel template exists to share **daily information** on Ag RDTs performed with chief physician, medical region, and MOH

- WhatsApp used for sharing **results** and conducting **follow-up** with patient
- HCWs also share **guidance** and ask questions via WhatsApp
- Email used for **sharing reports** to other facilities or MOH

- Phone number people could call at the beginning of the pandemic if they were **symptomatic**
- Phone operator would collect necessary patient information and send nearby facility worker to patient’s address

---

“The information is always shared with the patient at the moment with an explanation provided. If RDT is negative, the patient is recorded on the notification sheet and will then be accompanied to [take another] sample for a PCR. This allows the attending physician to have as well as the chief physician, the medical region, and the MoH. The notification sheets are scanned daily to inform of the RDTs performed, an Excel template is attached to give the daily information.”

“At the beginning of COVID-19, people called the alert cell, which did the investigation, [were] asking for the necessary information and sent to the affiliated facility according to the patient’s address.”
**Data reporting**

**Uses for reported data**

- **Patient follow-up** by nursing staff (MFI/IMF), including sharing test results and necessary actions to take, as well as contact tracing
- Reporting daily updates, such as number of Ag RDTs performed, to district and regional leadership, as well as the MOH
- Record patients who tested negative by Ag RDT that require confirmatory PCR test
- **Inventory tracking** based on number of Ag RDTs used per day
- **Ag RDT allocation** to different health districts, based on number of patients getting tested in different regions

- **Incomplete information** on registration forms makes it difficult to report and track patients
- Patients do not always have all necessary information
- **Duplicative entry due to** registration data on paper form which must be transferred to Excel
- Time needed to transfer data from paper to electronic systems is a key challenge. Double data entry at all health facilities
- Difficulty generating **timely** reports

"The MFI/IMF, made up mainly of the district management team, coordinates to identify patients and share the results of their tests, as well as the actions to be taken. For hospital patients, the information is given to the attending physician and the patient."

"More than 10,000 tests are carried out, which is tedious, too many papers/paperwork... in order to have real-time information."
Supply chain

Supporting organizations
- National Pharmacy distributes Ag RDTs based on notifications received from health districts

Procurement systems
- Supplies are managed by testing facilities
- Stock of supplies is managed at the district level
- Facilities inform National Pharmacy when Ag RDT supplies are low
- National Pharmacy provides additional stock to medical region, which then allocates Ag RDTs to lower levels

Supply security issues
- MOH suspended use of publicly purchased Ag RDTs due to concerns around test performance
- All COVID-19 tests must be validated in Senegal before approved for use

As most interviewees were working at the facility level, they were not dealing directly with the procurement of supplies and unable to provide detailed responses

"COVID-19 supplies monitored in the testing structure - Stock management (for sampling kits, medicines, etc.) managed by the district management team (management of incoming, outgoing, threshold, etc.)."
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<tbody>
<tr>
<td><strong>Referral support</strong></td>
<td>- Patients who present at private facilities are referred to or have samples sent to <strong>public facilities to ensure technicians have proper training</strong> in Ag RDTs and PCR tests</td>
<td>- System to coordinate optimal transport of samples across long distances (up to 114 km)</td>
</tr>
<tr>
<td><strong>Patient management</strong></td>
<td>- Initiating symptom treatment while results are pending - Confirmatory PCR testing, regardless of Ag RDT result, <strong>ensures fast and improved care of patients</strong></td>
<td>- Digital hub where patients can return to a clinic or any computer to view results, regardless of whether they have a cell phone</td>
</tr>
<tr>
<td><strong>Overall clinical management</strong></td>
<td>- Notification sheets of negative results shared with attending physician, chief physician, medical region lead, and MOH - HCWs use WhatsApp to seek advice</td>
<td>- HCW concerns around Ag RDT test performance due to lack of trust in results</td>
</tr>
<tr>
<td><strong>Digital record keeping, reporting, surveillance</strong></td>
<td>- Time required to transfer data from paper to Excel makes it difficult to generate real-time reports - Missing data can make it difficult to conduct patient follow-up</td>
<td>- Central database for all forms to be used for generating useful reports</td>
</tr>
<tr>
<td><strong>Capacity-strengthening</strong></td>
<td>- Private facilities cannot conduct Ag RDT or PCR testing due to lack of training and infrastructure</td>
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</tr>
<tr>
<td><strong>Supply chain support</strong></td>
<td>- National Pharmacy allocates stock of Ag RDTs to medical regions, which allocate to facilities - Ag RDT allocation based on notification reports about daily Ag RDT use in different regions</td>
<td>- Facilities do not have control over supply stock - Connection between facilities and district level for inventory management</td>
</tr>
<tr>
<td><strong>Digital ecosystem</strong></td>
<td>- DHIS2 for tracking patient information, sampling date, results, and contact tracing - Sharing reports via email in Excel sheets to inform stock allocation</td>
<td>- Internet connectivity and infrastructure challenges</td>
</tr>
</tbody>
</table>
Country-specific findings

Brazil
India
Senegal
Vietnam
Zambia
The COVID-19 situation in Vietnam has evolved very quickly and significantly since these 5 interviews were conducted in May and June 2021, there have been large outbreaks in many provinces and large cities of the country.

As an urgent response to the situation, widespread implementation of Ag RDTs has occurred in August and September 2021, differing from information provided in the interviews.

In September 2021, colleagues in the PATH Vietnam office provided updated information regarding Ag RDT use to supplement what was collected during stakeholder interviews.

Please note the following factors of interviews conducted in Vietnam:

- The COVID-19 situation in Vietnam has evolved very quickly and significantly since these 5 interviews were conducted in May and June 2021, there have been large outbreaks in many provinces and large cities of the country.
- As an urgent response to the situation, widespread implementation of Ag RDTs has occurred in August and September 2021, differing from information provided in the interviews.
- In September 2021, colleagues in the PATH Vietnam office provided updated information regarding Ag RDT use to supplement what was collected during stakeholder interviews.

List of abbreviations used in this section:

CDC: Centers for Disease Control and Prevention

DIC: Department of Infection Control

GDPM: General Department of Preventive Medicine

HCW: Health Care Worker

LIMS: laboratory information management system

NIHE: National Institute of Hygiene and Epidemiology

PIHCM: Pasteur Institute in Ho Chi Minh City
Status of COVID-19 diagnostic testing

Since the onset of the pandemic, the testing strategy has evolved significantly in Vietnam. Despite an initial reliance on molecular testing, deployment of Ag RDTs occurred in response to massive outbreaks across the country.

Where does testing occur?

- Provincial CDCs
- Private and public hospitals and labs
- PIHCM
- Community screening test points
- Resident homes
- Factory/business screening sites

Who gets tested?

- Travelers entering the country
- Individuals exiting period of home isolation
- Symptomatic patients presenting at select hospitals for screening
- Individuals living in outbreak or high-risk areas
- Shippers, workers, and other people who provide services in outbreak or high-risk areas
- Patients with positive Ag RDT result

MOH has provided detailed guidance on how to use Ag RDTs and confirm positive cases by rt-PCR. However, Ag RDT implementation and follow-up activities differ widely across the country.

"The MOH currently recognizes only one test to confirm for sure whether a patient has COVID-19 or not, which is the PCR test. The rest of the tests are for screening purposes only. Therefore, when using rapid tests for antibodies or antigens, it is possible to give initial information, for initial processing only. We still need the PCR test to have a confirmatory value. This is specified in the official guidance of the Ministry of Health."
Patient PCR testing process

The information presented on this slide reflects the COVID-19 testing situation as of May and June 2021, before the advent of Vietnam’s 4th Wave – when PCR tests were still primarily used. Patient’s experience with Ag RDT are outlined on the following slide.

Patient presents for PCR testing

- Patient sample tested in health unit with PCR capabilities

Patient receives results within 24 hours, but only if positive

- If positive, patient receives result verbally from health care provider. Results sheet only available upon request
- If negative, patient is not informed

If purpose for testing is for travel, patients would receive their result directly from the lab and be notified of negative results.

Clinical management in the event of a positive result

- Patients sent to isolation ward or directed to home quarantine; if seriously ill, patient will be transferred to intensive care unit
- DIC may initiate contract tracing
- Provincial CDC reviews results and determines whether patient should be quarantined or released
- Electronic medical records are updated to reflect results

Method of returning results varies by case:

1. Screening sample sent by different unit/hospital
2. Patient being treated at same hospital with testing facilities
3. Travelers registering at hospital with testing facilities

“We do not automatically issue the test results for any group of diseases. With the COVID-19 results, we only inform them informally, and do not return result slips. Except for HIV cases, [for which] a paper-based copy will be returned to the patient. This is a regulation of the State.”
Patient Ag RDT testing process

Although some Ag RDTs were deployed at the discretion of provinces and cities before Vietnam’s 4th Wave of COVID-19, the dynamic and rapidly evolving situation has significantly increased their use within the country.

Examples of Ag RDT use across Vietnam:

In Hanoi people are required to stay home; all non-essential activities have been halted since July, and the city is divided into red, orange and green zones based on infection risk.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Testing Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red zone, quarantine camp,</td>
<td>3x testing per week</td>
</tr>
<tr>
<td>and isolation area</td>
<td></td>
</tr>
<tr>
<td>Orange or green zone</td>
<td>1x testing per week</td>
</tr>
</tbody>
</table>

In Southern Vietnam,

- Used widely without confirmatory PCR testing
- Community members encouraged to self-test to unburden health system

Across the country as of September 2021,

- Outbreak or high-risk areas 1x testing per 1-2 weeks
- Shippers, workers, travelers, and other public service providers use Ag RDT often

While the MOH has provided guidance on how to use Ag RDTs and confirmatory PCR testing, the patient and provider experiences differ significantly between regions.
Provider procedure and training

Facility and testing environment

- Testing occurs in various settings such as health care facilities, community testing centers, and occupational settings.
- Testing center and healthcare ward configurations are frequently rearranged to accommodate patient numbers.
- Distancing recommendations are often violated at testing sites in severe outbreak areas.
- A critical operations concern is to ensure all patients are admitted and obtain medical care in a timely manner.
- Labs write down patient information on paper form and sample tubes then enter patient data and test results into computer.

Trainings and support

- CDC used Ag RDT testing to support training in hospitals.
- PIHCM trains members of Hospital of Tropical Diseases which in turn trains more HCWs at various hospitals.
- HCWs and lab technicians have group chats to receive advice on treatment, diagnosis, and machine maintenance.
- Some interviewees expressed concerns that online/virtual training would be ineffective, and they prefer staff to have in-person training.

Data collection form

<table>
<thead>
<tr>
<th>Community Testing Center</th>
<th>Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td>Demographics</td>
</tr>
<tr>
<td>Occupation</td>
<td>Occupation</td>
</tr>
<tr>
<td>Previous diagnosis</td>
<td>Previous diagnosis</td>
</tr>
<tr>
<td>Exposure class (F1, F2, etc.)</td>
<td>Exposure class (F1, F2, etc.)</td>
</tr>
<tr>
<td>Sampling location</td>
<td>Risk factors, medical conditions, and symptoms</td>
</tr>
<tr>
<td>Patient code</td>
<td>Patient code</td>
</tr>
</tbody>
</table>

"People have arranged a group chat where we can send a photo/message the group and get advice from experts in diagnostics, treatment or fixing machines. I find this form of support more convenient [than scheduling a meeting] because [we] don't have time flexibility."

"The most important information is the patient's risk factors, including contact history, such as where they went, with whom they came into contact. We collect all the information according to the regulations of the State. However, during the fight against the pandemic or during community screening, with thousands of samples to be taken, it is difficult for us to collect and fill in all this information form by hand. So, in these cases, we only get general information such as full name, age, address, gender, sampler, sampling date, etc."
Data reporting

## Existing systems

<table>
<thead>
<tr>
<th>LIMS CDC (preventive sector)</th>
<th>Labconn Software Hospitals (curative sector)</th>
<th>Microsoft Excel Data aggregation tool</th>
<th>Viettel Software/Portal Lab management</th>
<th>VIETTIN Lab management</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Works at provincial and district levels for data importation</td>
<td>• Data entered in Excel spreadsheets and posted to Labconn</td>
<td>• Used in conjunction with Labconn</td>
<td>• Used by provincial CDCs</td>
<td>• Provides health information system for testing labs at hospitals</td>
</tr>
<tr>
<td>• For NIHE: Tracks specimen collection, epidemiological data, specimen processing, and results returning</td>
<td>• Results and reports can be sent back to hospital via Excel and reuploaded</td>
<td>• Used by NIHE</td>
<td>• Manages processing specimens, not patient data</td>
<td>• Cloud storage capabilities, but facilities prefer local storage</td>
</tr>
<tr>
<td>• For PIHCM: all the above except sample collection</td>
<td></td>
<td>• Offline capability so no requirement for 3G or 4G</td>
<td>• Automatically appoints tasks to different unit, depending on stage in workflow</td>
<td></td>
</tr>
<tr>
<td>• Some issues with implementation due to lack of infrastructure</td>
<td></td>
<td>• Workforce has existing knowledge of tool, and it is easy to use by those with low IT skills</td>
<td>• Coordinates between Epidemiology Department and Diagnosis Department</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Able to handle large amounts of data</td>
<td>• Some issues with duplication and syncing patient codes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Easily adaptable to fit needs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**“We now have several online software, even free and using open-source codes which allow people to customize to their needs. But it still requires investment in infrastructure. 3G and 4G networks are not available in all communes and districts. And too many entries at the same time can cause system lags. In the situation of COVID-19 pandemic, we have to deal with a large number of samples/specimens, with huge volume of information to manage.”**

Viettel and VIETTIN are two of several software companies providing digital lab management solutions.
Uses for reported data

Provincial level

- Provinces that lack lab capacity send specimens to NIHE for confirmation where they review data before providing results back to health units for patient notification
- Provincial CDCs manage test results and determine whether patients need to remain quarantined or can be released
- Provincial Department of Health and COVID-19 Provincial Steering Committees receive all testing reports
- In some provinces, DIC uses reported data to initiate contact tracing

MOH

- GDPM receives list of positive cases and issues patient code to “announce” case and update case count; currently, because the number of cases increased dramatically, patient codes are not being issued or managed
- MOH manages a web-based portal that contains data related to the epidemic including new cases, old cases, total case count, hospitalizations, treatment, isolation areas, contact tracing, cases in isolation areas, and implementation of activities

Redundancies and inefficiencies

- Duplicative codes may be generated for one patient who has been tested multiple times to appear as multiple people
- Transfer of data from paper to electronic systems is a key challenge, particularly when COVID-19 case volume is high and in community screening settings
- Different units have different data reporting requirements and practices, leading to data discrepancies or redundancies
- Data must be incorporated from multiple sources to generate reports
- Many sites have limited internet connections and lack personal connections for work, leading to different levels of access due to lack of infrastructure or resources

“I think the biggest challenge is that there is no standard for a medical management software. The same circular is acknowledged and applied differently in different units. It is the same for standardizing data, information [exchange] within the software, etc. There is still no specific standard for all facilities to follow.”
Supply chain

Supporting organizations

- WHO provides support for specimen collection kits
- MOH and social health insurance cover costs of testing

Procurement systems

- Microsoft Excel used for supply chain management and inventory tracking
- Specific warehouse management software, separate from Labconn, used by hospitals
- Hospital of Tropical Diseases: Lab Department informs Department of Supplies and Faculty of Pharmacy what supplies are needed then Faculty of Pharmacy coordinates receipt of quotes and bidding and gets approval from Director
- CDC: Diagnosis Department informs Finance & Accounting Department of what supplies are needed to conduct purchases
- PIHCM: Supply Chain Management Department provides and manages biological products.
- Departments only request generic items, not specific brands of tests or supplies

Supply security issues

- Government required procurement processes are not amenable to emergency situations often stalling supply
- Supply estimation is difficult due to rapidly changing situation
- Fluctuations in pricing of supplies makes it difficult to get proper funding

“We already have multiple available circulars and guidance on which kit to be used as well as their unit price. They have been all well studied and announced by the Ministry of Finance. Hence, we have no choice about brand or price, we can only choose the type of test we want to use.”
<table>
<thead>
<tr>
<th>What’s working</th>
<th>Challenges</th>
<th>Opportunities to leverage a digital tool</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Referral support</strong></td>
<td>Viettel software for sample management and transfer between departments</td>
<td>Results sheets not provided for patients for potential referral</td>
</tr>
<tr>
<td><strong>Patient management</strong></td>
<td></td>
<td>Difficult to maintain social distancing at community screening sites during COVID-19 outbreaks</td>
</tr>
<tr>
<td></td>
<td>Viettel software for sample management and transfer between departments</td>
<td>Lacking sample transfer mechanism</td>
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<td></td>
<td>Results sheets not provided for patients for potential referral</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lacking sample transfer mechanism</td>
<td></td>
</tr>
<tr>
<td><strong>Overall clinical management</strong></td>
<td>Use of Ag RDT to screen in remote environments</td>
<td>Different departments/organizations have different data management systems (e.g., epidemiology department vs. testing department)</td>
</tr>
<tr>
<td></td>
<td>Difficult to maintain social distancing at community screening sites during COVID-19 outbreaks</td>
<td>Concern about Ag RDT performance but unable to confirm with PCR</td>
</tr>
<tr>
<td></td>
<td>Negative results not delivered to patients</td>
<td></td>
</tr>
<tr>
<td><strong>Digital record keeping, reporting, surveillance</strong></td>
<td>Excel is easy to use and adapt to different needs</td>
<td>Time to collect or transfer data</td>
</tr>
<tr>
<td></td>
<td>Time to collect or transfer data</td>
<td>Incomplete data capture especially in outbreak settings</td>
</tr>
<tr>
<td></td>
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<td>Complicated administrative procedures and forms preparation associated with reporting</td>
</tr>
<tr>
<td></td>
<td>Complicated administrative procedures and forms preparation associated with reporting</td>
<td>Quality checks are difficult to implement due to lack of standardization</td>
</tr>
<tr>
<td><strong>Capacity-strengthening</strong></td>
<td>Use of group chats to seek guidance and advice from other HCWs</td>
<td>Limited time available for health professionals</td>
</tr>
<tr>
<td></td>
<td>Limited time available for health professionals</td>
<td>Lack of time for training HCWs on new tools</td>
</tr>
<tr>
<td></td>
<td>Lack of time for training HCWs on new tools</td>
<td></td>
</tr>
<tr>
<td><strong>Supply chain support</strong></td>
<td>For each health facility, technical departments propose a list of test kits and consumables; financial departments will arrange bidding and procurement of the necessary commodities</td>
<td>Supply estimation difficult due to rapidly changing situation</td>
</tr>
<tr>
<td></td>
<td>Supply estimation difficult due to rapidly changing situation</td>
<td>Pricing fluctuations make it difficult to secure necessary funding</td>
</tr>
<tr>
<td></td>
<td>Pricing fluctuations make it difficult to secure necessary funding</td>
<td>Mandated bidding process is not amenable to emergency situations</td>
</tr>
<tr>
<td></td>
<td>Mandated bidding process is not amenable to emergency situations</td>
<td></td>
</tr>
<tr>
<td><strong>Digital ecosystem</strong></td>
<td>Plans to develop overall health information management system</td>
<td>Investment in infrastructure required to use many existing digital solutions (i.e., internet connection)</td>
</tr>
<tr>
<td></td>
<td>Plans to develop overall health information management system</td>
<td>Need to pay extra cost to add on COVID-19-specific management modules to existing digital tools</td>
</tr>
<tr>
<td></td>
<td>Need to pay extra cost to add on COVID-19-specific management modules to existing digital tools</td>
<td>Many regions do not have internet/3G or 4G</td>
</tr>
<tr>
<td></td>
<td>Many regions do not have internet/3G or 4G</td>
<td></td>
</tr>
</tbody>
</table>
Country-specific findings

Brazil, N=5
India, N=5
Senegal, N=4
Vietnam, N=5
Zambia, N=5
The information was gathered during the 3rd Wave of COVID-19, from May to June 2021; since then, guidelines for Ag RDT testing have evolved in some regions.

Some information has been added by the PATH team in Zambia since September 2021.

Please note the following factors of interviews conducted in Zambia:

- The information was gathered during the 3rd Wave of COVID-19, from May to June 2021; since then, guidelines for Ag RDT testing have evolved in some regions.
- Some information has been added by the PATH team in Zambia since September 2021.

List of abbreviations used in this section:

- APHL: Association of Public Health Laboratories
- CDC: Centre for Disease Control and Prevention
- DHIS2: District Health Information Software 2
- DisaLab and DisaLink: lab information management software
- ODK: Open Data Kit
- ZNPHI: Zambia National Public Health Institute
- ZAMMSA: Zambia Medicines and Medical Supplies Agency
Earlier in the pandemic, one had to qualify for COVID-19 testing, but at this time whoever walks in and asks for the test can take the test because there are an adequate number of tests on the ground.

**Who gets tested?**

- Initially, anyone could walk in to receive testing
- As supply availability issues increase, as of September 2021, tests are being offered to patients with symptoms after they have been screened
-教程中提到的测试途径包括
  - 约300个点
  - 一些高流量的市区设施
  - 农村测试点
- If **Ag RDT is negative**, it is at the discretion of the HCW to order a PCR test especially if the patient is symptomatic
  - Travelers
  - Mass testing

**Where does testing occur?**

- ~300 sites
- Some high-volume urban facilities
- Rural testing sites
- ~20 sites
- Urban facilities

"But specifically for COVID, not every site can wake up today and say ‘we are starting to test for COVID.’ So there are labs that have been designated to test for COVID."

Data collected is only shared as an aggregate and must be stored in-house.
Patient Ag RDT testing process

Patient presents for Ag RDT testing

- Patient is screened, asked questions about potential exposure, has testing process explained and sample collected by HCW
- Results extracted from DisaLab and communicated to COVID-19 lab response overseer

Patient receives results

- HCW or surveillance team member communicates results back to patient by phone or in-person at patient's address
- Results shared with surveillance team at central level

Clinical management in the event of a positive result

- Patient is advised to self-isolate
- Care is either provided at a major hospital with capacity or at home with community-based volunteers monitoring vitals for 14 days
- Patient is interviewed by surveillance team to initiate contact tracing

- HCW follows up with all positive cases
- Results shared with district surveillance teams
- Conduct contact tracing for positive cases

"Ideally, you're supposed to test them right there and then and the results are available between 15 to 20 minutes, but some of these tests have been aggregated, so clients have to wait a bit to get their results."

"We have inadequacies in terms of reverse data reporting, if I was to put it that way, especially to report back the negative results."

"Usually, the surveillance team [make] phone calls. Where they're unable to reach the client for one reason or the other, they will just use the address that was provided on the investigation form and just make a trip to the client's house."
Facility and testing environment

- Facility staff take down **patient and clinical information** either on hard-copy forms, DHIS2 Tracker, DISA lab system or ODK (few facilities only)
- Systems in use are **open-source**

Trainings and support

- **Facility staff** are trained in COVID-19 testing and management
- Facility staff performing tests must pass **competency assessments** as a form of quality assurance support

"For now, we just want to see whether it's feasible to use existing mobile devices in the facilities to record this data"

"Basically, there needs to be an integration between the DHIS2 tracker and the DISA labs so that this information feeds directly into the National COVID [platform]."

"All the systems that we're using are open-source systems; that's the DHIS2 and ODK."

<table>
<thead>
<tr>
<th>Name</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Address</td>
</tr>
<tr>
<td>Phone number</td>
<td>Locality (e.g. hospital name, institution, district, province)</td>
</tr>
<tr>
<td>Epidemic number</td>
<td>Lab ID number</td>
</tr>
<tr>
<td>Date specimen collected</td>
<td>Date specimen received</td>
</tr>
<tr>
<td>Final result</td>
<td>Date final result reported</td>
</tr>
<tr>
<td>Comments</td>
<td></td>
</tr>
</tbody>
</table>
### Existing systems

<table>
<thead>
<tr>
<th>DisaLink and DisaLab</th>
<th>KoboCollect</th>
<th>DHIS2 Tracker</th>
<th>Microsoft Excel</th>
<th>SMARTCARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab information management system</td>
<td>Data collection tool</td>
<td>Data collection tool</td>
<td>Data sharing tool</td>
<td>Electronic health record</td>
</tr>
<tr>
<td>• Lab fills out hard copies of Lab and ZNPHI surveillance forms then input into DisaLab</td>
<td>• Currently being used in Lusaka province and at ZNPHI</td>
<td>• Currently being piloted at 20 testing sites</td>
<td>• Paper-based line list form details all RDTs conducted within 24 hours at facility level</td>
<td>• EHR system for hospitals and healthcare facilities</td>
</tr>
<tr>
<td>• DisaLab is an information management software for labs</td>
<td>• Application in ODK Collect platform for primary data collection</td>
<td>• Evaluating feasibility of using existing mobile devices in facilities to record data</td>
<td>• Either imported into Excel sheet or photo of paper-based form sent through WhatsApp</td>
<td>• Discussions are taking place as to how this will be integrated into DisaLab</td>
</tr>
<tr>
<td>• DisaLink is a module within DisaLab which allows facilities to remotely pre-register details and test requests, and create barcode labels</td>
<td>• Discussions are taking place to assess integration of KoboCollect with lab information systems</td>
<td>• Line-list generated and sent to ZNPHI for forward reporting</td>
<td>• Facility data aggregated into new Excel sheet and sent to provincial health office by email</td>
<td></td>
</tr>
<tr>
<td>• Information entered into DisaLink is electronically transferred to DisaLab</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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"Most of their labs that are doing COVID-19 testing have Disa. So, these results are entered into Disa, are authorized, extracted and they are sent to central level where consolidation and reporting is done. So, all results are sent to central-level and they are electronic."

"And one of the other tools in terms of, for example, viral load and [early infant diagnosis], there is Smartcare that is being used."
Uses for reported data

- Data is stored locally in physical servers at Infratel (formerly Zambia National Data Centre)

- Data visualization dashboards available at MOH. Only MOH has access to certain confidential data

- Every 24 hours the following data is reported: total number of tests conducted, number of positive cases, number of negative cases, and where samples originate from.

Redundancies and inefficiencies

- Transfer of hard-copy information into digital platform for centralized reporting

- Lack of standardized digital data recording tools directly linked to or integrated with DisaLab

- Varying levels of data quality and data fields collected depending on the facility

“Remember that in responding, controlling the pandemic, what's most important is to be able to identify the cases, isolate them, that's how we break through our contact tracing. And that's how we break the chain of transmission. So, this data is helpful, because when we identify in the lab, they then use this data to do their contact tracing, identify these cases, and quarantine them and do their contact tracing.”

“Depending on what is coming out of the lab, again, for instance, the positivity rates, whether it's at national level or in different provinces, will also guide; for instance, we had to revise our what I would call it - it is a testing strategy. Who should we target? Should we just go in the market and test everyone? Should we just focus on those people who have symptoms or contacts of known cases?”
Supply chain

Supporting organizations
- Clinton Health Access Initiative
- US Agency for International Development
- Chemonics
- CDC
- Global Fund

Procurement systems
- Procurement processes differ between single sites and at the national level
- Single sites/labs: Requests for equipment (e.g., PCR machines) are through direct procurement request by heads of departments to MOH
- National level: Sites request for consumables/commodities (e.g., Ag RDTs, PPE, etc.) by submitting commodity usage reports to ZAMMSA. ZAMMSA is responsible for distribution of required supplies to sites across the country
- Commodities requests through ZAMMSA occur bimonthly and are through a digital, e-logistics management system for usage reporting

Supply security issues
- Numerous administrative hurdles to access supplies
- Variable usage of e-logistics management system and paper-based utilization reports

"Every day as facilities are reporting in the line list results, they also submit the logistics data in terms of their stock availability."

"Procurement cannot act unless there is an approved request and budget from the controlling officer."
<table>
<thead>
<tr>
<th></th>
<th>What’s working</th>
<th>Challenges</th>
<th>Opportunities to leverage a digital tool</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Referral support</strong></td>
<td>- HCWs follow up with patients who test positive either by phone or physically at the address they provided</td>
<td>- Missing or incorrect patient information (e.g., names, addresses)</td>
<td>- Data verification features for data entry</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Creating linkages between lab, surveillance, and clinical teams to share data</td>
</tr>
<tr>
<td><strong>Patient management</strong></td>
<td>- HCWs and surveillance team members reach patients either by phone or physically at the address they provided</td>
<td>- Inconsistent communication of results, especially for negative cases</td>
<td>- Inform patients of test result through mobile app</td>
</tr>
<tr>
<td><strong>Overall clinical management</strong></td>
<td>- Contact tracing initiated by surveillance team upon positive test result</td>
<td>- Misapplication of Ag RDT due to shorter turnaround time</td>
<td>- System focused on clerk or data personnel at sample-collection site to streamline data capture</td>
</tr>
<tr>
<td><strong>Digital record keeping, reporting, surveillance</strong></td>
<td>- Multiple data collection tools and management systems</td>
<td>- Incomplete information during data capture</td>
<td>- Mobile data collection tool focused on reducing transcription errors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Inadequacies in negative result data reporting</td>
<td>- Require some minimum amount of data to improve data quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Data transcription errors</td>
<td>- Provision for laypeople to input information into surveillance tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Underreporting especially due to digital infrastructure issues</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Variation across sites of data being captured</td>
<td></td>
</tr>
<tr>
<td><strong>Capacity-strengthening</strong></td>
<td>- Competency assessments for HCWs</td>
<td>- Poor adherence to guidelines</td>
<td>- Digitize and disseminate notifications and guidelines to HCWs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- High turnover of staff trained to conduct COVID-19 test often due to career advancement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- HCWs must take work home with them to ensure reporting</td>
<td></td>
</tr>
<tr>
<td><strong>Supply chain support</strong></td>
<td>- MOH and Zambia Medicines and Medical Supply Agency (ZAMMSA) work well together</td>
<td>- Multiple channels of procurement for different supplies</td>
<td>- Semi-automated inventory management to directly report usage to ZAMMSA</td>
</tr>
<tr>
<td><strong>Digital ecosystem</strong></td>
<td>- Effective access control for confidential health and testing data</td>
<td>- Blackouts and connectivity/internet challenges</td>
<td>- APIs to integrate existing information systems</td>
</tr>
<tr>
<td></td>
<td>- Connectivity support to DisaLab</td>
<td>- Lack of computers and related infrastructure</td>
<td>- Build upon existing HIV notification program to inform patients and caregivers of test result</td>
</tr>
</tbody>
</table>