SMARTER CROWDSOURCING
CORONAVIRUS

Strengthening National Testing Strategies

Recommendations and actions for latin american and carribean governments

30 July 2020

IDB Inter-American Development Bank

GOVLAB

Table of Contents

I. Executive Summary

Standing up an effective testing strategy goes beyond designing and manufacturing functional testing kits. It is a multifaceted problem that touches upon issues of privacy, data governance, and logistics. Implementing an effective testing strategy requires **widespread cooperation and trust** between citizens and the government. It also requires governments to work in new arrangements, including public-private partnerships, cooperation between multiple levels of government, between health authorities and universities, and coordination with community groups, to conduct tests and collect data.

This memo makes three recommendations for how governments can use innovative approaches to improve testing strategies and increase the proportion of the population being tested. These recommendations are focused on the priorities articulated by partner governments:

1. **Pooled Testing:** Governments and researchers should implement pooled testing strategies, innovating with pool design through ranking schemes or geographic schemes.

   Key actions:
   - ➔ *Partner with academic institutions, researchers and private sector laboratories.*
   - ➔ *Waive regulatory barriers.*
   - ➔ *Iterate learning and share best practices.*
   - ➔ *Rapidly pilot pooled testing schemes.*

2. **National Patient Identifiers:** Governments should take steps toward developing a unique health identifier/national patient identifier system (UHI/NPI) that unambiguously identifies each individual and links her to her health records, including test results.

   Key actions:
   - ➔ *Conduct feasibility studies.*
   - ➔ *Standardize data entry fields across existing systems.*
   - ➔ *Adjust existing data collection processes.*
   - ➔ *Develop, advocate for and pass legislation.*
   - ➔ *Establish a single organization to manage and oversee the UHI/NPI system.*
   - ➔ *Implement a UHI/NPI system.*

3. **Testing High-Risk Populations:** Governments should prioritize conducting tests among populations with a high probability of 1) contracting the virus; 2), spreading it to others; and 3) suffering serious consequences as a result of infection.

   Key actions:

- ➔ *Define high-risk populations who will receive prioritized testing.*
- ➔ *Partner with community and cultural leaders.*
- ➔ *Make testing free for low income or high-risk populations.*
- ➔ *Develop and use culturally and contextually relevant communication materials for testing resources.*
- ➔ *Rapidly conduct snapshot pooled testing among staff and residents in health and long-term care facilities, prisons, and other congregate housing facilities.*
- ➔ *Ensure adequate testing resources are available and accessible to high-risk communities.*
- ➔ *Reduce barriers to testing by conducting mobile testing units.*

What follows is a discussion of these three recommendations, including considerations prior to implementation, recommended actions that governments can take, examples of success, and a list of experts curated by The GovLab and interviewed for this memorandum and available for consultation.

II. Project Background

On July 8th, 2020, a group of 20 experts from nine countries joined officials representing the Argentine, Barbadian, Brazilian, Colombian, Costa Rican, Honduran, Mexican, Peruvian, and Trinidadian and Toboggan governments in a two-hour advising session to identify novel solutions that leaders can use to implement successful testing strategies in the fight against COVID-19. The IDB and The GovLab facilitated the session as part of a larger series of advising sessions aimed at tackling complex problems presented by the COVID-19 pandemic. Smarter Crowdsourcing in the Age of Coronavirus is supported by the Inter-American Development Bank (IDB).

The discussion focused on three topics around how to build a testing strategy: 1) designing and sourcing tests; 2) determining whom to test and how; and 3) collecting and sharing data. For more on the topics of discussion, please refer to the problem brief and refer to the regional report based on interviews with partner governments.

Following the advisory session, participants from the Latin American governments identified those solutions which they were most interested in implementing. The GovLab then conducted further research, interviewed various subject matter experts and potential partners, and developed this high-level action plan that Latin American governments can use to better incorporate testing strategy innovations into their efforts to combat COVID-19. The content of the document, including its recommendations, is the sole responsibility of The GovLab and does not represent IDB's official position or view on this matter, nor an endorsement of any individual or firm to perform activities related to the recommendations.

III. Why Testing Strategies: The Cornerstone of an Effective COVID-19 Response.

To control the pandemic and move towards reopening its economies, governments in Latin American and the Caribbean must develop and implement strong and effective testing strategies. Testing is essential for all governments because it is the cornerstone to any successful and comprehensive national strategy to curb the COVID-19 pandemic:

- Testing leads to quick identification and confirmation of positive cases;
- Testing informs clinical treatment;
- Testing indicates the need to isolate and quarantine;
- Testing helps identify people who need to be contacted because they were in contact with a positive COVID-19 case;
- Testing helps public health officials and researchers understand characteristics of the pandemic by understanding prevalence, transmission, hotspots and other important surveillance elements.

The below recommendations are not intended to be all-encompassing of a national testing strategy. Rather they are specific areas that, if addressed and implemented, will yield considerable returns to Latin American populations and their efforts to control COVID-19 within their communities and populations.

IV. Pooled Testing

Recommendation: Governments and researchers should implement pooled testing strategies, innovating with pool design through ranking schemes or geographic schemes.

Key actions:

- Partner with academic institutions, researchers and private sector laboratories.
- Waive regulatory barriers.
- Iterate learning and share best practices.
- Rapidly pilot pooled testing schemes.

Pooled testing contributes to overall testing strategy by mitigating or addressing the following bottlenecks:

- ➢ **Increasing testing capacity:** Due to a variety of factors (supply chain bottlenecks, training/workforce shortages, logististics), many countries in Latin America are not able to perform adequate numbers of tests for their population. Pooled testing addresses this issue where, depending on the prevalence of infection in a given population, governments that implement pooled testing strategies can expect to see their testing capacity increase by up to 300%.

- ➢ **Test kit and reagent shortages**: Test kits and reagents have been in short supply for the entirety of the pandemic, with current estimates putting overall capacity well below the needed thresholds for containing outbreaks and moving toward reopening. Pooled testing mitigates supply chain shortages and bottlenecks by increasing efficiency and stretching resource shortages, saving as much as 60% of the supplies needed.

- ➢ **Screening and surveillance**: Nations lack cost-effective ways to monitor community spread and detect hotspots; this is compounded by the fact that traditional tools like syndromic surveillance are not as effective given the high rate of asymptomatic positive cases and aversions to seeking treatment at clinics because of risk of exposure. Pooled testing is an efficient method to screen and practice disease surveillance. It yields advantages such as preserving testing reagents and resources, reducing the amount of time required to test large numbers of specimens, and lowering the overall cost of testing.

What is Pooled Testing

Pooled testing is a process where laboratories combine a predetermined number of samples and test them with a single test, often an RT-PCR test. Pooled testing can be an effective strategy for diagnostic, screening, and surveillance testing.[1] If the test comes out negative, it is assumed that all samples are negative, if it comes out positive, there are a few different methods for retesting the pool, depending on the intended use of the strategy (e.g. diagnostic, screening, or surveillance).

The simplest and most common method of pooled testing is Dorfman Testing, in which all individuals from a pool that flags positive are then individually tested.[2] Dorfman Testing's advantage is that it requires little coordination or planning and a maximum number of two stages. However, there are alternative methods which may be more economical for test reagents, especially when these resources are particularly scarce. Another technique is splitting, which involves splitting positive pools into smaller ones for retesting and progressively doing the same to the smaller pools which test positive.[3] While splitting can save reagents, it is administratively time consuming, due to the number of stages it requires. This may make it a better alternative for areas which are short on reagents, but have sufficient lab capacity and person-power. A third option, Sterret testing, is particularly effective when the viral prevalence in a community is very low (see appendix 1 for a table on prevalence and pooled testing). Sterret testing relies on randomly testing the individuals of a positive pool until one tests positive. The individuals who remain untested are pooled and if that pool tests positive, the process is repeated.[4] A fourth method is Matrix testing, which is performed by constructing a grid of specimens and grouping specimens within rows and columns. Specimens at the intersections of positive rows and positive columns of the matrix are tested individually to attempt to separate the positives from the negatives.[5] Matrix testing can be particularly effective at very high throughput testing facilities, but requires significant coordination and analysis work, increasing administrative and labor costs.

---

[1] "Diagnostic testing for SARS-CoV-2 is intended to identify occurrence at the individual level and is performed when there is a reason to suspect that an individual may be infected, such as having symptoms or suspected recent exposure, or to determine resolution of infection. Screening tests for SARS-CoV-2 are intended to identify occurrence at the individual level even if there is no reason to suspect infection—e.g., there is no known exposure. This includes, but is not limited to, screening of non-symptomatic individuals without known exposure with the intent of making decisions based on the test results. Surveillance for SARS-CoV-2 includes ongoing systematic activities, including collection, analysis, and interpretation of health-related data that are essential to planning, implementing, and evaluating public health practice."
https://www.cdc.gov/coronavirus/2019-ncov/lab/pooling-procedures.html#anchor_1595517996705
[2] Dorfman R. The detection of defective members of large populations. Annals of Mathematical Statistics 1943; 14:436–440.
[3] Litvak E, Tu X, Pagano M. Screening for the presence of a disease by pooling sera samples. Journal of the American Statistical Association 1994; 89:424–434.
[4] Sterrett A. On the detection of defective members of large populations. Annals of Mathematical Statistics 1957
[5] Bilder, Christopher R., and Joshua M. Tebbs. "Pooled-testing procedures for screening high volume clinical specimens in heterogeneous populations." Statistics in medicine 31.27 (2012): 3261-3268.

Considerations for Pooled Testing

Optimal conditions

- **Prevalence rates:** Experts interviewed for this memorandum[6] indicated that rates must be lower than 10% in the target population for pooled testing to be an efficient scheme. As prevalence goes down, the efficiency of pooling increases. See Appendix 1 for more information on optimal prevalence rates for conducting pooled testing.
- **Specimen collection and logistics:** Experts interviewed for this memorandum[7] indicated that adequate numbers of trained staff must be available to collect specimens safely and correctly. Once specimens are collected, the logistics of ensuring they are correctly labeled, shipped and delivered to a laboratory for pooled testing are very important.

Public-Private-People Partnerships

- **Private laboratories:** If the government does not have capacity to perform the testing of grouped samples at public laboratories, they must partner with private laboratories that have capacity to process large volumes of samples.

- **Expertise:** If governments do not have the capacity to coordinate sample collection or develop pooling methodologies they must be able to identify and partner with experts from universities or other sectors who can support pooled testing schemes. What are groups of experts that may have a particular valuable expertise that is underutilized? For instance, to help design pooled testing schemes, statisticians, engineers or mathematicians will have particularly useful skills that may not exist in the traditional laboratory or clinical setting.

- **Public partners:** If governments do not have the capacity to perform specimen collection or to access specific populations they must consider partnering with groups of health workers or other actors who can provide auxiliary support in collecting specimens.

Alternatives

- **Other ways to test:** What are alternative strategies that can be used for surveillance, diagnostic, or screening purposes if pooled testing is not feasible? Alternatives may include randomized testing, wastewater epidemiology, serology testing or symptom trackers.

---

[6] Baha Abdalhamid, MD, PhD https://www.unmc.edu/pathology/faculty/bios/abdalhamid.html
[7] Charles Thraves, PhD and Denis Sauré, PhD
https://isci.cl/wp-content/uploads/2020/06/MULTIPLYING-TESTING-CAPACITY-RT-PCR-POOL-TESTING.pdf

Actions Governments Can take to Capture the Opportunity

Partnerships	*Partner with academic institutions, researchers and private sector laboratories.* Governments should engage the academy, research firms, and private sector laboratories to develop algorithms, testing strategies, and innovative ways to design pooled testing schemes. Specific actions for governments include: ● Convene an advisory panel of experts with relevant skills and experience from research firms, universities, and private sector laboratories ● Commission an advisory panel to develop pooled testing strategy ● Identify specific partners to support implementation of pooled testing strategy
Regulatory	*Waive regulatory barriers.* Governments should consider ways to adjust regulations that restrict innovation pertaining to pooled testing schemes. Specific actions for governments include: ● Identify key legal and regulatory bottlenecks restricting pooled testing ● Review legislation and regulatory statutes that may restrict innovation pertaining to implementing pooled testing schemes ● Consider policy actions, such as waivers or emergency use authorizations that will allow for temporary approvals to implement pooled testing schemes
Innovate and Pilot	*Rapidly pilot pooled testing schemes.* Governments should act quickly (<1 month) to pilot various pooled testing schemes such as Dorfman, Splitting, Sterret, and Matrix testing to gauge scalability and utility amongst different contexts and populations. Specific actions for governments include: ● Convene an advisory panel of experts with relevant skills and experience from research firms and universities

	- Identify ideal populations to work with on pilot testing scheme such as nursing homes, congregate living residences, or groups of healthcare workers - Secure partnerships with laboratories to manage the throughput of pooled tests
Investments and Improvement	Iterate learning and share best practices. Governments should contract with or perform their own evaluation of pooled testing schemes, improve on existing processes, and share best practices across jurisdictions and sectors. Specific actions for governments include: - Document findings and lessons learned from pooled testing pilots - Share findings publicly and with relevant national and international stakeholders - Publish research and advocate for replication of successes within the country and in other comparator countries

Global Examples

Before the COVID-19 pandemic, pooled testing was mostly used for screening blood banking and was a strategy that helped combat the HIV/AIDS epidemic. However, in early March 2020 various countries started adapting the procedure to more effectively identify positive COVID-19 cases. The following is a list of countries who have adapted pooled testing as part of their testing strategies; the list includes information about what these jurisdictions did and how they did it.

Chile	Scientists at the Austral University in Chile (UACh) created an innovative COVID-19 mass testing model; a scientific report has been published explaining the findings. However, despite advocacy, this has not yet been adopted as a national strategy in Chile but it continues to be reported by local newspapers as an effective strategy that should be adopted. Researchers from the Complex Systems Engineering Institute (ISCI), Denis Sauré and Charles Thraves, are adapting groups testing strategies for a national model.

China

The government of Wuhan implemented a citywide testing drive, leveraging massive resources and intensive campaigning, to test over six million people in 10 days. The aggressively high throughput in testing was only possible due to pooling samples. This allowed the government to catch asymptomatic cases and prevent outbreaks, at a moment of low prevalence. Wuhan's example shows pooled testing potential to facilitate periodic population-wide testing for a particular community.

Germany

Germany's Homburg procedure has been used since March at Saarland University Hospital in Homburg to successfully protect high-risk patients from infection by asymptomatic COVID-19 carriers. Pooled testing allows the university to regularly test residents and staff of nursing homes and care facilities. For even greater efficiency, the researchers have used large pools of up to 30 samples and 'splitting' methods to reduce the number of individual tests necessary.

India

India established a pooled testing protocol for quarantined migrant workers and international travelers which combines 25 samples at a time. The country also uses pooled testing to monitor green zones where prevalence is low. Rather than monitoring specifically vulnerable populations, India is using pooling to test groups where prevalence is perceived as being low, thus maximizing the efficiency gains from pooled testing.

Rwanda

Rwanda has enrolled scholars from multiple disciplines to develop its pooling algorithm, based on matrix, or array testing to maximize its national pooled testing strategy and to better understand the spatial spread of COVID-19 at the national level and identify new infection hotspots. By making use of local experts, Rwanda has developed a protocol to further maximize the efficiency of pooling.

Singapore

Singapore has adopted pooled testing for residents and staff of nursing homes and residential care facilities. The Signaporean method is designed to catch infections before they become outbreaks in some of the most vulnerable locations. The spatial concentration of those sampled also facilitates the logistical aspect of collecting and transporting samples.

United States	The United States has issued an emergency use authorization for Quest Diagnostics to conduct pooled testing in diagnostic testing, which will allow for pooled samples containing up to four individual swab specimens, thus bypassing normally slow regulatory procedures. Stanford University and the State of Nebraska have been conducting pooled testing since before July 2020.

Cost and Resource Offset

Cost: Cost for pooled testing varies depending on location and methodology. Because it is a new process for many laboratories, there will be startup costs associated with implementing the methodologies. Some laboratories may initially charge more for pooled tests, and some of the pooling schemes will require extra coordination work (labor and administrative costs may increase in the short term). One study on pooled testing for *Chlamydia trachomatis* found that depending on a specific factor, cost reductions had considerable variance compared to status quo testing schemes (between 5-80% cost reductions in populations with prevalence rates up to 60%).[8]

Resource Offset: Pooled testing can reduce the cost in terms of reagents, test kits, and labor. As multiple samples can be tested with the reagents of a single test, the average quantity of reagents per sample decreases. According to Peter Iwen, director of the Nebraska Public Health Laboratory, 50% to 60% of the reagents can be saved and labor can be reduced by 25% to 30%. Similarly, sub-pools are being used to test large samples, in order to reduce the amount of individual testing that needs to be done, if a pool tests positive, thereby maximizing resources. In situations that allow more samples per pool, the cost reduction is bound to be more significant, not only in reagents, but in labor as well.

[8] Kathryn J. Ray, Zhaoxia Zhou, Vicky Cevallos, Stephanie Chin, Wayne Enanoria, Fengchen Lui, Thomas M. Lietman & Travis C. Porco (2014) Estimating Community Prevalence of Ocular Chlamydia trachomatis Infection using Pooled Polymerase Chain Reaction Testing, Ophthalmic Epidemiology, 21:2, 86-91, DOI: 10.3109/09286586.2014.884600

V. National Patient Identifiers

Recommendation: Governments should take steps toward developing a unique health identifier/national patient identifier system (UHI/NPI) that unambiguously identifies each individual and links her to her health records, including test results.

Specific actions include:

- Conduct feasibility studies.
- Standardize data entry fields across existing systems.
- Adjust existing data collection processes.
- Develop, advocate for and pass legislation.
- Establish a single organization to manage and oversee the UHI/NPI system.
- Implement a UHI/NPI system.

Working towards a UHI/NPI system contributes to overall testing strategy by mitigating or addressing the following issues:

➢ **Isolating and quarantining:** a positive test result is often the trigger that encourages individuals to quarantine or isolate until they are no longer symptomatic or contagious. Due to a variety of human and non-human errors, patient test results and other records are mismatched or delayed because of issues connecting results and records to an individual. A UHI/NPI system would allow records to be more accurately attached to individuals, allowing for speedier and more accurate isolating and quarantining.

➢ **Population level analytics and surveillance:** Different reporting standards, incomplete records, mismatched records, and data sharing between electronic health records all create inaccuracies and errors in aggregated population-level data sets. This results in demographers and public health officials not being able to accurately track COVID-19 in "real time," especially amongst populations where it may matter most (see "high risk populations"). A UHI/NPI system would ensure that test results and patient records are accurately attached to demographic information, thus allowing for less errored analyses from population-level databases.

➢ **Contact Tracing:** Contact tracing efforts are impeded when patients are incorrectly identified or are not connected to a test result. Health officials conduct contact tracing and are then not able to identify those infectious individuals nor are they able to warn that individual's high-risk contacts.

What is a UHI/NPI System

In its most basic uses, a unique health identifier/national patient identifier system (UHI/NPI) effectively assigns each individual in a society a unique identifier (alphanumeric, biometric, or other) that connects that individual to her health records (including testing records) across the entire healthcare system. Connecting patient records (including diagnostic test results) **accurately** and **precisely** to the individuals is an essential precondition for 1) quarantine and isolation; 2) contact tracing; and 3) population-level analysis and predictive analytics. These above issues have become more acute during the COVID-19 pandemic, highlighting the need for Latin American and Caribbean governments to design, test and implement UHI/NPI systems in their countries.

The reasons that countries tend not to have UHI/NPI systems are generally threefold: 1) fragmented healthcare systems with various public and private providers and insurers who use different records systems and have different data standards; 2) technological barriers; and 3) public opinion and political willpower. While a UHI/NPI system will have considerable utility in the fight against COVID-19, it is an investment that will yield dividends beyond the lifetime of the pandemic, thus creating a long-term incentive for governments to invest in this solution.

Considerations for Working Towards a UHI/NPI System

Current systems

- **Healthcare records format:** How are health records managed in and across your country's health systems? Are they electronic health records or are they primarily paper records?
- **Data entry and format:** How is data entry standardized (or not) for demographic information on health records, including test results? Do individuals use a single identifier in all settings? Are entry formats standardized (such as date of birth, first name, last name)? Are identifiers entered manually in a way that entry errors can cause matching issues?
- **Regional and population differences:** Do regions within your country operate differently? Are there unique needs and systems for specific demographics or communities, such as indigenous populations, migrants, or undocumented indiviudals?
- **Regulatory and legislative barriers:** What are the laws and regulations that currently govern how health data is collected, stored and shared? Is the mechanism by which health records are affiliated with a single individual addressed in legislation?

Stakeholders

- **Advocates and allies:** Who are the major stakeholders in your country who are in favor of implementing a UHI/NPI system? Are private healthcare providers likely to support steps to work towards a UHI/NPI system?

- **The public:** What does the public in your country think about the current system? Are there surveys that have captured public opinion on health identifiers? Are there political advocates or elites who are involved in shaping public opinion on health data?

- **Laggards and detractors:** Which stakeholders are likely to resist changes to the status quo? Who will be most burdened by changes to the current system as it is improved? Why might stakeholders resist changes, for instance is the cost of implementing new systems and data formats an issue?

Alternatives:

- **Patient matching:** How can the current system improve accuracy and precision of matching individuals to their health records, including test results? How can test results be better matched to individual demographics so population-level analyses can inform public health policies and priorities?

- **Interoperability and sharing health data:** How can the current system better share health records and test results across elements of the healthcare system, including delivering results to individuals, passing records between hospitals and providers, and aggregating health records and test results at the population level for trend analysis?

Actions Governments Can take to Capture the Opportunity

Analysis and Research	<u>Conduct feasibility studies.</u> Governments should appoint a group of government and external experts to conduct a feasibility study of jurisdictional and private/public context and document legislative opportunities or barriers to moving forward with a UHI/NPI system. Specific actions for governments include: ● Identify key stakeholders from government institutions, insurance companies, hospital/healthcare systems, provider networks, academic community and the public ● Establish study timeline as less than 3 months from first meeting

	• Commission this group to develop a comprehensive assessment in the allotted time frame ensuring that the assessment includes analyses of: current system, regional differences, key stakeholders, regulatory opportunities, and recommendations for a path forward
Partnerships	<u>Standardize data entry fields across existing systems.</u> Governments should work with partners to standardize data elements across health IT systems so that data is easily shareable between systems. Specific actions for governments include: • Convene stakeholders who manage Electronic Health Record systems in the country and encourage a cost benefit analysis of current system(s) • Identify specific opportunities to make immediate improvements to interoperability (such as standardizing similar fields across systems) • Identify specific opportunities to make long-term improvements to interoperability (such as inter-system identifiers)
Regulatory	<u>Develop, advocate for and pass legislation.</u> Governments should mandate adoption of standards providing for a standard national health identifier for each individual, employer, health plan, and health care provider for use in the healthcare system. Specifically, governments should: • Identify key legal and regulatory bottlenecks restricting adjustments to patient identifier systems • For regulatory barriers, consider updating regulations to better support interoperability, standardization, and the framework needed for a UHI/NPI system • For existing legislation, develop proposed replacement legislation and advocate for this legislation through the appropriate legislative processes and procedures

Innovate and Pilot	Adjust existing data collection processes. Governments should advance the use of regularly collected demographic data elements for patient matching and identification such as phone numbers, mailing addresses, or email addresses. This will ensure that public health authorities have up-to-date contact information when receiving reports from laboratories, hospitals, and other testing sites. Specifically, governments should: ● Identify standardized demographic data fields in existing systems such as phone numbers, email addresses, home addresses, social security numbers or voting IDs ● Develop guidance for laboratories, hospitals, and healthcare providers on how to more consistently capture these important fields ● Rely on existing data structures where possible, such as those maintained by telecom providers, voting registries, or social security administrators
Long-term investments and Improvement	Establish a single organization to manage and oversee the UHI/NPI system. Governments should establish a single organization with the responsibility to oversee and advise on ways to improve patient matching and incorporate new technologies and approaches as they emerge. This organization would identify and encourage adoption of certain standards—such as on biometrics or use of smartphones—by health care organizations and technology developers. Specifically, governments should: ● Appoint a special advisor on health informatics to oversee the development of identifier projects for the interim until an organization is established and functioning ● Identify the preferred organizational affiliation of this group and how it will fit into existing government agencies and structures ● Coordinate with international partners to learn about best practices and key steps for development and implementation

Implement a UHI/NPI system. Governments should roll out a comprehensive and single UHI/NPI system that integrates, delivers, and manages health information technology systems across all health care institutions, including the ability for individuals to access and control their own health records. Specifically, governments should:

- Actions listed above are all essential preconditions for this recommendation to be accomplished

Global Examples

Note: this is not an exclusive list. Many countries and regions use UHI/NPI systems.

Australia	The digital health strategy in Australia is managed by the [Australian Digital Health Agency]. The country uses an individual [healthcare identifier (IHI)] - a unique 16 digit number - to identify an individual for health care purposes. The system uses an interoperable national e-health program based on personally controlled unique identifiers supporting prescription information, medical notes, referrals, and diagnostic imaging reports. This system helps health professionals access their patients' *My Health Records* to read their medical history and add new information.
Brazil	Brazil's Unified Health System (SUS) uses a [National Healthcare Card], assigned to patients to keep track of medical records. The card, which has recently been digitized into an [electronic National Health identification card system] with a personal identification number, allows healthcare providers to access a patient's medical information anywhere in the country. This is possible due to a central database accessible from any public or private hospital within the Unified Health System network.
England	England's national health system (NHS) assigns an [NHS number] to every registered patient. This number serves as a unique identifier that helps manage patients' health records. The number is assigned after someone is born or the

	first time they receive care. Healthcare providers are required to offer patients access to their own detailed coded record, including information about diagnoses, medications and treatments, immunizations, and test results.
Estonia	Estonia has one of the most highly-developed national ID-card systems in the world, Every citizen in Estonia has an online e-health record that can be tracked, and linked to a person's electronic ID-card. The health records are secured with KSI Blockchain technology and are used to ensure data integrity. The information is only accessible to authorized health personnel. 99% of health data, prescription information and electronic billing in healthcare are digitized. The Electronic Health Record is a nationwide system that integrates data from diverse healthcare providers into a common record accessible to patients and doctors as a single electronic file. The system functions as a centralized, national database that retrieves data from various providers with different systems and presents the information into a standard format via the e-patient portal.
Singapore	Singapore's national electronic health record (EHR) is managed by the Integrated Health Information Services, which integrates, delivers, and manages information technology systems across all public health care institutions. Singaporeans can access their health records via a national health portal.
Slovenia	Slovenia uses both a unique identification number and universal health identifier. The two numbers are linked by the central population register (CPR). The government operates an online portal through which the insured can access their health information and manage a significant portion of their health care activities such as looking up their medical records and laboratory test results.
South Korea	South Korea's Resident Registration (RR) number is used as a UHI to access benefits through the national health insurance (NHI) system.[9] In the area of disease prevention and health promotion programs, the RR number is used to manage vaccination programs which are linked via the RR number between the

[9] Kang M, Bae G, Kim H, Hong SY. Korean resident Registration system for universal health coverage. Health, nutrition and population (HNP) Discussion Paper series, World Bank March 2019.

	Korea Centers for Disease Control and Prevention (KCDC). The RR numbers are utilized for disease treatment and management and for controlling and limiting the spread of contagious diseases. During an epidemic/pandemic, medical facilities and other infectious disease surveillance actors are required by law to report the infected person's RR number to the KCDC.
Thailand	Thailand assigns a personal identification number (PID) to each Thai citizen. Electronic medical records are used at all hospitals where patient identification numbers are linked to a patient's individual national PID. PIDs make electronic medical records sharable among health care providers and disease surveillance actors.
Other Countries	Canada, Denmark, France, Germany, Italy, India, Ireland, Israel, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, and Taiwan all use versions of a Universal Health Identifier system.

Cost and Resource Offset

Cost: Each action will bear different costs with the most expensive being the implementation and roll out of a UHI/NPI system nationally. In the United States, to transition to a UHI/NPI system, experts calculate the cost as over $1 billion USD. Other recommendations will be much less expensive, with feasibility studies being the least expensive. Cost sharing is also an option that governments should consider given that providers, citizens, researchers and regulators will all benefit from the increased efficiency of a UHI/NPI system.

Resource Offset: UHI/NPI systems are designed to reduce medium to long term costs, as the data they generate can help optimize resource deployment, improve contact tracing results, reduce duplicative administrative work, and allow for interoperability between providers.

VI. High-risk populations[10]

[10] Note: processes that consider testing for high-risk populations will be very useful for when a vaccine is eventually developed and distributed.

Recommendation: Governments should prioritize conducting tests among populations with a high probability of 1) contracting the virus; 2), spreading it to others; and 3) suffering serious consequences as a result of infection.

Specific actions include:

- Define high-risk populations who will receive prioritized testing.
- Partner with community and cultural leaders.
- Make testing free for low income or high-risk populations.
- Develop and use culturally and contextually relevant communication materials for testing resources.
- Rapidly conduct snapshot pooled testing among staff and residents in health and long-term care facilities prisons and other congregate housing facilities.
- Ensure adequate testing resources are available and accessible to high-risk communities.
- Reduce barriers to testing by conducting mobile testing units.

Prioritizing testing for high-risk populations contributes to overall testing strategy by mitigating or addressing the following issues:

➢ **Shielding those most at risk of and from COVID-19:** Individuals with comorbidities and underlying health conditions are at greater risk of contracting COVID-19 and getting seriously ill from COVID-19. Prioritizing testing for high-risk populations helps minimize the risk to these particularly vulnerable populations, reducing strain on the hospital system and overall severity of infections.

➢ **Shielding those most at risk of spreading COVID-19:** Individuals and populations who fall into certain risk categories such as the poor, homeless, and those living in congregate settings, are at higher risk of spreading COVID-19 and creating "superspreader events."[11] Prioritizing testing for these individuals can help prevent further spread of COVID-19.

➢ **Hospitalizations and intensive care:** There is considerable overlap between those at high risk for spreading and those at high risk for developing severe complications from COVID-19. When large numbers of very sick individuals are concentrated in specific communities, the healthcare system can become overwhelmed and ineffective. Aggressively and proactively testing high-risk populations offers direct and indirect

[11] Events where one person infects a disproportionate number of other individuals.
https://www.scientificamerican.com/article/how-superspreading-events-drive-most-covid-19-spread1/

benefits such as reducing mortality rates among high-risk populations and mitigating expected stresses on the healthcare system or limited testing kits and reagents.

- **Equity and harm:** Specific populations are at disproportionately higher risk for contracting and having serious illness from COVID-19, often for systemic and prejudicial reasons. Implementing a testing scheme that prioritizes these populations will help reduce health disparities and systemic disadvantages.

What are High-risk Populations

The rate of infection is relatively low in the general population making it not very efficient to test everyone as a surveillance or screening strategy.[12] As a result, many countries will need to establish priorities for who will receive tests when resources are limited. Governments should identify those at highest risk for serious illness and mortality because of underlying health conditions, occupations, social determinants of health,[13] or structural disadvantages such as racism or discrimination. These populations include health care and long-term care workers, people living in congregate housing (e.g. nursing homes, homeless shelters, prisons), older people living with comorbidities, including respiratory illness, hypertension, diabetes, or multiple comorbidities, homeless populations, populations with limited access to healthcare and underserved by healthcare institutions, and people with a known exposure to a person who has tested positive.

One goal of testing is to limit the spread of the virus by identifying people who are at high risk of contracting the disease and isolating them from the rest of the population. A second goal is to limit the spread of the virus among populations that are at high risk for experiencing serious illness or death. A third goal is to inform treatment of individuals who are confirmed positive. Governments can limit the spread of the virus, the strain on the healthcare system due to hospitalizations and staff attrition, and reduce overall deaths by identifying people who are at the highest risk of contracting and spreading the disease.

Considerations for Testing High-risk Populations

Identifying populations

[12] Obermeyer, Ziad, Ned Augenblick and Jonathan Kolstad. 2020. Here's one way to make daily covid-19 testing feasible on a mass scale. MIT Technology Review. July 22. https://www.technologyreview.com/2020/07/22/1005524/pooled-testing-covid-coronavirus-machine-learning-reopening/.

[13] This will include considering what social factors - such as education, housing, food security, economic well being, access to healthcare - are causally linked to health outcomes, especially during the COVID-19 pandemic.

- **Physical health:** What are the physical health conditions that put individuals at higher risk of contracting and having complications from COVID-19? For example, people with underlying conditions, those with long-term supportive needs, or elderly populations.

- **Behavioral health:** What are the behavioral health conditions that put individuals at higher risk of contracting and having complications from COVID-19? For example, individuals with substance abuse disorders may be at higher risk of contracting COVID-19 and having serious illness from the virus. Also, individuals with mental health disorders may be more likely to reside in congregate housing establishments where the risk of spread and infection is increased.

- **Social/economic factors:** What social or economic factors put individuals or populations at higher risk for contracting, spreading, and having complications from COVID-19? Minority and ethnic groups, due to systemic disadvantage, may be at higher risk for contracting and having complications from COVID-19. What occupations place individuals at higher risk for contracting, spreading, and having complications from COVID-19? Examples might include frontline health workers, flight attendants, cashiers, bus drivers, street grocers, or other jobs - particularly in the informal sector - where individuals are more likely to be exposed to large numbers of individuals or riskier environments, some of whom may be ill with COVID-19.

Identifying barriers to testing

- **Infrastructure barriers:** what are the main infrastructure barriers inhibiting widespread testing in high-risk communities? These may include access to public transportation, or test site design. For example, countries that have implemented drive-through testing sites often locate them in areas far from urban centers and require that patients have their own vehicle to access the site, thus creating barriers for low-income urban populations.

- **Identifier barriers:** what are the main barriers that may inhibit connecting high-risk populations to their test results? For example, migrant populations, undocumented populations, or homeless populations may not have requisite identification or means to track their test results such as a computer or cellphone.

- **Access and trust barriers:** see below.

Access and trust

- **Community leaders:** For a variety of reasons, specific high risk populations - including ethnic and minority populations - may not trust government or health officials. Trust in government and systems is an indicator for places where the COVID-19 response has been successful. Which community leaders can be partnered with to help build trust with vulnerable populations? Are there similar leaders that would be relevant to high-risk professions or other at-risk groups?

- **Targeted communications:** What are communications tools or strategies that need to be considered for a successful information campaign targeted at high-risk populations? What languages do materials need to be written in? What are the literacy rates of target populations and how do materials need to be presented (e.g. graphics, cultural examples, etc.)? Who needs to be delivering the key messages to specific populations?

Actions Governments Can take to Capture the Opportunity

Analysis and Research	Define high-risk populations who will receive prioritized testing. Governments should develop a working definition of which populations are high risk. Groups can be added to this list, but the list should identify populations that are at higher risk of contracting and having complications from COVID-19 due to physical health, behavioral health, or economic/social factors. Specifically, governments should: • Review population-level data to identify high-risk groups by health-condition, profession, race/ethnicity, age, or other demographic or socio/economic factors • Split identified groups into those needing immediate attention and those who will be at high risk in the future (e.g. food insecure populations) • Ensure criteria for test allocation is transparent, explicit, simple, and consistently followed • Post definitions publicly to ensure transparency and accountability
Partnerships	Partner with community and cultural leaders. Governments should conduct specific outreach and form partnerships with community and cultural leaders to 1) understand needs and concerns of specific communities and 2) amplify public health messaging encouraging surveillance, diagnostic, and screening testing. Specifically, governments should: • Conduct outreach to specific community and cultural leaders to understand optimal strategies for increasing

	access to testing for high-risk populations in their community ● Encourage community and cultural leaders to proactively advocate for frequent testing in their communities ● Provide talking points or education materials to community or cultural leaders describing the benefits of testing and what actions to take depending on testing results
Regulatory	Make testing free for low income or high-risk populations. Governments should reduce barriers to testing by making testing free for specific populations, ideally for screening or surveillance purposes. Specifically, governments should: ● Investigate if testing fees can be waived by government health agencies mandated to provide health services to low income individuals ● Consider legislative or regulatory actions that could support low-cost or free testing for identified high-risk populations
Communications	Develop and use culturally and contextually relevant communication materials for testing resources. Governments and public health officials should make all communication materials targeted at high-risk or vulnerable populations accessible and culturally-relevant. Specifically, governments should: ● Publish a mythbusters pamphlet dispelling common rumors or misinformation about testing ● Translate all testing materials into relevant languages and ensure materials are at the appropriate literacy level to ensure accessibility ● Provide testing information materials at testing locations in various languages, including specific information on what steps to take after receiving a specific result and how to get test results.
Innovate and Pilot	*Rapidly conduct snapshot pooled testing among staff and residents in health and long-term care facilities, prisons, and other congregate housing facilities.* Governments should conduct

snapshot pooled testing to provide a baseline that will help establish subsequent testing strategies within these settings, including the frequency of testing. Specifically, governments should:

- Identify partners with the capacity of conducting pooled tests
- Develop a strategy for identifying an appropriate pool size in collaboration with the testing partner (see above section on pooled testing)
- Develop a plan for what will happen to staff who test positive

Ensure adequate testing resources are available and accessible to high-risk communities. Governments should establish testing sites in communities with large numbers of high-risk individuals. Specifically, governments should:

- Locate testing sites in areas that allow for access to populations with transportation barriers
- Operate testing sites during specific times when populations that work non-traditional hours may have more availability, such as mornings, nights, or weekends
- Ensure testing site design accommodates populations that may have accessibility needs including language or physical disabilities

Reduce barriers to testing by conducting mobile testing units. To address transportation limitations, non-traditional work schedules, and lack of access that may keep some communities from getting tested, governments should strategically implement mobile testing units that travel to vulnerable communities. Specifically, governments should:

- Direct mobile testing sites to locations where high-risk populations are likely to congregate
- Operate testing sites during specific times when populations that work non-traditional hours may have more availability, such as mornings, nights, or weekends
- Ensure testing site design accommodates populations that may have accessibility needs including language or physical disabilities

Global Examples

Colombia	Colombia's Emergency Fund is identifying high-risk groups, including prison populations, people who have attended large gatherings, and people with known exposure to the virus, in order to test them and isolate them as needed to reduce the spread of the virus. This was done by leveraging the contact tracing methodology from Johns Hopkins University and adapting the strategies to Colombia's social context and implementing its own Testing, Tracing, Isolation – or Pruebas, Rastreo y Aislamiento Sostenible (PRASS) program, The government of Colombia is assisting vulnerable migrants and refugee populations by allowing NGO's trained in working with vulnerable populations, such as the IRC, to set up triage medical care centers and to assemble team doctors and nurses at the border with Venezuela to test for COVID-19 amongst vulnerable refugee populations. They also provide them with hygiene kits, clean water and food.
England	England limited the spread of the virus within health care and medical professional populations and ensured they could continue taking care of patients by conducting routine testing of frontline health care workers.
France	France is monitoring vulnerable populations in nursing homes by establishing a dedicated notification system for COVID-19 cases reported by long-term care facilities that includes frequent testing for residents and staff members.
Germany	Virologists at Saarland University Hospital in Homburg established the Homburg procedure to successfully protect vulnerable patients from infection by asymptomatic COVID-19 carriers. This was achieved by

pooling samples from different healthcare workers to screen them before allowing them into residence homes and hospitals.

Peru	Partners In Health, a non profit organization, is working to scale testing capacity to provide faster and accurate results by establishing mobile molecular testing labs which are trucks equipped with lab technicians and testing equipment that can process 500 to 600 tests per day. They also revamped mobile clinics that were used for TB testing to provide medical assistance to people living in remote neighborhoods. The municipal government of Lima created a temporary shelter for citizens in a state of abandonment that are specifically vulnerable to the spread of the virus. They did this by revamping an old historical building in 60 days and equipping it with the necessary equipment to provide food, shelter, and medical service, including testing for COVID-19.
Singapore	Singapore is screening health workers by implementing pooled testing for residents of nursing homes and residential care facilities. The government is also providing outpatient treatment to vulnerable populations by reactivating its Pandemic Preparedness Clinics which were used to provide outpatient treatment during the H1N1 flu, to administer tests and to provide follow up for ill individuals.
United States	Stanford University Hospital in California was able to resume previously delayed surgeries, tests and other procedures after conducting a snapshot pooled test of employees and learning that the infection rate was 0.3% among asymptomatic employees. In San Francisco, nursing homes that experienced fewer COVID-19 cases and deaths tested all staff and residents every few weeks and increased testing frequency if they start to see more positive results. Seattle, Chicago, the state of Wisconsin, and other local and state governments have set up mobile testing centers to safely collect

samples from healthcare workers and other high-risk or vulnerable populations.

Cost and Resource Offset

Cost: The total cost will depend on the total number of people who need to be tested and the frequency of tests that are required. These factors depend on 1) the number of people who fall into the high-risk categories within a country; 2) the use of pooled testing vs. individual testing; and 3) the infection rate that is found by the initial tests. If an initial round of testing discovers a high rate of infection at a facility, this will require more frequent individual tests.

Resource Offset: Testing high-risk populations is a cost effective strategy when compared to universal individual testing. This is a **prevention strategy** in that it allows governments to direct limited resources to the areas that, if unattended, could contribute to 1) amplified spread of the virus; and 2) costly healthcare interventions like intubation or other critical care measures. There is a broad consensus among the experts with whom we met that focusing tests on vulnerable populations is an efficient strategy and is consistent with previous efforts to implement targeted testing strategies.[14] If pooled testing is used, it should be possible to reduce the total number of tests that have to be processed by a lab by combining multiple samples into one test.

[14] Zulman, D. M., Vijan, S., Omenn, G. S., & Hayward, R. A. 2008. The relative merits of population-based and targeted prevention strategies. The Milbank quarterly, 86(4), 557–580. https://doi.org/10.1111/j.1468-0009.2008.00534.x

VII. Appendices

Appendix 1: Pooled Testing Chart

Figure 1: Comparison of Optimal Pool Size and Prevalence Rates on Test Efficiency

Comparison of Optimal Pool Size and Prevalence Rates on Test Efficiency[a]

Prevalence Rate (%)	Optimal Specimen Pool Size	Reduction in the Expected No. of Tests (%)	Expected Increase in Testing Efficiency (%)
1	11	80	400
3	6	67	200
5	5	57	133
7	4	50	100
10	4	41	69
15	3	28	39

[a]The Shiny application for pooled testing available at https://www.chrisbilder.com/shiny was used for calculations.

Source: Abdalhamid B, Bilder CR, McCutchen EL, Hinrichs SH, Koepsell SA, Iwen PC. Assessment of Specimen Pooling to Conserve SARS CoV-2 Testing Resources. *Am J Clin Pathol*. 2020;153(6):715-718. doi:10.1093/ajcp/aqaa064 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7188150/

Appendix 2: Advisory Session Resources

- Testing problem brief: defines the key challenges of testing regimes during the COVID-19 pandemic
- Regional report: summary of interviews with government partners highlighting key areas of interest and regional context
- Participant biographies

Appendix 3: Experts

[a] *indicates that the expert participated in follow up research for this memorandum*
[b] *indicates that the expert attended the advisory session on 7/8/2020*

1. Alex Greninger, MD, PhD, MS, MPhil University of Washington Medical Center [a b]
2. Anup Malani, PhD, JD University of Chicago Law School, Pritzker School of Medicine [a b]
3. Baha Abdalhamid, MD, PhD, University of Nebraska Medical Center (UNMC) [a b]
4. Ben Moscovitch, Project Director, Pew Charitable Trusts [a]

5. Charles Thraves, PhD Assistant Professor, University of Chile [a]
6. Christina Kong, MD, PhD Stanford University [b]
7. Claire Wathen Skoll Foundation [b]
8. Denis Sauré, PhD Assistant Professor, University of Chile [a]
9. Donna Orefice, MS Head Administrator Westfield Specialty Care Center, Aetna Health Systems [a]
10. Elza Erkip, PhD New York University Tandon School of Engineering [a b]
11. Erez Lieberman Aiden, Ph.D. Baylor College of Medicine and Rice University [b]
12. Felipe Peixoto Safetest [b]
13. Gonzalo Moratorio, PhD Institut Pasteur Montevideo [b]
14. José F. Rodríguez Orengo, Ph.D. School of Medicine, University of Puerto Rico [b]
15. Kristian Lopez Vargas, PhD University of California, Santa Cruz [b]
16. Larry De Koning, PhD University of Calgary [b]
17. Manoel Barral Netto, MD, PhD Institute Gonçalo Moniz - Fiocruz BA [b]
18. Marcos Lopez Casillas, University of Puerto Rico [b]
19. Maria Cecilia Goi Porto Alves, São Paulo Institute of Health [b]
20. Mark Smolinski, MD, MPH Ending pandemics [b]
21. Peter C. Iwen, MS, PhD, D(ABMM) University of Nebraska Medical Center (UNMC) [b]
22. Ravindra Kolhe, MD, PhD Augusta University [b]
23. Van Dinh Trang, MD, PhD National Hospital for Tropical Diseases [b]
24. Ziad Obermeyer, MD UC Berkeley School of Public Health [a b]

Appendix 4: Experts Available for Consultation

NOTE: to be connected to any of the below experts, please contact henri.hp@thegovlab.org

Topic	Area of Expertise	Name and Affiliation
Pooled Testing	Designing and executing pooled testing schemes, Cost benefit analysis of pooled testing	Baha Abdalhamid, MD, PhD, University of Nebraska Medical Center (UNMC)
Pooled Testing	Designing and executing pooled testing schemes	Peter C. Iwen, MS, PhD, D(ABMM) University of Nebraska Medical Center (UNMC)
Pooled Testing	Engineer with technical skills to design algorithms for pooled testing schemes in coordination with public health experts	Elza Erkip, PhD New York University Tandon School of Engineering

Pooled Testing	Designing and executing pooled testing schemes	Alex Greninger, MD, PhD, MS, MPhil University of Washington Medical Center
Pooled Testing	Designing and executing pooled testing schemes; latin american context	Charles Thraves, PhD Assistant Professor, University of Chile
Pooled Testing	Designing and executing pooled testing schemes; latin american context	Denis Sauré, PhD Assistant Professor, University of Chile
Pooled Testing	Designing and executing pooled testing schemes	Ravindra Kolhe, MD, PhD, Augusta University
UHI/NPI	Health information technology; mismatched health records	Ben Moscovitch, Project Director, Pew Charitable Trusts
UHI/NPI	Health informatics and electronic health records; mismatched health records	Shaun Grannis Vice President , Data and Analytics Regenstrief Institute, Inc.
UHI/NPI	Health informatics and electronic health records; mismatched health records	John D. Halamka President of Mayo Clinic Platform Professor of Medicine Harvard Medical School Chief Information Officer Beth Israel Deaconess Medical Center
High-risk Populati ons	expert on nursing home care; runs COVID-only nursing home	Donna Orefice, MS Head Administrator Aetna Health Systems

High-risk Populati ons	community testing for COVID, methods for estimating prevalence from observational data	Anup Malani, PhD, JD Professor at the University of Chicago Law School and Pritzker School of Medicine co-founder and Faculty Director of the International Innovation Corps
High-risk Populati ons	Machine learning, econometrics, health economics, equity and access	Ziad Obermeyer, PhD Acting Associate Professor of Health Policy and Management University of California at Berkeley