

RESPONDING TO COVID

A MOBILITY BASED SURGE CAPACITY FRAMEWORK

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POLICY BRIEF

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ABSTRACT

It would appear, based on the experience over the past year, that at a given point in time, CoVID-19 affects a part of the country and not the whole nation. What does this imply for the sharing of resources between more affected areas and less affected areas? What does it imply for where reserves of resources need to be maintained to meet sudden surges in caseload? This note looks at these questions, by examining the spatial pattern of the epidemic over time and the nature of the resources, i.e., the extent to which their supply can be increased, the ease with which they can be moved, etc., including, where possible and necessary, the movement of patients in addition to mobile resources. Our analysis based on current transmission dynamics, points out that there are a small set of areas permanently at risk for repeat surges. These are areas where health infrastructure may need to be augmented locally. For other areas, while increases in health infrastructure would be needed, inter-district and inter-state coordination can ensure that additional critical services can be made available through resource sharing. However, such a mobility-based surge capacity framework, as we have proposed, requires enabling governance structures that builds trust and facilitates coordination across district and state administrations, based on real time data analysis as well as formal institutional structures.

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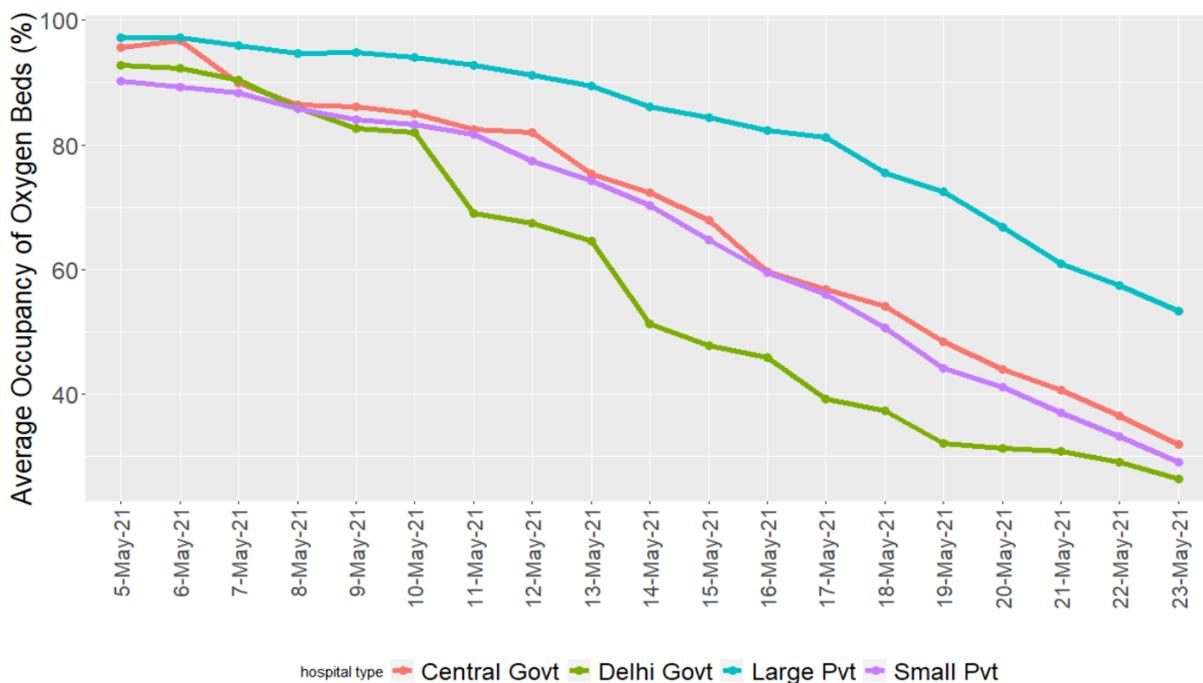
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I. INTRODUCTION

Between April 1st and May 23rd 2021, the situation in the city of Delhi changed from a significant shortages of hospital beds, critical care equipment, oxygen, medicines and doctors to vacant beds and excess capacity as the surge abated. Figure 1 (from Sheikh 2021) shows just how rapidly demand declined; for large private hospitals, utilization went down from close to 100% to below 60% in an 18-day period; the decline from 90% to 30% for Delhi government hospitals over the same period was even more dramatic. As Delhi limps back to normalcy, the city will have an abundance of resources, at least until the next surge. Meanwhile infections are beginning to spread in newer states and rural areas, and some will face the very same crisis Delhi confronted, with far less resources.

Delhi's experience, if repeated, illustrates that capacity will have to increase three to four-fold to meet Covid-19 demand in a very short period. But if this capacity is *used only at and by one area*, much of it will remain unused once the immediate surge has died away. Managing that short-term increase in demand successfully requires that all those who need appropriate care receive it within the time necessary to minimise the possibility of adverse outcomes. This brings together two critical and interrelated challenges that we call the 'surge elasticity' and the 'mobility premium'.

Figure 1: Average Occupancy of Oxygen Beds for COVID Patients by Hospital-type in Delhi, May 5 to May 23, 2021¹



Note: Large private hospitals have 50 or more oxygen beds and small private hospitals had less than 50 oxygen beds allocated for CoVID patients. Data from <https://coronabeds.jantasamvad.org/oxygen-beds.html>

1. Sheikh, Shahana (2021) Examining Patterns in Oxygen Supply at Delhi's Hospitals – A Follow-up Wire Science 26 May <https://science.thewire.in/health/examining-patterns-in-oxygen-supply-at-delhis-hospitals-a-follow-up/>

We think of surge elasticity within the health system as its ability to increase the availability of resources within a given area. This can be by increasing production, drawing on reserves, or importing from other locations, foreign or domestic. We think of the mobility premium as the ability of the health system to meet a spatially varying demand for health resources, as the virus travels through the country. If cities, districts and states surge at different points in time, health capacity at a location need not be fixed—it can also vary over time across geography. This note discusses each of these two aspects of our health system.

We highlight that the issues in this note only address the supply response, taking the number of cases as a given. As is well known, managing the pandemic requires both supply response to tackle surges and demand management responses, such as masking, physical distancing and containment measures, that dampen the surge. In the early days of the second surge, there was limited reliance on demand management, which may have exacerbated the problem. We do not address this issue here but recognise its very essential role in pandemic management.

II. COVID-19 SPATIAL AND TEMPORAL PATTERNS

To understand the relative role of mobility and surge elasticity, we need to understand the spatial-temporal aspects of the Covid-19 pandemic as it has manifested in India. Using district-level data on Covid-19 positive cases from the beginning of the pandemic till May 15th, which represents the peak of the second wave, we present two headline findings from our analysis.

2.1. Permanently at Risk Districts

We first analyze the propensity of locations that were hit by the first wave to be hit again during the second wave. A standard epidemiological model based on herd immunity, combined with the fact that seroprevalence studies in cities like Mumbai and Delhi suggested that upwards of 50% of the population living in very dense

slum locations had been infected during the first wave² would suggest that these areas had at least some form of limited immunity and were thus unlikely to be subject to a second surge. Alternatively, models of immune escape variants (such that past immunity conferred limited protection), or simply recognizing that a sizeable fraction of the population remained vulnerable, despite high seroprevalence in some areas of the city, would suggest that the past characteristics of these locations could make them vulnerable to future attacks.

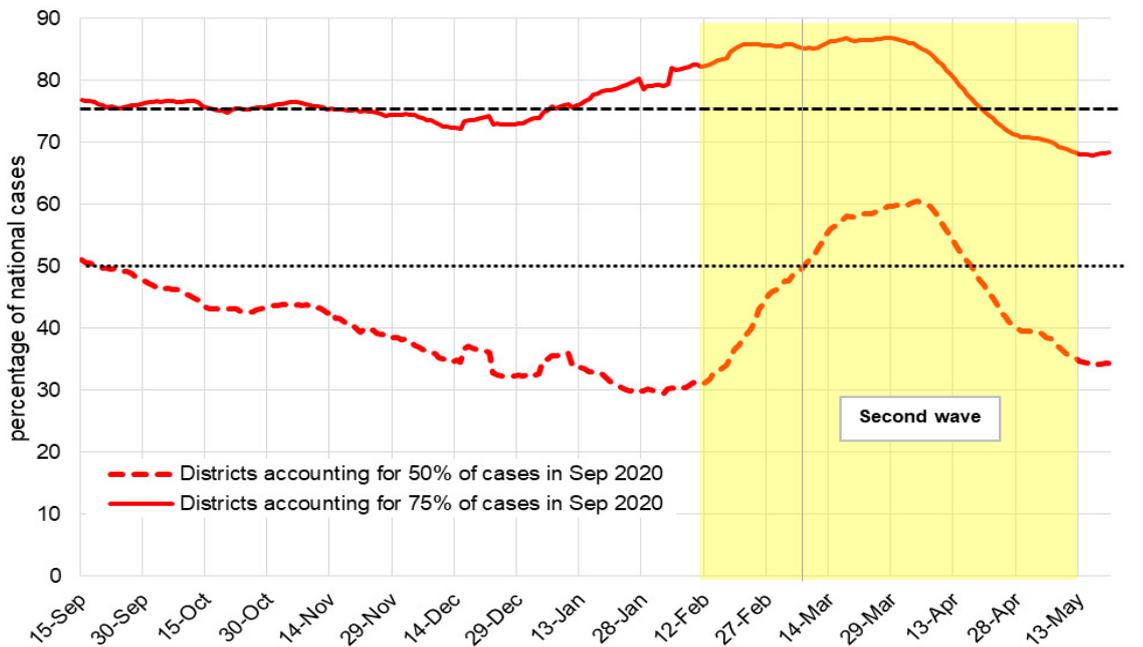
Figure 2 takes the 145 districts that were responsible for 75% of the cases towards the end of the first surge (September 9th to September 15th, 2020) and tracks the share of cases attributable to those districts over time. We find that the pandemic has been revisiting its old places. During the first two months of the second wave from mid-Feb to mid-April, these 145 districts from the first wave accounted for more than 80% of the new cases. With the benefit of hindsight, if we had focused on these districts, we may have been able to nip the epidemic in the bud. One could argue that roughly one-fifth of India's districts is still a large number of districts for an intensive effort. However, even if we considered just 45 districts that were responsible for 50% of the cases during the end of first surge, it still would have been possible to capture 50% to 60% of the cases during the second surge. Thus, earmarking reserves in these districts (6% of all districts in India) would have given us a head start in managing the pandemic. We regard these 45 districts as the 'permanently at risk' or PAR districts: These PAR districts are those where special resources need to be expended to track and detect potential surges at an early stage. We have presented the list of these 45 districts and their case shares in the first and second wave in Appendix 1.

2.2. Changes over Time

We then analyze how transmission dynamics change over time. In April 2021 as seen in Figure 3a & 3b, low case, low growth districts are few and far between, though there are some opportunities in Odisha, in Punjab and in Rajasthan. As the surge peaked in different locations, experiences started diverging. For instance, As Maharashtra moved from high case, high

2 See Malani, Anup, Daksha Shah, Gagandeep Kang, Gayatri Nair Lobo, Jayanthi Shastri, Manoj Mohanan, Rajesh Jain et al. "Seroprevalence of SARS-CoV-2 in slums versus non-slums in Mumbai, India." *The Lancet Global Health* 9, no. 2 (2021): e110-e111. accessed from [https://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(20\)30467-8/fulltext](https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(20)30467-8/fulltext)

Figure 2: Share of Cases in Districts that surged in the First Wave



Source: covid19india.org and author analysis

growth situation to a slowing of growth, north east and coastal Karnataka moved from a low growth to a high growth situation. The same is true for Delhi, even as its neighborhood remains stressed.

These two figures emphasize the point that there are two very different types of districts that have emerged in the pandemic. The first are the PAR districts,

which account for the bulk of cases in *both waves*; the second are districts that become more affected as a surge progresses, but ultimately account for a smaller proportion of the total. We do not attempt to isolate the reasons why this is so — it could be epidemiological or it could be driven by policy if a surge in the PAR districts leads to state-wide adoption of non-pharmaceutical interventions, such as lockdowns.

Figure 3a: Case Levels and growth (April 1 to 30 2021)

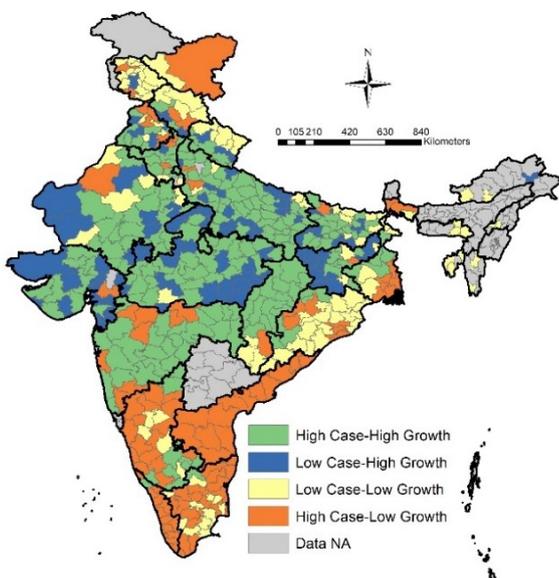
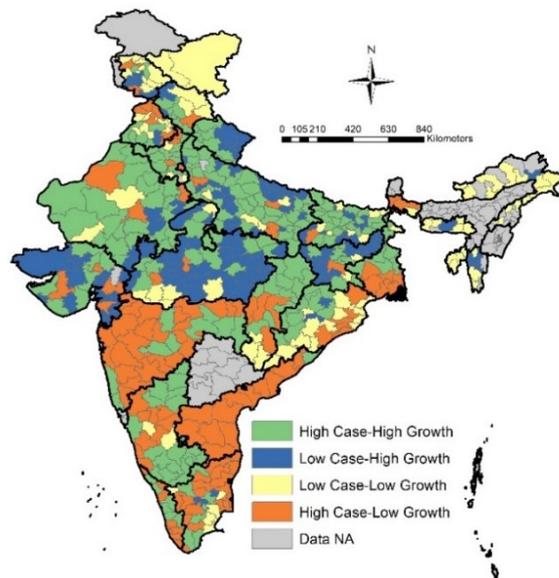


Figure 3b: Case Levels and Growth (April 15 to May 15 2021)



Note: High case (growth) are those districts where the number of cases (daily growth of cases) are more than the median for the period. The grey areas indicate those for which data was not available or where the number of cases was less than 100 for the period.

2.3. Benefits of Resource Mobility

Given these two different types of districts, we can then ask what the maximal benefit of resource mobility might be. Table 1 presents a simple hypothetical framework. Here, we have shown 3 districts at 3 times. District A is permanently at risk, and shows high caseloads throughout; District B surges in consort with District A, but District C is out-of-phase and surges at the end, when cases in Districts A and B have abated. We can then ask what capacity would have to be without any mobility of resources. Since all resources would have to be met by installed capacity within the district, District A would need 60 beds to meet its maximal need in Month 2; District B would need 30 beds in Month 2 and District C would need 60 beds in Month 3, i.e., we would require a total of 150 beds.

We can also ask, instead, what capacity would look like with costless mobility, which allows resources to be shifted from lower to higher case-load districts at their time of need. This is the maximum number of beds required at any given time across all districts, which is 100 in this case. In our example, perfect mobility would decrease fixed investment requirements by 50% because in Month 3, capacity is shifted away from Districts A and B to meet the surge in District C (or alternatively patients are shifted to District A or B). This is the theoretical minimal capacity required. In actual situations, the minimal capacity would be more, since actual reallocation would be costly, so, some excess capacity is optimal.

Interestingly, when we look at the actual data across all Indian districts, the patterns are similar to our hypothetical Table 1. During the existing surge between April 1 and April 30, the ratio of bed requirement under 'no mobility' would have been 50% higher than under the assumption of perfect mobility. This difference is not small and represents considerable potential savings, but is perhaps not as large as we would expect from a model of pandemics that starts in one place and then spreads out evenly.

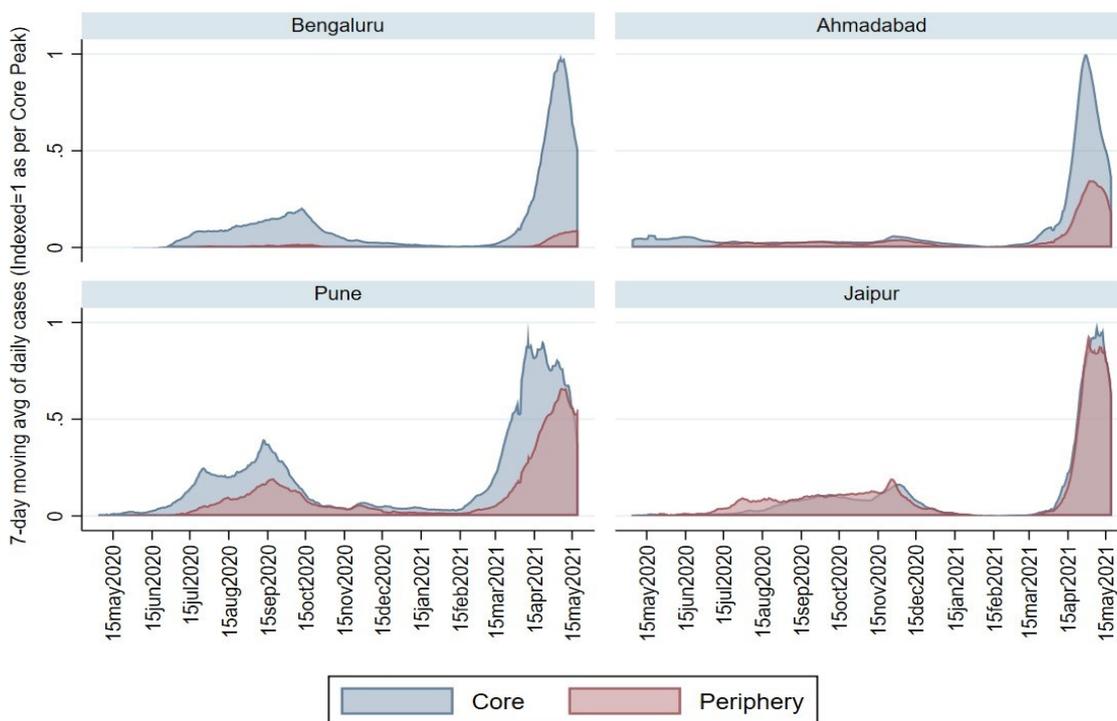
A closer look at the four cities of Bengaluru, Ahmadabad, Pune and Jaipur shows why this may be. In a city like Jaipur, the main district and the 5 other districts surrounding it surge together, affording virtually no benefits to mobility across these districts. In Bengaluru, the surrounding districts have not surged at all, so the entire capacity increase is required in the metropolitan area alone; it is only Pune where there is clear evidence of an out-of-phase surge, with the main city surging first, followed by a 2-week lag for its surrounding districts. The coordination of policies, the geographical clustering of cases, and the phased introduction and fade-out of the pandemic all suggest that a policy of full mobility would allow us to install fewer beds compared to increasing capacity in each district to individually meet the surge on their own. However, the extent of this 'capacity saving due to mobility' appears to vary by state and location.

To be sure, there are limitations to this analysis. We only have data on the number of cases by district and we are therefore assuming both that the ratio of hospitalizations to cases is similar across districts *and* that testing has been evenly distributed. Even if our first assumption is correct, the second one is almost surely wrong; peak demand has been truncated since cases have been limited by testing capacity, hospitalization by bed availability, and recording of deaths by many reasons, including lack of hospitalization. To the extent that this has happened more in rural districts, but asynchronously, we will underestimate the mobility premium. This is because if there are more cases in these districts than have been recorded, but if the cases are peaking at a different time from that of other districts, then the value of mobility in making on-time resources available in the affected districts is even higher.

Table 1: The benefits of mobility: A hypothetical example

District	Beds: Month 1	Beds: Month 2	Beds: Month 3	Bed requirement: No mobility
A	50	60	20	60
B	10	30	10	30
C	10	10	60	60
Total bed requirement	70	100	90	

Figure 4: Four metropolises and their surrounding districts



Source: covid19india.org and author analysis

III. COVID-19 SURGE PATTERNS

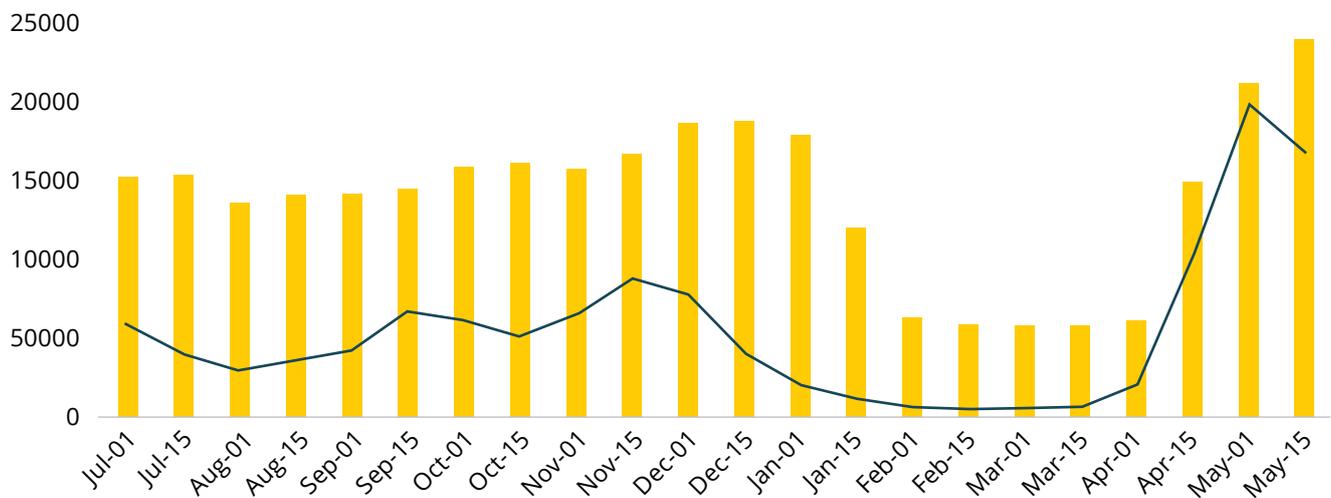
The alternative to moving resources across districts is to build up surge capacity *within* the district, which is probably necessary in the 45 PAR districts.³ To understand surge elasticity better, Figure 5 illustrates bed capacity add utilization, using data from Delhi's health Bulletin. Here, we show the total number of beds (bars) and bed occupancy (solid line) in the city starting from July 1, 2021 through May 15, 2021. There are several noteworthy features.

First, between July 1 and November 1, bed availability remained at 15,000 but occupancy hovered around

5000, at 33%. For comparison, average bed utilization in hospitals in the United States runs at around 65%. Then, from November 1 to December 1, there is a small surge in bed occupancy and an immediate increase in the number of beds, keeping utilization well below 50%. From there on, bed occupancy declines substantially and by January 1, the system is running at well over 80% excess capacity. These changes in bed capacity are largely internal to Delhi, in that it is not drawing upon resources from other areas to increase this capacity, except to some extent, capacity provided by facilities put up by the armed forces.

³ In a hypothetical third wave, the PAR districts may be spared for exactly the reason that they were expected to be spared in the second wave – herd immunity. But, we think that there is substantial unvaccinated and uninfected population still in these districts such that they remain vulnerable.

Figure 5: Number of total and occupied hospital beds in Delhi



Source: Data from Government of National Capital Territory of Delhi Health Bulletin COVID-19, various issues

Delhi then made the fateful decision to reduce the surge capacity, dramatically shrinking the number of beds from close to 20,000 at the beginning of the year back to its usual capacity of just above 5,000 at the beginning of February. For all of February and March, the decision appears to have paid off as capacity remains below 33% even as of March 15, but then it started increasing rapidly, as occupancy went from 33% to 90% in the first three weeks of April even as available beds tripled. This rapid increase in bed capacity from around 6,000 to more than 20,000, is very impressive⁴ but still insufficient in light of a ten-fold increase in cases, leading to thousands of people dead and devastated by the experience of 24-hour, often fruitless searches for oxygen and beds. Ultimately this is an example of the limitations of supply response and the need for early demand management measures.

The basic fact of the matter is that no system can either afford to put in fixed capacity that can successfully meet such a surge as more than 90% of

that augmented system will remain unused in normal times adding enormous expenditure to the health budget of the state. Further, while certain locations like Delhi and Mumbai can indeed build bed capacity in an impressively short time, doing so in a way that maintains the quality of care, for instance, by adding healthcare workers to the system is a much harder task, as is adding oxygen capacity, which is a necessary resource in this pandemic. So, even as more beds were put in, the number of doctors, nurses and oxygen remained a limiting factor in the care of patients. The experience of Delhi suggests that no system can hope to meet the requirements of such a rapid surge successfully without substantial advance planning and some sharing of resources. Arguably, even if demand management measures (which are also costly in terms of both fiscal revenue and more importantly, individual livelihoods) were in place, there would have been a need to increase supply rapidly. The question then is what can be done.

⁴ It is worth highlighting that the surge in bed capacity that Delhi accomplished is unprecedented—for instance, in the similar surge in New York City, bed capacity was increased by 50%, not the 3.5X we see in Delhi.

IV. THINKING OF CAPACITY

From the above discussion, it is clear that mobility and increase in capacity are both needed to meet the demands of a pandemic when there is a surge. Not all areas have the ability to increase capacity. For instance, large cities can add beds faster than other places, medicines and oxygen are produced at certain locations and moving some resources is easier than others. Finally, the greater the geographical area of coverage, the more efficient the resource sharing as surge-risk is more widely distributed. Therefore, the benefits of resource sharing are higher, if it is possible across state boundaries, as seen in Figure 3.

A simple scheme, presented in Table 2, is useful to organize our thoughts. Here, we have divided resources by their mobility costs and by their supply elasticity. For instance, concentrators, beds and medicines have both low mobility costs and high elasticity: they can be moved easily from one place to another and the overall supply can be increased by manufacturing and importing. On the other hand, ICU units have both high mobility costs and inelastic capacity—they cannot be moved and the overall supply cannot be rapidly augmented. Health workers are an interesting category in their own right: they are inelastic in the medium-run as we cannot train thousands more in a month, but they are *potentially* highly mobile; it should be possible to move doctors from one district hospital to another for short periods as required. Planning will require that resources with low mobility costs are kept in fewer locations, while those with high mobility costs need to be more evenly distributed. Similarly, identification of inelastically supplied resources need to be completed and contingent allocations made well before the eventuality arises.

This supply-side mobility also needs to be further augmented by mobility of patients – a spatial redistribution of demand, as it were. Within reasonable distances, it may be more effective to increase the supply of structured transportation to bring *patients* to care in a hub-and-spoke model rather than bring the care to the patient. We now discuss each of these in turn.

Mobility of Equipment: There are two issues that bear highlighting here.

Some forms of equipment are more mobile and require fewer complementary resources than others. For example, an oxygen concentrator can be moved quite easily and may be used by individuals without specialized medical training. However, while an ICU setup can also be moved, it is far more difficult to transport and, more importantly, needs complementary resources like specifically trained doctors, nurses and an ample supply of oxygen. There have been a number of news reports where such equipment could not be put to use due to lack of qualified healthcare personnel.

The other issue is ownership. Mobility of resources requires the consent of the owner. In the case of equipment, the ownership could be public or private, both individual and institutional. Moving public and private institutional resources is feasible with prior agreements, since the number of decision makers are few, but individually owned equipment, such as oxygen cylinders and concentrators, may be difficult to move – this could perhaps be left to the ingenious devices of civil society networks and the generosity of individuals, both of which have been on ample display during this pandemic.

Table 2: Classification of Supply-side Resources needed to address the pandemic

	Elastic Capacity	Inelastic Capacity
Low Mobility Costs	Concentrators, Beds, Medicines	Doctors, Nurses
High Mobility Costs	Oxygen	ICU Units

Mobility of Human Resources: Human resources are a critical bottleneck for any surge planning as we cannot augment national capacity during the course of a pandemic. However, it is useful to consider the following.

First, the induction of “almost-trained” final year medicine and nursing students as part of the workforce can help. This is already under process, as is the thinking of how to use retired medical personnel in the case of a surge, but it is likely a strategy that will add healthcare workers only in urban areas, though retired nursing personnel may be more widely distributed.

The second proposal is through task-shifting. A little-known fact about India’s rural healthcare system is that more than 70% of our primary care is provided through by providers who have little formal training, but the trust and respect of the community.⁵ Although the quality of care varies, studies consistently find that these providers are able to successfully manage many illnesses in the rural setting, and further, can be trained to do better.⁶ Even in urban areas, studies that have mapped out the full provider population (for instance in Mumbai) typically find that 50% are either AYUSH or informal providers.⁷

It is possible to train workers to perform basic functions, for example, to provide low-flow oxygen in a relatively short time. This will allow a number of patients to be taken care of outside a formal hospital setting in field-like environments under the supervision of doctors – an important consideration as the pandemic takes root in rural India. Building on the example of the Liver Foundation in West Bengal, it

may be possible to augment human resources by using the extensive healthcare workforce in the informal sector. This would also apply for other tasks that are more administrative, e.g., record-keeping as well as a key function – maintaining a line of communication between the patient and the patient’s family. The lack of such communication often inhibits people from accessing institutional care, until it is too late. Other paramedical workers can be trained in measuring oxygen saturation and temperature for instance and linked to a wider tele-medicine network that could ensure that treatment is provided to mild/ moderate patients in need of home care. Finally, this workforce can also be mobilized to assist in running rural vaccination camps.

The third possibility is to move healthcare workers to surging areas for short periods of time. For this to be possible, the conditions of service need to allow this: For instance, it has to be possible for a doctor from Gujarat to serve in Madhya Pradesh. One possible work-around is to issue a call for volunteers, possibly augmented with additional compensation from the receiving location, such as a temporary duty allowance.

Mobility of Patients: The third leg of mobility is moving patients from where they are to where they can get care. This is important for two reasons. First, moving COVID-19 patients early in their infection does not require specialized transportation⁸. Mumbai, for instance, has moved patients, using standard SUVs. Such transportation is easy to procure and provide (especially if they are not ambulances) but this capacity is very limited at this time. Thus, there is an element of triage, in that patients predicted to need more intensive

5 See Das, Jishnu, Benjamin Daniels, Monisha Ashok, Eun-Young Shim, and Karthik Muralidharan. “Two Indias: The structure of primary health care markets in rural Indian villages with implications for policy.” *Social Science & Medicine* (2020): 112799. <https://www.sciencedirect.com/science/article/pii/S0277953620300186>

6 See Chowdhury, Abhijit, Jishnu Das, Reshmaan Hussam and Abhijit V Banerjee (2016), “The impact of training informal health care providers in India: A randomized controlled trial”, *Science*, 354(6308) <https://economics.mit.edu/files/12110> and also <https://www.hindustantimes.com/cities/kolkata-news/bengal-to-use-quacks-as-first-line-of-defence-against-covid-19-101620285651026.html>

7 Shah, Daksha, Shibu Vijayan, Rishabh Chopra, Jyoti Salve, Ravdeep Kaur Gandhi, Vaishnavi Jondhale, Praveen Kandasamy, Sudip Mahapatra, and Sameer Kumta. “Map, know dynamics and act; a better way to engage private health sector in TB management. A report from Mumbai, India.” *Indian Journal of Tuberculosis* 67, no. 1 (2020): 65-72. <https://www.sciencedirect.com/science/article/abs/pii/S0019570719302306>

8 Previous work has shown that the 108 ambulance system played a key role in reducing infant mortality See Babiarz, Kimberly S., Swaminatha V. Mahadevan, Nomita Divi, and Grant Miller. “Ambulance service associated with reduced probabilities of neonatal and infant mortality in two Indian states.” *Health Affairs* 35, no. 10 (2016): 1774-1782. Accessed from <https://www.healthaffairs.org/doi/full/10.1377/hlthaff.2016.0564>

care, e.g., those older and with co-morbidities, would need to be moved before they become critical. Moving a critical patient is a much more complex exercise needing expensive specialized resources.

Second, the fear of Covid-19 means that regular means of transport are not usually available to patients. Transport has to be dedicated and the transport worker suitably trained and informed. It is near impossible, for instance, for someone in a village to call an ambulance to take them to a CoVID hospital without such dedicated local resources. Indeed, even in places like Delhi, patients were substantially overcharged for transportation, owing to its scarcity.

V. INSTITUTIONAL MECHANISMS

How to manage surges, especially in the PAR districts requires considerable attention to data, planning and ex-ante agreements that are agreed upon *prior* to the surge. Here, it is important to ensure that areas that agree to share do not regret it later, i.e., they are not short of resources when they need it. Ensuring this no-regret principle implies considerable co-ordination because the arrangement is not bilaterally reciprocal, i.e., the giving area (district/state) does not necessarily receive resources back from the same district or state that it gave to; it could be supported from another area that does not require the resources at that time. There is thus a need for a multi-locational co-ordination mechanism, that is in place, ex-ante. This is the governance element of a mobility-based surge capacity framework.

Given that resources are controlled not by district administrations, but by state governments, their involvement is of paramount importance. There needs to be an inter-state platform for decision makers at the highest level (political and administrative) to deliberate and negotiate resource allocation. India does have a history of some institutions that perform this function through inter-state dialogue. The Finance Commission and the GST council are two important examples. In this context, it is interesting to note that when there

was a surge in the national capital region, the NCR Planning Board – a high-powered body composed of the chief ministers and the senior bureaucrats of each state and the Union minister for urban development – was not activated as a forum to tackle the crisis at regional scale

Going forward, one institutional mechanism that could be deployed for this purpose is NITI Aayog's Chief Minister's sub-group structure. The sub-group model could be adapted to create a special COVID inter-state council. NITI Aayog could serve as the secretariat for the council working closely with administrators through the network of health secretaries and State Chief secretaries. This council's primary function would be to build trust and coordination between States, enabling states to accurately assess health capacity needs and arrive at a consensus formula for sharing resources. Doing this right will require the buy-in of the Ministry of Health and Family Welfare. The MoHFW should serve as the nodal authority to coordinate administration of resources between States. An alternative could be for the National Disaster Management Authority (NDMA) to serve as the secretariat with the inter-state council being set up within the NDMA. In the long term, this ought to be institutionalized via the inter-state council.

Another possible mechanism for building mobility albeit at a smaller scale is through the network of aspirational districts. The NITI Aayog can build a mobile, intrastate health systems network amongst the aspirational districts within a state, linking them through the state nodal officer to the State health department. NITI Aayog could also develop a real time inter-operable data base across the network of aspirational districts to allow for data sharing on COVID resources across districts and create a district specific platform for coordinating resource transfers across districts.

Increasing resource mobility in the midst of a disaster is difficult—we need to set up the institutional mechanisms to do so when the need is the least, precisely so that the deliberation and negotiation are not carried out at a time of great need.

VI. CONCLUSION

Over the next few months (and possibly years), India will need to confront the challenge of building surge capacity within the health system. This is essential for managing the current wave as it travels to rural India but also in the medium term for future waves of the pandemic. As we have demonstrated in this note, building surge capacity requires building infrastructure locally in some areas while others can be re-allocated across districts and states. Specifically, our analysis points out that there are a set of 45 *permanently at-risk* districts that have experienced repeat surges. These are areas where health infrastructure may need to be augmented locally. For other areas inter-district and inter-state coordination can ensure that critical services are made available through resource sharing. A mobility-based surge capacity framework, as we have

proposed, requires enabling governance structures that builds trust and facilitate coordination. Real time data analysis is the foundation of such a structure. In this spirit, this note proposes the setting up of an inter-state coordination body akin to the NITI Aayog Chief Ministers' sub committees. It also proposes the creation of a network of the aspirational districts that can enable district-district coordination.

COVID 19 has presented India with unprecedented challenges. Beating the second wave and preparing for future surges requires us to deploy all that we know about India's health system about the pandemic and about our governance systems to identify innovative solutions. This note is one small contribution in that direction.

APPENDIX 1

Name	State/UT	Share of cases Sep 9 to 15	Share of Cases April 14 to 16	Population in 2011 (mn.)	Share of Urban Population 2011	Share of Urban Population in Million plus cities
Delhi (all districts)	NCT of Delhi	4.7%	8.4%	16.8	98%	70%
Pune	Maharashtra	4.7%	4.5%	9.4	61%	84%
Bangalore	Karnataka	3.3%	4.5%	9.6	91%	97%
Thane	Maharashtra	2.9%	3.4%	11.1	77%	64%
Mumbai & Mumbai Suburban	Maharashtra	2.4%	4.2%	12.4	100%	100%
Nagpur	Maharashtra	2.1%	3.1%	4.7	68%	76%
East Godavari	Andhra Pradesh	1.6%	0.3%	5.2	26%	0%
Nashik	Maharashtra	1.4%	2.1%	6.1	43%	57%
West Godavari	Andhra Pradesh	1.2%	0.0%	4.0	20%	0%
Lucknow	Uttar Pradesh	1.1%	2.7%	4.6	66%	93%
Raipur	Chhattisgarh	1.1%	2.3%	4.1	37%	69%
Sangli	Maharashtra	1.1%	0.4%	2.8	26%	0%
Prakasam	Andhra Pradesh	1.1%	0.2%	3.4	20%	0%
Chennai	Tamil Nadu	1.1%	1.2%	4.7	100%	100%
Jalgaon	Maharashtra	1.0%	0.4%	4.2	32%	0%
Raigarh	Maharashtra	1.0%	0.7%	2.6	37%	0%
Satara	Maharashtra	1.0%	0.6%	3.0	19%	0%
Chittoor	Andhra Pradesh	1.0%	0.4%	4.2	29%	0%
Sri Potti Sriramulu (Nellore)	Andhra Pradesh	0.9%	0.1%	3.0	29%	0%
Ahmadnagar	Maharashtra	0.8%	1.3%	4.5	20%	0%
Kolhapur	Maharashtra	0.8%	0.2%	3.9	32%	0%
Guntur	Andhra Pradesh	0.8%	0.3%	4.9	34%	0%
Khordha	Odisha	0.7%	0.2%	2.3	48%	0%
Aurangabad	Maharashtra	0.7%	0.6%	3.7	44%	73%
Solapur	Maharashtra	0.7%	0.5%	4.3	32%	0%

Name	State/UT	Share of cases Sep 9 to 15	Share of Cases April 14 to 16	Population in 2011 (mn.)	Share of Urban Population 2011	Share of Urban Population in Million plus cities
Srikakulam	Andhra Pradesh	0.7%	0.3%	2.7	16%	0%
Y.S.R. (Cuddapah)	Andhra Pradesh	0.7%	0.1%	2.9	34%	0%
Mysore	Karnataka	0.7%	0.2%	3.0	42%	0%
North 24 Parganas	West Bengal	0.6%	0.7%	10.0	57%	0%
Kolkata	West Bengal	0.6%	0.8%	4.5	100%	100%
Vizianagaram	Andhra Pradesh	0.6%	0.1%	2.3	21%	0%
Anantapur	Andhra Pradesh	0.6%	0.1%	4.1	28%	0%
Thiruvananthapuram	Kerala	0.6%	0.3%	3.3	53%	0%
Kanpur Nagar	Uttar Pradesh	0.5%	0.6%	4.6	66%	92%
Visakhapatnam	Andhra Pradesh	0.5%	0.2%	4.3	47%	85%
Krishna	Andhra Pradesh	0.5%	0.1%	4.5	41%	62%
Kurnool	Andhra Pradesh	0.5%	0.2%	4.1	28%	0%
Coimbatore	Tamil Nadu	0.5%	0.3%	3.5	76%	40%
Jammu	Jammu & Kashmir	0.4%	0.1%	1.5	50%	0%
Dehradun	Uttarakhand	0.4%	0.4%	1.7	56%	0%
Allahabad	Uttar Pradesh	0.4%	0.8%	6.0	25%	79%
Ranchi	Jharkhand	0.4%	0.6%	2.9	43%	85%
Cuttack	Odisha	0.4%	0.1%	2.6	28%	0%
Bellary	Karnataka	0.4%	0.1%	2.5	38%	0%
Dakshina Kannada	Karnataka	0.4%	0.1%	2.1	48%	0%



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