Smart Containment with Active Learning: A Proposal for a Data-Responsive and Graded Response to COVID-19

Working Draft – Version 1: April 16th, 2020

This multidisciplinary proposal draws on the expertise and experience of researchers and practitioners in public health, infectious diseases, epidemiology, economics, policy and public management, technology and data science as well as business & non-profit leaders. Elements of this proposal are being tested in various places – including Pakistan – where several members of the team have been actively supporting the state’s response efforts at national and sub-national levels. The proposal is intended as a living document that will be updated as more information becomes available. Updated versions will be available at https://www.hks.harvard.edu CENTERS/ CID/ COVID-19 and https://www.cerp.org.pk/pages/covid-19-response. For comments, please reach out to us at covidrapidresponse@cerp.org.pk.

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Executive Summary

COVID-19 has presented governments with two very hard and contrasting choices. If they don’t act immediately and lock-down, they risk thousands of deaths from COVID-19 and the medical burden it imposes on healthcare. Alternatively, shutting down the economy risks economic collapse with high mortality from non-COVID related reasons, especially in poorer places. Worse, these decisions have to be made in the face of substantial uncertainty: We know the broad parameters of the problem – physical distancing will help but imposes substantial costs – but lack the clarity and precision needed to make the tough tradeoffs.

Our proposal argues that standard frameworks from decision making under policy uncertainty can be used as a way out of this conundrum. For decisions that will essentially remain the same regardless of what information becomes available – such as expanding testing capacity, PPE for health workers and health messaging – we should act immediately and unequivocally. For decisions that can benefit from collecting some information – such as how lockdowns may affect migrants leaving urban areas – we have to put in the resources and time needed to do so before acting. Moreover, many decisions – such as understanding the underlying risk profile and typing policy response to it – can benefit from using prior information on age and health-vulnerabilities present in standard population and health surveys. The key is to recognize that not only should we be learning through decisions taken, but these actions in turn be undertaken to generate the knowledge needed.

We propose an active learning strategy that uses real time testing and refinement of policy responses together with a graded approach that varies by local disease projections. We grade areas into four distinct “alert” levels – from green to red – and develop set of operational strategies for each level that focus on: (i) smart testing & data collection, with testing evolving with the levels (from symptomatic testing, to contact tracing and testing, to therapeutic & antigen testing) and collecting relevant socio-economic and health outcomes data to inform strategy and policies at each level; (ii) detailed physical distancing measures that vary in their degree; (iii) community messaging and compassionate enforcement that promotes voluntary compliance and trust; and (iv) the strategic decisions and policy refinements that are needed at each level.

Our model of ‘smart containment with active learning’ is a structured way to help governments learn faster and make better decisions in a shorter time period.
I. The Problem: A Knowledge Gap Makes for Difficult Choices

Whatever policy response countries adopt, one thing is clear – most are acting under surprisingly limited knowledge. While we know enough to understand the value of physical distancing and lock-downs, we don’t have the numbers needed to make the hard benefit-cost calculus that will be increasingly needed in the coming days.

A. What we Do Know:

Public health and infectious disease experts and epidemiologists have helped us understand COVID-19 – we know its symptoms, the incidence of its likely morbidity and mortality, and the speed and nature of its spread. We have also learnt from past experiences – notably the 1918 Spanish flu – that early intervention in terms of physical distancing can reduce peak demand for hospitals and the total number of infections.¹ Discoveries continue apace, with new treatments, new tests and new vaccines at various stages of the product development cycle.

We also know – both from the immediate and projected fallout of the physical distancing actions taken across the world – that the costs of these remedial measures are and will likely be significant. UN’s trade and development agency, UNCTAD, estimates that it will likely cost the global economy $1 trillion in 2020. The IMF projects global growth in 2020 to fall to -3 percent in their April World Economic Outlook.² With economic activity at a stand-still in most places, this pandemic presents both substantial demand and supply side shocks to the economy.

Physical distancing and lockdowns are likely to have particularly deleterious effects in low-income countries for multiple reasons.³ Much of the economy is informal. This means it is harder to provide financial assistance to those who may need it most. The food chain, from crop production to distribution and sale, is more labor intensive and maintaining food supply may become hard in extended lockdowns. A significant fraction of the disease burden remains acute. Childhood diarrhea, pertussis and Tuberculosis all require regular care, and, in a lockdown, this may not be feasible. Fiscal space at the state/provincial level is limited,⁴ and unlike in the U.S. or Europe, where money flows in when times are

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³ “Poor Countries Need to Think Twice About Social Distancing” Mobarak & Barnett_Howell, Foreign Policy, April 10 2020 https://foreignpolicy.com/2020/04/10/poor-countries-social-distancing-coronavirus/
uncertain, in low-income countries, the money flows out. Spending now needs to be more carefully managed against the possibility of a BOP crisis down the road.

B. What we still Need to Know:

While we have learnt a fair bit in a relatively short time, there is even more we still don’t know. This lack of knowledge is consequential. We still don’t sufficiently understand COVID-19’s transmission mechanism or environmental triggers to be able to provide precise projections. While epidemiological models have been instrumental in our response, they do not internalize or account for human behavior, nor do they incorporate the wider health and economic implications of physical distancing measures. Physical distancing policies attempt to lower the “R0” parameter that determines viral growth, but we are only beginning to understand compliance with these policies and know even less about actually how effective they are in reducing disease spread.

Projections for societal and economic losses are even harder to pin down – and are less reliable in the longer-term. While market reaction is one signal, markets are notoriously volatile especially in the face of such inherently uncertain conditions. Estimates of economic losses can vary substantially. For example, the WTO estimates world trade could fall by between 13% and 32% in 2020 ⁵ - and even this range could quickly change. Projections on the impact on job losses, poverty, and other health outcomes begin to get even more speculative. In fact, historical evidence may even question the supposed trade-off between population health and the economy may be illusory if, as was found for the 1918 flu epidemic in the U.S., places that locked down faster were also those that recovered fastest after the epidemic was over.

C. Why this Matters

The fear of exponential growth in infections has forced countries to enact policies, but it has also led to panicked and poorly thought-out decisions. Not knowing reasonably well what the costs and benefits of these different policies look like, there has been incredible confusion about the timing and extent of physical distancing and lock-downs as well as a strategy to ease them. While one side of experts is clamoring for more aggressive physical distancing, others seem ready to start opening the economy. These decisions are admittedly weighty and even with more knowledge would still involve the usual adjudication over different outcomes. But that is what politicians are supposed to do, and that is what is regularly done for millions of other decisions that are made every year. The fundamental question then is: What should be done given that we really don’t know what the effects of these different policies will be?

⁵ https://www.wto.org/english/news_e/pres20_e/pr855_e.htm
II. Enabling an Active Learning Process

In responding to the current crises and situations like this, we should recognize that there is a well-developed and well-tested machinery for how to make decisions under uncertainty (Manski 2013). We need to use it.

Key to understanding this process is the importance of learning. Not only should policy actions inform our learning so that policies are tested and refined in real-time, but knowing that learning is so valuable, we should also take actions that speed up the learning process. In other words, “learn as you act and act to learn”.

We highlight four distinct parts of such an active learning process:

First, there are some decisions that will essentially remain the same regardless of what information becomes available. For instance, we just don’t see information that will change an urgent requirement to expand testing capacity and PPE for health workers or careful communication regarding COVID-19. In these cases, there is no point waiting for the information to become available. Act Now and communicate unequivocally.

Second, there are other decisions that are best made after collecting some information—especially if that information is relatively costless to collect. Suppose you are driving a car and you can’t see beyond a point. You have been told that beyond that point, either there is both a cliff and you will die if you go over it, or there is a beautiful meadow where you can stop and have a picnic. The obvious decision is to stop the car before that point and check before driving on. For countries that imposed sudden lockdowns, a 2-day survey could have helped the government understand that migrants would leave urban areas with a lockdown and this would have allowed multiple mitigation measures to have been put in place. Countries can be prompt in their response but without rushing blindly into decisions.

Third, in making decisions, all prior information should be used. Below we will give examples of prior information that is currently underutilized—an idea of the underlying vulnerability of populations so that governments can undertake a spatially targeted strategy.

Fourth, recognize that every decision will have an impact on the outcomes of interest, but will also provide further information. This new learning can critically inform the decision-making process tomorrow. So, a decision that may have little impact on potential outcomes but can massively increase information should be favored. This moves us away

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from passive to active learning and has to be a key component of the strategies in both high- and low-income countries.

We further elaborate on the third and fourth points.

**Using Prior Information:**

The difference between a general lockdown and a 'graded' lockdown is that certain groups are allowed greater freedom of movement to keep our economic engines running and offer a degree of hope, especially for the poor. One idea proposed is that of risk stratification: Hospitalization risks for COVID-19 increase with age and pre-existing chronic conditions. Therefore, allowing for potentially greater movement among the young and healthy while protecting our elders will allow for the resumption of economic activity and gradually build up immunity in our populations; even though the young will remain more likely to be infected.

Can risk stratification be spatially targeted by maintaining stricter restrictions in places with a larger agglomeration of older people and/or those with additional co-morbidities? Box I shows that this can in fact be accomplished in practice as there is substantial degree of variation in the number of elderly across communities. We are not flying

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Box I: Using Age for Spatial Targeting: The figure below shows the age distribution in Pakistan, according to the U.N databook for 2007. The striking fact is that only 3.3% of the population is above the age of 65. Contrast this with Italy which has a much higher fraction of elderly. What does this mean for rural areas? Assuming that the rural population is 63% of the country (World Bank) and there are 50,000 villages in the country, there are an average of 63 people above the age of 65 in the average village (and around 35 males). These people will not be distributed evenly—there will be some villages with a large number of older males; there will be others with a small number, perhaps even less than 10.

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7 What we know to date about the effects of COVID-19 are in terms of hospitalization and mortality risks are that (a) it affects men and the elderly disproportionately and (b) it affects those with other co-morbidities disproportionately. To date, the co-morbidities that have been considered are all chronic conditions (hypertension, diabetes and obesity) as well as smoking. There are many other possibilities in low-income countries, ranging from anemia (especially in women) to asthma and pollution related problems to Tuberculosis. We do not know what hospitalization and mortality risks will look like in populations with a very different morbidity burden; neither are we sure about the likelihood of infection.
completely blind here. There is enormous prior information that can be brought to bear on this issue. It should.

What about pre-existing risk factors? Box II gives an example from an urban setting and shows there may be significant variation across neighborhoods in a given city and hence potential for a varied policy response even within cities.

These kinds of risk profiles can be built up using pre-existing data (like population censuses and health surveys) to construct a more comprehensive spatial vulnerability index that allows policymakers to follow a graded approach, both in their precautionary measures, but also in their expectations of hospitalizations if the pandemic hit a village or urban neighborhood. Policymakers can start from simpler approaches, using only age and sex, and as more data becomes available, these can be modified in real time to reflect the latest learning from the field.

**Box II: Pre-existing conditions:** Using data from the National Family Health Survey (V) Das & Daniels show tremendous variation in Delhi in age, sex, hypertension, diabetes and smoking and hence, risk of hospitalization. The figure below plots risk variability across neighborhoods, where green is least risky and red is highly risky. There are a large number of neighborhoods in Delhi that are green, but also a longish tail that is red; it is the red areas where we would expect the highest number of hospitalizations to come from if COVID-19 hits. Further, risk profiles are very different for poorer and richer neighborhoods. Poorer households tend to be more predominantly male and with higher rates of smoking. Richer neighborhoods have more people above the age of 65.

**Active Learning:**

The fourth point, and a key part of the process, is *active rather than passive learning*. We apply this to the biggest question many face at this moment—is lockdown the only option? In order to answer this question, we have to generate structured data on what happens in (say) villages that vary in the strictness of their lockdowns. Knowing the value of this, a “graded approach” - whereby the degree of severity of physical distancing depends on the current and projected situation of an area - becomes invaluable as it generates critical evidence on relative compliance to and effectiveness of our remedial measures rapidly enough that our responses can be readjusted and refined in real time.
Whereas all systems will benefit from active learning, low-income countries stand to benefit even more given the peculiar enforcement, implementation and compliance challenges on policy response imposed by weak state capacity in these countries. This is compounded by governments having to face multiple challenges often in the absence of clear prioritization of policy objectives, coordination across different agencies/actors, and credible communication with the citizens to enable voluntary compliance.

Tying policy response to active learning does not come easy to governments as they face pressures from media, political and citizen groups and sometimes other governments to respond as if they fully know the best response. Following the herd is seen as less risky as failing in common with other countries is perceived as less politically damaging than failing in charting your own response.

However, knowledge gained from other contexts, though useful, cannot be blindly applied. Part of active learning comprises context specificity in knowledge-generation and application. This means policy experiments done in parallel and calibrating policy response in real time. As well as clear protocols and standard operating procedures (SOPs) to better support generation and application of active knowledge by the relevant actors that enables decision-making, coordination and compliance and the optimal mix between centralized and decentralized decision-making. Having a “learning state” is key to ensuring effective policy response at present and to producing greater resilience for dealing with crises in future.

III. The Plan: A Graded & Data-Responsive Smart Containment Policy

An action plan that works has to be clear and decisive, yet flexible and modular to incorporate rapid learning, public and credible to enable coordination and compliance, and yet simple and feasible enough that it can be implemented in states with varying capacity and resources. This calls for a graded approach that will provide governments a clear direction to act and coordinate among different agencies while generating the information governments need to make tough tradeoffs and policy calibration to their own contexts. This will also mitigate the last-mile problem by providing citizens clear signals to manage expectations and change behavior.

The plan we propose therefore emphasizes the following key features: (i) the critical role of data; (ii) the need for policy responses to be data-responsive; (iii) enable “smart containment” with the degree of physical distancing be based on local conditions; (iv) the importance of community messaging and compassionate enforcement to ensure
voluntary compliance; (v) the response catering to both immediate considerations but also accounting for more sustained and longer terms needs; and (vi) partnership with on the ground implementers to leverage existing capacity.

The table below shows this graded action plan. We envision these plans being carried out by regional units of decision making authority “D” (these are sub-national units such as provinces(states, districts, counties etc.) which have the mandate, administrative capacity and local information to tailor their response at the smallest feasible geographically contiguous and potentially isolatable areas “S” (these could be neighborhoods in urban areas or villages/village clusters in rural areas).

<table>
<thead>
<tr>
<th>Stage</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No infection</td>
<td>Infection detected &amp; moderate projections</td>
<td>Infection detected &amp; severe projections</td>
<td>Widespread disease</td>
</tr>
<tr>
<td>PREPARE</td>
<td>DISTANCING</td>
<td>LOCKDOWN</td>
<td>RESTORE</td>
<td></td>
</tr>
<tr>
<td>Smart Testing &amp; Data</td>
<td>Screening of high-risk/high-impact people; Syndromic testing and Sentinel surveillance</td>
<td>Level 1 plus: Contact tracing &amp; testing; Testing of front-line workers; surveys to assess other impacts, monitor compliance</td>
<td>As in Level 2 but expand to adjacent S areas, and begin surveys of recovered cases</td>
<td>Test primarily for therapeutic purposes, begin antigen testing; Collect additional data on impact of morbidity and health sector capacity</td>
</tr>
<tr>
<td>Physical Distancing</td>
<td>Basic physical distancing preventive measures</td>
<td>Stronger physical distancing, isolate confirmed cases &amp; quarantine contacts</td>
<td>Move towards lockdown in S &amp; quarantine in D</td>
<td>Continue Level 3 w/ added health &amp; welfare support; consider distancing/lock-down easing in S based on antigen testing</td>
</tr>
<tr>
<td>Community Messaging</td>
<td>Consistent with Social Distancing measures and Community Messaging principles</td>
<td>Level 1 plus, keep people informed on prevalence of infection (w/o revealing identities) and welfare measures</td>
<td>Same as Level 2 and expand to entire D</td>
<td>Emphasize severity, reassure people of government preparedness and support measures</td>
</tr>
<tr>
<td>Actionable Decisions</td>
<td>Monitor and prepare contingency plans; leverage/build capacity for implementing plan</td>
<td>Launch and assess effectiveness of implementation plan; Monitor and use data to refine response, assess adverse impacts and target support</td>
<td>Same as Level 2, and expand to entire D. Prepare for Level 4 through new capacity, ask for support from higher tiers</td>
<td>Same as Level 3, and prep for expanded medical, food and social security needs.</td>
</tr>
</tbody>
</table>
The appendix provides a more detailed version of the Table along with details of the recommended actions. Here we highlight a few key aspects. First, as we noted above key to the response is recognizing that it will be heterogeneous based on an area’s current and projected disease prevalence and impact. In order to communicate this effectively – both for the response teams and public at large – we borrow from the “public alert” terminology and color code each situation (columns in the Table). Level 1 (Green) is the preparation grade for districts that do not have any detected infections; Level 2 (Yellow) is for cases where a community acquired infection has been detected in the district, but the projected disease spread and underlying vulnerability index in the village is low. This may be, for instance for areas where the population density and number of elderly males are low and/or co-morbidities are limited. Level 3 (Orange) is for cases where multiple cases have already been detected in area S and the population has a high projected spread and vulnerability index. Finally, Level 4 (Red) is for areas where there is already significant community spread, which implies that the infection is already rampant.

The rows in Table highlight the key action items that are needed. First and foremost of these is the testing and data collection strategy to be adopted. Testing balances the need for both therapeutic and disease prevalence information. We recognize this may be especially challenging for countries that have weak testing/reporting infrastructure or where there is risk of under-reporting. However, this is an area where the government will have to deploy all possible resources and embrace transparency if they have any hope of a smart and cost-effective response. We also highlight additional data that needs to be collected beyond testing that captures non-COVID related health as well as relevant socio-economic outcomes that will be critical in alleviating the impacts of remedial policies and targeting support more effectively. This information directly feeds into and validates the physical distancing strategy (row 2) that varies depending on the underlying situation (i.e. column).

Community messaging (row 3) is key for crises in general but especially those where individuals’ own decisions – such as voluntary and informed compliance to policies - will have huge implications on the efficacy of policy measures. Such a policy calls for “compassionate enforcement” so (infected) individuals don’t feel ostracized or victimized but are confident that their needs will be taken into full consideration. The last row emphasizes the strategic and operational decision cycle for key decisions that are to be made based on the information gathered. This pertains to the decision-makers responsible for ensuring implementation and coordination of the overall plan. The

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refinement process envisions a 2-3 week decision making cycle after which the actions are again modified according to what we have learnt.

While the specificities of these actions in each stage will depend on the context and capacity of each country, and necessarily evolve as we learn more, here we highlight some key aspects of these decisions for each prevalence level (colors in the columns).

In Level 1 areas, our advice closely mirrors best practices being adopted in other countries. The focus here is on testing, surveillance and community messaging. For testing, we are suggesting PCR-based tests for high risk individuals, such as healthcare workers and/or those involved in law and order, as well as for symptomatic individuals, we are not suggesting testing of random samples (unless they can be pooled at sufficiently large numbers) since the possibility of picking up an infection is extremely small given limited testing capacity. For messaging, it is imperative that citizens understand the basic health preventive messaging – physical distancing, washing etc. – with regards to COVID-19. For surveillance, we are suggesting that any testing of individuals be accompanied with a short questionnaire that helps build up better predictive models of the sickness and quickly allow for better models of high risk in these populations.

In Level 2 areas, our advice again follows best practice, but it does not advocate for a full lockdown. For testing, we suggest contact tracing and testing as well as testing of frontline workers. We are suggesting stronger physical distancing measures, as well as isolation of people who are sick and quarantining of their families. However, we are not suggesting that the entire S area be shut down with zero economic activity.

One key difference between low-income contexts and OECD countries is that other infectious and acute diseases that require immediate care may exact a heavy toll. Therefore, in terms of the data, we suggest that in these areas, a full log of all mortality be maintained carefully, with some basic information on the cause-of-death. Verbal autopsy methods are available, in case there is administrative capacity to implement these.

Finally, in terms of messaging, we are adding that people should be given specific information on a regular basis about how many cases there are in each area, and how people are being cared for. These messages have to be carefully designed to ensure that there is no panic, while at the same time, providing clear, accurate and actionable information. One of the most important factors that is emerging is that sick people—and their families—may face stigma and discrimination. There are already cases where people are scared of being taken to a quarantine facility or having their illness leading to a lockdown of their village with a real possibility of starvation. This would be a disaster as the news will quickly spread that they must do everything in their power to not be detected.
with the illness, especially if they are young and therefore may face lowered risks. There is a real possibility that people will not report their illness, even if severely sick. The messaging must reassure people that in any quarantine center or hospital people will be treated with dignity and compassion, and will have all the necessary amenities. Of course, this message will be believed only if it is actually true—stories to the contrary will immediately seed doubt in people’s minds.

In Level 3 areas, we are suggesting that the S areas be entirely locked down till infections reduce to very small numbers. For testing, contact tracing and testing of high-risk workers be extended to adjacent areas as well. The key difference is in terms of the physical distancing measures. For at least the initial 2-3 week learning period, we are suggesting that these areas be fully locked down, with no entry into the village or exit from it. We are also suggesting that people be required to remain in their houses. This will require substantial mobilization from relevant authorities, as it will both require a degree of compassionate enforcement and a parallel effort to make sure that people have all the necessities they need for the duration of the lockdown. Therefore, authorities will have to ensure the delivery of food (and water where required) packets to every household on a daily basis, as well as the delivery of medicine (for those who need them on an ongoing basis) and transport of sick individuals to hospital care. After a 2-3 week lockdown we advocate prevalence surveys as well as phone surveys that look at other health (including deaths) and socio-economic outcomes to capture the costs of imposing such strong physical distancing measures to be conducted in the locked-down village using antibody tests.

Finally, in Level 4 “Widespread Disease” phase, we are suggesting that testing be used primarily for therapeutic processes. We also suggest that locked-down status be eased if prevalence surveys using antibody tests show a high degree of infection (and herd immunity) in the population. We are suggesting that there is such a prevalence survey of sufficient sample size. We fully recognize that these tests are not yet perfect, but they will give us an idea of the extent of disease spread in the village after the lockdown as well as the presentation of the infection (how many were asymptomatic etc.). At the same time, we suggest clear messaging for residents and adequate facilities to maintain the relevant precautions and protocols for monitoring, managing and controlling further transmission. We also suggest authorities adopt preventive measures to protect the elderly, vulnerable population and frontline workers from getting infected. Moreover, it is critical that these areas be provided substantial and expanded medical, logistical and financial support so that their (increased) needs are met completely.

Re-evaluation: It is worth emphasizing that a key component of our strategy is reevaluation of the specific policy measures being taken every 2-3 weeks. This is critical in helping us better understand the benefits and costs of each policy and in refining the
details of each response. For example, consider the two contrasting policy choices (a) a weaker lockdown where there is isolation and care for those who are sick but there is also greater freedom of movement. In particular allowing essential workers, such as food producers and distributors, to continue their work or (b) strict quarantines and physical isolation which will require massive investments in maintaining food chains, ensuring necessities for every family and providing critical care for those who need it—regardless of the underlying condition.

In our proposed plan we are effectively deploying a form of choice (a) for level 2 and choice (b) for level 3. Based on data collected after the first 2-3 weeks there are three possibilities: (i) the outcomes between Level 2 and Level 3 were similar (ii) the outcomes were worse in Level 2 villages or (iii) the outcomes were better in Level 2 villages. Here outcomes are not only those from COVID-19, but also from mortality due to other causes and economic outcomes. If this strategy is followed, we will be able to provide a full accounting across multiple outcomes on how Level 2 villages fared versus Level 3. This will provide valuable evidence that policymakers and politicians require on how to move forward.

This process of continuous re-evaluation can provide a full roadmap for the next 18 months that is fully guided by the evidence informing the implementation and extent of physical distancing measures as well as enabling the subsequent and eventual easing of these measures and better targeting the support measures needed to rebuild the economy and society.

IV. Concluding Thoughts

COVID-19 presents a unique challenge to all countries, especially low-income ones, but thus far, active learning has not been incorporated into country plans. Therefore, decisions are made in the face of substantial uncertainty, but there isn’t a clear guideline for how those decisions should be made to resolve the uncertainty as rapidly as possible. Our graded smart containment action plan incorporates prior information and best practice in a structured fashion to help resolve this problem. Implementation of such an action plan will allow us to better formulate policies for the country rapidly and in real time. In the spirit of learning, we intend to update this document as we learn more from our and others’ experiences – especially since countries have adopted varying approaches that we can all learn from. Such learning will be key for us to succeed in addressing the current pandemic and becoming resilient to future ones.
APPENDIX: This operational plan lays out a district evidence-responsive response strategy that seeks to minimize disease spread and limit adverse socio-economic impact by targeting response to the current & projected level of prevalence in the smallest feasible area (S) within the District (D). Each set of actions is associated with a set of agents.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Level 1 – PREPARE</th>
<th>Level 2 – INFECTION DETECTED in S</th>
<th>Level 3 – MULTIPLE CASES in S</th>
<th>Level 4 – WIDESPREAD DISEASE in S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No infection identified in District (D)</td>
<td>First case identified in area (S) in the District (D)</td>
<td>Multiple cases identified in area (S) in the District (D)</td>
<td>Widespread disease in area (S) in the District (D)</td>
</tr>
<tr>
<td></td>
<td><strong>Smart Testing &amp; Data</strong></td>
<td><strong>Sentinel surveillance</strong></td>
<td><strong>Follow-up Phone surveys of infected</strong></td>
<td><strong>Test</strong> primarily for therapeutic purposes in infected S</td>
</tr>
<tr>
<td></td>
<td><strong>Syndromic surveillance</strong> to screen &amp; test symptomatic patients and people with high impact &amp; health risk vectors</td>
<td><strong>Contact tracing &amp; testing</strong> (required data)</td>
<td><strong>Survey of recovered</strong></td>
<td>Begin testing for antigens</td>
</tr>
<tr>
<td></td>
<td><strong>Syndromic Surveillance Robocalls</strong> to focus on infected S’s</td>
<td><strong>Testing of front-line workers</strong></td>
<td><strong>Start syndromic surveillance robocalls</strong> in adjacent S’s</td>
<td>Collect additional data on impact of morbidity and health sector constraints to meet Level 4 needs</td>
</tr>
<tr>
<td></td>
<td><strong>Social mobility data</strong> to monitor compliance</td>
<td><strong>Syndromic Surveillance Robocalls</strong></td>
<td><strong>Survey of recovered</strong></td>
<td><strong>Consider easing lockdown in S based on antigen testing results (continue physical distancing &amp; self-quarantine for high-risk people)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Level 1 plus:</strong></td>
<td><strong>Level 2 plus:</strong></td>
<td>Implement stronger measures &amp; <strong>lockdown</strong> with additional measures (on top of level 2):</td>
<td><strong>Level 3 plus:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Level 2 plus:</strong></td>
<td><strong>Expand contact tracing</strong></td>
<td><strong>Move infected S’s into full lockdown</strong></td>
<td><strong>Same as Level 3, but emphasize severity</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Level 3 plus:</strong></td>
<td><strong>Start syndromic surveillance robocalls</strong> in adjacent S’s</td>
<td><strong>Declare adjacent S’s to be in Level 2</strong></td>
<td><strong>Emphasize health &amp; relief response</strong></td>
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<td></td>
<td><strong>Level 4 plus:</strong></td>
<td><strong>Survey of recovered</strong></td>
<td><strong>District Quarantine</strong></td>
<td><strong>Special expedited helpline for Level 4 S’s</strong></td>
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<td><strong>Level 4 plus:</strong></td>
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<td><strong>Level 4 plus:</strong></td>
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<td><strong>Consider easing lockdown in S based on antigen testing results (continue physical distancing &amp; self-quarantine for high-risk people)</strong></td>
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<td><strong>Level 4 plus:</strong></td>
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<td><strong>Level 3 in adjacent S’s</strong></td>
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<tr>
<th>Physical Distancing Measures</th>
<th>Physical distancing by additional measures (on top of level 1):</th>
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<tr>
<td><strong>Standard health practices (washing, masks)</strong></td>
<td><strong>S-Unit distancing</strong></td>
<td><strong>Isolate</strong> confirmed cases, move severe to ICU</td>
<td><strong>Declare adjacent S’s to be in Level 2</strong></td>
<td><strong>Prepare for expanded medical, food and other needs</strong></td>
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<tr>
<td><strong>Protective Organizational &amp; Management practices</strong></td>
<td><strong>Isolate</strong> confirmed cases, move severe to ICU</td>
<td><strong>Quarantine</strong> confirmed cases and contacts</td>
<td><strong>District Quarantine</strong></td>
<td><strong>Draw on dedicated external and internal support - e.g. army, volunteers</strong></td>
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<tr>
<td><strong>Light physical distancing measures</strong></td>
<td><strong>Enact enforcement &amp; protection</strong></td>
<td><strong>District Quarantine</strong></td>
<td><strong>Consider easing lockdown in S based on antigen testing results (continue physical distancing &amp; self-quarantine for high-risk people)</strong></td>
<td><strong>Ensure Level 4 S’s needs are being heard and met</strong></td>
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<td><strong>District distancing</strong></td>
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<th>Community Messaging</th>
<th>Community Messaging principles</th>
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<tr>
<td><strong>Consistent with Physical Distancing measures and Community Messaging principles</strong></td>
<td><strong>Public Information on Prevalence</strong></td>
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<td><strong>Level 3 plus:</strong></td>
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<td><strong>Scale up support resources and welfare measures</strong> to address morbidity impact</td>
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<td><strong>Regularly monitor the situation &amp; determine alert level</strong></td>
<td><strong>Prepare contingency plans</strong></td>
<td><strong>Monitor the situation and refine response:</strong></td>
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<td><strong>Based on social mobility data, increase messaging and enforcement if needed</strong></td>
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<td><strong>Use testing data to monitor infection rate &amp; determine alert level</strong></td>
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<td><strong>Use data to assess adverse impacts &amp; target health &amp; socio-economic support</strong></td>
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**Overall Approach**: Target differential, staggered and staged policy response based on three steps:

1. Gather relevant information/evidence → Respond accordingly → Refine the response, based on data and evidence on the impact of policy response

**Glossary of Terms Used & Further Details**

*D = District & S = Smallest geographical unit within district where SOPs can be effectively enforced*: The unit of decision making is assumed to be the district (D) and within that we hope to work at the smallest unit, S, where one can effectively quarantine people. S can be Union Council/Village/along natural boundaries in rural areas and separate cities/neighborhoods/societies in urban areas — this should be determined by D officials given their context.

**Agents & Partners at District:**

<table>
<thead>
<tr>
<th>Smart Testing</th>
<th>Physical Distancing</th>
<th>Community Messaging, Support</th>
<th>Strategic and Operational Decisions</th>
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<tbody>
<tr>
<td>Public Health &amp; Testing</td>
<td>Data Collection &amp; Analysis</td>
<td></td>
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</tr>
<tr>
<td>Health Department</td>
<td>Government IT and Health Departments</td>
<td>District Task Force led by district administration</td>
<td>Overall leadership and coordination by District Administration supported by Law Enforcement Authorities</td>
</tr>
<tr>
<td>Private health clinics, hospitals, labs</td>
<td>Universities, Thinktanks, Research Centers, others</td>
<td>Law Enforcement Authorities including Police, Rangers, Army</td>
<td>Government Agencies – PHED, Education, Food, others</td>
</tr>
<tr>
<td>Existing capacity may be insufficient: draw on other resources (call centers, polio workers, community health workers, students, volunteers e.g. COVID tigers) to meet health sector needs</td>
<td></td>
<td>Government agents at the local level – e.g. Village Health Workers</td>
<td>Businesses – Essential Services, Economic Activity, etc.</td>
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<td>Community Orgs and Volunteers</td>
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<td></td>
<td></td>
<td>Local Organizations – Community Organizations, NGOs, Volunteers</td>
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**Roles and Responsibilities at tiers of government to support policy response:**

- **National**: Provide overall leadership; ensure national level messaging, coordination and enable big data analytics; ensure provision of social safety net.
- **Provincial**: Provide leadership and direct management of districts; build partnerships for data analytics and where possible release data publicly for analysis; declare alert levels across districts; resource health authorities; ensure provision of testing labs, treatment and quarantine facilities at district level, ensure smooth running of essential supplies and functions.
- **District**: This is the key unit for decision-making and implementation. Plan, stress-test, implement and refine district contingency plans for each alert level; define and set up smallest feasible local (S) areas using the criteria and local information, and enable/ensure functioning of S areas; set up testing labs, treatment and quarantine facilities at district level; ensure smooth running of essential supplies and functions.
- **Local**: Implement and monitor physical distancing at S under different alert levels.
**Impact and Health Risk Vectors:** Impact vector provides a sense of how likely a person may become infected/infect others. High impact vector individuals are those with a higher number of contacts during the day, with each contact of longer duration and of the kind where infection risk is high. Health risk vector determines the health risk if a person is infected. This is high for the elderly and those with pre-existing health conditions - the simplest measures for these two vectors would be population density (for impact vector) and elderly fraction (for health risk vector). Both measures can use population census - Table 39 - along with a measure of the physical area) with Census Block/Mauza as the basic unit but can complement this with cell phone data and qualitative information from local agents like Village Health Workers.

**Testing:** For testing we are suggesting drive-through testing or remote testing centers where people can call a central helpline and someone from the center then comes to their location. This also requires that logistics have been planned through trained teams (maybe use the "COVID Tigers" task force) and that teams have sufficient PPE. Wherever feasible, we suggest pooled testing with ideally not more than 4-5 individuals being pooled. Individuals living in the same household/physical space can have their samples pooled and tested together. The average household size in Pakistan is between 6 and 7. For implementing this strategy at the household level, between 4 and 8 samples can be combined.

**Sentinel Surveillance:** Sewage monitoring for COVID-19, by testing sewage samples to detect COVID-19 prevalence. May use the polio network for this since sentinel surveillance is already being done for polio.

**Frontline Workers:** Individuals who have high likelihood of being infected because they are directly working with infected individuals. These include health workers, staff in quarantine facilities, exposed bureaucratic staff, emergency response teams, enforcement officials, supply-chain logistics providers, immigration/border officials, public transport workers, etc.

**Contact Tracing and Testing for contacts of confirmed cases:** Test contacts of confirmed cases in each S in circles of increasing radius, starting with closest/direct contacts. Radius 1: those with whom a person has had extended contact during the past 2 weeks (could be family members or co-workers). Moving outwards in increasing radius, start with Radius 1 and test all; then to one degree removed and test. If there is no infection there, then contact testing may stop; if there is infection, then go to the next radius of contact. In each stage prioritize those who have had the most contact (as determined by frequency and duration of each interaction). An effective data strategy will be required for contact tracing and, where in-person contact tracing is required, workers must be provided PPE.

**Physical Distancing Measures:**
- **Level 1:** Avoid large gatherings > 100 people; Schools open but plan for distance learning, avoid gatherings, assemblies, events; Businesses and shops remain open but emphasize standard health practices and physical distancing; work from home for high health risk/high impact people
- **Level 2:** Avoid large gatherings > 50 people; Close schools, implement distance learning; Restrict all non-essential businesses and shops and production to those that both (i) have small groupings of people (i.e. workers can be put in smaller sub-groups with minimized interaction between them) and (ii) can allow for 6 feet physical distancing; Consider de-densifying industries where feasible (by restricting number and proximity of employees onsite); Implement telework wherever feasible for workplaces; Lockdown high risk clusters; discourage movement in and out of S; **NOTE:** Monitor closely and if infection in S starts spreading despite these measures then tighten them all and bring closer to Level 3 measures
- **Level 3:** More towards full lockdown – ban all large gatherings, schools remain closed, all non-essential businesses, shops closed (only basic needs groceries and pharmacies open, encourage deliveries through trained personnel), all non-essential production activity shutdown (some sectors may be directed towards producing medical equipment, e.g., textile, auto); Quarantine District – allow movement in and out only with proper permission and quarantining
- **Level 4:** Continue Level 3 measures but consider easing the lockdown based on results from antigen testing – those who are vulnerable/high risk continue to practice physical distancing.
Protective Organizational & Management Practices:

- **Working Remotely & Physical Distancing:** Encourage remote work where possible. Avoid large meetings with officers/managers from different agencies present. For unavoidable in-person meetings, ensure that it’s always the same people going to each meeting. Avoid bringing deputies to meetings to take notes for senior officials.

- **Working in Teams:** If working in teams is important, pre-define teams formed at the smallest possible size. Partner people based on specialization and complementarity but also social factors and solidarity. Allow interaction within teams but minimize it across teams. If one member gets infected, the entire team should self-quarantine. Do not re-form teams. Have supervisors only interact physically with each other and front-line workers only with each other.

- **Rewarding Workers:** Adopt measures that make workers more productive and less stressed. Delegate as much authority as is feasible but adopt measures for coordination in real time. Celebrate and reward the bravery of workers confronting the crisis on the front lines and those in the background ensuring things keep running. Provide special access to their families to food and essential services. Announce family package for frontline workers.

- **Promoting Efficiency:** Reduce non-essential paperwork and monitoring of frontline staff. Reduce file work in offices. Scan as much paperwork as possible and make it (securely) accessible online. Allow digital signatures to carry legal weight.

**Quarantine Mechanism:** Quarantine people in immediate radius of infected person immediately; if testing reveals no infection within this group then remove the quarantine restriction; next quarantine people in wider circle of contacts of the infected person; again if testing reveals no infection, remove the quarantine restriction. Whenever possible, encourage patients to quarantine within their homes to prevent draining limited hospital resources. While at home, patients should stay in a private room and use a separate bathroom for 10-14 days. Where families are large and homes are small, to protect family members, put up a screen, or hang a thick cotton curtain from the ceiling to divide the room. If patients walk around, they must do so while wearing a facemask.

**Isolation Protocols:** Isolation is used to separate sick people from healthy people. In isolation stay at home and separate from all family members by using separate bedroom and bathroom facilities. For large families in small homes, to protect family members, put up a screen, or hang a thick cotton curtain from the ceiling to divide the room. If patients walk around, they must do so while wearing a facemask. If the case becomes severe move the patient to hospital/ICU.

**District Distancing Measures:** People within District are not to travel to other Districts with known cases of infection; People entering from other Districts are to self-quarantine for 2 weeks and request a test if they become symptomatic.

**District Quarantine:** Once a district is quarantined, people can only move into or out of the district with proper permissions. Those doing inter-district travel must self-quarantine for 2 weeks and request a test if they become symptomatic. Supply of goods and services (including abatement goods such as soap and sanitizers) must be ensured.

**S-Unit Distancing Measures:** In S’s where cases have been discovered, add stronger measures which discourage movement into and out of the infected S’s; ensure supply of goods & services into infected S places and any issues citizens raise are addressed in a timely manner. Trained teams should be put in place.

**Full Lockdown Mechanism:** Curfew-like situation, people are not allowed to leave homes unless for emergency situations, household and logistics needs are supplied by approved personnel, trained to take precautions.

**Enforcement & Protection Mechanisms:** ■ Attempt to (lightly) enforce policies by having officials check that these policies are being followed and impose possible sanctions if they are not. ■ Need to ensure that police/enforcement teams are trained to (A) form groups that do not mix, and the moment 1 person in the group falls sick, everyone is isolated and (B) they are not overly harsh or physically reprimanding people; this is abusive, not required and may further increase spread of the infection as virus becomes aerosol. ■ The identity of infected persons must not be revealed as they may be at risk. It should also be emphasized that infected...
people are victims and they are blameless. Make sure there is no law & order situation or threats to infected person or their family. This will also improve policy compliance and self-reporting.

**Scale-up of Medical Resources and Welfare Measures:** At Level 4, there needs to be a massive surge in the availability of treatment resources (medical staff, respirators etc. for treatment, perhaps through mobile treatment units) and support measures (welfare, food, economic relief, supply chain logistics) so that people in infected S's are well taken care of and don’t have an incentive to try and leave.

**Preparation and Contingency Plans:** Ensure all relevant actors within and outside government prepare contingency plans; Test preparedness through simulations; Check how effective different communication channels are for sharing information and coordinating within government agencies, across government agencies, between agencies and key players/citizens, etc.; Prepare health and quarantine facilities and ensure PPE and other equipment is readily available; prepare infrastructure and mobilize resources for contact tracing and testing. Engage with the technology sector to find creative solutions for problems such as physical distancing and contact tracing.

**Data to be Collected in addition to Testing data:**
- **Levels 1-4 – Syndromic Surveillance through Robocalls/Chatbot:**
  - Are you experiencing any symptoms?
  - Impact vectors questions, such as, how many people live in your household, how many people do you come in contact with on a daily basis and for how long?
  - Health Risk vectors questions, such as, how old are you, do you have any underlying health conditions?
  - Are you aware of your closest testing center?
- **Additional Questions for Levels 2-4:**
  - Do you understand the physical distancing regulations and the benefits of those? How are you complying with the restrictions?
  - Other Health/Economic Outcomes that may be impacted by isolation: infant/maternal mortality, employment/income
- **Levels 2-4 – Follow-up Phone Surveys:** Surveys of confirmed cases with survey questionnaire (smart testing + economic vulnerability + food insecurity)
- **Levels 2-4 – Social Mobility Data:** Cell Phone records, WhatsApp traces, etc., on infected people and infected S’s (data should be used to ensure physical distancing rules are being followed and should show decreased mobility)
- **Levels 2-4 – Contact Tracing Data:** Use tools such as, call detail records, WhatsApp, and algorithms for contact tracing, (e.g., define contacts using call records and then use tower locations and time stamp to figure out which of these contacts may have shared a physical location at the same time in the past two weeks.)
- **Levels 3-4 – Follow-up survey of the recovered to ensure no re-infection or mutation**
- **Level 4 – Focus on impact of morbidity on households; Differential data at S/D level of morbidity – mortality; Hospital / patient data to understand health sector constraints, resource allocation**

**Community Messaging:**
- **Evidence-based community messaging is key** to keep people informed, promote compliance, encourage good behaviors, and prevent panic
- **Effective Community Messaging:** Maintain trust, promote self-efficacy, share successes, promote social norms, model desirable behavior
- **Educate** people on and operationalize safety: encourage people to wear facemasks, wash their hands frequently, keep distance from others and **ensure safety and calm**, re-assure people that patients will not be punished or held against their will and that they are victims. Celebrate and reward local heroes - public employees, private/NGO workers and citizens who have delivered special services.

- **Public Information on Prevalence:** Keep people informed of the prevalence of infection but do not reveal the identities of infected people, to ensure their safety. Reinforce that infected people are victims and should not be blamed. Inform people not to travel to infected S’s.

- **Public Information on Support:** Emphasize government preparedness, support and welfare, and mitigation measures being taken. If people feel they are taken care of, they will not panic or have the incentive to leave.