EDMOND J. SAFRA CENTER FOR ETHICS AT HARVARD UNIVERSITY
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Center for Ethics

PANDEMIC RESILIENCE: GETTING IT DONE

A Supplement to the Roadmap to Pandemic Resilience

MAY 12, 2020

AUTHORS

Institutional affiliations are provided for purposes of author identification, not as indications of institutional endorsement of the roadmap.

DANIELLE ALLEN
James Bryant Conant University Professor, Director, Edmond J. Safra Center for Ethics, Harvard University

ALICIA BASSUK
Ubica Leadership Strategy

SHARON BLOCK
Executive Director and Lecturer on Law, Labor & Worklife Program, Harvard Law School

GEORGE BUSENBERG
Associate Professor of Environmental Management and Policy, Soka University of America

MARIE CHARPIGNON
PhD candidate, Institute for Data, Systems, and Society, MIT

JOSHUA COHEN
Faculty, Apple University; Distinguished Senior Fellow, University of California, Berkeley; Professor Emeritus, MIT; Editor, Boston Review

PETER ECKERSLEY
Convener, stop-covid.tech

DEAN FOSTER
Marie and Joseph Melone Professor Emeritus of Statistics, University of Pennsylvania

LAWRENCE GOSTIN
Founding O'Neill Chair in Global Health Law; Faculty Director, O'Neill Institute for National and Global Health Law, Georgetown Law

KEVIN GUTHRIE
President, ITHAKA

LISA HANSMANN
JD Candidate, Yale Law School

KAZUMI HOSHINO

SHAM KAKADE
Washington Research Foundation Data Science Chair, University of Washington

JULIUS KREIN
Editor, American Affairs

JOHN LANGFORD
Partner Researcher, Microsoft Research New York City

TED NORDHAUS
Founder and Executive Director, Breakthrough Institute

PUJA AHLUWALIA OHLHAVER
Senior Fellow, RadicalxChange Foundation

NICOLÁS DELLA PENNA
Research Affiliate of the Laboratory for Computational Physiology at MIT

MEREDITH ROSENTHAL
C. Boyden Gray Professor of Health Economics and Policy, Harvard T.H. Chan School of Public Health

RAJIV SETHI
Professor of Economics, Barnard College, Columbia University; External Professor, Santa Fe Institute

SEMA SGAIER
Co-Founder and Executive Director, Surgo Foundation; Adjunct Assistant Professor, Harvard T.H. Chan School of Public Health; Affiliate Assistant Professor, University of Washington, Department of Global Health

CARMEL SHACHAR
Executive Director, Harvard Law School and Petrie-Flom Center for Law and Bioethics

DIVYA SIDDARTH
Research Fellow, Microsoft Research India

JOSHUA SIMONS
Graduate Fellow, Edmond J. Safra Center for Ethics, Harvard University

GANESH SITARAMAN
Chancellor Faculty Fellow, Professor of Law, and Director of the Program on Law and Government, Vanderbilt Law School

ANNE-MARIE SLAUGHTER
CEO, New America; Bert G. Kerstetter '66 University Professor Emerita of Politics and International Affairs, Princeton University

PETER SMITTENAAR, SENIOR
Research Scientist, Surgo Foundation

ALLISON STANGER
Leng Professor of International Politics and Economics, Middlebury College; External Professor, Santa Fe Institute

NICHOLAS STEWART
Research Scientist, Surgo Foundation

ALEX TABARROK
Bartley J. Madden Chair in Economics at the Mercatus Center at George Mason University

LILA A. TRETIKOV
Global Leader, World Economic Forum; CVP o/CTO Microsoft; Board Director, Onfido; Advisor on Innovation, United Nations

E. GLEN WEYL
Founder and Chair, RadicalxChange Foundation and Microsoft's Office of the Chief Technology Officer Political Economist and Social Technologist

ACKNOWLEDGMENTS

With gratitude for contributions, expertise, advice, and corrections from Mary Travis Bassett, Jorrit de Jong, Eric Lander, Rebecca Kahn, Marc Lipsitch, Glenn Cohen, Lindsay Wiley, Matt McKnight, Baratunde Thurston, Tyler Cowen, Glenn Hubbard, George Roberts, Jay Brooks, David Coble, Russell Hopkins, Jeffrey Levin, Steve Benjamin, Ashish Jha, Raj Chetty, David Williams, Sarah Oppenheimer, Brooke Bohnet, Darshan Goux, Liza Pagano, Lisa See Kim, Nan Whaley, Torey Hollingsworth, Daniel Ziblatt, Lothar Wieler, David Holt, Josh Fryday, and teams at US of Care and NAACHO. We called on the expertise of all of these people; we make no representation of where and how the report does or does not align with their views.

With thanks to The Rockefeller Foundation for their generous collaboration and support for the release of this report.

INSTITUTIONAL AFFILIATES FOR THE ROADMAP TO PANDEMIC RESILIENCE

Many of the undersigned do not typically take institutional positions. Moreover, some may differ with aspects of the report, and have stressed other matters of primary focus. All signed on to the original Roadmap to Pandemic Resilience as an urgent call to respond to a national crisis, and did so with the greatest sense of vital unity.

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The Edmond J. Safra Center for Ethics at Harvard University has worked in the space of ethics and public affairs for more than thirty years. We help people do integrated policy work that always keeps values and ethical choices front and center. Any big problem will be multidisciplinary. The Center has a long history of doing work in the bioethics space specifically. Harvard's Center for Bioethics developed out of our center, and we are also closely affiliated with the Petrie-Flom Center for Law and Bioethics. As the COVID-19 crisis took shape, we saw a need to connect public health expertise to economic expertise, legal expertise, political science, and philosophical/ethics expertise. So we set out to build a space for that integrated policy conversation.

EDMOND J. SAFRA
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EXECUTIVE SUMMARY

ON APRIL 27, THE CDC CHANGED ITS GUIDANCE TO SUPPORT BROADER USE OF TESTING NOT ONLY FOR THERAPEUTIC PURPOSES, BUT ALSO FOR DISEASE CONTROL. In the most recent guidance, released May 3, first priority goes to hospitalized patients, first responders with symptoms, and residents in congregate living contexts with symptoms. But there is now also a second priority category that includes asymptomatic individuals from groups experiencing disparate impacts of the disease and "**persons without symptoms** who are prioritized by health departments or clinicians, for any reason, including but not limited to: public health monitoring, sentinel surveillance, or *screening of other asymptomatic individuals according to state and local plans*" (bold in original, italics added). The last phrase supports broad testing of contacts of COVID-positive individuals and of essential workers, even when they have mild symptoms or none at all. This Supplement to our Roadmap to Pandemic Resilience offers guidance to help state and local governments develop TTSI (testing, tracing, and supported isolation) programs in support of such testing for purposes of disease control and suppression.

> ***Importantly, different levels of disease prevalence require different testing strategies. With community specific approaches, we will be, in aggregate, maximally efficient and effective in suppressing COVID-19 in this country.***

Low prevalence areas ("green zones") should focus on surveillance and therapeutic testing. Moderate-prevalence areas ("yellow zones") should **aggressively** use TTSI to suppress COVID-19 over the next one to two months and can do this even with the economy fully open. High-prevalence areas ("red zones") should focus over the next two months on mitigation testing and tracing strategies, targeted especially at their most vulnerable populations, while also maintaining stay-at-home orders and advisories.

When high prevalence areas have brought prevalence down, they can then finish the job of disease suppression with an aggressive push at full TTSI in the context of a fully open economy. Both moderate and high prevalence areas should also employ "critical context" testing—routine testing in contexts of high vulnerability or national security need. In aggregate the nation needs approximately 5 million tests a day for the periods of aggressive surge. The more ambitious a given locale is in ramping up its testing program, the sooner it will be able to drop back to low levels of testing suitable for low prevalence areas. While we can expect to be employing TTSI programs to mitigate, suppress, and contain COVID-19 for some period of time—six months at a minimum and quite possibly 18 or 24—we need five million tests a day only for an aggressive surge this summer.

In support of the efforts of state, tribal, and local leaders to establish testing and tracing programs, Congress needs to make substantial investment in TTSI infrastructure. We recommend investments in local public health offices ($5.5 bn), contact tracing personnel ($9 bn), voluntary self-isolation facilities ($4.5 bn), income support for voluntary self-isolation ($30 bn), investment in test kits, test processing, and mega-labs ($25 bn).

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INTRODUCTION

THE POLICY-MAKING LANDSCAPE HAS CONVERGED AROUND THE VIEW THAT MASSIVELY SCALED UP TESTING, TRACING, AND SUPPORTED ISOLATION PROGRAMS (TTSI), as well as local infection control, should be at the core of the nation's pandemic response prior to the arrival of a vaccine or major therapeutic breakthrough. The goal of ramping up TTSI programs is to reopen the economy safely and sustainably and to stay open, building an infrastructure of resilience that can withstand repeated further waves of COVID. In the *Roadmap to Pandemic Resilience*, we recommended a national goal of 5 million tests a day (Allen et al. 2020; modeling in Siddarth and Weyl 2020), supported by extensive and effective contact tracing. Given current rates of disease prevalence, testing at that level would drive the reproduction number of the virus to .75 and put its prevalence on a steady downward trajectory. A national strategy of massively scaled up TTSI would replace blanket stay-at-home orders with targeted isolation and would save both lives and livelihoods.

The adoption of such a strategy by the national government, complete with the national authority to create the necessary supply-chains and manufacturing capacity remains the ideal. As it stands, however, the federal government is depending on the states for execution of COVID-response strategy.

HOW DO I CALCULATE PREVALENCE?

Your community should be tracking deaths and confirmed cases. If your community is seeing 1 or more deaths for every 1000 people on a daily basis, you are in a high prevalence community where 1% or more of the population is actively infected. Deaths provide the best way of judging prevalence but they are a "lagging indicator." They tell us what the prevalence of active disease was about two weeks earlier. Confirmed cases can be useful to get a snapshot of the present but you have to be careful. If your community is not testing at a very high rate, then confirmed cases will be undercounted and will give you a misleading picture of prevalence. If you are part of a community with higher vulnerability to the disease, even moderate prevalence (below 1% of the population) would cause 1 or more deaths for every 1000 people on a daily basis.

Also, note that wherever possible, it is better to calculate via excess deaths (deaths today vs deaths same time last year) rather than with COVID-attributed deaths, especially in places where there is little to no testing.

On April 27, the CDC changed its guidance to support broader use of testing not only for therapeutic purposes, but also for disease control. In the most recent guidance, released May 3, first priority goes to hospitalized patients, first responders with symptoms, and residents in congregate living contexts with symptoms. But there is now also a second priority category that includes asymptomatic individuals from groups experiencing disparate impacts of the disease and "**persons without symptoms** who are prioritized by health departments or clinicians, for any reason, including but not limited to public health monitoring, sentinel surveillance, or *screening of other asymptomatic individuals according to state and local plans*" (bold in original, italics added).

The last phrase supports broad testing of contacts of COVID-positive individuals and of essential workers, even when they have mild symptoms or none at all. This is an opportunity to build a TTSI program. Yet the aggregate national goal set forth in our original Roadmap gives insufficient guidance to policy makers and crisis managers seeking to set TTSI targets for state, tribal, and local testing plans. More nuanced analysis is essential because different parts of the country have different levels of disease prevalence and so need different kinds of testing programs.

This Supplement to the Roadmap divides the country into low and high population density areas and explains the different kinds of testing infrastructure each category needs. Testing infrastructure comes in "slow lane," "fast lane," and "carpool lane" variants; these need to be organized differently in low and high density locales.

THE FIRST JUDGMENT CALL ON TESTING STRATEGIES

How much testing should your community have? The answer depends on what goals your community chooses for its testing program. Your community might want to use testing mainly for therapeutic purposes to help treat those who are sick. Or your community might want to use testing and contact tracing to help suppress COVID-19 and remove it from your community, as one tool among many alongside stay-at-home orders for surges. Or your community might want to use testing and contract tracing as a tool of disease suppression powerful enough itself to keep second waves at bay. Each of these purposes requires a different level of testing. The CDC guidance on testing supports all three approaches. So here's the judgment call elected officials and public health officials make when they set up a testing program for their community.

Should we test:

1. For therapeutic purposes?
2. To assist disease suppression as a tool working alongside stay-at-home orders and advisories?
3. As our main tool for disease suppression?

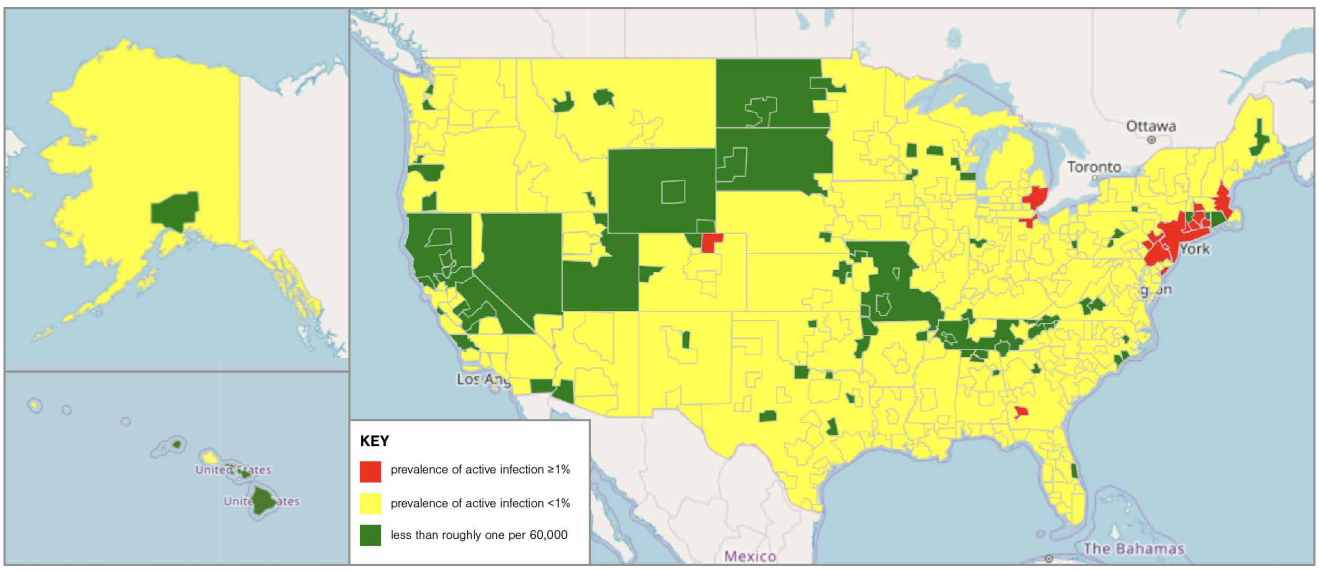
Each choice requires a different level of testing from minimal to moderate to the robust standard of South Korea.[1]

1 Based on estimates from successful regions such as South Korea, we estimate the necessary number of tests to detect positive cases and suppress all transmissions. Extrapolating from tests conducted as well as positive percentage (https://ourworldindata.org/grapher/full-list-covid-19-tests-per-day?country=KOR), this suggests about ~25 tests conducted to detect one positive case, which is the figure we use in our estimations. We also analyze the capacity required to maintain green regions by assuming this equals the per-capita capacity used for such maintenance successfully in South Korea. This level of testing is crudely determined by the population of the region divided by 10000. This was chosen to be equal maintenance levels currently used in South Korea, although this number can easily be refined with time.

This Supplement also divides the country into three zones according to disease prevalence in each metropolitan statistical area: green (low), yellow (moderate), and red (high) zones (see Figure 1).[1] Green zone communities have few active infections (a current infection prevalence of less than roughly one per 36,000). Yellow zone communities have known active infections at a small scale (less than 1% prevalence of active virus in the population). Red zone communities have an outbreak which public health authorities have not been able to suppress (1% or higher prevalence of virus in the population).[2] We provide guidance for target testing levels in each prevalence zone.[3]

At this phase in the pandemic, population density is highly correlated with disease prevalence; more dense locales have higher levels of active virus circulation. This is, however, a contingent and not a necessary correlation and could change. Indeed, when we began writing this supplement two weeks ago, the country still had green zones as represented in Figure 1. (For current prevalence, see Appendix A for a listing of MSA prevalence levels.)

FIGURE 1. DISEASE PREVALENCE IN LATE APRIL BY METROPOLITAN STATISTICAL AREA (MSA) BASED ON EXCESS DEATH DATA FROM MAY 6. For an interactive version of this map, please see: https://theartofresearch.org/interactive-msa-map/)



DEMOGRAPHIC CONTEXT

PERCENTAGE OF POPULATION WHO ARE MINORITIES	INCOME PER CAPITA
green: 25%	**$29,174**
yellow: 33%	**$29,834**
red: 39%	**$34,773**

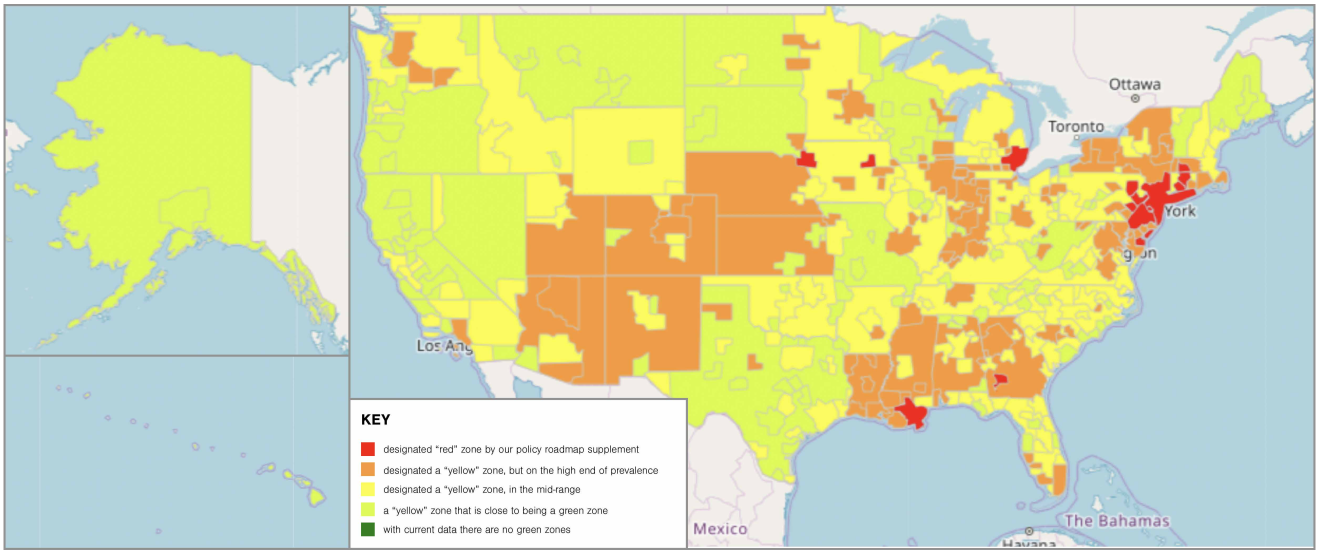
1 Prevalence is a measure of the amount of disease currently in a population and therefore of the level of the infectious population. For cumulative levels of those who have been infected over time, we refer to the "cumulative incidence" of infection.

2 Estimating prevalence is notoriously difficult. Case count is not a reliable methodology as it fundamentally reflects the level of testing in a given locale. The only solid basis for assessing prevalence is by reference to deaths. This, however, produces a lagging indicator. Once we are able to test at the target capacity, the combination of case counts and deaths should provide a reasonable basis for estimating prevalence.

3 Our model suggests we need to test roughly 3 to 5 times as many people per day as currently are COVID-positive (the current prevalence number). Once we pass 1% prevalence, we are testing enough people per day that the entire population is being tested roughly once a month. At this point, the policy becomes effectively one of more universal testing rather than TTSI-style testing. This is an arbitrary threshold, but is a nice round number with these properties.

Now, however, as of May 8, 2020, no metropolitan statistical area falls in the lowest prevalence category. See the distribution of prevalence in Figure 2. In this map, the prevalence ranges within the yellow zone are now represented by lime green, yellow, and orange to indicate which yellow zone areas are close to green and which are close to red.

FIGURE 2. DISEASE PREVALENCE BY METROPOLITAN STATISTICAL AREA (MSA) AS OF MAY 8, 2020 (BASED ON EXCESS DEATHS AND NEW INFECTIONS). Interactive maps are available at [https://theartofresearch.org/covid-maps.](https://theartofresearch.org/covid-maps)



Drawing on the two distinctions between high and low population density areas and low, moderate, and high disease prevalence contexts, we offer planning frameworks for state, tribal, and local decision-makers (e.g. municipal leadership and city and county health officials) responsible for developing testing plans.

State, tribal, and local governments need to scale up infrastructure for managing test administration, sample transport and processing, and data management. In addition, states and regions need to coordinate test kit supplies, test processing capacity, and infrastructure investments. Infrastructure investments are needed in tribal and local public health offices (including IT capacity), high quality contract tracing jobs, voluntary self-isolation facilities, income support for voluntary self-isolation, investment in test kits and test processing, investment in point-of-care testing machines, and investment in mega-labs. Both the level of infection and the capacity to address it vary considerably by location. Even as states, tribal, and local governments take on most of the burden for developing TTSI programs, the federal government has a continued and necessary role. Both the executive and legislative branches need to support state efforts with strategic public investment, knowledge coordination, and flexible financing.

In what follows, we provide summary guidance for TTSI program testing and tracing targets (section 2), guidance on the infrastructure necessary to run TTSI programs (section 3), and implementation action steps (section 4).

SUMMARY GUIDANCE

IN ORDER TO PUT THE VIRUS ON A PATH OF STEADY DECELERATION, to reopen the economy fully and safely, and to keep the economy open, we have modeled a testing and tracing program similar in impact to that employed in South Korea, disaggregating the needs of the country. Our testing targets aim at achieving breadth and inclusivity in access to testing, and a 4% positivity rate. This is the percentage of tests administered each day that return a positive result.

Our core recommendation is that the nation use an ambitious surge of testing and tracing this summer to pursue a near-term (2 to 3 months) national target of bringing the reproduction number of the virus down to .75 (R = .75) and a long-term target (12 to 18 months) of consistent suppression to produce a context in which outbreaks will be easily containable. Since the country no longer has any green zones, we should now consider it the first priority of our testing regime to suppress or fully clear covid-19 from yellow zone locales (on the map above, these are represented by lime green, yellow, and orange). A second priority is to mitigate and then suppress or fully clear covid-19 in red zone locales. Within any given locality, high priority should be given to vulnerable populations, and particularly to minority communities experiencing the disparate impact of COVID-19 and higher infection fatality rates. Ramping up to 5 million tests a day for a period of surge, while maintaining stay-at-home orders and advisories in red areas, would permit us to pursue both priorities simultaneously.

In addition, we add a recommendation for "critical context" testing as another important element of an overall package of testing policies. "Critical contexts" are defined either by high vulnerability or by criticality to the country's national security: these critical contexts include health care settings, elder care facilities, correctional facilities, meatpacking plants and other assembly line-type conditions (e.g. retail warehouses), grocery stores, the White House, military barracks, and naval ships. As is defined more fully below, to achieve dependable suppression in these "critical contexts," we need to add sustainable levels of routine testing for those sites. That said, routine testing is highly inefficient and should be a minimal part of overall testing.

Finally, we recommend accelerating the ramp up of testing capacity in order to achieve the full national target across all three zones in a compressed time period (two to three months), rather than an extended timeframe (six months, or even longer). The more aggressively we set our testing targets the faster we can set our world to rights.

At the level of individual locales, this strategy yields the following rules of thumb for calculating testing and tracing needs:

- **GREEN ZONES**: one test per day for every 10,000 people; one five-person contact tracing team for every 100,000 people.
- **YELLOW ZONES:** 60 teams of five tracers for every death/day in the locale; testing capacity at the level of 2500

tests x (#deaths/day).[1]

- **RED ZONES:** 60 teams of five tracers for every death/day in the locale; testing capacity at the level of 2500 tests x (#deaths/day).

These are aggressive targets whose goals are to clear out the disease as quickly as possible during a surge period of testing. Ideal execution would carry this out over the course of a month. In current circumstances, however, we expect achievement is more likely to take two to three months. Testing levels could thereafter decline to a maintenance level, as zones move from yellow to green.

In addition, other measures would continue to be relevant according to the following pattern:

TABLE 1. STRATEGIES FOR NON-PHARMACEUTICAL INTERVENTIONS OTHER THAN TESTING BY ZONE

Based on disease: **Close to zero; <1%; ≥1%**	**GREEN**	**YELLOW**	**RED**
Stay-at-home orders necessary?	No	Not if this aggressive level of testing and manual tracing capacity is in place and digital apps are in use to support contact tracing in large public spaces.	Yes, until this testing and tracing capacity is in place AND disease prevalence has fallen below 1% AND ICU capacity is sufficient and stable.
Is universal mask wearing necessary?	Recommended for high risk groups	Yes	Yes
Improved infection controls necessary?	Yes	Yes	Yes
Bans on large gatherings?	No	Not if this testing and tracing capacity is in place and digital apps are in use to support contact tracing in large public spaces.	Yes

In an accompanying modeling white paper (Charpignon, Foster, Hoshino, Kakade, et al. 2020), we have disaggregated our analysis of testing targets into recommendations specific to the level of virus prevalence in different parts of the country. In addition, we provide an aggregate picture of testing needs. These locale specific targets are also available at pandemictesting.org.

Two weeks ago, green zones encompassed 19 million people. A modest aggregate testing level of 1,900 tests a day could have kept those zones green. Now those zones have all entered into the yellow category of moderate prevalence. Our testing needs have therefore modestly increased in the past two weeks. **A basic lesson of TTSI programs is that the earlier the investment, the less expensive it will be.** The picture of current aggregate testing needed to clear the disease and get much of the country back to green is as follows:[2]

1 Tests per day are based on deaths per day, even though deaths are a lagging indicator, because of the difficulty of getting reliable prevalence estimates. We may want to invest some tests in random sampling for a more accurate estimate of prevalence, but it is not clear this is the right strategy given test scarcity.

2 The modeling behind these numbers is reported in Charpingon et al. 2020. We begin with data on COVID-19 and excess mortality from state public

TABLE 2. STRATEGIES FOR TESTING AND TRACING BY ZONE

Based on disease prevalence (ascertained from death rates and new infections) as of May 8, 2020	**GREEN**	**YELLOW**	**RED**
Population in each zone (millions)	0m	290m	38m
Test/day surge capacity needed to suppress	N/A	3m	3m
Total tests at peak (millions)	N/A	60m	70m
Tracers needed to suppress	N/A	300,000	400,000
Lives saved with this investment	N/A	3,000,000	400,000
Number of lives saved per test/per day	Theoretically, 125 lives would be saved for each allocation of 1 test/day if there were still any areas like this.	1 life saved for every 1 test per day allocation	1 life saved for every 8 tests per day allocation

Importantly, our analysis of potential lives lost in each region draws heavily on an analysis of the vulnerability of different regions to harms from COVID-19, based on the COVID-19 Community Vulnerability Index (CCVI, see Surgo Foundation 2020). Our use of this index, however, goes beyond merely accounting for the greater number of lives lost in each area; we assume a greater variance in the lives lost than can be accounted for merely by differences across regions in infection fatality rates. Many of the most vulnerable regions are less densely populated and located in the South, according to the CCVI. The CCVI index can be used to give higher priority for testing resources within each of the three zones (green, yellow, and red) to those communities with higher degrees of vulnerability. Our proposed testing numbers per locale (available on the interactive tool here at pandemictesting.org) embed that higher resource provision prioritization to more vulnerable areas.

This prioritization would result in the following recommended strategies for decision-makers, as articulated from the decision-maker's point of view.

health authorities and use this to recover current prevalence rates based on estimates of the Infection Fatality Rate (IFR). We then use a model, calibrated to the success of Asian and Australasian countries in controlling the disease, to estimate required TTSI resources to achieve disease suppression by locality, broken down by MSAs and the non-MSA areas of each state. Finally, we combine this C19 specific data with the static, pre-existing, CDC-endorsed COVID-19 Community Vulnerability Index (CCVI), incorporating epidemiological and socioeconomic factors, to approximate the death toll and impact of the disease if it spreads in that community. These underlie our recommendations on resource allocation.

TESTING STRATEGIES FROM THE PERSPECTIVE OF DECISION-MAKERS

If I'm in a green zone, my job is to keep COVID out of my jurisdiction; I need one test per day for every 10,000 people in my jurisdiction, as well as one five-person contact tracing team for every 100,000 people. I need to make sure my state decision-makers know that keeping all green areas green is the #1 priority and that doing this will take only a small percentage of our testing capacity.

If I'm in a yellow zone, my job is to get my jurisdiction back to green and to keep it green. If the state government can allocate to me or if I can build a contact tracing infrastructure with 60 teams of five tracers for every death/day in my region and if the state government can allocate me or I can build testing capacity on the following formula—2500 x (#deaths / day)[1]—I can keep 100% of my economy open. If my testing allocation is lower than that, I should keep less of my economy open, pretty much in straight percentage terms to my testing allocation. I need to make sure my state decision-makers know that turning all yellow zones green is their number #2 priority. The more aggressive I can be up front, the less I will have to invest in aggregate.

If I'm in a red zone, I should keep only essential services open and I need to allocate tests per day on the following formula: 2500 x (#deaths /day). I also will need contact tracing infrastructure with 60 teams of five tracers for every death/day. If I can maintain these testing levels and contact tracing teams, I can open my economy fully when I get to yellow or prevalence below 1%. Recognizing that I will be the #3 priority of my state, I need to expect that stay-at-home advisories will last longer for me than for my peers in yellow and green zones. My zone will require a huge volume of tests to clear the disease and I recognize that we can collectively get there faster, if we first protect all green zones and help all yellow zones achieve clearance and reach green, before we return to the project of fully clearing the disease from red zones. That said, I should focus within my zone on directing all available resources to vulnerable populations in the first instance.

I also know that I will ultimately get the lion's share of total testing resources, in exchange for waiting in line just a little longer. The one thing that would change this priority assessment across green, yellow, and red zones would be if my state government could activate mega-labs that could in fact process millions of tests per day and bring total national capacity during a surge period to 5 million tests per day. I could also fall back into a less testing-intensive approach in which we quarantine all the contacts of a COVID-positive individual and trace further contacts only for those who become symptomatic AND have been active in the essential workforce.

Regardless of whether I am in a green, yellow, or red zone, I am aware that my constituents may have higher than average vulnerability to the disease and, if so, I will want to adjust my calculations to take that into account.

If total national capacity hits 5 million tests a day, then we could cover the testing needs of all three categories of locales simultaneously.

These considerations should include, at the local level, an understanding of the proportion of elderly people, racial minorities, and essential workers within my population. Given that these disparities are much more likely to be present within rather than between zones, they should factor into my resource allocation at a local level.

1 Tests per day are based on deaths per day, even though deaths are a lagging indicator, because of the difficulty of getting reliable prevalence estimates. We may want to invest some tests in random sampling to get good prevalence, but it is not clear this is the right strategy given scarcity.

Also, if I am in a yellow or red zone, I need to help local businesses and organizations achieve appropriate standards of infection control and develop physical and social distancing and de-densification policies for transportation and public spaces. This will require a mixture of large investments to de-densify and to introduce digital contact tracing for public spaces. In addition, I will need to assess the specific impacts of all these policies on my local economy; the pattern of impact will be variable from one context to another, including support for workers who become or continue to be unemployed as a result of these policies.

If I am in state government, I need to pursue build-out of the testing supply chain to hit a resource level that can support all three kinds of locale (green, yellow, and red). Until we reach full capacity, I need to prioritize green areas, then yellow areas, and prepare red areas for extended time under stay-at-home orders.

Acting on this guidance requires, of course, that decision-makers have access to an adequate infrastructure to support a TTSI program. We turn now to the infrastructure needs.

HOW MUCH SHOULD MY COMMUNITY BE TESTING?

First, you need to know whether you live in a low prevalence, moderate prevalence, or high prevalence community.

Low prevalence communities have few active infections (a current infection prevalence of less than roughly one per 75,000). Moderate prevalence communities have known active infections at a small scale (less than 1% prevalence of active virus in the population). High prevalence communities have an outbreak which public health authorities have not been able to suppress (1% or higher prevalence of virus in the population

If you live in a low prevalence community, your community needs to be testing only 1 out of every 10,000 people per day.

If you live in a moderate or high prevalence locale, your community wants to find as many cases as possible. To do this, public health officials can use contact tracing. This means finding the contacts of infected person so those contacts can get a test. An aggressive contact tracing program that would surge to suppress the disease in a moderate prevalence zone would need to be testing as many as one out of every 100 people per day over the course of a few weeks, until the levels of disease fall off. In a high prevalence zone, an effective surge would mean testing one out of every 13 people per day. Contact tracing programs that result in fewer numbers of people being tested also help; they just can't suppress the disease on their own without the assistance of other tools like stay-at-home orders and advisories.

What if you live in a moderate or high prevalence locale, and your community isn't testing at that kind of rate? Then you need to look at the **numbers of tests in your community and how they are distributed**. The number of tests needs to be high enough for there to be equal access to them and tests need to be distributed equitably throughout your community so that vulnerable populations have access to them.

If and only if your community is testing broadly and equitably, then it is also useful to look at **the positivity rate**. This is the percentage of tests administered each day that return a positive result. The lower the positivity rate, the better the testing program is doing. A low positivity rate (10% or lower) means public health officials are looking very hard to find COVID-positive individuals, to treat those who need treatment, and to support the rest in isolating to take the virus itself out of circulation. They are looking hard enough to help suppress the disease. A positivity rate of only 4% means public health officials are being maximally ambitious and achieving the same level of testing as South Korea. This level of testing is such a powerful tool of disease suppression that it dramatically reduces the need for stay-at-home orders and advisories.

Johns Hopkins Center for Health Security, drawing on on World Health Organization guidance, recommends a positivity rate no higher than 12%.

The Harvard Global Health Institute, also drawing on World Health Organization guidance, recommend a positivity rate no higher than 10%.

The example of South Korea recommends a positivity rate of no higher than 4%. This report uses the South Korea standard for analyzing needed levels of testing. This is the standard that generates a need to test as many as 1 out of every 100 people per day in moderate prevalence contexts.

So how can you tell how well your community is doing? Use the 12-10-4 rule.

If my town has equitable access to testing but the positivity rate is above 12%, public authorities may not be seeing enough cases to know if there is a fresh outbreak or new surge emerging or they may be missing the spread of the disease in parts of our community.

If my town has equitable access to testing but the positivity rate positivity rate is above 10%, public authorities will have less time than would be ideal to respond to a surge.

If my town has equitable access to testing but the positivity rate above is 4%, public authorities will probably have to use stay-at-home orders again to control a new surge.

If my town has equitable access to testing and the positivity rate is only 4%, we are using testing in the most robust way possible to suppress covid-19.

TTSI INFRASTRUCTURE

THE TESTING TOOLKIT

In order to know what infrastructure investments to make to support a TTSI program, it is important to understand the several categories of diagnostic testing that are available and how they interact with each other.[1]

In the *Roadmap to Pandemic Resilience*, we focused on four broad categories for diagnostic testing that are or should be in the nation's testing toolkit: therapeutic testing, "broad quarantine," which uses limited contact tracing and testing, a TTSI program with extensive contact tracing and testing, and "universal testing," which tests the population at random.[2] In contrast to therapeutic testing used by clinicians to support the treatment of patients, the latter three approaches to testing have the purpose of disease control. "Broad quarantine" traces the contacts of COVID-positive individuals and quarantines them. A TTSI program tests the contacts of COVID-19 positive individuals and traces the contacts of those who test positive, testing that new set of contacts in turn, and continuing down a chain of transmission until no new cases are found. The precise criteria for who is a contact should be driven by data, but the current CDC definition counts people within 2 meters for 15 minutes or more from two days before symptoms appear to fourteen days afterwards. This approach folds the asymptomatic and pre-symptomatic into a testing program. In addition, there is also a fifth category called "sentinel" testing, which public health authorities use to spot when outbreaks are emerging. All five categories are captured in Table 3: "The Nation's Testing Toolkit as Per the Pandemic Resilience Roadmap."

TABLE 3. THE NATION'S TESTING TOOLKIT, PER THE PANDEMIC RESILIENCE ROADMAP

TESTING CATEGORIES	TESTING TARGETS	#S OF TESTS/DAY NEEDED NATIONALLY
Sentinel Testing	**Target Level 1:** Testing in routine clinical tests to monitor disease outbreaks (automatic testing for flu, COVID, strep, etc. whenever people present with particular symptoms; automatic testing of women in delivery, etc.)	100,000 per day (Charpignon et al. 2020)

1 We do not discuss serology testing in the Roadmap or in this Supplement. The science of immunity is still insufficiently stable and the quality of serology tests are still too problematic for solid policy to rest on these resources. We hope and expect that that circumstance will change soon.

2 On the TTSI program, we trace contacts but do not in the first instance only quarantine them. Instead, we also test them. For each positive identified among those contacts, we trace contacts again, and test that next round of contacts and so on. Contacts who test positive are isolated or connected to treatment. But what about contacts who test negative? Infection control protocols would dictate two negative tests prior to release from quarantine. Consequently, we have two possible protocols for the treatment of contacts who test negative:

1. Test those traced, isolate the positives and follow up with further tracing, quarantine the negatives.
2. Test those traced, isolate the positives and follow up with further tracing, test the negatives again (possibly after several days of quarantine) and either follow up or release.

TESTING CATEGORIES		TESTING TARGETS	#S OF TESTS/DAY NEEDED NATIONALLY
Therapeutic Testing		**Target Level 2:** Testing in epidemic/ pandemic contexts to differentiate pneumonia-type diseases for purposes of treatment and infection control	100,000 per day (Gottlieb et al. 2020)
Disease Control Testing	**Broad Quarantine**	**Target Level 3:** Target Level 2 + contact tracing with contacts being quarantined	700,000 per day (Jha et al. 2020; Rockefeller 2020)
	TTSI	**Target Level 4:** Target Level 2 + effective contact tracing + testing of contacts through as many links in the chain necessary to find zero positives + supported isolation, with testing at sufficient rates to prevent the disease from circulating in the essential workforce still active in the economy	2 million per day (Siddarth & Weyl 2020)
		Target Level 5: Target Level 2 + effective contact tracing + testing of contacts through as many links in the chain necessary to find zero positives + supported isolation, with testing at sufficient rates to prevent the disease from circulating in an economy with a 100% active workforce	5 million per day (Siddarth & Weyl 2020)
		Target Level 6: Target Level 2 + marginally effective contact tracing + testing of contacts through as many links in the chain necessary to find zero positives + targeted and supported isolation at sufficient levels to prevent the disease from circulating in an economy with a 100% active workforce	20 million per day (Siddarth & Weyl 2020)

We currently believe the first protocol is best, partly because it minimizes the number of required tests in a condition of scarce testing supplies. The cost is a lot of unnecessary quarantining. Ultimately, the second protocol is preferable. However, it will nearly double the required surge capacity as well as the required number of total tests. Because of current test scarcity, we have modeled based on the first protocol. We should aspire, though, to increase testing supply sufficiently to transition to the second protocol. Furthermore, as testing capacity expands, it would make sense to switch to the second protocol for essential workers before doing so for the general population.

TESTING CATEGORIES		TESTING TARGETS	#S OF TESTS/DAY NEEDED NATIONALLY
Disease Control Testing	**Universal Testing**	**Testing Level 7:** Random routine testing of whole population	25-50 million per day (Romer 2020)[3]
	Across all three disease control methods in conditions of moderate to high prevalence	Encourage vulnerable populations to remain out of circulation in all of these testing levels via risk communications and provision of data.	

Although "broad quarantine" is a standard public health tool for disease control, it has less power for suppression in the context of a disease like COVID-19 because of the high percentage of asymptomatic and pre-symptomatic carriers (estimated at 25% but potentially higher). As the name suggests, it is insufficiently targeted to interrupt the actual chain of transmission. Nonetheless, it is a valuable tool for mitigation in contexts of scarcity of testing resources.

On the other hand, universal testing has significant drawbacks, primarily the massive volume of testing and its imposition on people's lives, as well as the infeasibility of testing at these levels in the near term. If we exclude universal testing from the toolkit, the disease control tool of TTSI, which places the emphasis on extensive and effective contact tracing along all the links of the chain of transmission, is the most powerful tool for disease suppression.

The size of the work force needed for TTSI programs can be estimated using the approximate rule "5 contact tracers per new case per day."[4] The reason for this is that 1 tracer needs to do an interview (as soon as possible), and then a team of 5 people should spend the next 12 hours to try and find all those at risk and discuss with them how to take appropriate steps.

Why do we need to get tracing done within 12 hours?

Suppose we give a test to person A and start the clock. We send this test out and get the results back. Suppose person A has tested positive, and we mobilize a trace team. They talk to A, find a list of exposed people, contact people on this list and test them. We stop the clock when the at-risk individuals have been given a test. All of this is the "trace time." *This process needs to move fast*—any delays to check and confirm will likely lead to more deaths rather than save more lives. A trace time beyond three days has little value in controlling the epidemic while a trace time of one day is plausibly effective.[5] See Feretti et al. 2020, particularly figure 3, which expresses this.

Achieving a one-day trace time appears possible, although it requires an optimized process. For example, for low population density areas, testing facilities supporting contact tracing must be dispersed across the country to avoid significant transport delays. Mega-labs in high density population areas need to be able to turn around tests in 12 to 24 hours. The tracing process should be ready to go 24 hours a day, and significant organization is required.

3 While Paul Romer's estimate of the number of tests needed for universal testing is 25 million a day, others have argued that his program would actually require more like 50 to 80 million tests a day. See Siddarth and Weyl 2020.

4 This number is estimated based on numbers used in Asia generally.

5 This is assuming we are treating people early enough to interrupt the disease, which requires catching cases on average two to three days in.

While the benefits of contact tracing for disease suppression are clear, there is also something to be learned from the universal testing model. Fear of exposure to COVID-19 has a dampening effect on economic activity, even when stay-at-home advisories are lifted. The primary motivation for universal testing is to counteract that fear.

People need to be confident that their risk level will be tolerable if they are mobile and active. Routine testing of the whole population on a three-day rolling basis would certainly achieve such confidence. But that rate of testing is neither feasible in the near term nor desirable for quality of life. Still, public confidence is essential. The upshot is that we need alternatives to universal testing that also inspire public confidence.

In particular, there are some contexts in which it is not enough to decelerate the disease over time through TTSI—we need even more rapid control. This is especially true of "critical contexts" defined either by high vulnerability or by criticality to the country's national security; these critical contexts include health care settings, elder care facilities, correctional facilities, meatpacking plants and other assembly line-type conditions (e.g. retail warehouses), grocery stores, the White House, military barracks, and naval ships. To achieve dependable suppression in these "critical contexts," we need to add sustainable levels of routine testing for those sites.

This testing should be weekly individual testing for staff members in high prevalence locales and weekly pooled testing for staff members in moderate prevalence locales. To use **Critical Context Testing**, locales need to survey their region to identify the number of workers in these critical contexts. Locales can then work from these numbers to determine the number of tests they will need for weekly pooled testing or weekly individual testing. That said, critical context testing is highly inefficient and should be a minimal part of overall testing. We need to maximize the value of broad testing and tracing programs in order to minimize the need for critical context testing.

Replacing Universal Testing with Critical Context Testing yields a revision to the Testing Toolkit. See Table 4 for an updated chart summarizing the Nation's Testing Toolkit.

TABLE 4. THE NATION'S TESTING TOOLKIT (UPDATED)

TESTING CATEGORIES	TESTING TARGETS	#S OF TESTS/DAY NEEDED NATIONALLY
Sentinel Testing	**Target Level 1:** Testing in routine clinical tests to monitor disease outbreaks (automatic testing of people with particular symptoms for flu, COVID, strep, etc.; women in delivery, etc.)	100,000 per day
Therapeutic Testing	**Target Level 2:** Testing in epidemic/pandemic contexts to differentiate pneumonia-type diseases	100,000 per day (Gottlieb et al. 2020)

TESTING CATEGORIES		TESTING TARGETS	#S OF TESTS/DAY NEEDED NATIONALLY
Disease Control Testing	**Broad Quarantine**	**Target Level 3:** Target Level 2 + contact tracing with contacts being quarantined	700,000 per day (Jha et al. 2020; Rockefeller 2020)
	TTSI	**Target Level 4:** Target Level 2 + effective contact tracing + testing of contacts through as many links in the chain as it takes to find zero positives + supported isolation, with testing at sufficient rates to prevent the disease from circulating in essential workforce still active in the economy	2 million per day (Siddarth & Weyl 2020)
		Target Level 5: Target Level 2 + effective contact tracing + testing of contacts through as many links in the chain as it takes to find zero positives + supported isolation, with testing at sufficient rates to prevent the disease from circulating in an economy with a 100% active workforce	5 million per day (Siddarth & Weyl 2020)
		Target Level 6: Target Level 2 + marginally effective contact tracing + testing of contacts through as many links in the chain as it takes to find zero positives + targeted and supported isolation, at sufficient levels to prevent disease from circulating in an economy with a 100% active workforce	20 million per day (Siddarth & Weyl 2020)
	Critical Context Testing	**Target Level 7:** Weekly pooled testing for staff in critical contexts in low prevalence locales; weekly individual testing for staff in critical contexts in high prevalence locales: health care settings, elder care facilities, correctional facilities, meatpacking plants and other assembly line-type contexts (e.g. retail warehouses), grocery stores, the White House, military barracks and naval ships	Depends on number of locations identified as critical contexts and frequency of routine testing.
	Across all three disease control methods in conditions of moderate to high prevalence	Encourage vulnerable populations to remain out of circulation in all of these testing levels via risk communications and provision of data.	

Fighting COVID-19 requires using sentinel testing, therapeutic testing, TTSI-based testing, and critical context testing. However, different contexts require different combinations of these tools.

THE TESTING TOOLS IN USE

Different levels of disease prevalence call for different testing strategies. Green zones primarily need sentinel testing and modest amounts of TTSI testing. Yellow zones need sentinel testing, a full-scale TTSI program, and some critical context testing. Red zones need robust critical context testing and, to the degree possible, full scale TTSI tracing programs. (Also, note, if the ratio of SARS-CoV-2 infection to other respiratory infections is high enough, red zones may be able to decrease therapeutic testing of patients with influenza-like symptoms, and presume that most of these cases are COVID-19: cf Moss *et al*, 2011).

In addition, all zones need local infection prevention control policies (WHO 2020). Yellow and red zones also need ongoing physical and social distancing and de-densification policies.

An analogy to our interstate infrastructure is helpful. We have a clear need for the fast testing systems of a TTSI program, but there is a role for slower testing systems as well—they can be used to discover unknown outbreaks through wide-scale surveillance of symptomatic individuals. Thus, we envision two “lanes”: a fast lane used for ``hot pursuit” contact tracing and a slow lane used to discover outbreaks from symptomatic individuals. In addition, there is a need for a carpool lane. To keep workers in the most critical contexts safe and effectively able to participate in the workplace and to keep those with whom they interact safe, we will need some amount of routine weekly testing in the most critical contexts: health care settings, elder care facilities, correctional facilities, meatpacking plants and other assembly line-type contexts (e.g. retail warehouses), grocery stores, the White House, military barracks, and naval ships.

SLOW LANE

We need sentinel testing at all times, even in green zones, but we do not need huge numbers of tests to achieve sufficient levels of surveillance. Standard surveillance testing is done mainly in health clinics when patients come in for a wide range of symptoms; they get tested for flu, strep, and COVID-19 simultaneously, for instance. Women coming in for childbirth can be routinely tested as part of surveillance regimes. Elder homes and nursing homes should also be folded into surveillance testing. We should be able to maintain this capacity level consistently over time and ubiquitously across geographies.

FAST LANE (TTSI)

We also need the capacity to move faster, find the disease, and stop it when it is surging. For this, we need the TTSI infrastructure, which drives the number of tests up dramatically because of contact tracing. In this instance, we need surge capacity, but the communities that need surge capacity will change as the disease moves. For many locales, testing sites can be mobile collection sites;[6] they do not need to be permanent infrastructure. Importantly, on Friday, May 8, 2020, the FDA approved the first antigen test for COVID-19 (a protein based test that is simpler and faster than the DNA tests currently in use). This has the potential to transform fast lane infrastructure by simplifying the testing process.

TTSI programs start with testing the symptomatic who come to clinics and tracing their contacts. Contacts are advised to come to testing sites and/or contact tracers fan out to collect samples. Temperature checks and symptom attestations in workplaces should also be administered to expand the testing pipeline beyond the current therapeutic model, allowing employers to participate in building a more resilient public health infrastructure.[7] Until home testing

6 “Mobile sample collection sites” could include coming to people’s residences, taking a spit test and returning it to a hub—a potentially powerful architecture.

7 We note, however, that any participation of employers in the public health infrastructure will require developing and implementing strict restrictions on the

kits are readily available, locales will need to decide how to distribute testing across clinics (including RiteAid/CVS clinics), drive-thru testing sites, mobile sample collection sites, or mobile point-of-care testing labs.

Low population density communities at a distance from major population centers will want to use clinics with point-of-care testing instruments and mobile testing labs that offer immediate test results and/or a regional network of public and commercial labs (e.g., LabCorps and Quest) that are accessible with a one-day turnaround time on test results. Regional assets like veterinary clinics can also be activated for surge capacity.[8] Mobile labs deployed to provide this testing should be thought of on the load balancing model of ventilators where supplies are moved from one hotspot to another.

High density population communities will want to use drive-thru testing sites, clinics, and mobile or stationary sample collection sites.[9] The number of sites would need to be sufficiently constrained to ensure that sites are collecting a minimum of 96 tests per day, which would permit batch collection in trays and simplify test processing workflow in high capacity labs or mega-labs. Surge collection sites would send tests to mega-labs capable of processing a minimum of 200,000 tests a day. This scale of processing is needed to ensure 24 hour turnaround of results.

Therapeutic testing is also part of fast lane infrastructure, as surging cases necessitate more tests. When prevalence levels are sufficiently high, however, therapeutic testing should diminish as clinicians can presume COVID and instead rely on CT-Scans and other diagnostic tools for confirmation. Available testing capacity can then be redirected to TTSI uses.

CARPOOL LANE

Finally, there is critical context testing—also part of managing surge capacity. Workplaces that need this capacity should be equipped either with testing equipment on a temporary basis or should establish protocols for routine group collection in minimally sized batches of 96 tests per day. Pooled testing could also be a valuable tool.[10]

Green zone locales need only the slow lane. Yellow and red zone locales need all three lanes. Red zone locales need the most robust carpool lanes. Table 5 represents how different locales should use the testing toolkit.

TABLE 5. LOCALE-SPECIFIC USE OF TESTING TOOLKIT

	SLOW LANE		FAST LANE		CARPOOL LANE	
	Sentinel Testing	Maintenance Therapeutic Testing	Surge Level Therapeutic Testing	TTSI Testing	Critical Context-Pooled Testing	Critical Context-Individual Testing
Green Zones	x	x				
Yellow Zones			x	x	x	
Red Zones			x	x	x	x

Stabilizing green zone communities requires sufficient slow lane testing capacity to cover all symptomatic individuals. As we have indicated, while the country had green zones two weeks ago, it no longer does. For those communities

use that employers can make of information obtained through testing to protect workers from abusive and inappropriate use of such information.

8 Martinez-Keel 2020.

9 Innovators are working on development of at-home tests, which could make a considerable difference.

10 Pooled testing has the potential to decrease testing requirements by a factor of 10 or more, but has to be done by sophisticated trained individuals or machines programmed to do it properly.

that have recently shifted from green to yellow, we should organize to assist them to return efficiently to green. Since many recently green zone communities are rural, there should be a contingent of mobile testing facilities available at the state or interstate level and ready for use, a trained reserve of contact tracers, and contingent agreements with hotels or motels and local volunteers to support isolation.

Stabilizing yellow zone communities requires active investment in fast lane testing. Many of these communities have contact tracing now, but with either insufficient capacity or insufficient alacrity. More personnel with better procedures are necessary to reduce the tracing time to under one day. Finally, supported isolation locations such as dedicated isolation hotels need to be commissioned and ready for use. With these preparations, yellow zone communities can safely end stay-at-home advisories, and when outbreaks occur, they can suppress them by TTSI rather than stay-at-home orders.

As was mentioned above, the precise criteria for who is a contact should be driven by data, but the current CDC definition counts people within 2 meters for 15 minutes or more from two days before symptoms appear to fourteen days afterwards. If all contacts are tested immediately using a fast lane approach, isolated until they stop shedding virus if they are positive, and quarantined for the full fourteen days and/or receive a second confirmatory test if negative, then the number of active infections should rapidly decline in yellow zone communities.[11] Having sufficient capacity to execute TTSI with a trace time of less than one day enables safe re-openings of the economy beyond the essential workforce. Re-openings undertaken without this capacity in place will be accompanied by increases in disease prevalence.

Stabilizing red zone communities requires investments similar to those made in yellow zone communities coupled with stay-at-home orders until TTSI capacity is sufficiently built. Because it will take longer to build up sufficient TTSI capacity for red zones, stay-at-home orders to suppress the virus are necessary as an interim measure. This will result in the number of active infections declining.

Another alternative for red zones is to fall back to a broad quarantine testing strategy, quarantining all contacts of covid-positive individuals, presuming all influenza-like illness is COVID-19, and testing only those who become symptomatic AND who are in the essential work force. Engaging the full TTSI strategy for a fraction of cases before TTSI capacity has been fully built will provide valuable experience and information, and further suppress the virus beyond what stay-at-home orders and advisories alone achieve.

After TTSI has reached the needed capacity level, all active cases will be a part of the TTSI strategy and this will cause a rapid decrease in new infections every week. More caution is required in opening up the economy in red zone communities because of the large number of active infections, so we recommend weekly assessments, with every week of significant decline leading to reopening of another portion of the economy (40% –> 55% –> 80% –> 100%, as per the four phases of the Roadmap to Pandemic Resilience).

We plausibly already have sufficient slow lane capacity for surveillance across the nation, so our focus as a nation should be on increasing fast lane capacity. (Note here that fast lane tests can be used for slow lane purposes, but not vice versa since by the time slow lane test results come back the disease has already been transmitted to new people.)

BUILDING THE INFRASTRUCTURE

There are five categories of relevant infrastructure for TTSI testing programs: personnel, isolation supports, sample collection infrastructure, sample processing infrastructure (including transport if needed), and IT infrastructure

11 The capacity to allow contacts who test negative to leave quarantine via a second test will depend on the total availability of tests. Our target national goal of 5 million tests per day does not include the quantity of second tests that would be required to release from quarantine contacts who test negative prior to the end of the recommended period.

for data management. How a given locale **activates its testing infrastructure** will depend on whether it falls in a green, yellow, or red zone, but the specific **kind of infrastructure** the locale needs to have at the ready depends on population density. Population density affects the average transport time of samples to processing labs and the volume of samples available to a lab to process and so determines the kind of testing lab infrastructure that can meet the specific needs of a TTSI program in different places. Every locale wants to be prepared for the possibility of being

in any of a green, yellow, or red condition. Consequently, every locale needs slow lane, fast lane, and carpool lane testing infrastructure.

LOW POPULATION DENSITY INFRASTRUCTURE

SLOW LANE

Basic slow lane infrastructure should include the capacity to do a low level of contact tracing (one five-person team for every 100,000 people) and plans to administer larger contact tracing programs in the event of a surge. These plans should detail how to secure and incorporate personnel, including volunteer management or capacity for managing national service corps personnel who might be deployed to support a surge.[12] Plans should set requirements to ensure that any jobs created meet high labor standards, including family-sustaining wages, healthcare coverage, paid leave and the right to engage in collective bargaining.

Slow lane sample collection would typically consist of the capacity of the existing network of clinical point-of-care providers to test for COVID-19 in the same ways they are able to test for influenza. Sample collection would be based on the individual patient. Patient records for sample collection should be digitized.

Samples could be processed at point-of-care or sent to an existing network of labs. Processing labs need to be able to report results to local public health offices as well as to clinicians; and local public health offices need IT infrastructure for data management. Given the current state of the country's public health infrastructure, local public health offices may need investment by states in their IT infrastructure. States should canvass data management capacity in all their local health offices and invest in that.

FAST LANE

Basic fast lane infrastructure in a low population density context would involve a surge of contract tracing personnel to the level of one team of five tracers for each new case per day. These contact personnel can come from existing public safety resources via municipal/county health office partnerships or other structures (see Appendix C for an example). In the event of a surge, the locale should also expect to request additional personnel from the state, an interstate compact, and/or the U.S. Public Health Service Corps. Staffing needs include the capacity to manage volunteers and/or service corps personnel deployed to the region. The fast lane also requires a surge in personnel to support isolation—whether with home visits and monitoring, provision of groceries and food, telehealth, or other services. Any new jobs created to meet these needs should meet high labor standards, including family-sustaining wages, healthcare coverage, paid leave and the right to engage in collective bargaining.

Fast lane sample collection in low population density locales would be most efficient if consisting of mobile labs with point-of-care test processing machines. The mobile lab would be simultaneously a collection site and a processing site. Contact tracing personnel could also collect samples and send to the pre-existing network of labs in the area within sufficient geographical proximity and with sufficiently efficient lab processes to provide a result in 12 to 24 hours. Veterinary clinics can be repurposed as labs, as demonstrated in Germany and Oklahoma.

12 Service personnel should be allowed to move across jurisdictions (and probably state lines). This may present challenges for both financial and structural reasons that would require attention via legislation.

Drawing on the lab inventory provided by the federal government Coronavirus Task Force, every tribal, county, and municipal jurisdiction should keep a digitized inventory of where its fast lane surge capacity exists in existing site-based laboratories, identify gaps, and identify the level of anticipated need for mobile lab support in the case of a surge. State-level governments and/or interstate compacts need to identify the likely total capacity of surge lab support needed and be prepared to move that lab capacity around the state on an as-needed basis. Interstate compacts can support regional sharing of equipment to improve coordination and efficiencies for low population density areas. The sharing model used for ventilators is appropriate here.

If the region contains critical context facilities, contact tracing personnel can support employer-based weekly carpool lane testing.

Finally, the fast lane requires identification of specific residential locations where those needing a place to isolate effectively can spend the period of their isolation.

The necessary IT infrastructure to support fast lane surge work should be built into the slow lane infrastructure, as well as into the mobile labs.

HIGH POPULATION DENSITY INFRASTRUCTURE

SLOW LANE

The needs for slow lane capacity are identical in kind in high and low population density contexts but different in absolute quantities.

FAST LANE

Basic fast lane infrastructure in a high population density context would involve a much more significant surge of contract tracing personnel to the level of, on average, one team of five tracers for every 4000 people in a yellow zone and one team for every 450 people in a red zone given current levels of prevalence. In the event of a surge, the locale should expect to request additional personnel from the state, an interstate compact, and/or the U.S. Public Health Service Corps, as well as using municipal mechanisms for hiring contact tracers. Staffing needs include the capacity to manage volunteers and/or service corps personnel deployed to the region and setting requirements to ensure that any jobs created meet high labor standards, including family-sustaining wages, healthcare coverage, paid leave and the right to engage in collective bargaining. Locales in the red zone might choose to fall back to a broad quarantine strategy for testing which makes less intensive demand on contact tracing resources.

Fast lane sample collection in high population density locales will be most efficient if concentrated in a sufficiently constrained number of clinics, drive-thru testing sites, and contact tracing collection sites (whether mobile or sited). The number of collection sites needs to be constrained to a level that they are likely to routinely collect 96 or more samples per day. This sample collection number facilitates a more efficient supply chain for large labs by delivering samples in trays that require less preparatory processing prior to analysis.

Unless test processers achieve a scaling breakthrough supporting processing of tens of millions of results per day with results reported within 12 to 24 hours, employer-based collection points should be established for carpool lane testing **in critical contexts only**.

Fast lane infrastructure in high population density areas also requires transport logistics to support the rapid transport of samples from collection points to processing labs.

Areas of high population density should be supported by mega-labs capable of processing 200,000 samples a day during peak surge periods. Ideally, these labs leverage orthogonal supply chains to prevent the risk of systemic disruption. These labs could be commercial labs that scale up with proprietary qPCR methodologies; academic research labs that temporarily scale up with open IP for innovative PCR methods to process 200,000 samples; or Next Generation Sequencing (NGS) labs, whether commercial or academic, that should ultimately have the capacity to process millions of tests a day, contingent on the batch sample collection process described above.

Finally, the fast lane requires identification of specific residential locations where those needing a place to isolate effectively can spend the period of their isolation. The necessary IT infrastructure to support fast lane surge work should be built into the slow lane infrastructure, as well as into the infrastructure of the surge contact tracing operation.

The four categories of infrastructure needed are captured below in Table 6.

TABLE 6. FOUR CATEGORIES OF INFRASTRUCTURE NEEDED

	LOW POPULATION DENSITY	HIGH POPULATION DENSITY
Slow Lane Operations	Collection at clinics; testing at usual labs; digital records management in local health offices. Existence of surge plan for: contact tracing-based collection (mobile collection sites); isolation supports; use of veterinary clinics; surge capacity at usual labs; deployment of state or federally held mobile labs for processing.	Collection at clinics; testing at usual labs; digital records management in local health offices. Existence of surge plan for: contact tracing-based collection (mobile or sited collection sites; drive-thrus); critical employer-based collection points; isolation supports; transport logistics for sample transport; quick activation of mega labs.
Fast Lane Operations, including Carpool Lane Operations	Activation of surge plan • Collection at clinics and via contact tracing collectors; • Additional lab capacity comes online through pre-existing lab relationships, area veterinary clinics, and mobile collection and processing labs. • Contact tracing personnel can support employer-based weekly carpool lane testing, if the region contains critical context facilities. • Employer-based collection points should be established for carpool lane testing in critical contexts only. • Support personnel and facilities for isolation are needed.	Activation of surge plan • Significant collection at clinics/hospitals, drive-thru testing sites; via contact tracing collection points (whether mobile or sited); and via critical context employer-based collection sites; • Activation of transport logistics; • Activation of mega-labs, which necessitates collection points that can do >100 samples per day; • Existing lab relationships continue to service collection points with lower volume. • Employer-based collection points should be established for carpool lane testing in critical contexts only. • Support personnel and facilities for isolation.

For maximally efficient use of our resources, different parts of the country will need to use fast lane TTSI infrastructure at different points in time. Since the White House has established a strategy of response to the pandemic that empowers states to run testing programs, there will be little national coordination of these decisions. Consequently, it is important that states have a decision-making structure for achieving allocations across regions.

The best vehicle for doing so would be through an interstate compact. A region of states could deploy an interstate compact to set up a mega-lab and to build a stockpile of mobile test administration sites, and test administration and processing sites. With federal investment in a structure of interstate compacts, the necessary testing capacity could be delivered to the nation (please see Appendix B for the mechanics of creating and deploying an interstate compact).

To coordinate use of surge capacity, state and territorial health officers will have to work closely with tribal, county, and local health officers, as well as with municipal leaders and the leaders of organizations and facilities in the "critical context" category, to ensure that surge resources reach communities in need.

At the local level, tribal, county, and local health officers, as well as with municipal leaders, need readiness plans to prepare for the use of surge capacity should they need it. They need clear lines of communication to the clinics and labs that will be responsible for delivering their surge capacity, in the event of need. See Appendix C.

TTSI INFRASTRUCTURE FROM THE PERSPECTIVE OF:

MUNICIPAL DECISION-MAKERS

If I want to run a successful TTSI program in my community, I need to know:

1. How to build collaborative organizational structures with my local health officials;
2. How to source, train, and organize contact tracers to find contacts who will be tested;
3. How to organize and administer sample collection sites (doctor's office, drive-thru, walk-in clinic, mobile clinic, critical context site-based collection, at-home collection), including in ways that reach vulnerable and at risk constituents;
4. How to ensure my collection sites have sufficient numbers of test kits and access to transport logistics and processing labs;
5. How to ensure that symptomatic COVID-positive individuals identified by contact tracing have access to health resources;
6. How to provide supports for isolation to asymptomatic or mildly symptomatic COVID-positive individuals;
7. How to advocate to my state government for the test kits and lab access that my community needs;
8. How to communicate consistently and effectively with constituents so they know where and how to get tested.

STATE DECISION-MAKERS

If I want to run a successful TTSI program in my state, I need to know:

1. What the testing, contact tracing and supported isolations needs are in each community;
2. What the inventory of lab resources in my state and region are; what testing modalities they use; and what their surge capacity is;
3. How to build or bring more mobile and/or sited lab resources to my state or region, if there are gaps between need and capacity;
4. How to build differentiated testing infrastructure for low and high population density parts of my state;
5. How testing modalities in my state interact with the supply chain so that I can support continuity of supply chain as testing levels ramp us;
6. How to communicate with local health officials and municipal leaders about the designs of their sample collection programs so that they align with the testing modalities available in the labs to which we have access.

IMPLEMENTATION ACTION STEPS

IN SUPPORT OF THE EFFORTS OF STATE, TRIBAL, AND LOCAL LEADERS, Congress needs to make substantial investment in TTSI infrastructure. We recommend investments in local and country public health offices, contact tracing personnel, voluntary self-isolation facilities, income support for voluntary self-isolation, test kits and test processing, point-of-care testing machines, and mega-labs. The investments will address the current pandemic and also provide the foundation for the infrastructure of long-term pandemic resilience.

INVESTMENT IN LOCAL AND COUNTY PUBLIC HEALTH OFFICES

Slow lane infrastructure largely exists across the country but requires reinforcement. In particular, tribal and local health offices do not all have capacity for digital records management, nor do all have the staff or technical expertise to support contact tracing and test administration. Slow lane infrastructure needs reinforcement through state and federal investment in tribal and local health offices. One of Germany's earliest steps in addressing the COVID-19 public health crisis was to ensure that all local health offices could function with up-to-date digital records management systems. We recommend:

- $1 billion for IT infrastructure upgrade—the model is Germany which made this a critical early step in activating its pandemic response.
- $4.5 billion in additional annual mandatory funding for local, state, tribal, and territorial core public health infrastructure, in addition to existing annual discretionary appropriations. The contact tracing surge can only be as successful as the public health infrastructure that supports it. By building the core public health infrastructure of localities, states, tribal governments, and territories the nation will be better prepared for the next threat (NACCHO 2020).

INVESTMENT IN CONTACT TRACING PERSONNEL

We calculate $3.6 billion per year for 100,000 contact tracers. A total of 700,000 tracers are needed. Of these 600,000 would be needed primarily for the period of an intensive surge over the course of summer 2020. $5.4bn is needed to support an aggressive surge of contact tracers for fast-lane TTSI infrastructure. $3.6bn is needed to support slow-lane TTSI infrastructure (100,000 full year tracers). Some portion could be picked up by Service Corps budgets). We therefore recommend a total of $9bn over 12 months for contact tracing.

INVESTMENT IN VOLUNTARY SELF-ISOLATION FACILITIES

"In order to prevent infection spread, we will need to offer individuals the opportunity to self-isolate for up to two weeks if they are unable to do so in their homes. There is substantial evidence that providing a voluntary option to safely isolate will help to dramatically reduce spread of infection to one's family and therefore the spread of infection overall. We believe 14 percent of infected individuals and exposed contacts will need such an option. Hotels are largely sitting idle at present and can provide local options for such voluntary self-isolation sites. Utilizing otherwise vacant hotels over the course of 18 months will both maximize the ability to contain COVID-19 and also provide a much-needed stimulus for the hospitality industry across the country as hotels deliver an essential public service. The total funding is estimated to be $4.5 billion."[1]

INVESTMENT IN INCOME SUPPORT FOR VOLUNTARY SELF-ISOLATION

"A key ingredient in maximizing the ability to contain COVID-19 is the ability to offer income support to individuals for whom loss of income during 14 days of voluntary self-isolation represents a prohibitive barrier to being able to self-isolate. We estimate 40 percent of individuals will need a measure of income support in order to be able to afford to voluntarily self-isolate. Paying these individuals a stipend of $50 per day (analogous to federal jury duty) will greatly increase the success of containment efforts and the ability to maintain an expanded measure of openness in the economy.[2] We estimate this income support will require approximately $30 billion in funding over the course of 18 months."[3]

INVESTMENT IN TEST KITS AND TEST PROCESSING IN EXISTING NETWORK OF LABS

Funding for tests (kits, handling, processing) is calculated as $4 billion for one month's worth of test kits @ $25/kit, or $24 billion over six months. Some portion of that could be paid by private insurance. In addition, employers should be asked to take on the testing required to operate in high-risk industries. This also requires addressing the need for liability protection (a matter of both federal and state law). If OSHA put out detailed guidelines and employers followed them, there could perhaps be a no-fault fund that could pay out for harms.

INVESTMENT IN MEGA-LABS

Higher population density locations are most in need of increased fast lane capacity. We recommend investment in surge capacity in commercial and academic labs (capable of achieving processing levels of 200,000 tests a day), via a

1 Extract from "Bipartisan Public Health Leaders Letter to Congress" submitted by Andy Slavitt, Scott Gottlieb, Larry Brilliant, Atul Gawande, et al. to The Honorable Nancy Pelosi, The Honorable Kevin McCarthy, The Honorable Mitch McConnell, and The Honorable Chuck Schumer, April 27, 2020.

2 Ibid. As we recommended in our Roadmap, supported isolation also requires job protection, so covid positive individuals can get their jobs back after isolation. For unemployed people, they will need exemption from job search requirements in order to be able to continue to receive unemployment insurance.

3 Ibid.

Defense Production Act "Title III" style investment in 5 to 10 regional labs, at a cost of $50 to $100 million each.[4] For labs to pivot to delivering this surge capacity, they need capital for equipment to rapidly support buildout. Additionally, to expand operational capacity to the required numbers, these providers will need working capital for the supply chain. Dedicated purchasing contracts, also known as "guaranteed offtake" agreements for specific quantities of tests that meet certain criteria are a powerful way to create the private working capital liquidity to fund expansion. The funding program could be structured with full pre-purchase contracts being awarded on the basis of a rapid DARPA-style application process, but with milestones to unlock tranches of funding. The target level of cost per test should be $25 per test. We recommend an investment of $500 million in total for this program.

INVESTMENT IN POINT-OF-CARE TESTING MACHINES

Lower population density locations may need increased access to Abbott Point-of-Care testing machines. There are already 18,000 Abbott ID Now Machines throughout the U.S., and Abbott is currently shipping 50,000 tests a day for use on these machines. The Department of Health and Human Services purchased 1,200 ID Now Machines and has sent 250 to the Indian Health Service and 50 to Alaska, as well as adding machines to the federal stockpile.[5] A public audit should be conducted of the locations of the existing Abbott machines to evaluate whether they provide sufficient slow lane and fast lane capacity for low population density locales. These locales also need investment in bringing their regional labs to higher biohazard levels.

The total investment we recommend comes to $74 billion, most of which would be spent over 12 months, with some being spent over 18 months. This contrasts to a monthly cost for collective stay-at-home orders of $350 billion. These recommendations are a response to the crisis at hand AND an investment in a pandemic resilient economy that, once it has this infrastructure in place, will be less likely in the future to need to bear the costs of shutdown.

HOW CAN CONGRESS AND THE PRESIDENT HELP THE NATION BUILD STRONG TTSI PROGRAMS?

Congress and the President should invest in:

- Local public health offices: $5.5 billion
- Contact tracing: $9 billion
- Voluntary self-isolation facilities using vacant hotels: $4.5 billion
- Income support for voluntary self-isolation: $30 billion over 18 months
- Mega-Labs and Other Test Processing Capacity: $25 billion (in addition to the $25 billion passed in April)

4 See US Dept. of Energy, "Title III of the Defense Production Act.
5 Rachal, "HHS, CVS, Walgreens get behind Abbott's coronavirus test."

INDIVIDUAL RISK

THE TTSI PROGRAM, INCLUDING CARPOOL LANE TESTING IN CRITICAL WORK CONTEXTS, KEEPS THE DISEASE IN A STEADY DECELERATION until the arrival of a vaccine or game-changing therapeutics. In green and yellow zone communities, the goal is elimination of the disease so that **slow lane** surveillance programs can then function to contain outbreaks as they arise, without recourse to stay-at-home advisories.

In green zone locales, high-risk individuals may reasonably consider their risk through mobility within the green zone as being similar to their risk in the face of influenza.

In red zone locales, high-risk individuals should understand that prevalence levels are exceedingly dangerous for them and they should seek to maintain their practices of shelter at home.

In yellow zone locales, the individual risk calculations are most challenging. A cautious approach would recommend that individuals in high-risk categories (on the basis of age or health status) treat yellow zone locales as if they are red zone locales and to be patient and to wait, if possible, until the achievement of green status before resuming ordinary activities. High-risk individuals would be recommended to mostly stay at home and practice social distancing, handwashing, and face covering when out. More research is needed to achieve a clearer view of the specific risk levels pertaining to specific categories of vulnerability when the locale is in the yellow category. This research will be essential for helping people make sound decisions about their own health and well-being in the context of an overall TTSI strategy. Such research will also be critical to the adjustment of disability benefit programs.

PUBLIC MESSAGING

1. Risk communication messaging from government officials should incorporate the concept that this pandemic will not be over soon and that people need to be prepared for possible periodic resurgences of disease over the next two years (Moore, Lipsitch, Barry and Osterholm 2020).

2. Risk communication messaging from government officials should incorporate the concept that TTSI is a strategy for disease control designed to put the disease on a constant downward deceleration, to achieve its near elimination, and to leave the country well-positioned to respond rapidly to new outbreaks by containing them.

3. Risk communication messaging from government officials should incorporate the concept that residents of locales in the red zones should avoid inessential travel to yellow or green zones and should ideally self-quarantine for fourteen days upon arrival in a green or yellow zone.

4. Public service messaging about social distancing and contact tracing practices should include the message that these practices are good examples of the golden rule: we should do unto others as we would have them do unto us. We would like others not to spread infection to us, and we would like others to give us a warning if we have been exposed to an infection. We should do the same in turn. All of us can make a difference by working together. Also, we should recognize that those who self-isolate are heroes too.

CONCLUSION

THE COVID-19 PANDEMIC HAS BEEN WIDELY DESCRIBED AS THE GREATEST GLOBAL DISRUPTION SINCE THE SECOND WORLD WAR. World War II was a time of both national trauma and mobilization, sacrifice and innovation. Even amid deployment, injury and death on a massive scale, the war impelled enduring advances in both technology and social organization (Weinberg 2005). After the war and during the subsequent Cold War, the United States not only emerged as the leading global economy but also invested in the development of a defense establishment that spilled over into the domestic economy in ways that improved the standard of living for the majority of Americans and made the nation a superpower.

World War II also brought social inequities in the U.S. into stark visibility for all Americans. The GI Bill lifted white working class Americans into new opportunities for prosperity and well-being. African-American servicemen returned and fought for the same treatment at home that they experienced abroad; women who were thrust into the workforce during the war had valuable experiences of earning an income that later led to transformations of opportunity for women. The kind of valuable changes that emerged from World War II were not just technical advances but also increases to equality and human flourishing.

History therefore demonstrates that massive disruptions can serve as opportunities for advancements in technology, social organization, and commerce. These disruptions can also bring into clear focus where our society falls short. The disparate impact of COVID-19 on racial minorities and other vulnerable populations casts into sharp relief the insufficiency and inequity of our underlying health system, including of our community health infrastructure.

THE RESPONSE TO THE COVID-19 PANDEMIC IN THE UNITED STATES IS ALREADY IMPELLING RAPID ADVANCES IN TECHNOLOGY AND SOCIAL ORGANIZATION. These advances include research initiatives to develop and test various treatments and vaccines for COVID-19, as well as social distancing measures achieved in part through the expansion of online commerce, learning, and working. The TTSI infrastructure and equitable investment in public health we describe in this supplement would be another such advance with both near-term and long-term value. The advancements impelled by this pandemic should be incorporated into a process of sustained policy learning to improve our defense against future pandemics and to strengthen our national health infrastructure as a bulwark of our national defense.

In sum, sustained investments are needed to maintain and improve public health institutions through a strategy of policy learning. Our common purpose should be to achieve pandemic resilience: an inclusive and equitable foundation of health for all parts of the country's population combined with vigilance against the perpetual threat of novel pathogens.

APPENDIX A: GREEN, YELLOW, ORANGE, AND RED COMMUNITIES (AS OF MAY 8, 2020)

We begin with data on COVID-19 and excess mortality from state public health authorities and use this to recover current prevalence rates based on estimates of the Infection Fatality Rate (IFR). Orange is used to indicate regions that have recently transitioned out of red or are close to being red. Whereas two weeks ago, some communities were still green zones, now no such locales remain.

The chart below is provided for illustrative purposes only to indicate the diversity of experience across Metropolitan Statistical Areas in the U.S. The broad categorizations are accurate but decision-makers should not rely on the specific numbers in this chart for guidance. They should rely instead on up-to-date local data. We continue to scrub this data and updated versions will be available, via an interactive map, on our website: pandemictesting.org. For a good review of the challenges of producing clean data about COVID-19 cases and deaths, please see Jon Hilsenrath and Jon Kamp, "How a Johns Hopkins Professor and Her Chinese Students Tracked Coronavirus," *Wall Street Journal*, May 9, 2020.

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
USA	324	308
BERGEN-PASSAIC, NJ	3028	33
NEWARK, NJ	2507	40
MIDDLESEX-SOMERSET-HUNTERDON, N	2004	50
JERSEY CITY, NJ	1813	55
TRENTON, NJ	1788	56
NEW HAVEN-BRIDGEPORT-STAMFORD-WATERBURY-DANBU	1721	58
HARTFORD, CT	1629	61
DETROIT, MI	1534	65
ALBANY, GA	1453	69
SPRINGFIELD, MA	1291	77
PINE BLUFF, AR	1283	78
PHILADELPHIA, PA-NJ	1255	80

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
BOSTON-WORCESTER-LAWRENCE-LOWELL-BROCKTON, MA	1145	87
MONMOUTH-OCEAN, NJ	1130	88
NEW YORK-NEWARK, NY-NJ-PA	1081	93
ALLENTOWN-BETHLEHEM-EASTON, PA	1044	96
NEWBURGH, NY-PA	940	106
NASSAU-SUFFOLK, NY	938	107
HOUMA, LA	915	109
NEW ORLEANS, LA	900	111
SCRANTON-WILKES-BARRE-HAZLETON, PA	877	114
DELAWARE (excluding all MSAs)	854	117
TOLEDO, OH	796	126
CHICAGO, IL	725	138
FLINT, MI	686	146
READING, PA	678	147
ATLANTIC-CAPE MAY, NJ	643	156
INDIANAPOLIS, IN	625	160
SHREVEPORT-BOSSIER CITY, LA	611	164
BUFFALO-NIAGARA FALLS, NY	608	164
LANCASTER, PA	593	169
DOVER, DE	579	173
SAGINAW-BAY CITY-MIDLAND, MI	569	176
SUMTER, SC	535	187
BALTIMORE, MD	523	191
LOUISIANA (excluding all MSAs)	505	198
CUMBERLAND, MD-WV	489	204
FLORENCE, SC	482	207
VINELAND-MILLVILLE-BRIDGETON, NJ	478	209
CEDAR RAPIDS, IA	441	227

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
GARY, IN	436	230
LAFAYETTE, LA	431	232
PUNTA GORDA, FL	416	240
HATTIESBURG, MS	413	242
YOUNGSTOWN-WARREN, OH	405	247
NEW LONDON-NORWICH, CT	404	248
GREELEY, CO	396	252
ANN ARBOR, MI	391	256
KOKOMO, IN	390	256
WILMINGTON-NEWARK, DE-MD	389	257
WASHINGTON, DC-MD-VA-WV	380	263
GEORGIA (excluding all MSAs)	377	265
BENTON HARBOR, MI	373	268
FORT WAYNE, IN	361	277
MASSACHUSETTS (excluding all MSAs)	361	277
JACKSON, MI	361	277
FARGO-MOORHEAD, ND-MN	348	287
MOBILE, AL	329	304
AKRON, OH	325	308
CANTON-MASSILLON, OH	323	309
SIOUX FALLS, SD	309	324
NEBRASKA (excluding all MSAs)	303	330
BARNSTABLE-YARMOUTH, MA	302	331
BINGHAMTON, NY	299	334
ROCKY MOUNT, NC	294	340
LIMA, OH	290	345
PITTSFIELD, MA	286	350
BOULDER-LONGMONT, CO	285	351
NEW MEXICO (excluding all MSAs)	283	353
FLAGSTAFF, ARIZONA-UTAH	283	353

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
MONROE, LA	280	358
ST. LOUIS, MO-IL	279	358
SARASOTA-BRADENTON, FL	273	366
WATERLOO-CEDAR FALLS, IA	272	367
MINNEAPOLIS-ST. PAUL, MN-WI	271	369
BATON ROUGE, LA	267	374
RICHLAND-KENNEWICK-PASCO, WA	262	381
AUBURN-OPELIKA, AL	260	384
KANKAKEE, IL	260	385
WEST PALM BEACH-BOCA RATON, FL	255	393
ST. JOSEPH, MO	254	394
MIAMI, FL	252	396
MUNCIE, IN	250	399
DENVER, CO	246	407
MISSISSIPPI (excluding all MSAs)	243	411
MILWAUKEE-WAUKESHA, WI	242	413
KALAMAZOO-BATTLE CREEK, MI	241	416
COLUMBIA, SC	240	417
SOUTH BEND, IN	236	423
LAKE CHARLES, LA	234	427
VICTORIA, TX	233	430
GLENS FALLS, NY	228	438
LOS ANGELES-LONG BEACH, CA	223	448
GRAND FORKS, ND-MN	221	452
INDIANA (excluding all MSAs)	221	453
DUBUQUE, IA	220	454
MARYLAND (excluding all MSAs)	215	465
DES MOINES, IA	210	476
ROCHESTER, NY	207	482
KENOSHA, WI	202	495

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
PARKERSBURG-MARIETTA, WV-OH	199	502
ALBANY-SCHENECTADY-TROY, NY	192	521
HARRISBURG-LEBANON-CARLISLE, PA	189	530
PITTSBURGH, PA	184	544
CHARLESTON, WV	183	547
RICHMOND-PETERSBURG, VA	177	566
GOLDSBORO, NC	174	575
ELKHART-GOSHEN, IN	173	578
SPRINGFIELD, IL	173	579
COLUMBUS, OH	171	585
GREENVILLE-SPARTANBURG-ANDERSON, SC	168	594
FORT LAUDERDALE, FL	154	651
CLEVELAND-LORAIN-ELYRIA, OH	153	653
RALEIGH-DURHAM-CHAPEL HILL, NC	151	661
UTICA-ROME, NY	148	677
BIRMINGHAM, AL	147	682
SEATTLE-BELLEVUE-EVERETT, WA	145	691
LAS VEGAS, NV-AZ	144	693
ATLANTA, GA	144	697
BOSTON-WORCESTER-LAWRENCE-LOWELL-BROCKTON, MA-NH	142	706
SOUTH CAROLINA (excluding all MSAs)	140	713
GADSDEN, AL	140	716
CINCINNATI, OH-KY-IN	139	720
CONNECTICUT (excluding all MSAs)	134	747
JANESVILLE-BELOIT, WI	131	762
DAVENPORT-ROCK ISLAND-MOLINE, IA-IL	131	764
BURLINGTON, VT	130	771
BLOOMINGTON, IN	128	779

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
ALABAMA (excluding all MSAs)	127	785
GALVESTON-TEXAS CITY, TX	125	798
RIVERSIDE-SAN BERNADINO, CA	125	801
VISALIA-TULARE-PORTERVILLE, CA	123	816
OKLAHOMA (excluding all MSAs)	123	816
CHARLOTTESVILLE, VA	122	821
LOUISVILLE, KY-IN	121	824
DAYTONA BEACH, FL	118	851
CHEYENNE, WY	116	860
SIOUX CITY, IA-NE	116	862
MACON, GA	114	876
HAGERSTOWN, MD	113	881
NEW YORK (excluding all MSAs)	112	891
NAPLES, FL	111	898
ROCKFORD, IL	111	902
ALEXANDRIA, LA	110	908
RACINE, WI	109	916
GREEN BAY, WI	108	926
ELMIRA, NY	107	935
COLORADO (excluding all MSAs)	107	936
GAINESVILLE, FL	106	942
LAKELAND-WINTER HAVEN, FL	105	951
MODESTO, CA	104	964
ABILENE, TX	103	966
LAREDO, TX	103	968
EL PASO, TX	102	979
PENNSYLVANIA (excluding all MSAs)	102	982
SYRACUSE, NY	98	1015
LINCOLN, NE	98	1015
IOWA (excluding all MSAs)	98	1020

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
MICHIGAN (excluding all MSAs)	97	1026
YOLO, CA	97	1029
ALBUQUERQUE, NM	95	1053
IOWA CITY, IA	95	1058
ILLINOIS (excluding all MSAs)	94	1068
JACKSON, TN	92	1083
DECATUR, IL	92	1092
TUSCALOOSA, AL	91	1099
BEAUMONT-PORT ARTHUR, TX	91	1099
RENO, NV	91	1100
EVANSVILLE-HENDERSON, IN-KY	91	1103
ATHENS, GA	89	1121
FORT PIERCE-PORT ST. LUCIE, FL	88	1142
FLORIDA (excluding all MSAs)	86	1163
YAKIMA, WA	85	1171
GREENSBORO–WINSTON-SALEM–HIGH POINT, NC	84	1187
AMARILLO, TX	84	1191
OHIO (excluding all MSAs)	83	1210
MYRTLE BEACH, SC	81	1239
SALEM, OR	79	1266
KENTUCKY (excluding all MSAs)	79	1267
LAFAYETTE, IN	79	1267
MEMPHIS, TN-AR-MS	79	1269
MONTGOMERY, AL	79	1272
FORT COLLINS-LOVELAND, CO	78	1278
AUSTIN-SAN MARCOS, TX	77	1299
FORT WORTH-ARLINGTON, TX	77	1303
TULSA, OK	76	1321
GRAND RAPIDS-MUSKEGON-HOLLAND, MI	75	1336

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
SAVANNAH, GA	73	1377
ROCHESTER, MN	72	1385
LANSING-EAST LANSING, MI	71	1407
BISMARCK, ND	70	1422
WYOMING (excluding all MSAs)	70	1423
ANNISTON, AL	70	1433
WICHITA, KS	69	1441
NASHVILLE, TN	69	1455
WHEELING, WV-OH	69	1459
BROWNSVILLE-HARLINGEN-SAN BENITO, TX	68	1481
SAN FRANCISCO, CA	67	1483
UTAH (excluding all MSAs)	67	1499
NORTH CAROLINA (excluding all MSAs)	66	1515
WILLIAMSPORT, PA	63	1586
HOUSTON, TX	62	1609
ROANOKE, VA	62	1620
LONGVIEW-MARSHALL, TX	62	1626
NEW HAMPSHIRE (excluding all MSAs)	61	1638
CLARKSVILLE-HOPKINSVILLE, TN-KY	61	1651
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	60	1654
DANVILLE, VA	60	1657
BRYAN-COLLEGE STATION, TX	60	1663
ARKANSAS (excluding all MSAs)	59	1688
VIRGINIA (excluding all MSAs)	59	1689
LAWTON, OK	59	1690
JACKSON, MS	58	1727
COLUMBUS, GA-AL	57	1749
PENSACOLA, FL	57	1759

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
FAYETTEVILLE, NC	57	1761
ALASKA (excluding all MSAs)	56	1771
OWENSBORO, KY	56	1776
GREENVILLE, NC	56	1782
FORT MYERS-CAPE CORAL, FL	56	1798
SAN JOSE, CA	56	1799
LYNCHBURG, VA	55	1810
LUBBOCK, TX	55	1812
JONESBORO, AR	55	1817
ARIZONA (excluding all MSAs)	55	1818
PANAMA CITY, FL	55	1834
FORT WALTON BEACH, FL	54	1844
PORTLAND, ME	53	1885
ERIE, PA	53	1888
LEWISTON-AUBURN, ME	53	1895
MAINE (excluding all MSAs)	52	1909
TOPEKA, KS	52	1935
AUGUSTA-AIKEN, GA-SC	51	1951
SAN LUIS OBISPO-ATASCADERO-PASO ROBLES, CA	51	1952
FLORENCE, AL	51	1954
ASHEVILLE, NC	50	1981
LITTLE ROCK-NORTH LITTLE ROCK, AR	50	1998
WEST VIRGINIA (excluding all MSAs)	50	1998
SAN DIEGO, CA	49	2032
SOUTH DAKOTA (excluding all MSAs)	49	2036
DUTCHESS COUNTY, NY	49	2060
IDAHO (excluding all MSAs)	48	2074
SANTA FE, NM	48	2084
TEXAS (excluding all MSAs)	48	2089

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
YORK, PA	48	2096
DALLAS, TX	48	2102
CHARLESTON-NORTH CHARLESTON, SC	47	2106
OAKLAND, CA	47	2119
ST. CLOUD, MN	47	2121
NEVADA (excluding all MSAs)	47	2132
SAN ANGELO, TX	47	2139
JACKSONVILLE, FL	47	2142
TYLER, TX	47	2144
TAMPA-ST. PETERSBURG-CLEARWATER, FL	47	2150
OKLAHOMA CITY, OK	46	2164
STATE COLLEGE, PA	46	2165
ANCHORAGE, AK	46	2168
DOTHAN, AL	46	2171
BRAZORIA, TX	46	2183
DAYTON-SPRINGFIELD, OH	46	2197
CHAMPAIGN-URBANA, IL	45	2202
JAMESTOWN, NY	45	2221
HAMILTON-MIDDLETOWN, OH	45	2235
WISCONSIN (excluding all MSAs)	44	2262
DECATUR, AL	44	2273
MANSFIELD, OH	44	2277
KANSAS CITY, MO-KS	44	2286
PHOENIX-MESA, AZ	43	2309
SHARON, PA	43	2321
CASPER, WY	43	2329
HUNTSVILLE, AL	43	2342
CHATTANOOGA, TN-GA	42	2355
TACOMA, WA	42	2376

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
TEXARKANA, TX-TEXARKANA, AR	42	2389
NORTH DAKOTA (excluding all MSAs)	41	2416
SPOKANE, WA	41	2440
BANGOR, ME	40	2506
BREMERTON, WA	39	2568
KANSAS (excluding all MSAs)	39	2597
TERRE HAUTE, IN	38	2603
YUMA, AZ	38	2625
COLUMBIA, MO	38	2632
SANTA ROSA, CA	37	2682
MERCED, CA	37	2700
MELBOURNE-TITUSVILLE-PALM BAY, FL	37	2710
STEUBENVILLE-WEIRTON, OH-WV	36	2754
SANTA CRUZ-WATSONVILLE, CA	36	2812
BILLINGS, MT	35	2823
PORTLAND-VANCOUVER OR-WA	35	2894
PUEBLO, CO	34	2947
WICHITA FALLS, TX	33	2986
HAWAII (excluding all MSAs)	33	3014
SHEBOYGAN, WI	33	3047
LAS CRUCES, NM	33	3055
OMAHA, NE-IA	32	3145
APPLETON-OSHKOSH-NEENAH, WI	31	3242
BOISE CITY, ID	30	3320
JOHNSON CITY-KINGSPORT-BRISTOL, TN-VA	30	3342
LAWRENCE, KS	30	3356
JACKSONVILLE, NC	29	3464
WASHINGTON (excluding all MSAs)	29	3492
EAU CLAIRE, WI	28	3538

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
JOHNSTOWN, PA	28	3564
SHERMAN-DENISON, TX	28	3598
OLYMPIA, WA	28	3632
FAYETTEVILLE-SPRINGDALE-ROGERS, AR	27	3665
TUCSON, AZ	27	3665
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS, VA-NC	27	3754
CORPUS CHRISTI, TX	27	3754
CORVALLIS, OR	26	3832
WILMINGTON, NC	26	3884
BAKERSFIELD, CA	25	3938
VENTURA, CA	25	3948
ORANGE COUNTY, CA	25	3970
BELLINGHAM, WA	25	4012
ORLANDO, FL	25	4057
SALT LAKE CITY-OGDEN, UT	24	4144
HUNTINGTON-ASHLAND, WV-KY-OH	24	4192
DULUTH-SUPERIOR, MN-WI	24	4239
ENID, OK	23	4274
GRAND JUNCTION, CO	23	4406
MISSOULA, MT	23	4406
PROVO-OREM, UT	22	4454
SPRINGFIELD, MO	21	4718
TALLAHASSEE, FL	21	4749
ODESSA-MIDLAND, TX	21	4803
PEORIA-PEKIN, IL	20	4892
COLORADO SPRINGS, CO	20	5043
OCALA, FL	20	5118
MINNESOTA (excluding all MSAs)	19	5129
HICKORY-MORGANTON-LENOIR, NC	19	5176

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
YUBA CITY, CA	19	5232
SAN ANTONIO, TX	18	5548
VERMONT (excluding all MSAs)	18	5650
HONOLULU, HI	18	5685
LA CROSSE, WI-MN	17	5796
SALINAS, CA	16	6077
MCALLEN-EDINBURG-MISSION, TX	16	6081
KILLEEN-TEMPLE, TX	16	6144
SANTA BARBARA-SANTA MARIA-LOMPOC, CA	16	6251
MEDFORD-ASHLAND, OR	16	6313
ALTOONA, PA	15	6822
BILOXI-GULFPORT-PASCAGOULA, MS	14	6988
JOPLIN, MO	14	7394
MADISON, WI	13	7654
OREGON (excluding all MSAs)	13	7670
GREAT FALLS, MT	12	8137
VALLEJO-FARIFIELD-NAPA, CA	12	8195
LEXINGTON, KY	12	8541
MISSOURI (excluding all MSAs)	12	8661
REDDING, CA	11	9337
WAUSAU, WI	11	9498
EUGENE-SPRINGFIELD, OR	10	10092
RAPID CITY, SD	9	10619
POCATELLO, ID	9	11176
MONTANA (excluding all MSAs)	8	12364
FORT SMITH, AR-OK	8	12527
STOCKTON-LODI, CA	7	13338
KNOXVILLE, TN	7	14922
CHICO-PARADISE, CA	6	18051

MSA	ACTIVE INFECTIONS PER 100,000 PEOPLE	ONE OUT OF EVERY X # OF PEOPLE HAS COVID-19
FRESNO, CA	5	20237
CALIFORNIA (excluding all MSAs)	5	21599
TENNESSEE (excluding all MSAs)	3	33769
SACRAMENTO, CA	**3**	37507

APPENDIX B: DESIGNING AN INTERSTATE COMPACT FOR A PANDEMIC TESTING BOARD

Lisa Hansmann & Ganesh Sitaraman[1]

Analysts have recently focused their attention on two pathways for the United States to reopen prior to the development of a vaccine for COVID-19. The first is to accept a series of rolling openings and closings: reopening as infection rates decrease, then reclosing as they rise again due to increased interactions. This approach is generally thought to be enormously costly economically and socially, as people will be kept in their homes and commerce restrained for considerable amounts of time. The second approach is to massively ramp up testing, either through a universal testing regime (which would test all 300+ million Americans every week or two)[2] or a system of testing, tracing, and supported isolation (which would test 5 million Americans a day, plus tracing those who were in contact with the infected and isolating them).[3] The testing pathway would enable the United States to reopen without having to close repeatedly and would, as a result, save billions of dollars.

The problem is that we do not have the number of tests necessary to pursue a testing pathway to reopening. Scaling up testing presents a variety of challenges—including supply of the underlying materials within the supply chain;[4] coordination problems that link supply to demand; and personnel and plans for how to deploy millions of tests per day. One solution to these challenges, outlined in the Harvard Roadmap for Pandemic Resilience, is to establish a single coordinating body—a Pandemic Testing Board—to be tasked with ensuring the necessary supply of tests, deploying those tests, and facilitating a tracing program.[5] This body could either be a federal government institution, part of the Executive Branch, or it could be built through an interstate compact, with federal appropriations but not federal administration. This paper offers a blueprint for the interstate compact variant.

INTERSTATE COMPACTS: THE BASICS

Interstate compacts are legally binding agreements between states, territories, and/or tribal nations that allow them to take collective action to solve shared problems or enact a common agenda. The Compacts Clause of the U.S. Constitution grants states the right to create interstate compacts for their common benefit.[6] The text of the Compacts Clause requires congressional consent to these agreements, and compacts are even allowed to take on powers reserved to the federal government.[7] Compacts that receive congressional approval have the force of federal law and

1 Respectively, J.D. Candidate, Yale Law School, and Chancellor Faculty Fellow, Professor of Law, and Director, Program on Law and Government, Vanderbilt Law School.

2 Romer, "Roadmap to Responsibly Reopen America."

3 Allen et al., "Roadmap to Pandemic Resilience."

4 Allen, Weyl & Guthrie, "The Mechanics of the Covid-19 Diagnostic Testing Supply Chain 2.0."

5 Krein, Sitaraman & Weyl, "A War Production Board for Coronavirus Testing," Boston Globe, April 13, 2020.

6 "No State shall, without the Consent of Congress, . . . enter into any Agreement or Compact with another State." U.S. Const., art. I, §10, cl. 3.

7 *Virginia v. Tennessee*, 148 U.S. 503, 519 (1893). In the Court's latest handling of interstate compacts, it held that congressional approval served to "prevent any compact...which might affect injuriously the interests of the others" or "check any infringement of the rights of the national government." *Texas v. New*

therefore supersede state laws.[8]

CREATING AN INTERSTATE COMPACT

The most straightforward way to establish an interstate compact is for Congress to preemptively give its approval by adopting legislation authorizing the creation of a compact. The enacting legislation would outline the compact's nature, purposes, and policies, and establish that the compact goes into effect once a certain number of states have entered into it. As with all federal statutes, the House or Senate would introduce the compact bill, both bodies would approve it, and the president would sign the compact into law. The states who want to participate in the compact would pass identical statutes through their own state legislatures. In doing so, they would assume the conditions attached by Congress. Congress can appropriate funds for the operations of interstate compacts, or states can fund them directly.

EXAMPLES OF INTERSTATE COMPACTS

Today, over two hundred interstate compacts are in operation. Many compacts are regional, and roughly two dozen are national. The average state is a party to twenty-five of these interstate agreements.[9]

Up until the 1922 creation of the Port Authority of New York and New Jersey—one of the most famous examples of interstate compacts—states mostly used compacts to address boundary issues rather than complex interstate challenges.[10] But since the 1970s, the majority of compacts have emerged to serve regulatory purposes, including creating regulatory agencies to manage complex interstate problems.[11] The 2008 Regional Greenhouse Gas Initiative (RGGI) created a nine-member cap-and-trade program to limit CO2 emissions in response to federal inaction to curb rising emissions.[12] All fifty state and federal territories have entered into the congressionally approved Emergency Management Assistance Compact (EMAC). EMAC enables states (usually through the state equivalents of FEMA) to deploy personnel to assist in times of crisis, such as wildfires or hurricanes.[13]

While some reports have called newly formed regional COVID-19 agreements "compacts," these do not appear to be interstate compacts. The current state regional agreements more closely resemble voluntary actions: they establish shared "priorities" and suggest that states will consult one another and work together, but they don't bind the participants, each of whom will establish "state-specific" plans. These agreements don't have any force of law, state or federal, and do not take on federal powers.

HOW TO DESIGN A PANDEMIC TESTING BOARD THROUGH AN INTERSTATE COMPACT

A Pandemic Testing Board can be created via interstate compact. Congress would pass a law creating the interstate compact; states would then pass legislation joining the compact. Alternatively, the states could create an interstate compact, and Congress could approve of it and appropriate funds for its operation. In this section, we offer a blueprint for the design of an interstate compact that creates a PTB, whether the states or Congress is the first mover.

Mexico, 138 S. Ct. 954, 958 (2018) (internal quotation marks and citations omitted).

8 *Texas v. New Mexico*, 138 S. Ct. 954, 958 (2018) ("once Congress gives its consent, a compact between States—like any other federal statute—becomes the law of the land."); *Cuyler v. Adams*, 449 U.S. 433, 440 (1981) (holding that congressional consent "transforms the States' agreement into federal law under the Compact Clause").

9 Council of State Governments, National Center for Interstate Compacts, "Understanding Interstate Compacts."

10 Frankfurter & Landis, "The Compact Clause of the Constitution: A Study in Interstate Adjustments."

11 Florestano, "Past and Present Utilization of Interstate Compacts in the United States."

12 Regional Greenhouse Gas Initiative, "Welcome."

13 Vock, "The Pact Changing How Governments Respond to Disaster."

STRUCTURE

The PTB would be structured as a nine-person board that reports to the states in the compact. Any state, territory, or tribal nation would be permitted to join and participate in the interstate testing compact (ITC), and the compact would take effect upon three states' passing legislation to join the compact. Governors of two states, ideally one from each political party, would be identified in advance of passing legislation and would co-chair the compact.

- **PTB COMPOSITION.** The PTB would be made up of nine members. The chair should be a former government official with experience in public health, such as a former surgeon general or head of the CDC. Four members should come from industry and philanthropy, including persons with experience in supply chains related to drug and medical device production. The remaining four members should include one person with experience in each of the following categories: public health research, labor, civil liberties, and regulatory or consumer affairs. This combination will not only ensure a diverse set of perspectives on the PTB, but also guarantee that the board is not dominated by industry interests or their allies. This should give the public confidence in the board's actions and decisions.

- **APPOINTMENTS AND REMOVALS.** Members would be appointed by the co-chairs to serve for the duration of the PTB's existence. Members can be removed at will by the co-chairs and replaced by the co-chairs. Because the PTB would operate as an interstate compact, rather than a federal agency, the appointment of members can be vested in the governors who co-chair the commission; appointments would not require Senate confirmation, and the co-chairs can direct their removal.[14] The PTB's authorities should expire on December 31, 2021, unless extended by Congress. Any funding left over on that date should be remitted back to the United States Treasury.

FUNDING AND SPENDING GUIDANCE

Congress would appropriate funds for the PTB. States would be free to contribute to the PTB as well, though given how strapped state budgets are, we do not expect they will have the finances to do so.[15] The PTB should be directed by statute to allocate those resources that go to the states (rather than those for procurement of testing supply) based on need, taking into account the population of the states, the prevalence of the virus, and any other factors essential to addressing the public health emergency.

POWERS

The PTB would have information gathering, testing supply and production, testing deployment, tracing, and statistical powers.

- **INFORMATION GATHERING.** The PTB would have the power to compel information from industry to identify supply chain components and bottlenecks, determine production levels and shortfalls, analyze logistical issues, or gather information for any other purposes related to the production, supply, and deployment of tests. While the PTB would respect trade secrets that predated its contracts, the PTB would reserve the right to share with the public information that it deemed essential to public health or oversight.

- **SUPPLY AND PRODUCTION.** The PTB would have the power to ensure the supply and production of tests in quantities needed to ensure the full reopening of the ITC states, and after having secured that supply, to ensure

14 The Ninth Circuit rejected an appointments clause attack on gubernatorial appointment of commissioners who exercised substantial authority over a federal program. The threatened compact, a congressionally-authorized regional electric power planning agreement, gave appointments authority for commissioners to governors of the affected states. The court rejected the petitioner's theory because it "would outlaw all interstate compacts because all or most of them impact federal activities and all or most of them have members appointed by the participating states." *Seattle Master Builders Ass'n v. Pacific Northwest Elec. Power and Conservation Planning Council*, 786 F.2d 1359, 1365 (9th Cir. 1986). See also Frohnmayer, "The Compact Clause, the Appointments Clause and the New Cooperative Federalism."

15 Stewart, "States and Cities Are 'Falling off a Ciff' as the Economic Crisis Sets In"; McNichol, Leachman, and Marshall, "States Need Significantly More Fiscal Relief to Slow the Emerging Deep Recession."

additional supply and production for export to non-ITC states and foreign countries facing shortages of tests. This level of capacity is essential not only to reopen the United States but to reopen channels of global tourism, travel, and commerce.

- *Office of Testing Supply and Production.* The PTB would establish an office of testing supply, which would be responsible for ensuring the necessary supply of tests for ITC member states and, after reaching that supply, for export beyond the ITC member states.
- *Contracting and Production.* The PTB would have the power to make contracts for goods and services related to testing supply and deployment. This power should include authorities akin to those under the Defense Production Act to guarantee production of goods and services that the PTB deems necessary.
- *Public Production.* Under existing laws, the federal government has the power to produce or license a patented product or use a patented process, as long as it provides reasonable compensation to the patent-holder.[16] The PTB should be given this same authority, to exercise in case the PTB finds it necessary to expand production of tests or supplies and processes involved in testing.
- *Testing Innovation Prizes.* The PTB should create a COVID-19 Testing Innovation Prize fund that would offer modest monetary prizes to inventions that bring down the cost, improve the speed, or enable greater access to testing.
- *Anti-Profiteering Provisions and Enforcement.* The PTB should be required to follow a variety of anti-profiteering provisions. To ensure that profit-motivated mark-ups do not inflate taxpayer costs, contracts for goods and services would be based on the lower of current prices or prices of those goods and services as of a date prior to the virus. To ensure profiteering does not take place, an excess profits tax should also be imposed. The PTB and the PTB inspector general would also have the power to refer any possible corruption, hoarding, profiteering, fraud, or other unlawful activities to the relevant state attorney(s) general.

- **DEPLOYMENT.** The PTB would coordinate with states, territories, local governments, tribal nations, businesses, universities, non-profits, and other entities to ensure the distribution and deployment of testing.
    - *Office of Testing Deployment.* The PTB would establish an office of testing deployment in order to develop plans and best practices on how to distribute and deploy tests through the ITC's member states. The office would work in conjunction with state testing coordinators to deploy these tests.
    - *State Testing Coordinator.* Each governor would appoint a state testing coordinator, who would be responsible for working with the PTB and entities within the state, including state agencies, the private sector, and nonprofit organizations, to ensure the distribution and deployment of testing throughout the state. The coordinator would develop plans for deployment, in coordination with the office of testing deployment and with the approval of the PTB.
    - *Pandemic Response Corps.* The PTB would have the power to develop and fund a Pandemic Response Corps, in conjunction with state testing coordinators and as part of their state testing plans. The PTB would develop guidance and materials based on best practices to support states in training Corps members. The Corps would consist of persons who would assist with testing, tracing, and supported

16 28 U.S.C. § 1498 (2019).

isolation, ideally from within the communities in which they work, and would also staff social support specialists who would connect patients and their contacts with the social services necessary. The PTB would compensate Corps members at least at the same rate as US Census takers and provide them with benefits. Corps members would be provided with the necessary protective equipment and protected by strong labor standards, including the right to organize.

- **CONTACT TRACING.** The PTB would coordinate with states, local governments, tribal nations, businesses, universities, non-profits, and other entities to implement a program of contract tracing.
    - *Office of Contact Tracing.* The PTB would establish an office of contact tracing that would develop a plan for contact tracing throughout the ITC's member states. The office would work in conjunction with state tracing coordinators to implement the plan.
    - *State Tracing Coordinator.* Each governor would appoint a state tracing coordinator who would be responsible for working with the PTB and with entities within the state, including state agencies, the private sector, and nonprofit organizations, to ensure that persons who have been in contact with someone infected with the virus are identified and informed so that appropriate actions can be taken. The coordinator would develop plans for tracing, in coordination with the office of contact tracing and with the approval of the PTB.
    - *In-Person Tracing.* The PTB would create an in-person contact tracing mechanism, and would have the power to assign members of the Pandemic Response Corps to tracing operations.
    - *Electronic Tracing.* The PTB would also have the power to approve of an electronic tracing mechanism (ETM) (such as a smartphone app), if it deems electronic tracing necessary and appropriate. Electronic testing shall not be mandatory, and the PTB would be required to consider and develop alternatives to electronic testing. Any electronic tracing mechanism would be required to be operated and run by a non-profit entity, and the non-profit must not transfer, share, sell, or otherwise release to any other entity any data from the ETM, except for de-identified aggregate data for public information purposes in conjunction with the office of data and statistics. The ETM must also not store data beyond two months. Any ETM must be designed to maximize equity, and the PTB should work with the private sector and other entities to develop or distribute technologies for free to those who need access. The PTB would also appoint a deputy inspector general for civil liberties, who would report to the inspector general, to oversee any ETM program.

TRAVEL RESTRICTIONS FROM OUTSIDE THE ITC

- **DATA AND STATISTICS.** The PTB would open an office of data and statistics, which would ensure the collection and public availability of statistics on data relevant to the virus and testing, including but not limited to the number, location, and frequency of tests; and virus prevalence, including by age, race, gender, other demographic characteristics, and geography. The PTB would publish a report on state-by-state metrics relevant to testing and tracing on a monthly basis to help the public understand the virus's progression.

The ITC states may be inclined to restrict entry from non-ITC states, potentially interfering with of the constitutional right to travel.[17] The Court has made it clear that efforts to restrict movement between states will

17 In *Saenz v. Roe*, the Supreme Court identified a constitutional right to travel between states but did not identify a specific textual source for it. 526 U.S.

be subject to strict scrutiny: that is, the government will need to show that the restriction of the constitutional right serves a compelling interest and is narrowly tailored towards that end.[18]

In this context, the compelling interest is in states' power to protect their citizens, which is at its zenith during a public health emergency.[19] In *Jacobson v. Massachusetts*, for example, the Supreme Court held that a mandatory vaccination law was a valid exercise of Massachusetts' police power to protect its residents' public health.[20] At the same time, restrictions cannot be "arbitrary, oppressive, and unreasonable."[21] For example, in *Jew Ho v. Williamson*, the Court struck down racially discriminatory quarantine, in which San Francisco had targeted Chinatown residents on the belief that rice-based diets increased susceptibility to plague.[22]

- **TREATMENT OF OUT-OF-ITC PERSONS.** To prevent states in the ITC from overreaching constitutional bounds, a Pandemic Testing Board should be restricted in its authority to prevent out-of-ITC persons from entering into the ITC states. The PTB and states in the ITC would be allowed to require persons coming into an ITC state from a high-risk state to be tested and quarantined until the test results return. Those who object to testing can choose instead to be quarantined for a safe number of days. And the PTB could establish a fine for those who violate these rules. A high-risk state would be defined as any state that is either testing its population at a rate of below a certain percentage or that is testing above a certain percentage and has an infection rate of above a specified percentage. The particular number of days for isolation and thresholds for determining a high-risk state should initially be set by statute, with a provision to require the PTB to revise those thresholds based on the latest evidence-backed scientific findings on infection prevention and containment. Once inside the ITC area, persons would be subject to the same testing and tracing rules as everyone else. This structure serves the government's compelling interest in preventing spread of the virus, while being narrowly tailored to achieve that end.

OVERSIGHT AND ETHICS

Any public-private funding or production structure comes with considerable dangers in the form of corruption, conflicts of interest, profiteering, and self-dealing. These behaviors can destroy public trust in institutions and in their recommendations—in addition to wasting hard-earned taxpayer dollars. To ensure that the PTB's activities are not marred by these practices, there should be the following protections:

- **TRANSPARENCY REQUIREMENTS.** The PTB's data and statistics office should update statistics on an ongoing basis, in order to keep the public fully updated on the prevalence of the virus, testing rates, and other actions taken to address it. Contracts with suppliers and producers, including all terms and conditions, should be made public immediately upon being concluded. Actual output and production rates should also be reported on an ongoing basis, including broken down by firm and factory. The PTB's office of data and statistics would also produce a final report on the Board, detailing its operations and activities.

489, 501 (1999) ("For the purposes of this case, we need not identify the source of [the right to travel] in the text of the Constitution. The right of 'free ingress and regress to and from neighboring states which was expressly mentioned in the text of the Article of Confederation, may simply have been 'conceived from the beginning to be a necessary concomitant of the stronger Union the Constitution created.").

18 Ibid. at 499 (1999) (holding that a federal restriction on the right to travel between states that leads to unequal treatment of citizens can still be upheld if it is "shown to be necessary to promote a compelling governmental interest"); see also *Dunn v. Blumstein*, 405 U.S. 330, 343 (1972) ("It is not sufficient for the State to show that durational residency requirements further a very substantial state interest. In pursuing that important interest, the State cannot choose means that unnecessarily burden or restrict constitutionally protected activity. Statutes affecting constitutional rights must be drawn with 'precision.").

19 Kreis, "Contagion and the Right to Travel."

20 *Jacobson v. Commonwealth of Massachusetts*, 197 U.S. 11, 27, (1905). ("Upon the principle of self-defense, of paramount necessity, a community has the right to protect itself against an epidemic of disease which threatens the safety of its members."). See also *Oregon-Washington R. & Nav. Co. v. State of Washington*, 270 U.S. 87, 93 (1926); *O'Connor v. Donaldson*, 422 U.S. 563, 582-83 (1975) (Burger, J., concurring) ("There can be little doubt that in the exercise of its police power a State may confine individuals solely to protect society from the dangers of significant antisocial acts or communicable disease.").

21 *People ex. rel. Barmore v. Robertson*, 134 N.E. 815, 817 (Ill.1922).

22 *Jew Ho v. Williamson*, 103 F. 10, 26 (C.C.N.D. Cal. 1900).

- **ANTI-CORRUPTION AND ETHICS REQUIREMENTS.** To prevent conflicts of interest, corruption, or the appearance thereof, members of the PTB and heads of departments within the PTB would be required to sell any individual stocks and invest only in total market or broad market index funds. Members and heads of departments would also be prohibited from purchasing stock in any company doing business with the PTB for an additional year after their time of service. Firms contracting with the PTB should be prohibited from raising CEO pay, offering bonuses to executives, paying out dividends, or buying back stock during the contracting years and for two years thereafter.

- **OVERSIGHT.** The ITC co-chairs would also be required to appoint an inspector general who would monitor transparency, anti-corruption, and ethics provisions, and conduct oversight of the PTB's operations and activities. A deputy inspector general for civil liberties would be dedicated to ensuring civil liberties are protected in all of the PTB's activities, with particular focus on any ETM that is created. The inspector general and deputy would refer possible corruption, hoarding, profiteering, fraud, or other unlawful activities to the relevant state attorney(s) general.

APPENDIX C: LOCAL LEVEL READINESS FRAMEWORKS

JOINT PANDEMIC RESPONSE MODEL: NORTHEAST TEXAS PUBLIC HEALTH DISTRICT, SMITH COUNTY AND CITY OF TYLER, TEXAS[1]

BACKGROUND

This is a landscape analysis of a joint pandemic response model conducted for the Pandemic Resilience Working Group for America's Mayors. This model was selected due to its combined command structure amongst county and city governments and the local health department, which allows for a coordinated response across independent jurisdictions.

Northeast Texas Public Health District (NET Health) is a local health department providing health services and disease surveillance activities in seven counties in Northeast Texas—Smith, Gregg, Wood, Rains, Van Zandt, Henderson, and Anderson. NET Health works both with the Texas State Department of Health Services and the Centers for Disease Control (CDC). Following Smith County's first case of COVID-19 on March 13, 2020, NET Health set up a joint pandemic response effort with Smith County and the City of Tyler to coordinate resources and actions. Primary roles and responsibilities in the joint pandemic response model can be found on Smith County's website.

OPERATIONAL STRUCTURE

NET Health, Smith County, and the City of Tyler set up a joint **Emergency Operations Center** (EOC) that is the core of joint pandemic response planning, logistics, and coordination. The EOC meets regularly and is jointly led by the Smith County Judge Nathanial Moran and City of Tyler Mayor Martin Heines. The Smith County Fire Marshal and the City of Tyler Fire Chief serve as deputies coordinating the overall work of the EOC. NET Health is the operations lead for the EOC and the liaison to state and federal government health interlocutors.

The **Executive Committee** is the decision-making entity for the EOC and consists of the Smith County judge and City of Tyler mayor, Smith County fire marshal, City of Tyler fire chief and captain, City of Tyler manager, City of Tyler police chief, the Smith County Health Authority, the City of Tyler Health Authority, NET Health CEO, NET Health director of public health emergency preparedness and disease surveillance, and representatives from the Joint Information Center (see Communication, below).

Within the Executive Committee, the Smith County judge and Tyler City major are designated "emergency management directors" (decision makers), with the Smith fire marshal and Tyler fire chief serving as "emergency

1 Source: Interviews with NET Health, Smith County, and City of Tyler officials, conducted April 29 through May 5, 2020.

management coordinators" (commanders who oversee the execution of decisions made by the decisionmakers).[2] Commanders also steer the Executive Committee on what decisions need to be made next.

The commanders follow FEMA incident command system structure[3] to limit span of control and to ensure clear functional responsibility. In the Northeast Texas model, there are four functional groups that report to the commanders, outlined below. Each functional group has a chief, a deputy chief, and dedicated staff to carry out the pandemic response work.

- **PLANNING:** Plans what needs to be done next and recommends strategy to the Executive Committee. When a decision is made to proceed, Planning hands over execution to Logistics and Operations (see Supported Isolation for Planning's work on housing facilities). Makes procurements and signs contracts with vendors. Provides daily updates to the State by submitting an Incident Action Plan.[4]

- **LOGISTICS:** Involved with overseeing use of supplies, including PPE, food, personnel, and other resources needed to run pandemic response operations and facilities. Keeps track of people who check in and out of facilities and their needs. Logistics provides receipts to Finance.

- **OPERATIONS:** (NET Health) leads the operational response to the pandemic and coordinates with functional groups on the health aspects of their work. Corresponds with medical personnel, hospitals, clinics, local medical societies, nursing and group homes, shelters, correctional facilities, and schools on their pandemic response needs.

- **FINANCE:** Tracks and documents funds spent on pandemic response including operations, supply, and personnel. Applies for reimbursement from FEMA, CARE, or other grants. Works with Planning to identify and apply for grants to fund pandemic response.

How it works using test site planning as an example:

1. Planning recommends to the Executive Committee that the EOC designate sites for scaled up testing.

2. Executive Committee approves the recommendation and hands it to the commanders to oversee execution.

3. Planning selects test site locations with Operations input and plans for traffic and security.

4. Logistics coordinates with Operations (NET Health) on what is needed to administer scaled up testing from test supplies to personnel administering the tests. Logistics assigns resources and coordinates the setting up of the sites.

5. Operations oversees all public health aspects of test site planning and operations.

In addition to the Executive Committee, there are approximately 80 EOC participants who comprise representatives from the local emergency services districts; constable offices; county coordinators and mayors from other towns in Smith County; local health authorities and the Smith County Medical Society; hospitals, nursing and group homes, health clinics and federally-qualified health centers; and local independent school districts.

2 In accordance with Texas state emergency preparedness directives.
3 For more information: https://www.fema.gov/incident-command-system-resources
4 Incident Action Plan documents what each functional group did over a reporting period, typically one working day.

The six other counties in NET Health's district have EOCs that operate independently, one of which is also a joint county-city effort (Gregg County and the City of Longview). The EOCs share information on confirmed cases only.

For EOC planning, the University of Texas Health Science Center set up a joint hospital dashboard for the three local hospitals. This dashboard, which is not publicly available, allows the EOC and hospital administrators to track confirmed and suspected COVID-19 cases being treated in area hospitals. The joint hospital dashboard also tracks the location of ventilators and critical supplies in the hospitals' systems.

REGULATORY AUTHORITY

The Executive Committee coordinates on regulation and its implementation in line with state and national directives. Where there are jurisdictional differences, over fire safety codes for example, the Executive Committee will determine a solution that works for both jurisdictions. The Smith County judge and City of Tyler mayor issue pandemic response directives and guidance to their respective jurisdictions working through the Joint Information Center (see Communication). County and city staff conduct advocacy and take input from residents and businesses in each of their jurisdictions, bringing key findings to the Executive Committee.

COMMUNICATION

The **Joint Information Center (JIC)** provides daily public communication (COVID-19 case dashboard, press releases, website updates), and public guidance cleared by the EOC, and convenes a weekly press conference. The JIC is comprised of Smith County, City of Tyler, and NET Health public information officers, as well as public information officers from area hospitals and school districts.

NET Health for East Texas Public Health District has created public dashboards of active COVID-19 cases for Smith County and the other counties within that district. Dashboard information includes numbers of confirmed, recovered, and deceased cases, and tracks age range and gender of cases. The Smith County dashboard also includes the numbers of confirmed and suspected cases in local hospitals.

- East Texas District dashboard
- Smith County dashboard (includes City of Tyler)

PROCUREMENT

The EOC works with the Regional Advisory Council in its jurisdiction to procure PPE and COVID-19 resources. The State of Texas has 22 Regional Advisory Councils that are the administrative bodies responsible for oversight of their region's Emergency Medical Service Trauma System Plan. The Regional Advisory Council has a prioritized system for distribution of supplies to hospitals, health centers, first responders, nursing and group homes, and penitentiaries. To reprioritize supply of such materials at the local level, NET Health submits a request through the state.

In addition to working with the Regional Advisory Council, the EOC conducts its own procurement from private and commercial vendors but remains short of necessary levels of tests, PPE, and other COVID-19 resources. In one notable instance, 40,000 masks were found locally but with disintegrated elastic bands. The University of Texas Health Science Center at Tyler helped retrofit new elastic bands and the masks are now in use.

SCREENING AND TESTING

Prior to the change in CDC guidance, residents were advised to consult their medical provider to be screened prior to testing. The locality's hospitals and health centers have call centers. NET Health established a call center for COVID-19 screening for area residents without a primary care provider. Community health workers staff the call line and refer residents to local medical providers. A call center was also established for medical providers requesting information or guidance on testing and care of COVID cases.

The locality offers a combination of testing sites, including at area hospitals, health centers, and mobile test sites provided by the state (Department of Emergency Management and Department of State Health Services). To aid residents, NET Health made available a public map of active test sites including type of testing site. Test providers submit test data to the Department of State Health Services, which issues a report on tests by county.

While there is a dearth of testing materials currently, to prepare for a scale up in testing the EOC has identified several test sites in accordance with Strategic National Stockpile[5] guidance. Test sites are outdoors and include the parking lot of the local convention center, which can have up to seven lanes of drive through testing. Other outdoor sites allow for ease of drive-up testing and test administration. A call center referral for vulnerable members of the population who are immobile or lack access to a vehicle would result in testers being sent to them to collect a test sample.

Testing efforts are primarily conducted in private labs with the support of the state's Public Health Laboratory of East Texas. Early on, tests had to be approved by the regional office of the Department of State Health Services and shipped to the CDC. From late March, Texas opened its state public health labs for test processing, including one in the City of Tyler. Hospitals are authorized to contract with private or commercial laboratories, which have greater capacity to process test results.

CONTACT TRACING

NET Health Disease Surveillance had a rush in casework following confirmation of the locality's first COVID-19 case. Tyler City and Smith County officials provided help with contact tracing by assigning members of the county sheriff and city police and fire departments, as well as the District Attorney's office, all of whom are trained investigators.

Contact tracing is manually done. NET Health Disease Surveillance provides the contact tracers training on how to test and contact trace using CDC forms provided by the Texas Department of State Health Emergency Preparedness and Response division. NET Health Disease Surveillance coordinates with Texas state health authorities on contact tracing training. To ensure privacy standards, contact tracers must undertake Health Insurance Portability and Accountability Act (HIPAA) training online and send NET Health their certificate of training before they are authorized to contact trace.

Contact tracing information is sent to NET Health Disease Surveillance, which manages data on COVID-19 cases and exposures.

- Positive cases are shared with state health authorities and case numbers are updated on the Smith County and East Texas District Dashboards. Home addresses of positive cases—but not their individual names—are shared with emergency medical service personnel. This ensures that the emergency medical service personnel wear PPE if called to that address.

- Exposed cases are not shared outside of NET Health until or unless they are confirmed positive in line with HIPPA regulations.

5 The Public Health Service Act authorizes the secretary of Health and Human Services, in coordination with the secretary of Homeland Security, to maintain a stockpile of drugs, vaccines, and other medical products and supplies, known as the Strategic National Stockpile (SNS), to provide for the emergency health security of the United States and its territories.

NET Health Disease Surveillance communicates with exposed cases to let them know they have been exposed and to provide CDC guidance.

- For individuals, guidance is to self-isolate for 14 days and to contact a medical provider should symptoms emerge. NET Health Disease Surveillance monitors individual cases and follows up at the end of the 14-day period.
- NET Health Disease Surveillance contacts employers of confirmed cases to guide them on monitoring, disinfecting, and social distancing and spacing measures in the work environment. For the area's largest employers with exposed cases, NET Health conducts weekly check-ins to monitor for disease spread and to provide support.

NET Health is exploring a partnership with the University of Texas Health Science Center to be part of its contact tracing database system. The contract tracing database system stores information on prior movements of positive cases gleaned from manual tracing. It then allows users to monitor virus spread and to identify hot spots by making connections between places visited by positive cases (churches, shops, schools) and onward spread. The Texas Department of State Health Services is working on a state-wide contact tracing database system.

SUPPORTED ISOLATION

Smith County and City of Tyler residents currently isolate at home.

The EOC has planned for isolation facilities at two local colleges and a hotel. The facilities are for health care workers and first responders who chose to self-isolate to protect family members, as well as suspected and active COVID cases in the event of hospitals becoming overwhelmed. The EOC has contracted with a nonprofit to manage a 200-bed dormitory at one of the colleges. Twelve rooms are set aside at the hotel for isolating health care workers. The EOC arranged for the use of an old firehouse to house self-isolating correctional facilities officers.

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