

The background of the entire page is a photograph of a large cable-stayed bridge with two tall pylons, set against a clear blue sky. The bridge spans across a body of water with white-capped waves. A red line graph is overlaid on the image, showing a fluctuating trend that peaks sharply on the right side. The text is centered in the lower half of the image.

TURNING THE TIDE

IS MUMBAI READY FOR THE NEXT WAVE?

SAYLI UDAS-MANKIKAR
LEAD AUTHOR

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RAMANATH JHA, JYOTI SHELAR, DHAVAL DESAI, SHASHIDHAR KJ, ADITI RATHO

CONTRIBUTING AUTHORS

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Observer Research Foundation

20 Rouse Avenue, Institutional Area

New Delhi 110002, India

contactus@orfonline.org

www.orfonline.org

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EXECUTIVE SUMMARY



A roadside wall mural depicting medical staff as frontline COVID-19 warriors in Mumbai on 21 March 2021.

(Photo by INDRANIL MUKHERJEE/AFP via Getty Images)

‘Turning the Tide: Is Mumbai Ready for the Next Wave?’ traces the intricacies of managing the COVID-19 pandemic in the city. It captures **lessons and learnings** from existing innovations and hurdles encountered during the first two waves of the pandemic and presents factors to reimagine Mumbai’s response to a potential third wave.

MUMBAI’S unique health service delivery system is led by the Municipal Corporation of Greater Mumbai (MCGM) and aided by a robust private hospital network. The COVID-19 pandemic forced the Mumbai health system to undergo rapid adaptation and transformation to combat its impacts.

The city’s first case was recorded in March 2020, and its first wave peaked in September 2020 and flattened by January 2021. A second wave hit in March 2021, peaking in April. Based on past pandemic patterns, the findings of Mumbai’s four rounds of sero-survey, and global examples, the possibility of the third wave cannot be ruled out. While vaccination is the only viable solution to this crisis, only 13.7 percent of Mumbai’s above-18 population have been fully vaccinated and about 38 percent has received the first dose (as of 7 July 2021). The city’s estimated adult population is over 9 million.

‘Turning the Tide: Is Mumbai Ready for the Next Wave?’, a report by Observer Research Foundation (ORF) Mumbai, traces the intricacies of managing the COVID-19 pandemic in the city. It captures lessons and learnings from existing innovations and hurdles encountered during the first two waves of the pandemic and presents factors to reimagine Mumbai’s response to a potential third wave.

The report looks at the specifics of the first and second wave, detailing lessons learnt from issues related to oxygen, and medicine supply and vaccination. It also considers hidden groups—migrants, crematorium and graveyard staff, and ASHA workers—who bore the brunt of the crisis.

Further, it details other crucial aspects of COVID-19 management—technology and

The character of Mumbai's second wave differed greatly from the first. **Infections moved from the slums, such as Dharavi** (which was badly impacted in the first wave), to more affluent areas; hit the younger population; and **spread faster, leading to oxygen and medicine shortages**. The circulation of new variants and a drop in social vigil fueled the second wave.

the associated challenges; the importance of the Mumbai Metropolitan Region (MMR) in fortifying the city; and learnings from global successes in pandemic handling.

'Turning the Tide' is an attempt to complement the existing research in dealing with the pandemic. Deliberations with over 20 government, medical, tech and media experts, along with a study of media reports and government communication formed the basis of this analysis. Important learnings were also drawn from the MCGM's June 2021 report titled 'Principles of Medical Management of COVID-19: The MCGM Experience' that acts as a guide for medical practitioners involved in pandemic management.

THE FIRST AND SECOND WAVES

The character of Mumbai's second wave differed greatly from the first. Infections moved from the slums, such as Dharavi (which was badly impacted in the first wave), to more affluent areas; hit the younger population; and spread faster, leading to oxygen and medicine shortages. The circulation of new variants and a drop in social vigil fueled the second wave.

In addition to physical health infrastructure, the handling of the pandemic revolved around two aspects—testing, tracing, tracking, quarantine and treatment; and setting up decentralised digital ward-level 'war rooms' for hospital bed and patient management (in what came to be known as the Mumbai model).

THE VACCINATION IMPERATIVE

Vaccination is the most critical aspect of the fight against COVID-19. The inclusion of private hospitals in the vaccination programme has improved Mumbai's inoculation capacity. On 28 June 2021, Mumbai vaccinated 1,80,821 individuals, the highest single-day count.

LEARNINGS FROM MUMBAI'S EXPERIENCE WITH THE FIRST TWO WAVES

COVID-19-appropriate behaviour is vital and public campaigns for awareness should continue and be scaled up.	There should be no decline in testing, especially in areas reporting spikes. Data on home-based antigen testing needs to be linked to the ward level monitoring system.
Ward-level surveillance teams should track spurts and genome sequencing must be intensified.	Training primary and secondary care doctors, para-medical staff, and ASHA and anganwadi workers is vital, as is increasing the intake in medical and nursing colleges.
MCGM should improve its home isolation care by connecting patients with doctors through video consultation. More private doctors should be hired and linked to war rooms for triaging and patient management at home.	Tele-ICUs and tele-wards should be set up to handle growing patient load.
Oxygen tankers and ambulances must be GPS-tagged to track their real-time movement.	All large hospitals must establish private oxygen generation plants.
	Requirements for medicines and special facilities for pediatric care should be adequately assessed and addressed.

In addition to physical health infrastructure, the **handling of the pandemic** revolved around **two aspects—testing, tracing, tracking, quarantine and treatment**; and setting up **decentralised digital ward-level 'war rooms'** for hospital bed and patient management (in what came to be known as the **'Mumbai model'**).

LEARNINGS FROM MUMBAI'S VACCINATION EXPERIENCE

Intermittent vaccine supply has proven to be the biggest hurdle in sustaining a consistent inoculation programme. The private sector should be further activated to meet the shortfall.

All citizens must have multiple avenues to access vaccines, such as through online registration, walk-ins, drive-ins, vaccine buses and vans, or in housing societies and workplaces.

Workforce training and repurposing roles during a pandemic is critical to tide over staff shortages.

Information dissemination is critical for vaccination and should be done through online and offline avenues.

Women's self-help groups and NGOs must assist all women to access vaccines.

RELIABLE DIGITAL PILLAR

Handling the third wave will require the construction of a more comprehensive information pipeline with a thrust on:

- Technology solutions that focus on legacy infrastructure to reach every citizen and empower on-ground response personnel with accurate information
- 'Phygital' technology responses in line with governance mechanisms
- Beefing up existing disaster management protocols

MMR AND THE PANDEMIC

Given the deep economic integration of Mumbai in the MMR, any flattening of the curve in the city can only be in conjunction with similar efforts in the whole MMR. About 7,00,000 people from the MMR enter Mumbai daily for work. Most of this 'to and fro' travel happens by local trains that could become a 'super spreader' of the virus. The MMR saw high infection rates during the previous COVID-19 waves, contributing about 35 percent to Maharashtra's caseload and deaths.

GLOBAL LEARNINGS

Global examples can provide insights on vaccination and transportation strategies for pandemic management. For instance, while Mumbai followed the age-based national guidelines for vaccination, an area-based strategy (as seen in Toronto, Canada) could prove just as successful. Similarly, the concept of digitally verifiable vaccine records and passports, versions of which are now being tried across the world, could be beneficial in Mumbai.

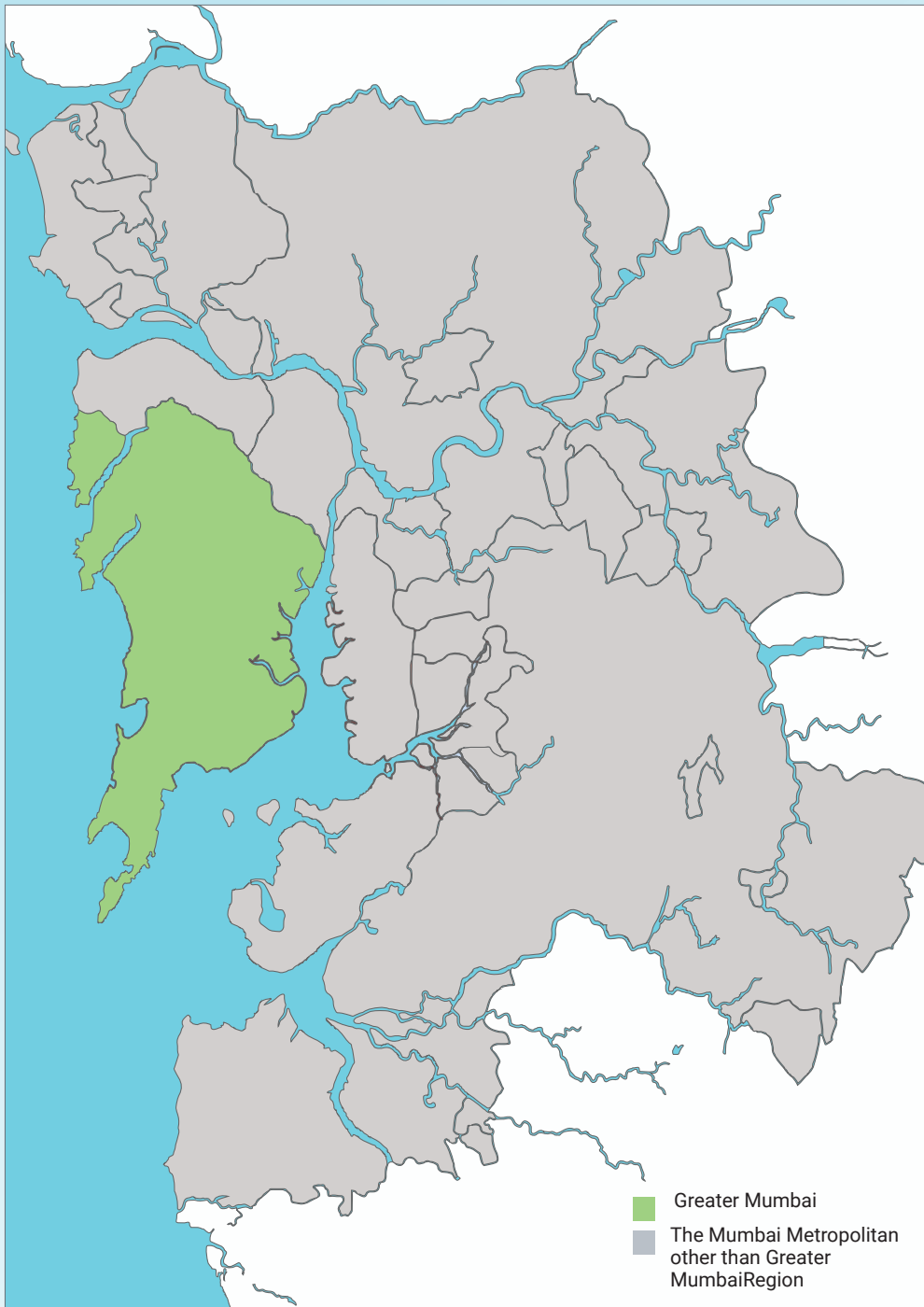
PREPARING FOR THE THIRD WAVE

Data suggests that barring the brief periods when COVID-19 infections spiked, Mumbai **managed the pandemic with relative success** on the **back of strong leadership, quick decision-making, and innovative strategies**. Nevertheless, to prepare for a third wave, certain interventions should be considered:

<h3>A MUMBAI+ PLAN</h3>	<p>The MCGM can adopt a 'Mumbai+' approach for vaccinations and reopening the city. A special MMR task force of health experts, administrators, transport specialists and spatial planners should be able to drive this plan to ensure a uniform vaccination and unlock schedule.</p>
<h3>THE MIGRANT STRATEGY</h3>	<p>A 'city migrant policy' is the need of the hour. Such a policy should begin with creating a database of migrants, their state/city/town/village of origin and job description. The civic body could set up migrant resource centers to register them, and link and track the health, housing and livelihood needs of the migrant's family.</p>
<h3>CHROME HELMETS</h3>	<p>While the MCGM has prioritised their vaccinations, it is also important to provide the hidden frontline workers—such as ASHAs and crematorium and graveyard workers—enough financial protection through health and life insurances from the state government.</p>
<h3>COVID CHAMPIONS</h3>	<p>A dedicated campaign to appoint citizens, including the youth, as 'COVID Champions' can ensure some adherence to COVID-19 appropriate behaviour in all public spaces.</p>
<h3>DISASTER MANAGEMENT PROTOCOLS</h3>	<p>The newly created standard operating procedures for the pandemic at the municipal headquarters and ward levels need to be instituted. An alternate workforce creation system should be initiated where a new batch of people from within the administration and outside (teachers, bank staff and citizen volunteers) are repurposed in emergencies like a pandemic.</p>
<h3>THE 'PHYGITAL' APPROACH</h3>	<p>Machine learning and artificial intelligence must be used to produce modelling patterns and forecast surges in caseloads. But these digital tools have limitations and involve several variable human factors. Therefore, a 'phygital' approach (digital tools plus on-ground implementation and monitoring) must be considered to supplement the use of innovative technologies.</p>
<h3>EARLY HEALTH WARNING SYSTEM</h3>	<p>Real-time data on emerging diseases must be tracked and a robust warning system established to help the MCGM respond more quickly in the event of another disease outbreak.</p>

MUMBAI

METROPOLITAN REGION



1. Geographical Area
(As per GIS)
Greater Mumbai (sq. km.)

437

Mumbai Metropolitan Region
(sq. km.)

6328

2. Population
(Figures in lakhs)
As per Census 2011

235.98

Municipal Corporations

1. Municipal Corporation of Greater Mumbai
2. Thane Municipal Corporation
3. Kalyan-Dombivali Municipal Corporation
4. Ulhasnagar Municipal Corporation
5. Mira -Bhayandar Municipal Corporation
6. Bhiwandi-Nizampur Municipal Corporation
7. Navi Mumbai Municipal Corporation
8. Vasai Virar City Municipal Corporation
9. Panvel Municipal Corporation

Municipal Councils

1. Amarnath Municipal Council
2. Kulgaon-Badalapur Municipal Council
3. Alibag Municipal Council
4. Pen Municipal Council
5. Uran Municipal Council
6. Matheran Municipal Council
7. Khopoli Municipal Council
8. Karjat Municipal Council
9. Palghar Municipal Council

INTRODUCTION



A large migrant population awaiting transportation to return to their hometowns soon after the government eased restrictions on the lockdown in Mumbai on 21 May 2020.

(Photo by INDRANIL MUKHERJEE/AFP via Getty Images)

As the number of **positive cases soared** across the country, Mumbai—among the most populated cities globally—started to feel the heat. The daily average number of cases was **230 in April 2020, rising to 2,013 by September** (during the first wave); the number reached **a record high of 7,786 in April 2021** at the peak of the second wave.

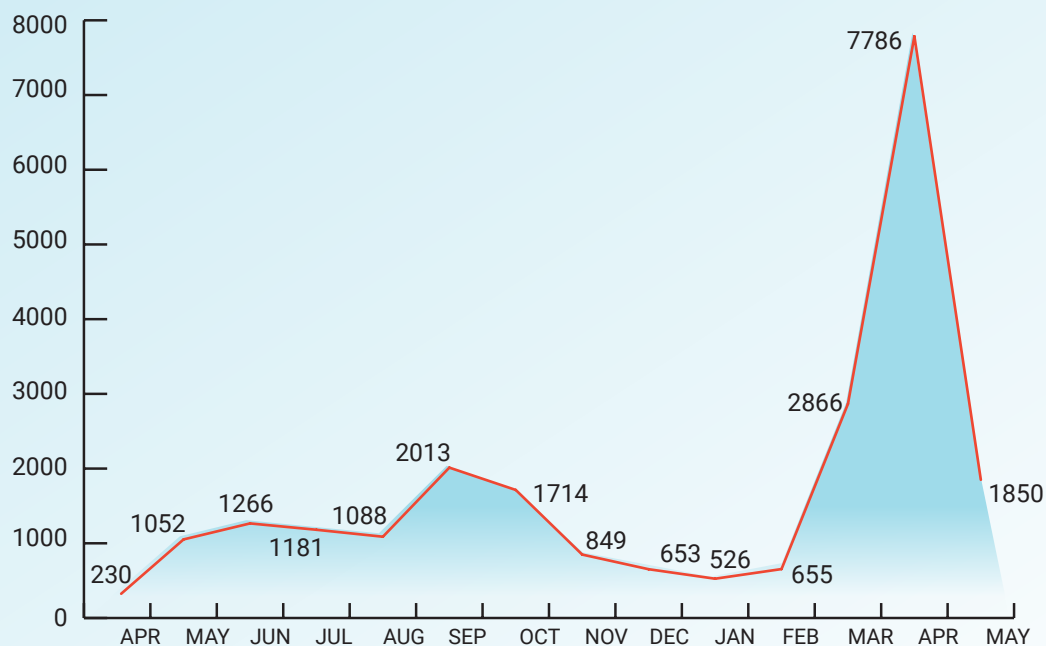
MUMBAI'S first confirmed case of the novel coronavirus (COVID-19) was recorded on 11 March 2020,¹ the day the World Health Organization (WHO) characterised it as a pandemic.²

As the number of cases soared over the next few weeks, Mumbai—among the most populous cities globally, with a density of 26,000 people per square kilometre—started

to feel the heat. India's financial capital, with a US\$310-billion GDP and which accounts for up to 9 percent of the country's economy,³ was left devastated.

Over 65 percent of the city's 12.5 million inhabitants live in informal houses (slums)⁴ with extremely high densities and low hygiene standards. This makes it easier for any contagious pathogen to spread

Figure 1: Daily average number of cases in Mumbai (April 2020-May 2021)



Source: Compiled by authors from the Municipal Corporation of Greater Mumbai (MCGM) press briefings.

Table 1: City-wise COVID-19 Statistics (as of 23 June 2021)

	Mumbai	New Delhi	Bengaluru	Kolkata	Chennai
Population (as per Census 2011)	1,24,42,373	1,67,87,941	84,43,675	44,96,694	46,46,732
Total Positive Cases	7,23,324	14,33,366	12,08,104	3,06,949	5,30,432
Total Positive Cases per Million	58,133	85,381	1,43,077	68,261	1,14,151
Total Deaths	15,338	24,940	15,523	4,866	8,115
Total Deaths per Million	1,233	1,486	1,838	1,082	1,746
Total Testing	69,47,290	2,09,75,900	1,43,15,983	Not available	26,67,777
Total Testing per Million	5,58,357	12,49,462	5,89,807	Not available	5,74,118
Total Vaccinations	47,95,160	66,95,944	6,86,363	28,96,766	27,70,671
Total Vaccinations per Million	3,85,389	3,98,854	81,287	6,44,199	5,96,262

Sources: Municipal Corporation of Greater Mumbai; Government of Delhi – Department of Information & Publicity; Department of Health and Family Welfare Bulletin, Government of Karnataka; Directorate of Public Health and Preventive Medicine, Health and Family Welfare Department, Government of Tamil Nadu.

rapidly and last a long time. Mumbai, the tuberculosis capital of India, ⁵ presented an easy breeding ground for the fast-spreading Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) that causes COVID-19. Additionally, the large number of international passengers arriving in the city daily (about 42,000) exacerbated the situation.

The daily average number of cases was 230 in April 2020, rising to 2,013 by September (during the first wave); the number reached a record high of 7,786 in

April 2021 at the peak of the second wave (see Figure 1).

A multi-city comparison of positive cases, testing, vaccinations, and deaths as of 23 June 2021 (the assumed end of the second wave) shows that Mumbai has fared well on some parameters but not others (see Table 1). Despite its huge population density, the city has fewer cases per million people than the four other megacities (New Delhi, Bengaluru, Kolkata and Chennai) and deaths per million lower than New Delhi, Bengaluru and Chennai. Where it falls short

Despite its huge population density, **Mumbai has fewer cases per million people** than New Delhi, Bengaluru, Kolkata and Chennai. But it has also **conducted fewer tests per million** than New Delhi, Bengaluru and Chennai.

Table 2: Mumbai's Case Fatality Ratio (March 2020-May 2021)*

Month (2020)	CASE FATALITY RATIO (in %)
April 2020	4.06
May 2020	3.03
June 2020	8.63
July 2020	4.90
August 2020	3.86
September 2020	2.10
October 2020	2.48
November 2020	2.19
December 2020	1.80
January 2021	1.44
February 2021	0.69
March 2021	0.24
April 2021	0.63
May 2021	3

Source: Data taken from the Maharashtra government's daily media bulletins.

*Case fatality rate is calculated based on confirmed cases and deaths. The peak of the first wave of COVID-19 was recorded in September 2020, while the second wave peaked in April 2021.

is in the number of tests per million, which is lower than in New Delhi, Bengaluru and Chennai (data is not available for Kolkata).

Mumbai's case fatality ratio (CFR)—which determines the proportion of people who die from a specified disease among all individuals diagnosed with the disease over a certain period⁶—was higher during the first wave (*see Table 2*). The CFR declined in the second wave, to 0.63 percent in April 2021, even as the absolute number of cases

(2,33,594) and deaths (1,479) were higher. This is mainly because the higher number of confirmed cases, which is the denominator, pulled down the CFR.

The Municipal Corporation of Greater Mumbai (MCGM), the city's main urban local body, oversees its entire healthcare service and delivery system. Health is a state subject and public health is one of the 18 responsibilities of urban local bodies (as detailed in the Twelfth Schedule of the Constitution).⁷ The

Mumbai's case-fatality ratio was **high during the first wave** and **declined in the second**, even though **the absolute number of cases (2,33,594) and deaths (1,479) were higher**.

Table 3: Shortage of medical facilities in Mumbai

	Health posts and Dispensaries	Maternity homes/wards + post-partum centres	Hospitals (Municipal + State-run)
Island City	118	13	12
Suburban Mumbai	225	36	16
Greater Mumbai	343	49	28
NUHM standards	1197	239	62
Deficit (Units)	854	190	34
Deficit (Expressed as %)	70%	79%	55%

Source: MCGM preparatory study¹¹ and Existing Land Use 2012 survey, Urban Development Research Institute (UDRI)-NGO Praja Report,¹² National Urban Health Mission (NUHM).¹³

Note: Island City includes the areas in South of Mumbai (from Colaba to Sion and Mahim); suburban Mumbai region covers the east and west (from Bandra to Dahisar and Kurla to Mulund); Greater Mumbai includes the Island City and Suburban Mumbai.

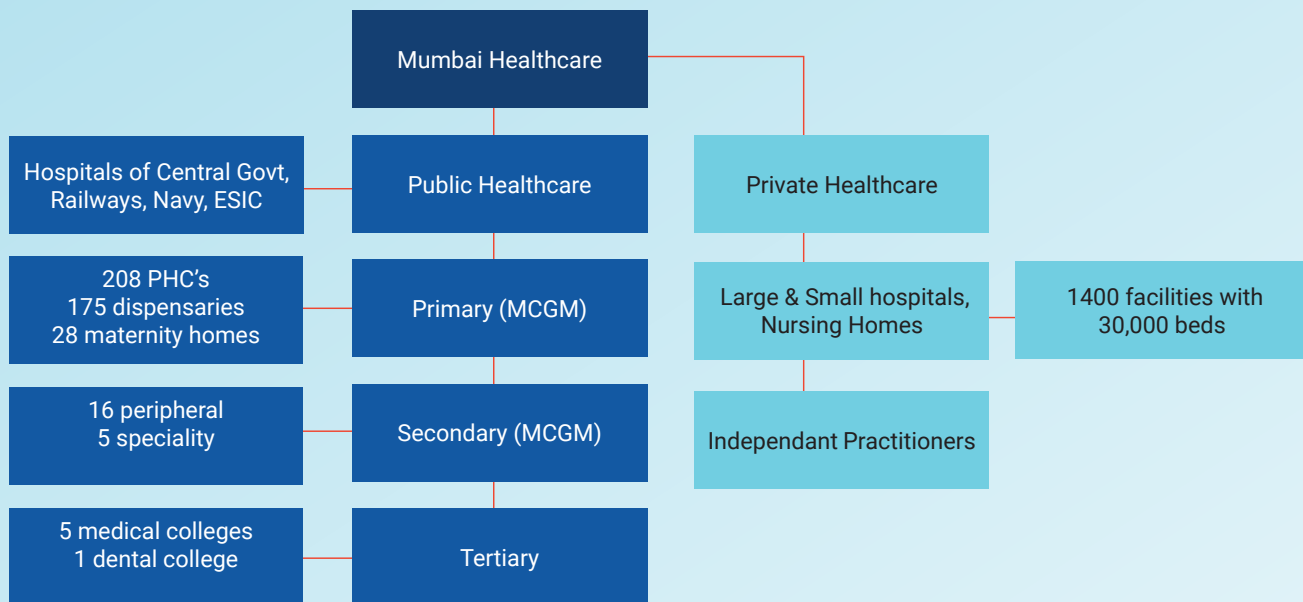
National Urban Health Mission (NUHM) defines the number of health services and facilities that city administrations must provide based on the size of the population.⁸ Mumbai's healthcare system is divided across the public and private sector through layers of primary, secondary and tertiary care (see Figure 2). The city has four state government-run hospitals that collectively come under the umbrella of JJ Group of Hospitals: JJ Hospital, St George Hospital,

Gokuldas Tejpal Hospital, and Cama and Albless Hospital. According to MCGM health officials, Mumbai also has a strong private hospital network, which has roughly 30,000 hospital beds.⁹

According to the 2009 Mumbai Human Development Report, the city has a total of 20,700 public-sector beds.¹⁰ There has not been any significant increase to this count since. In India, the NUHM standards are followed

Based on National Urban Health Mission standards, Mumbai has a **70-percent shortage** in primary healthcare facilities, **79-percent deficiency** in secondary healthcare and a **55-percent shortfall** in providing tertiary healthcare.

Figure 2: Mumbai's Healthcare System



Source: Compiled by authors from MCGM sources

to determine the number of medical facilities and infrastructure needed for a certain-sized population. If the NUHM standards are considered, Mumbai has a 70-percent shortage in primary healthcare facilities (health posts and dispensaries), 79-percent deficiency in secondary healthcare (maternity homes/wards and post-partum centres), and a 55-percent shortfall in providing tertiary healthcare (hospitals) (see Table 3).

Several lessons have emerged from Mumbai's experience during the two COVID-19 waves, including the limitations of and pressures on its health infrastructure. How Mumbai strategically and swiftly charts the course for the immediate future until the people of the megacity and its suburban regions are vaccinated will determine how unscathed it emerges from this health crisis.

Mumbai's experience with the first two COVID-19 waves has highlighted **the limitations of and pressures on its health infrastructure**, as well as the merits of a **decentralised decision-making system**. Its learnings from these events will **determine how unscathed it emerges** from a predicted third wave.

THE FIRST WAVE: TRAVERSING THE UNKNOWN



Healthcare workers
conducting door-to-door
screening of residents at
Sathe Nagar, Mankhurd,
on 16 August 2020.

(Photo by PRATIK
CHORGE/Hindustan Times
via Getty Images)

Densely-populated Dharavi had **491 cases in April 2020**, with a **12-percent growth rate** and **18-day doubling period**. Aggressive measures like **proactive house-to-house screening, timely quarantining, and isolation** helped in improving the doubling period of cases and curbing the spread of the virus.

MUMBAI'S first wave (roughly, from April to November 2020) was slum-centric, although the origins of transmission were people returning from foreign countries. For instance, a domestic worker employed at the home of an individual who had returned from a foreign country was among the early COVID-19 cases recorded in slum dwellings.¹⁴

The city is divided into two district zones, Mumbai Island City and Mumbai suburban collectorates, and has 24 administrative wards.¹⁵ In many wards, over half the population lives in slums.¹⁶ By 1 April 2020, Dharavi, the city's largest slum pocket, had recorded its first case; and over the next few weeks, clusters of cases were reported from other slum pockets as well, such as Malwani, Govandi, Mankhurd, the Bombay Development Department (BDD) chawls and Worli Koliwada. By June, the number of confirmed cases in Mumbai crossed 50,000 and over 1,700 people had lost their lives.

Dharavi, where over 9,00,000 people are crammed into a 2.5 sq. km-wide space,¹⁷ saw 491 cases in April 2020, with a 12-percent growth rate and 18-day doubling period.¹⁸

But aggressive measures like proactive house-to-house screening, timely quarantining and isolation helped in improving the doubling period of cases and curbing the spread of the virus. A slew of measures, such as providing hand sanitisers outside community toilets and cleaning these spaces every two hours, proved beneficial.

The MCGM also worked with several NGOs to interact with the community and sensitise people about self-hygiene and wearing masks. Health workers visited homes to screen people for fever and check oxygen saturation levels. Suspected COVID-19 cases were sent to quarantine centres, even before testing, to break the chain of infection. Additionally, micro-containment zones were created in areas with high infection rates, and ration and food packets provided to those residing in such zones. The Dharavi model, which drew praise from the WHO, hinged on a 4-T strategy – tracing, tracking, testing, and treating.¹⁹ This strategy also helped Mumbai keep the daily case count low during the second wave.²⁰

The screening of international travellers and quarantining of individuals began in

January 2020 as COVID-19 spread in many other countries. Yet, the planning to deal with the pandemic remained largely on paper until Mumbai recorded its index (first) case in March 2020.

BOOSTING HEALTH INFRASTRUCTURE

In March 2020, the 129-year-old Kasturba Hospital for Infectious Diseases, Chinchpokli, was the only dedicated COVID-19 testing and treatment facility in the city. It had 28 beds in an isolation ward (created during the 2009 H1N1 outbreak);²¹ the bed strength increased to 275 by May.²²

As cases multiplied, the administration rushed to enhance the existing hospital infrastructure and create new facilities. The first facility to be commissioned for expansion was the 1,700-bed SevenHills Hospital in Andheri, where only 100 beds were operational in April 2020. It was quickly converted into a quarantine facility for international travellers and was later turned into an isolation centre. The hospital now has 1,850 beds (as of 30 June

2021).²³ By mid-April 2020, the MCGM-run BYL Nair Hospital in Mumbai Central was converted into an exclusive COVID-19 facility with 800 beds. It was also designated as the nodal centre for COVID-positive pregnant women.

Around this time, infection rates among healthcare workers soared and several hospitals were declared containment zones,²⁴ aggravating existing manpower shortages. The MCGM scrambled to hire doctors, nurses, ward boys, ambulance drivers, among other healthcare staff,²⁵ offering substantive salary hikes.²⁶

As the number of cases increased, the MCGM decided to build massive field hospitals (jumbo COVID-19 centres) on the lines of what China did in Wuhan when health facilities fell short.²⁷

In April 2020, the first jumbo centre was commissioned at the National Sports Club of India in Worli. It started with 100 beds and grew to become a 2,328-bed facility. The opening of this jumbo centre coincided

The first **jumbo centre** was commissioned in April 2020 at the dome stadium at the National Sports Club of India in Worli. It started with **100 beds** and grew to become a **2,328-bed facility**.

In May 2020, Mumbai had **only 530 ICU beds** in the public sector. With **16,800 active cases** (on 20 May 2020) and estimating that at least **5 percent of these patients were critical**, the city required at least **840 ICU beds**.

with the spike in cases from the congested Worli Koliwada locality (a densely populated slum area that became Mumbai's first containment zone) and BBD chawls (about 120 three-storey buildings with tiny houses stacked in rows with common toilets).²⁸

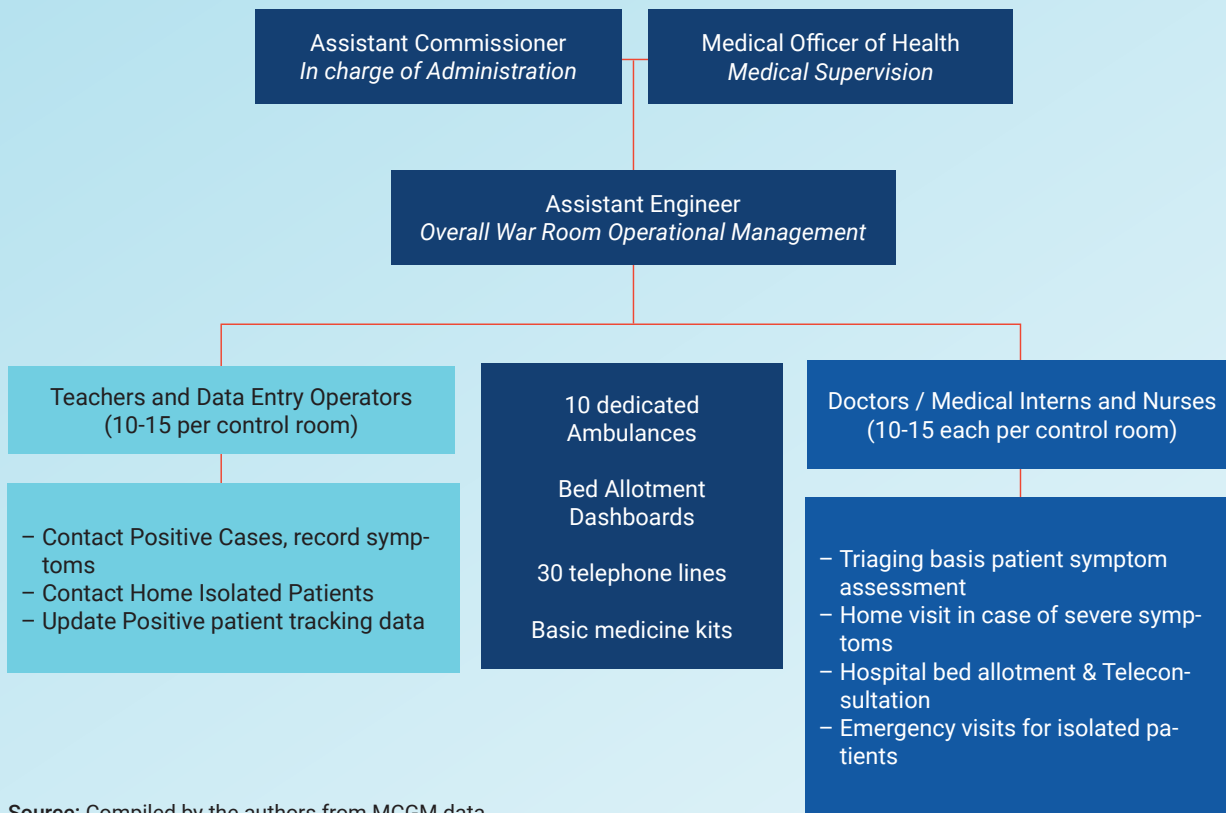
The next jumbo centre was commissioned at the MMRDA Grounds in Bandra Kurla Complex (BKC) in May 2020. By July, field hospitals were set up in Byculla, Mulund, Goregaon and Dahisar. Overall, the six jumbo centres have added 8,915 beds to Mumbai's hospitalisation

capacity and have seen over 89,206 patients treated (as of 5 June 2021).²⁹ The jumbo centres were mandated to not turn away a patient, no matter how critical. But these centres have also faced criticism over hygiene levels and patient care.³⁰

In a bid to reduce the risk of infection, contactless cubicles were set up at the jumbo centres for registration and daily patient monitoring. Medbots (remote controlled medical trolleys) were used at the BKC jumbo facility to substitute healthcare workers in high-risk situations.³¹

Infection rates among **healthcare workers soared** and several hospitals were declared containment zones, aggravating existing **manpower shortages**. In a bid to reduce the risk of infection, **contactless cubicles** were set up at the jumbo centres for **registration and daily patient monitoring**. **Medbots** (remote controlled medical trolleys) were used at the BKC jumbo facility **to substitute healthcare workers in high-risk situations**.

Figure 4: Mumbai's Decentralised Ward War Room System



Source: Compiled by the authors from MCGM data

Additionally, government dispensaries were also involved in the diagnosis and treatment of COVID-19 patients by measuring oxygen saturation, and conducting other basic investigations and testing.³²

WARD WAR ROOMS AND BED ALLOCATION

While the jumbo centres were able to tackle the mild and moderate COVID-19 cases, the city needed more intensive care unit (ICU beds and a good triage system to determine which patients needed hospitalisation and who could be treated at home.

In May 2020, Mumbai had only 530 ICU beds in the public sector. With 16,800 active cases (on 20 May 2020) and estimating

that at least 5 percent of these patients were critical, the city required at least 840 ICU beds.

In the absence of triaging, asymptomatic people or those with mild symptoms occupied hospital beds for treatment even when not required. As the fatality numbers soared from 281 in April 2020 to 989 in May and 3,277 in June, the medical fraternity signalled that those in real need of ICU beds were unable to access any.

As a result, the MCGM undertook a multi-pronged approach—a centralised bed allotment system was created to be executed by the ‘war rooms’ set up under the civic body’s existing decentralised administrative

MCGM auditors were deputed to each major private hospital to implement **the price cap by scrutinising every bill** for COVID-19 treatment. By October 2020, the auditors had screened **6,861 bills worth INR 1120 million** and were instrumental in getting private hospitals **to reduce or refund overcharged amounts** to the tune of **INR 140 million**.

system (wards). Each ward established a ‘war room’ headed by a ward officer or assistant commissioner (*see Figure 4*), and each war room was equipped with a dedicated phone number and 30 lines manned by doctors, medical interns, social workers, teachers, and other volunteers.

The MCGM barred laboratories from sharing ‘positive’ reports with the patients directly. The war rooms were tasked with communicating the ‘positive’

reports to people and assessing the patient’s symptoms, comorbidities and living conditions before allotting hospital beds or deciding on home isolation. This system helped in localised triaging. The ward war room system has received many accolades,³³ and states like Karnataka replicated it during the second wave.³⁴

There was a mismatch between the patient load handled by the private and public hospitals in Mumbai. A surprise check

EXPLAINED: MCGM’S BED ALLOCATION SYSTEM

A bed allocation dashboard created to track real-time bed availability.

Hospitals update bed availability status every 2 hours.

Strict guidelines to public and private hospitals to allot beds only to symptomatic and high-risk patients.

MCGM staff conducts triaging on phone for all positive patients with assurance of beds.

System to make beds available for suspected positive cases.

Appointing auditors to check hospitals for compliance of orders.

Involvement of central disaster unit to control and coordinate for beds.

by the Maharashtra government in early June 2020 revealed that 53 private hospitals had collectively opened only 2,400 beds, including 421 ICUs, for COVID-19 patients, even as the state had expected 12,000 beds, with some private facilities only opening 10 percent of their beds.³⁵ In addition, there were also complaints of overcharging in private hospitals.³⁶

On 30 April 2020, the state government passed an order to take over 80 percent of private beds and cap their rates by drawing powers from five laws — the Epidemic Diseases Act 1897, the Disaster Management Act 2005, the Maharashtra Essential Service Maintenance Act 2011, the Mumbai Nursing Home Registration Act 2006 and the Bombay Public Trusts Act, 1950.³⁷ Following this, the total number of ICU beds rose to 1,165, and

the MCGM war rooms could allot beds from the private sector as well.³⁸

MCGM auditors were deputed to each major private hospital to implement the price cap by scrutinising every bill for COVID-19 treatment. By October 2020, the auditors had screened 6,861 bills worth INR 1120 million and were instrumental in getting private hospitals to reduce or refund overcharged amounts to the tune of INR 140 million.³⁹

The creation of jumbo centres, takeover of the SevenHills hospital, augmentation of existing facilities, and the establishment of ward war rooms were crucial factors in Mumbai avoiding the critical bed shortage seen in many other major cities (like New Delhi) during the second wave peak in April and May 2021.⁴⁰

NOTABLE TRENDS

Mumbai's first wave was slum-centric, although the origin of transmission were the people returning from foreign countries.

Interventions like plasma therapy were tried and repurposed drugs like Remdesivir and Tocilizumab were used as treatment plans.

Senior citizens and those with underlying conditions like diabetes and hypertension were likelier to get a severe form of COVID-19 and were at a high risk of death. There were fewer hospitalisations among those below 50 years.

THE SECOND WAVE: TACKLING THE UNEXPECTED



Volunteer social worker Ashok Kurmi dressed as comic character Spiderman sprays disinfectants on a public bus in Mumbai. Kurmi is helping an army of young fans fight the coronavirus in Mumbai's slums using an unusual accessory: a clown costume.

Photo by PUNIT PARANJPE/AFP via Getty Images)

As the **second wave intensified** between April and May 2021, case numbers increased substantially, **disrupting supply chains** for essentials. India saw **a shortage of critical-care COVID-19 facilities**, ICUs were cramped, and access to hospital beds with ventilator support was limited. **A high volume of deaths** was recorded due to the **non-availability of hospital beds, oxygen supply, and essential medicines**.

MUMBAI experienced a slight respite in the number of COVID-19 cases between December 2020 and January 2021. In September 2020 (during the peak of the first wave), the daily average of new cases was 2,013, steadily dropping in the following months (to 653 in December and 526 in January 2021). Despite this decline, Mumbai's daily positive cases remained in the hundreds (unlike cities like New Delhi, where the numbers dropped to double digits), suggesting that the infection continued to spread and a potential spike was likely when stay-at-home orders were relaxed, a trend experts have described as a "thick tail" (occurrence of new cases at the end of the wave).⁴¹ While the exact cause for the thick tail is not known, some experts attribute it to a combination of high population density and mobility, better reporting and more testing. By end 2020, the Maharashtra government introduced some relaxations in the lockdown, reopening places of worship and public spaces like beaches and gardens.

In February 2021, Mumbai saw a rise in new cases (starting February 10, exactly ten days after the local trains were reopened for public use), as did the rest of the country. As the second wave intensified between April and May 2021, case numbers increased substantially, disrupting medical supply chains. All levels of government (centre, state and local) were unprepared for the surge. India soon saw a shortage of critical-care COVID-19 facilities, ICUs were cramped, and access to critical-care beds with ventilator support was limited. A high volume of deaths was recorded due to the non-availability of hospital beds, oxygen supply, and essential medicines.

On 4 April, Mumbai registered 11,206 cases, its biggest single-day surge,⁴² and in April-May, people were forced to purchase essential medicines from the black market at up to ten times the approved cost.⁴³ However, even as the rest of India was reeling under the second wave, the city navigated the crisis relatively quickly, drawing international

Table 4: Average oxygen demand for Mumbai and capacity installed (as of June 2021)

Average oxygen demand during first wave	Oxygen demand at second wave peak	Total capacity installed
150 MTDP	270 MTDP	300 MTDP

Source: Compiled by the authors from MCGM data

praise,⁴⁴ due to timely and deft interventions by the MCGM. Mumbai's bed-availability crisis was quickly resolved as the MCGM got private hospitals to free more beds for COVID-19 patients. At the same time, the number of ICU beds was augmented in jumbo facilities.

OXYGEN SUPPLY

As the number of cases spiked in April 2021, oxygen shortages became more acute; on 18 April, 168 patients were moved from six civic-run hospitals to jumbo centres as oxygen supplies fell short.⁴⁵ The city's oxygen requirement increased from 210 metric tons per day (MTPD) during the first wave to 270 MTPD in the second.⁴⁶ This forced Maharashtra to access 920 MTPD of liquid medical oxygen (LMO), but the demand had surged to nearly double this number. All oxygen produced in the state was diverted for medical use, with more imported from Andhra Pradesh, Odisha and Gujarat through 'Oxygen Express' trains.⁴⁷

In 2020, the MCGM had prioritised the supply of oxygen to dedicated COVID-19 health centres and hospitals, which were treating many moderately severe and severely ill patients who needed medium-to-high oxygen support. As a result, some of the smaller private hospitals that were solely dependent on refillers for their oxygen

supply came under distress.⁴⁸ In May 2020, following stray reports of deaths due to oxygen shortage, the MCGM mapped its oxygen resources and prepared an inventory of the generation-to-bed supply chain for each hospital.⁴⁹

The increased demand for oxygen beds was anticipated during the first wave, for which the city's traditional supply chains proved sufficient.⁵⁰ All big public and private hospitals received their LMO in cryogenic tankers directly from the plants. This accounted for nearly 70 percent of the total requirement. The remaining was procured by smaller private hospitals from refillers. Once the refilled cylinders arrive at a hospital they are connected in a "manifold" series and piped to individual beds.

However, as the second wave swelled, Mumbai fell short of localised oxygen storage capacity.⁵¹ To address this problem, hospitals were equipped with 22 cryogenic LMO storage tanks—13 hospitals with 13 kilolitre tanks each,⁵² seven with 10 kilolitres, and two with six kilolitre tanks each. It took the MCGM only 45 days to design, fabricate and operationalise these, and prepare a distribution plan.⁵³

By the time these tanks were installed, the first wave had receded, and the oxygen

To address the shortage of localised oxygen storage capacity, hospitals were equipped with **22 cryogenic LMO storage tanks**. It took the MCGM **only 45 days** to design, fabricate and operationalise these tanks and prepare a distribution plan.

demand returned to the non-COVID-19 normal of around 150 MTPD. However, it jumped to 270 MTPD in the initial days of the second wave.⁵⁴ Finding enough LMO for the new storage tanks became a challenge. To bridge the gap, MCGM procured an additional supply of 50 MTPD from steel plants in the neighbouring Raigad district and 60 MTPD from Jamnagar in Gujarat.⁵⁵ Mumbai relied minimally on the railway transported LMO, which was sent directly to Pune for onward state-wide distribution.⁵⁶

Auxiliary oxygen storage depots were created at six strategic locations in Mumbai, with 25 jumbo tankers on standby.⁵⁷ Oxygen from these locations was rushed to hospitals facing a shortage, and coordination and logistics were managed by the ward-level COVID-19 war rooms. Surplus storage was maintained at all depots to address emergencies due to the delayed arrival of tankers from the refillers or other unexpected supply disruptions.

Plans are underway to augment the MCGM's captive oxygen generation capacity (currently, 500 cubic metres at the Kasturba Hospital, Chinchpokli, and 1,740 cubic metres at the Trauma Hospital,

Jogeshwari) by installing pressure swing absorption (PSA) plants at all hospitals and jumbo centres to provide an additional 45 MTPD to the city.⁵⁸ Tenders have been floated for 16 PSA plants.⁵⁹ The goal is to have a dedicated availability of an additional 150 MTDP so that Mumbai is prepared for any extraordinary oxygen demand amid a potential third wave.

As factory operations resumed following a relaxation in lockdown restrictions, Maharashtra has diverted 20 percent of its total daily oxygen production for industrial use.⁶⁰ However, all plants have been instructed to prioritise supply to hospitals over industries if the need arises.

MEDICINES

The MCGM has adhered to the procedures and line of treatment prescribed by the Maharashtra COVID-19 task force.⁶¹ For instance, while Remdesivir has been removed from the global treatment protocol, it is still commonly used in the initial days of treatment for hospitalised patients,⁶² as it has proven to be an effective anti-viral drug.⁶³

By the end of the first wave, doctors had underlined some crucial observations and learnings—senior citizens and those

The impact of such polypharmacy was felt during the second wave with rising cases of **mucormycosis** (a deadly, invasive fungal infection), which experts have termed as “**an epidemic within a pandemic**”.

with underlying conditions like diabetes and hypertension were more likely to get a severe form of COVID-19 and were at a high risk of death. While the initial thrust was on ventilators, doctors marked that timely oxygen therapy proved more beneficial. The medical fraternity experimented with various interventions like plasma therapy and repurposed drugs like Remdesivir and Tocilizumab and a consensus emerged that these drugs were to be used sparingly. There was stronger advocacy from the fraternity itself that a wide cocktail of drugs, including antibiotics, antivirals, steroids, anticoagulants and supplements, are used, despite little evidence backing this. The impact of such polypharmacy was felt during the second wave with rising cases of mucormycosis (a deadly, invasive fungal infection), which experts have termed as “an epidemic within a pandemic”.⁶⁴

The production of all essential medicines like Remdesivir⁶⁵ and Tocilizumab fell as the demand reduced during the lull between the two waves. As a result, the volumes were insufficient to meet the increased demand amid the second wave. As a shortage of Remdesivir was seen across the country, in April 2021, the MCGM swiftly procured 2,00,000 vials at 300 percent above the original price.⁶⁶

In July 2020, amid a country-wide shortage of Tocilizumab, the MCGM purchased 20,000 doses from Cipla, the sole distributor of the drug in India.⁶⁷ Tocilizumab, referred to as the “drug of the last resort”, is typically the go-to medicine when a patient’s condition worsens despite the use of Remdesivir, other anticoagulants and steroids.⁶⁸

Similarly, the MCGM also made arrangements with Bengaluru-based Biocon to procure Tocilizumab, which was given restricted emergency use authorisation by the Drug Controller General of India (DCGI) in July 2020.⁶⁹ The MCGM has also authorised its Central Purchase Authority to make a bulk purchase of Amphotericin B to treat mucormycosis.⁷⁰

Additionally, learning from Brazil, where the third wave affected many children, the MCGM has undertaken measures for the bulk procurement of paediatric medicines ahead of a potential third wave.⁷¹

NEW VARIANTS, NEW CONCERNS

The emergence of a new SARS CoV-2 variant (B.1.617) created a new pronounced threat as variations allow the virus to spread rapidly or make it treatment- and vaccine-resistant.⁷²

The Delta Plus was declared as a variant of concern by the Union Ministry of Health on 22 June 2021, with characteristics like **increased transmissibility, stronger binding to receptors of lung cells** (believed to contribute to the **highly contagious transmission rate**) and a **potential reduction in monoclonal antibody response**. The MCGM is in the process of starting a **genome sequencing laboratory** to analyse the **COVID-19 variants circulating in Mumbai**.

According to the WHO, the earliest documented sample of the B.1.617 variant in India is from October 2020. The three sub-lineages (1, 2 and 3) of B.1.617 were found in at least one-third of samples sent for genome sequencing from Mumbai, calling attention to the need to analyse more samples to understand its prevalence.⁷³ The results of the Mumbai samples first appeared in the media in May 2021. B.1.617.2, now classified as Delta, has been labelled as a variant of concern by the WHO.⁷⁴ A mutation of Delta, identified as AY.1 or Delta Plus, was reported in Mumbai in June among COVID-19 positive samples collected in April 2021. The Delta Plus was declared as a variant of concern by the Union Ministry of Health on 22 June 2021,⁷⁵ with characteristics like increased transmissibility, stronger binding to receptors of lung cells (believed to contribute to the highly contagious transmission rate) and a potential reduction in monoclonal antibody response (monoclonal antibody cocktail is a newer COVID-19 treatment).

The MCGM is in the process of starting a genome sequencing laboratory to analyse the COVID-19 variants circulating in Mumbai.

ASHA WORKERS

Accredited Social Health Activists (ASHAs) are often the first point of contact in informal settlements to implement health programmes, such as population-based disease surveillance, immunisation drives for children, and pre- and postnatal care. During the pandemic, they have played a key role in door-to-door contact tracing, and screening people for temperature and oxygen saturation. ASHA workers have also been instrumental in promoting COVID-19-appropriate behaviour like masking and sanitising and have encouraged people to get vaccinated.

In recognition of their contribution to pandemic-mitigation efforts and the resultant impact on their lives, in June 2021, the Maharashtra government announced a pay hike of INR 1,000 and a COVID-19

ASHA workers have played a key role in pandemic-mitigation efforts, through **door-to-door contact tracing, screening people for temperature and oxygen saturation, promoting COVID-19-appropriate behaviour like masking and sanitising, and encouraging people to get vaccinated.**

allowance of INR 500 for ASHA workers, who otherwise receive abysmally low remunerations (approximately INR 4,000 per month). Only about 220 of the 750 sanctioned ASHA positions are currently filled in Mumbai.⁷⁶

The Central government has also released training resources on COVID-19 management for ASHA and *anganwadi* (childcare centre) workers. Training resources for volunteers, students, different kinds of doctors are also included in the manuals.⁷⁷

It is important to strengthen the network of ASHAs by increasing their remuneration further, as better pay will encourage more women to come forward to join the ASHA workforce. Continuous education and training of ASHA workers in pandemic management and disease management can help to stem delays in diagnosis and vaccine hesitancy.

CREMATORIUM WORKERS

According to MCGM data, Mumbai has 46 traditional crematoriums, 11 electric crematoriums, and 18 gas pyres that were

operational during both COVID-19 waves.⁷⁸ Gravediggers across the city have also been working in 24-hour shifts with few safety precautions.

Several cemeteries in the city reported a severe scarcity of land as the number of fatalities increased.⁷⁹ For instance, the Wadala Muslim Sunni Kabrastan announced its closure after having no land left to bury the dead. Before its closure, authorities were forced to dig up graves less than a year after a burial to create space, but the buried bodies were undecomposed since they were wrapped in personal protective equipment (PPE) kits (which could mean the body takes at least four years to fully decompose).

Across the country, crematorium staff are working in inhuman conditions during the pandemic. Workers have not been provided with PPE kits and N95 masks, often using handkerchiefs to protect themselves. Additionally, families of the dead turn up in large numbers and are at times maskless, in violation of COVID-19 protocols. Furthermore, these jobs pay meagrely and are usually contractual, with little job security. Crematoriums and graveyards can be hotspots

It is important for the state to **provide health insurance to all crematorium and graveyard staff** as they are **not covered** under schemes for other essential workers. This would be in line with the Supreme Court's recent direction to the Centre **recognising such workers as essential and in need of health cover**.

for the spread of the virus as many at-home deaths are not tested for COVID-19 and the virus can be transmitted to workers and others in the absence of proper precautions. Additionally, the workers do not have any insurance scheme to protect them in case of contracting the virus.⁸⁰

It is pivotal for the state to provide health insurance to all crematorium and graveyard staff as they are not covered under schemes for other essential workers. This would be in line with the Supreme Court's recent direction to the Centre recognising such workers as essential and in need of health cover.⁸¹ The court indicated that state governments can follow the lead of Bhopal-based NGO Sarokar Sanstha that insured crematorium and graveyard workers for INR 2,00,000.

MIGRANTS

In April 2020, weeks into the first nationwide lockdown, thousands of desperate migrant workers rushed out of Mumbai and other cities to return to their hometowns by foot or through congested buses and trains. With no means of livelihood and no savings, migrant

workers (a critical driver of growth for the city through their participation in the informal sector) faced severe distress due to the lack of safe, secure and affordable health and housing, forcing them to leave the cities. During the first wave, the National Centre for Disease Control attributed the rise in cases in several cities to the movement of migrant labour and cross-migration from other states.⁸²

According to a January 2017 report by the Ministry of Housing and Urban Poverty Alleviation's Working Group on Migration, Greater Mumbai and Thane saw the largest influx of migrants over the last ten years, with approximately six million migrants living in these areas.⁸³

There are two distinct groups of urban migrants: interstate migrants and intrastate migrants, with diverse needs and participating in vastly different jobs and services (*see Table 5*). In addition to manufacturing and traditional services, migrants from rural Maharashtra are more likely to find employment in public and social services in Mumbai due to linguistic advantages. However, rural migrants from

Table 5: Migration Patterns for Mumbai

	Manufacturing	Construction	Traditional Services	Modern Services	Public and Social Services
Rural (In state)	28%	9%	30%	9%	24%
Urban (In state)	25%	5%	29%	15%	24%
Rural (Other states)	35%	10%	38%	6%	11%
Urban (Other states)	31%	7%	33%	13%	16%

Source: January 2017 report of the Working Group on Migration, Ministry of Housing and Urban Poverty Alleviation⁸⁴

other states are more likely to be employed in manufacturing and traditional services.

These origin and employment patterns are important from the healthcare perspective as they illustrate the need for intervention in making health services more accessible and portable (the ability to seamlessly access healthcare across city, state and district borders through the public health authority and system of that area). Mumbai and Maharashtra, which are heavily reliant on migrants, will need to introduce several

urgent measures to ensure such individuals are included in the public health system.

A starting point could be a state database on migrants with categorisations for children, women, men, and working migrants and their health and medical conditions. This will ensure that concerns related to child vaccination, women’s healthcare, and occupational health hazards are recorded and tracked. This should be the starting point for a city- and state-wide migrant policy.

NOTABLE TRENDS

Affluent class and the non-slum population was hit,⁸⁵ while slums were largely spared.

Disease progression was faster, with the below-50-years population affected.

Volume of daily cases and a rapid spread pressurised Mumbai’s health infrastructure, despite learnings from the first wave.

Highest single-day surge recorded (11,206 on 4 April 2020).

Oxygen shortage was more pronounced.

Experts believe the reason for the rapid spread and severity was the circulation of variants,⁸⁶ coupled with relaxation of social distancing measures and allowing free movement of people.

THE NEXT WAVE(S): SURVEYS, IMPACT AND MITIGATION STRATEGIES



Thane Civil Hospital stocks oxygen cylinders to avert any shortage of supply, 4 May 2021 in Mumbai, India.

(Photo by PRAFUL GANGURDE/Hindustan Times via Getty Images)

The state-level paediatric task force has recommended that hospitals and jumbo COVID-19 centres **earmark paediatric and combined wards to accommodate parent-child positive cases, set up more Sick New Born Care Units, ensure availability of infant-friendly ventilators, and determine a children-specific treatment protocol.**

THERE is much debate and discussion on the potential occurrence of the third COVID-19 wave.⁸⁷ Past pandemics and the global pattern of COVID-19 point towards the likelihood of a third wave arriving sometime between September and November 2021.⁸⁸

The MCGM conducted four serological surveys across the city to estimate the prevalence of the infection in the population. The first two rounds were conducted in three wards, and the third and fourth round in all 24 wards. The surveys aimed to capture the exposure of the virus in slum and non-slum populations. The fourth round (conducted between 1 April and 15 June 2021) focused on the city's child population due to predictions that a potential third wave will severely impact youngsters.⁸⁹ (see Table 6D).

The serological surveys were done by testing the blood of people to identify the presence (or absence) of SARS CoV-2 antibodies. The presence of antibodies shows that people have been exposed to the virus (meaning, they have been infected). Sero-

surveys can therefore be helpful to predict the actual number of people infected in the community—those tested and treated for the disease, those who are asymptomatic, and those completely unaware of being infected. Repeated serosurveillance can offer insights into the infection rates and progression in various demographics and areas.⁹⁰

The first sero-survey revealed a high prevalence of COVID-19 in the slums (see Table 6A), while the second round showed a slight shift to the non-slum areas (see Table 6B). The surveys were initiated by the Tata Institute of Fundamental Research.

The third serosurvey explored the infection rates in slums and non-slum areas across all 24 wards (see Table 6C). The fourth survey was designed to study the exposure of the virus in the city's child population (see Table 6D). The third and fourth serosurveys were initiated by the MCGM.

According to experts, there is typically a 100–120-day gap between the peaks of two

Table 6A: Mumbai Serological Survey – First Round

Study period: 14 days in July 2020

Areas: Three wards (R-North, M-West and F-North)

Key findings: 57 percent prevalence in slums and 16 percent prevalence in non-slums

Ward	Estimated Prevalence in Slums	Estimated Prevalence in Non-Slums
F North (Matunga)	57.8%	17.4%
M West (Malad West)	56.7%	15.6%
R North (Dahisar)	51.0%	11.4%

Source: SARS-CoV2 Serological Survey in Mumbai by NITI-Aayog, Municipal Corporation of Greater Mumbai and the Tata Institute of Fundamental Research, and partner organizations, viz. Kasturba Molecular Diagnostic Laboratory, Translational Health Science and Technology Institute (THSTI), A.T.E. Chandra Foundation and IDFC Institute.

Table 6B: Mumbai Serological Survey – Second Round

Study period: 14 days in August 2020

Areas selected: Three wards (R-North, M-West and F-North)

Key findings: 44.9 percent prevalence in slums and 17.5 percent prevalence in non-slums

Ward	Estimated Prevalence in Slums	Estimated Prevalence in Non-Slums
F North (Matunga)	44.2%	19.6%
M West (Malad West)	48.4%	18.1%
R North (Dahisar)	43.6%	12.5%

Source: SARS-CoV2 Serological Survey in Mumbai by NITI-Aayog, Municipal Corporation of Greater Mumbai and the Tata Institute of Fundamental Research, and partner organizations, viz. Kasturba Molecular Diagnostic Laboratory, Translational Health Science and Technology Institute (THSTI), A.T.E. Chandra Foundation and IDFC Institute.

waves in any pandemic.⁹¹ By this measure, Mumbai's next COVID-19 wave could arrive around September or October 2021.⁹² But predictions made by the state's COVID-19 task force in a June 2021 meeting chaired by Chief Minister Uddhav Thackeray stated that the third wave could arrive by second week of July.⁹³ These differing forecasts underline the urgency of being prepared for a potential resurgence in cases.

The innate characteristic of the virus to attack easy targets places the unvaccinated in a vulnerable position. A sizeable proportion of the city's senior citizens have already been vaccinated, and many more will receive the jab over the next few months along with a large percentage of adults (18-60 age group) as vaccine availability improves and production is expanded. In such a scenario,

the largest unvaccinated group will be those below 18 years and children. Attending to infected adolescents and children will require specialised arrangements, medicines and equipment, as well as facilities for parents, with a customised treatment protocol.

The state-level paediatric task force, the first such body in the country, has recommended that hospitals, including jumbo COVID-19 centres, earmark paediatric and combined wards to accommodate parent-child positive cases. It has also urged the setting up of more Sick New Born Care Units, to ensure the availability of infant-friendly ventilators, and determine a children-specific treatment protocol.

In Mumbai, the MCGM's preparations for a potential third wave are underway since

Table 6C: Mumbai Serological Survey – Third Round

Study period: March 2021

Areas: All 24 administrative wards

Population covered: 10,197

Key findings: 41.6 percent prevalence in slums and 28.5 percent prevalence in non-slums

Slums	41.6%
Non slums	28.5%
Men	35.02%
Women	37.12%

Source: MCGM press notes

Table 6D: Mumbai Serological Survey – Fourth Round (Children)

Study period: 1 April 2021 to 15 June 2021

Areas: All 24 administrative wards

Population covered: 2176

Key findings: The overall sero-positivity among children was 51.18 percent, suggesting that nearly half the paediatric population has developed COVID-19 antibodies.

Age group	Sero-positivity
1 to 4 years	51.04%
5 to 9 years	47.33%
10 to 14 years	53.43%
15 to 18 years	51.39%

Source: MCGM press notes

The MCGM conducted **four serological surveys across the city** to estimate the prevalence of the infection in the population. The first two rounds were conducted in **three wards**, and the third and fourth round in **all 24 wards**. The surveys aimed to capture the **exposure of the virus in slum and non-slum populations**. The fourth round **focused on the city's child population** due to **predictions that a potential third wave will severely impact youngsters**.

mid-April 2021, with the commissioning of three new jumbo COVID-19 centres (with a total capacity of 5,300 beds), augmenting paediatric beds⁹⁴ and planning the installation of 16 more oxygen generation plants.⁹⁵ Additionally, existing jumbo centres are being repaired to ensure they can withstand seasonal changes.

RELAXING LOCKDOWN MEASURES

The WHO recommends a test positivity rate (TPR) below 5 percent for at least two weeks before governments consider reopening or relaxing lockdown measures. The TPR increases when most of those getting tested are positive and drops when

most tests return negative. Mumbai considers a weekly positive rate (WPR).

During the first wave, Mumbai followed the state government guidelines for unlocking when the city's TPR remained below 5 percent for two weeks. In the second wave, the Maharashtra government implemented a five-level unlocking plan based on two main parameters—TPR and occupancy of oxygen beds (*see Table 7*). Mumbai qualified for level 1 in mid-June 2021, yet the MCGM decided to follow the level 3 curbs by keeping schools, malls and theatres closed as a precaution until the end of the month due to concerns that new variants like Delta and Delta Plus may cause a third wave.⁹⁶

Table 7: Lockdown levels and criteria for Maharashtra

INDEX	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
Weekly Positive Rate	<5%	<5%	5% - 10%	10% - 20%	<20%
Oxygen Bed Occupancy	<25%	25% - 40%	<40%	<60%	<75%
Allowed	Complete Unlock	Public transport without standees Local trains for essential and medical workers, women Shops, offices, industry, public spaces for walkers and joggers open 50 percent capacity in malls, theatres, restaurants, gyms and salons Indoor sports activities	Public transport without standees Local trains for essential and medical workers Parks, gardens open 5-9 AM Essential shops open till 4 PM all days Minimal movement after 5 PM	Essential shops till 4 PM Restaurants only for takeaway and home delivery Public transport at 50 percent capacity	-
Closed	-	-	Malls and theatres	-	-
Restrictions	-	-	-	Curfew for non-essential work	Strictest restrictions Inter-district travel e-pass required

Source: Directorate General of Information and Public Relations office, Government of Maharashtra

THE BIG IDEAS

MUMBAI'S handling of medical shortages during the first and second waves has drawn national and international acclaim. But while vaccination is the surest way to end the pandemic, the MCGM must build on everything that has gone right and overcome its shortcomings to prepare for and tide over an almost inevitable third wave.

COVID-19-APPROPRIATE BEHAVIOUR⁹⁷

Adhering to COVID-19-appropriate behaviour is crucial to controlling future spikes. Wearing masks, washing hands, and maintaining physical distancing will be a part of the new normal for the foreseeable future. The MCGM has started door-to-door check-ups for children⁹⁸ and is disseminating the necessary information on do's and don'ts.⁹⁹ More focussed and sustained public awareness campaigns should be introduced to emphasise sanitation practices, curb spitting in public places, and promote etiquette in crowded and closed spaces.

TARGETED AND CONSISTENT TESTING¹⁰⁰

High volumes of daily testing are a must, especially in areas that show signs of spikes or clusters. High- and low-risk contacts of positive patients should be tested without fail. Rapid Antigen Tests should be rolled out where RT-PCR tests are not readily available. Antigen-negative individuals should undergo RT-PCR only if they show COVID-19 symptoms. Home-based antigen testing should be made available widely at affordable rates. Currently, Mumbai is seeing a fall in daily testing numbers¹⁰¹ and there seems to be little or no data on the availability of home-based antigen testing.¹⁰² Notably, antigen testing is almost as widely administered as RT-PCR.

ROBUST SURVEILLANCE TO MONITOR SPIKES¹⁰³

In June 2021, the MCGM started conducting genome sequencing in several of its 24 administrative wards.¹⁰⁴ Ward-level surveillance teams are monitoring and identifying spikes in infections that can become new waves. Genome sequencing should be a crucial part of surveillance to help identify new variants and their potential impacts. The early detection of variants will help with local containment measures. Lay reporting by spotters (laypersons from the local community, such as schoolteachers and community leaders), can help in early detection of outbreaks.¹⁰⁵

TRAINING PRIMARY AND SECONDARY CARE DOCTORS¹⁰⁶

General physicians and practitioners of alternative medicine (such as Ayurveda, Homeopathy and Unani) are typically the first responders. There must be an inclusive approach to train all doctors at the primary level in diagnosis, management, timely referral and triaging. At the secondary level, doctors in nursing homes and smaller hospitals must be trained in moderate to severe COVID-19 management. Such training has taken place for vaccination and needs to be extended to all medical management requirements.¹⁰⁷

WORKFORCE CAPACITY BUILDING¹⁰⁸

The administration must increase student intake at medical, nursing and postgraduate colleges. Improving the nurse-patient ratio at municipal and private hospitals must be prioritised. New COVID-19 facilities like the jumbo centres must recruit nurses on monthly contracts, extended as per the need.¹⁰⁹ Nurses, paramedics, doctors and specialists at hospitals must be hired on a permanent basis to avoid overworking existing staff and ensure patient care is not affected. The MCGM should ensure that all vacant healthcare posts are staffed and must create and hire for additional openings to cope with the high influx of patients expected during COVID-19 waves. The civic body must also train ASHA workers and anganwadi workers, often the first point of contact in informal settlements.¹¹⁰

UPGRADING CIVIC HOMECARE SERVICES¹¹¹

The MCGM should improve its home isolation care by connecting patients with doctors through video consultations. The existing model, where patients receive brief cursory calls from war rooms, may not be adequate in instilling confidence. Citizens must feel confident about the home care offered by the MCGM. The MCGM should hire private doctors to provide detailed consultations for physical and mental health during recovery. It can develop a public-private partnership model with private practitioners in each ward for telephone and video consultations.

DEVELOPING BETTER TELEMEDICINE SYSTEMS¹¹²

To overcome workforce shortages, robust telemedicine networks should be developed. Tele-ICUs and tele-wards will allow doctors to remotely assist about 40 patients simultaneously by studying reports and interacting live online. The Medical Council of India's 'Telemedicine Practice Guidelines' mentions COVID-19 only once, but could nevertheless serve as a basis for the MCGM to adopt such measures.¹¹³

MIGRANT POLICY, SPECIAL RESOURCE CENTRES AND HEALTH PORTABILITY

Health portability, currently partially available through central government schemes, is yet to percolate into the city systems. Migrants must be ensured healthcare access at their origin and destination locations, as well as have access to transit health services. The Aadhaar card or ration card must be accepted as identification for such facilities. Mumbai should map all health service delivery units and set up migrant resource centres and a state-wide call centre for the health care needs of migrants. Needs of migrants. Vaccinations should be prioritised for this group and should be provided near or on-site if common locations can be identified near workplaces in the city. Amid the pandemic, the MCGM held medical camps, conducted awareness campaigns and provided temporary shelters for migrants.¹¹⁴

COMMUNITY COVID-19 CARE CENTRES

The MCGM must make efforts to eliminate hesitation among the middle and upper classes to seek treatment at the jumbo COVID-19 centres. One way to do so is to encourage community care centres on a larger scale in big housing societies and in gated complexes that have large and enclosed but well-ventilated utility areas. Community halls, clubhouses and gyms can be converted into such facilities with a provision of ten beds and at least one oxygen cylinder and nebuliser.

REGULATING SMALL HOSPITALS

The civic body must regulate admissions to smaller private hospitals to avoid utilising beds over the available capacity, a main reason for Mumbai experiencing oxygen shortage in April-May 2021.¹¹⁵

OXYGEN PLANTS IN PRIVATE HOSPITALS

Barring Dr LH Hiranandani Hospital, Powai,¹¹⁶ no large well-established private hospital has an oxygen generation facility. All large hospitals must be mandated to set up oxygen generation plants. PSA plants are cost-effective, require less space than LMO plants, and have an approximately 30-year service life.¹¹⁷ Private hospitals must invest in this technology to reduce their dependence on outsourced oxygen. The government must consider offering easy payment options on loans and interest rate concessions to hospitals that are unable to take on the full financial burden of setting up these plants at one go.

GPS TAGGING OF TANKER TRUCKS

Currently, the transportation of oxygen happens by road using tanker trucks. This system is prone to pilferage and other malpractices. All oxygen tanker trucks must be GPS-tagged to track real-time movement and reduce delays and theft.

PAEDIATRIC-FRIENDLY MEDICINES AND FACILITIES

Experts have predicted the third wave to be about twice as severe as the second.¹¹⁸ Planning for medicines and other health facilities must take this into consideration. Certain conditions in the Revised Manual of Office Procedures for Procurement by the Government Departments, 2016¹¹⁹ must be relaxed to fast-track the bulk purchase of COVID-19 medical essentials. Newer medicines with varying degrees of success (such as Verafin, Baricitinib,¹²⁰ Colchicin,¹²¹ Casirivimab+, and Imdevimab,¹²²) must be included under the protocolled line of treatment with proper usage guidelines. Given the predicted target of the third wave (children), the priority must be on procuring paediatric medicines and creating childcare facilities with parent/guardian presence in all COVID-19 centres.

THE VACCINE IMPERATIVE



A lady senior citizen getting her vaccination at a drive-in facility at the Kohinoor public parking in Mumbai. Walk-in and drive-in vaccinations are open to senior citizens and the differently abled.

((Photo by ASHISH VAISHNAV/SOPA Images/LightRocket via Getty Images))

With only **10 vaccination centres** at the start of the inoculation drive, Mumbai now has **370 centres, including 87 in the private sector**. The city has bolstered its vaccination capacity to provide around **1,00,000 doses per day**, administering **the highest number of doses (1,80,821) on 28 June**. The MCGM has also commissioned the construction of a new **vaccine depot in Kanjurmarg** with a capacity to store up to **15 million doses**.

MUMBAI, like the rest of India, launched the first phase of its COVID-19 vaccination drive for healthcare workers on 16 January 2021. The vaccines were provided by the central government to all states, while on-ground logistics (allocating centres and workforce, creating cold chain for storage and other infrastructure) was provided by the local administrations (the MCGM in Mumbai).

Mumbai followed the central government's COVID-19 vaccination policy—a phased rollout for healthcare workers, then other frontline workers, and senior citizens and those above 45 years with comorbidities. This was followed by opening up vaccinations for everyone above 45 years and finally all above 18 years.

While the vaccines were developed and released quickly globally, there was limited data on efficacy and side effects, even when the DCGI announced emergency-use approvals for two vaccine candidates—Serum Institute of India's Covishield and Bharat Biotech's Covaxin.¹²³

The initial weeks of the vaccine drive saw widespread hesitancy; merely 50 percent of Mumbai's 1,90,000 registered healthcare workers took the shot in the first 30 days.¹²⁴ The drive saw an uptick in pace after it was opened for frontline workers on 3 February, and average daily vaccinations rose from 3,966 in January to 7,896 in February.¹²⁵ The programme accelerated only when expanded to include senior citizens and those above 45 years with comorbidities (1 March onwards), with the daily average rising to about 35,000 (*see Table 8*). Many vaccination centres saw chaos and overcrowding.¹²⁶ Soon, vaccine stockouts were reported from across the city due to a slowdown in supply from the Centre.¹²⁷

The MCGM estimated that 3.5 million people were eligible to get vaccinated as part of the prioritised groups; with the addition of all eligible individuals in Mumbai (above 18 years old), the number increased to an estimated 9 million.¹²⁸ As of 30 June, over one million people have been fully vaccinated, while more than 3.3 million have got at least one dose.¹²⁹

The **dissemination of information** to the public **was challenging** due to the irregular availability of vaccine doses and collation of data. Nevertheless, in addition to press briefings, the MCGM used **Twitter to communicate** with the masses regularly.

DIGITAL AND CLASS DIVIDE

India's fully digitised COVID-19 vaccination drive (run through the CoWin portal and app) is a first for the country. The MCGM identified 4,000 frontline healthcare workers to receive the vaccine on the launch day (16 January). The contact details of these individuals were fed into CoWin system so they could get automated text messages about the vaccination. But glitches with the app forced the MCGM to send out SOS messages to all ward officials to reach out to the beneficiaries. Finally, 1,926 individuals were vaccinated on the first day.¹³⁰ The MCGM responded to the persistent CoWin glitches over the following days by allowing walk-ins, a deviation from the Centre's policy to vaccinate only through online appointments. Soon, the state allowed other corporations and districts to vaccinate by registering people on the spot.¹³¹

CoWin-related digital roadblocks became more pronounced as the vaccination drive was opened to more people. The initial mandate for online registrations and appointments at vaccination centres in Mumbai also caused a clear class divide—people from educated and affluent backgrounds formed the majority of those vaccinated, while those from the lower socio-economic strata were excluded.¹³²

Some of the causes for this were the difficulty in accessing and using the app,¹³³ and the potential loss of income for taking a day off to get vaccinated.¹³⁴ As a result, the MCGM piloted a project in Dharavi with an NGO, Bharatiya Jain Sanghatana, to assist beneficiaries in registering on the app.¹³⁵ They also set up a community vaccination facility at the Dharavi Urban Health Centre attached to the LTMG Hospital and Medical College in Sion, but only 64 vaccines were administered on the first day (22 March), far below the targeted 1,000, underlining the rampant vaccine hesitancy.¹³⁶ To counter this, the MCGM partnered with local corporators, physicians and influential leaders in the area to speak to the locals about vaccinations. By mid-April, the Dharavi centre was vaccinating an average of 600 people daily.¹³⁷

The dissemination of information to the public was challenging due to the irregular availability of vaccine doses and collation of data. Nevertheless, in addition to press briefings, the MCGM used Twitter to communicate with the masses regularly.

FROM SHORTAGE AND CHAOS TO DECENTRALISATION AND DECONGESTION

On 1 April, the day vaccinations were opened for all above 45-year-olds, several centres

in the city reported shortages of Covaxin. In the following days, Covishield scarcities were also recorded. On 9 April, the MCGM announced the suspension of vaccination drives at some of its biggest centres, including the BKC jumbo centre, citing a shortage of vaccines.¹³⁸ As a result, the city's daily average fell to around 25,000 doses from a high of 40,000 doses.¹³⁹

Interestingly, the shortage triggered a change in people's behaviour and "vaccine hesitancy was replaced by vaccine desperation".¹⁴⁰ Serpentine queues stretching for kilometres were seen at several centres when vaccinations were restarted, prompting the MCGM to consider better ways of crowd management. The civic body introduced a slew of measures for the decongestion of vaccination centres. Following the Centre's decision to give states and local bodies more freedom over their vaccine drives in May, the MCGM diversified its centres beyond hospitals. In April 2021, the MCGM announced 227 new centres (one in each electoral ward) to complement the existing 63 centres.¹⁴¹ Corporators were tasked with identifying and setting up such centres.

On 12 May, the city adopted a new vaccination strategy—on-the-spot

registrations on the first three days of the week, targeting those who could not book appointments online; the remaining days were reserved for online appointments. This move led to a significant reduction in overcrowding. Public centres were also told to limit vaccinations to about 200 people. Mumbai, which started its vaccination drive with ten centres, now has 370 centres, including 87 in the private sector.¹⁴²

Mumbai has bolstered its vaccination capacity to provide around 1,00,000 doses per day, administering the highest number of doses on 28 June (1,80,821).¹⁴³ The MCGM also commissioned the construction of a new vaccine depot in Kanjurmarg with a capacity to store up to 15 million doses. However, the facility has not yet been filled to capacity, indicating that vaccines are still not available in the desired quantity.¹⁴⁴

PRIVATE SECTOR TAKES OVER

The MCGM was among the earliest local administrations to seek the participation of major private hospitals in the vaccination drive, with people paying for their vaccines.¹⁴⁵ However, initially, the Centre only allowed private hospitals empanelled under the Pradhan Mantri Jan Arogya Yojana (PMJAY)

Table 8: Average Daily Vaccinations in Mumbai (as of 14 June 2021)

January	3,966
February	7,896
March	34,418
April	43,982
May	31,843
June	71,964*

Source: Data compiled from daily MCGM vaccination reports.¹⁴⁶

The MCGM announced **227 new vaccination centres** (one in each electoral ward) to complement the existing **63 centres**. Corporators were tasked with identifying and setting up such centres.

to provide this service. But most PMJAY-empanelled hospitals in Mumbai lacked the resources, space and workforce required for such an effort.

By March 2021, the Centre relaxed the norms to allow big trust-run private hospitals to join the national vaccination programme. Jaslok Hospital at Peddar Road, Dr LH Hiranandani Hospital in Powai, and Sir HN Reliance Foundation Hospital at Charni Road soon began vaccination drives.

On 27 February, the Centre announced that private hospitals can procure vaccines from it at INR 150 per dose and vaccinate people for INR 250.¹⁴⁷ Several other private facilities, including Breach Candy Hospital, Lilavati Hospital and Bombay Hospital, joined the drive. This helped significantly decongest public vaccination centres.

The Union health ministry's Liberalised Pricing and Accelerated National COVID-19 Vaccination Strategy marked a major shift from the existing policy.¹⁴⁸ From 1 May, the Centre ceased providing vaccines to the private sector, forcing them to negotiate directly with manufacturers to procure stocks and causing a severe slowdown in the vaccination drive.

Nevertheless, by end May, daily vaccinations at private hospitals surpassed

those in the public sector, and by early June, the private sector was administering up to 70 percent of all doses in the city.¹⁴⁹

As supply increased, private hospitals held vaccination drives in housing societies and workplaces, but vaccine pricing became an issue. Private facilities were charging between INR 700–1,000 per Covishield dose and INR 1,250 for a Covaxin dose.¹⁵⁰ In May, the Serum Institute of India had announced a price of INR 600 per dose of Covishield for private hospitals and Bharat Biotech priced a dose of Covaxin at INR 1,200.¹⁵¹ On 8 June, the Union health ministry capped the service charge levied by private hospitals to INR 150, reducing the cost of a Covishield shot to INR 780, Covaxin to INR 1,410 and the newly approved (for use in India) Russian vaccine Sputnik to INR 1,145.¹⁵²

The lack of policy cohesion created many hurdles in the vaccination drive. In May, the onus of procuring vaccines for the 18–44-year age group was put on the states and private hospitals. But over a month later (on 7 June 2021), the Centre amended the policy to again acquire vaccines for the states while private hospitals would continue to buy from manufacturers directly.¹⁵³ A record 8.5 million vaccine doses were administered across India on 21 June. Additionally, the number of doses administered in Mumbai crossed 1,00,000 on the same day.¹⁵⁴

THE BIG IDEAS

Ensuring vaccine availability is among the MCGM's most crucial tasks. Stockouts break the momentum of the vaccination drive and inconvenience people, potentially demotivating them from returning to the centres if they have been turned away once. The civic body should provide real-time online and offline updates on vaccine stocks.

MULTI-PRONGED APPROACH FOR VACCINATION CENTRES

The MCGM should consider a three-pronged strategy for those getting vaccinated in public centres—separate facilities for pre-registered individuals, walk-ins, and drive-ins for those unable to walk into centres. More drive-in centres should be started. More centres should be accessibility-friendly by creating ramps and making wheelchairs readily available to encourage the old and differently-abled to get vaccinated. Providing transportation to the vaccination centres (by partnering with NGOs) and reducing the wait time there are key issues that need attention.

TARGETING EXCLUDED GROUPS¹⁵⁵

Data suggests that by June, a sizeable proportion of the 45-59-year age group (a vulnerable section) had a lower uptake of vaccines.¹⁵⁶ Vulnerable groups are those that step out to work and are largely mobile, or who have comorbidities. Targeted campaigns should be conceptualised to engage and convince increased participation from groups that are not participating enough in the vaccination drives. The MCGM should appoint trusted vaccine ambassadors to encourage people to get inoculated. For instance, in Madhya Pradesh, vaccinated frontline workers educated young family members on the need to get vaccinated.¹⁵⁷

TAILORED COMMUNICATION STRATEGIES¹⁵⁸

Vaccine hesitancy continues to persist in slum pockets and among sections of the educated and affluent groups. The MCGM should tailor communication strategies to target specific audiences and open two-way communication channels to address people's apprehensions. Community health workers on the field should conduct quick surveys to understand the public perception about the vaccine and the vaccination drive.

BRIDGING THE GENDER GAP¹⁵⁹

According to the CoWin data, as of 10 July, only 27,17,306 women have been vaccinated compared to 34,13,830 men. In Mumbai, there is a 23-percent gap in vaccinations between men and women,¹⁶⁰ and the MCGM must investigate the causes (are women excluded because of lack of identity proof documents, no access to a device to register, or perhaps inability to reach a vaccination centre?). One way to encourage more women to get vaccinated is to organise women-only drives. Women-led self-help groups, especially those in the slums, can play a crucial role in motivating women to get vaccinated.

TRAINING STAFF AND REPURPOSING ROLES¹⁶¹

Trained staff is crucial to conduct vaccination drives and identify immediate 'adverse event following immunisation'. A trained workforce is also important to ensure that vaccine storage in the cold chain is not compromised at any point. Webinars and training sessions should be conducted at regular intervals for healthcare and paramedical staff.

A RELIABLE DIGITAL PILLAR



Municipal employees at work in the disaster management room at their headquarters in Mumbai. When COVID-19 arrived in India, few places looked as vulnerable as Mumbai, but the city managed to tackle a vicious second wave with a fair degree of success.

Photo by PUNIT PARANJPE/AFP via Getty Images)

Given India's massive digital divide, **technology solutions for pandemic management** should focus on **legacy infrastructure** that can **reach every citizen** and **empower on-ground personnel** with accurate information. Tech responses should be **"phygital" (physical + digital)** in nature to **enable offline teams to physically verify and report situations on the ground** for an accurate picture of the crisis.

DIGITAL responses during the first wave of the pandemic saw the use of a variety of smartphone apps to detect potential and active COVID-19 cases, given India's vast number of mobile phone users. In cities like Bengaluru, people who had travelled abroad were required to download a government app and upload a selfie every hour to show that they had not violated their quarantine.¹⁶² However, many of these interventions were ineffective in controlling the spread or giving accurate information and also raised privacy concerns.

Unable to automate the collection of reliable data directly from users on how the virus was spreading, Mumbai's governance using technology during the first and second waves was an iterative process. Information and data were manually gathered and entered into shared spreadsheets during the early days of the first wave, and then gradually automated with software tools with MCGM staff entering information on patients to coordinate efforts. It is tempting for administrators to leverage the large number

of telephony users to coordinate and get data about citizen's health through various smartphone apps.

Mumbai has a large tele-density of about 38 million subscribers making it an important telecommunications hub.¹⁶³ But India suffers from a massive digital divide among internet users and a lack of digital literacy. Further, a significant part of the population still only uses 2G services and do not use smartphones and are therefore not connected to the mobile internet. Against this backdrop, technology solutions for pandemic management should focus on legacy infrastructure that can reach every citizen and empower on-ground personnel with accurate information. Tech responses should be "phygital" (physical + digital) in nature to enable offline teams to physically verify and report situations on the ground for an accurate picture of the crisis.

BUILDING AN INFORMATION PIPELINE

Several information pipelines were built during the first and second waves, for instance

India has also had **to tackle an infodemic** along with the pandemic. **Initial misinformation focused on the nature of the disease** (origin and means of transmission), then **on testing and vaccination**, finally evolving into **propaganda to create divisions** among different sections of people.

those that helped the MCGM handle hospital bed capacities. Tackling a potential third wave will require more such information pipelines.

Creating information pipelines was possible because of the MCGM's existing decentralised hierarchy (see Figure 4). The decentralised system was activated to create a digital conduit for information, and ward staff was repurposed to support this system. This helped the MCGM follow a 'hub and spokes model' to share information and resources.

The pipeline originated at the testing labs. Labs were instructed to delay giving information about COVID-19 positive cases to the patients directly and to inform the MCGM instead. This practice allowed the civic body to get a headstart on triaging resources and curbing panic and crowding at hospitals to avoid potential bed scarcity. MCGM staff in the ward war rooms contacted COVID-19 positive patients to determine if they required hospitalisation or could be moved to isolation and quarantine centres. The staff also verified if at-home patients were following COVID-19-appropriate behaviour.

The MCGM also built a database of hospital beds, with information uploaded via the SEER software on a dashboard for easy visualisation.

MCGM officials actively involved in contact tracing efforts said information pipelines are key to coordinate responses in a timely and efficient manner.¹⁶⁴ For instance, following the unanticipated oxygen crisis during the second wave, MCGM teams evaluated the storage capacities and structures in hospitals across the city, and created a database on available oxygen capabilities. This process will now be automated in cooperation with hospitals to monitor oxygen levels amid the anticipated third wave.¹⁶⁵

HEALTH AND VACCINE TECH

Functioning ambulances are crucial to control fatalities during public health crises. The Maharashtra State Emergency Services runs 937 ambulances for free for the public through the 108 hotline. During the second wave of the pandemic, 10 ambulances were stationed at each of the city's 24 wards.¹⁶⁶ In addition, 800 SUVs were refurbished to function as makeshift ambulances to transport patients with mild symptoms to hospitals.

The MCGM also launched the Project Victory initiative to assist around 10,000 kidney failure patients who were undergoing dialysis on a prolonged basis.¹⁶⁷ The MCGM partnered with the Indian Institute of Technology Bombay, to develop a web portal and software that captures available dialysis slots across the city, and also set aside 84 dedicated machines for COVID-19 patients who needed dialysis.

All eligible citizens are required to use the centralised CoWin portal or app to register for vaccinations. While it gives accurate information about available vaccine slots and maintains individual vaccination records, CoWIN is plagued by many issues and is in dire need for improved accessibility.¹⁶⁸

Initially, the CoWIN app was inaccessible to many citizens since the interface was available only in English. Since July 2021, the app is available in ten languages, including Hindi and Marathi. Some state governments have also floated the idea of building news apps for their vaccination drive.¹⁶⁹

New technologies like machine learning and artificial intelligence (AI) can play a big role in modelling patterns and forecasting surges in caseloads. However, agent-based solutions and apps that require users to enter data have not been effective in containing the virus. Machine learning algorithms require enormous sets of data to build context and with input data constantly changing in a pandemic, it might lead to inconsistent outputs.

For instance, contact tracing app Aarogya Setu, which uses Bluetooth and

GPS, was meant to be an early warning system of potential hotspots by crunching data collected using AI algorithms. But this plan did not account for the significant population that does not use smartphones and that contact tracing apps require 60 to 80 percent adoption to be accurate.¹⁷⁰

Aarogya Setu also requires users to self-declare symptoms, but users may not always input accurate information. The reliance on user-generated data to tackle COVID-19 has not been effective owing to several barriers to access and understanding. Setting up manual data pipelines with accurate data and information through 'phygital' models can augment ground staff efforts.

DIGITAL OUTREACH AND MISINFORMATION

Amid the pandemic, India also had to tackle an infodemic (when online misinformation leads to the spread of diseases¹⁷¹). The crisis of fake news and misinformation has had a deep impact due to increased social media usage. Initial misinformation focused on the nature of the disease (origin and means of transmission), then on testing and vaccination, finally evolving into propaganda to create divisions among different sections of people.¹⁷² To curtail the spread of misinformation, the Centre invoked Section 54 of the Disaster Management Act, 2005.¹⁷³

The Union IT ministry has issued several advisories to social media platforms, which are required to follow due diligence as prescribed in the IT (Intermediary Guidelines and Digital Media Ethics Code) Rules, 2021, under Section 79 of the IT Act. These advisories expect social platforms to initiate awareness campaigns, take action

to disable or remove content identified as misinformation, promote the dissemination of authentic information, and issue warnings to imposters misusing the platform.¹⁷⁴

The MCGM has also taken steps to curb misinformation, allying with the WHO to enhance these efforts.¹⁷⁵ Additionally, the Mumbai police issued orders under Section 144 of the Criminal Procedure Code that prohibits persons from disseminating ‘incorrect’ or factually distorted information

through social media platforms and other websites. The order also prohibits the spread of statements that are discriminatory to any community or may cause confusion or panic among the public.¹⁷⁶ Nevertheless, misinformation persists, impacting vaccination efforts. For instance, a large proportion of Dharavi residents refused to take the vaccine due to misinformation related to its efficacy and side effects, prompting the civic body to revamp its immunisation drive for the area.¹⁷⁷

THE BIG IDEAS

TECH VOLUNTEER FORCE

The MCGM should partner with volunteers and NGOs to help people register on CoWIN or other COVID-19 apps to help close the digital divide. Volunteers aiding people with digital tools was previously seen during the 2016 demonetisation exercise.¹⁷⁸ Similar initiatives can help in the vaccination drive.

STRENGTHEN AND SUPPLEMENT COWIN

The programming interface of the CoWIN app is public, and state and city governments can design apps and websites in local languages to support other functionalities. Although multiple users can be registered on a single phone number on CoWin, vaccine slots must be booked individually. Local governments should consider building functionalities for booking slots for multiple individuals simultaneously.

A DIGITAL CREMATORIUM PIPELINE

A crematorium pipeline can help assess whether there is enough capacity for a dignified cremation or burial. In Bengaluru, the Bruhat Bengaluru Mahanagara Palike (BBMP) partnered with the state civil defence and animal husbandry departments, local NGOs and volunteers to ease delays at crematoriums.¹⁷⁹ The BBMP has now instituted a real-time monitoring system that separates COVID-19 patients from others, and a control room to handle the crisis. The MCGM can consider establishing a similar information pipeline for Mumbai.

DEVELOP MISINFORMATION-CURBING STRATEGIES

The MCGM must partner with fact-checking companies as well as develop a system for citizens to flag misinformation. The civic body uses Twitter to clarify or dismiss misinformation, but there is scope to use other forms of media to tackle COVID-19 related fake news and spread awareness. The WHO has teamed up with the UK government to create the ‘Stop the Spread’ programme that is aired on *BBC*.¹⁸⁰ Cambridge University and the UK Cabinet Office have also created an innovative online game ‘Go Viral!’ to reduce the perceived reliability of coronavirus related fake news.¹⁸¹

METROPOLITAN MUMBAI AND THE PANDEMIC



Clouds hover over Mumbai skyline as visible from a high-rise at Elphinstone in Mumbai, India.

(Photo by PRATIK CHORGE/Hindustan Times via Getty Images)

At least **40 percent** of Mumbai's public health services are accessed by **people from the MMR**, particularly **Thane, Navi Mumbai, Vasai-Virar, and Mira Road**. Given the excess pressure of individuals from the MMR, the MCGM built jumbo centres **at Dahisar and Mulund** and redirected patients from MMR to those facilities.

THE MMR is one of the fastest growing metropolitan regions in India. Spread over an area of 6,328 sq km,¹⁸² the MMR comprises nine municipal corporations, nine municipal councils and over 1,000 villages,¹⁸³ and is home to over 23.59 million people.¹⁸⁴

The MMR consists of Greater Mumbai (Island City and Suburban) and the three part-districts of Thane, Palghar and Raigad. Greater Mumbai is the area that falls under the purview of the MCGM (and what is commonly referred to as Mumbai), spanning from Colaba in the south to Dahisar in the north, Versova in the west and Mulund in the East. The satellite cities are Thane, Navi Mumbai, Mira-Bhayander, Kalyan-Dombivli and Panvel among others.

Mumbai cannot flatten the COVID-19 curve in isolation; this must simultaneously happen across the MMR to be effective. The MMR is deeply integrated with the city of Mumbai, which is in effect “the mother city and represents a significant engine of growth for the whole region”.¹⁸⁵ Under normal circumstances, about 7,00,000 people enter Greater Mumbai from the surrounding areas in the morning peak hours for work,¹⁸⁶ returning home in the evening.

From an overall planning, economic and transportation perspective, all the urbanised areas of the MMR function as a single entity, with people traveling between municipal jurisdictions for work, education, shopping and personal needs.¹⁸⁷ The lack of affordable housing in Mumbai and higher costs of living have forced people to live outside the city but travel to it daily for work.

At least 40 percent of Mumbai's public health services are accessed by people from the MMR, a trend seen during COVID-19 as well, particularly Thane, Navi Mumbai, Vasai-Virar, and Mira Road. Given the excess pressure of individuals from the MMR, the MCGM built jumbo centres at Dahisar and Mulund and redirected patients from MMR to those facilities.¹⁸⁸

Most of the travel between Mumbai city and the MMR happens by local trains run by the suburban railway system. The rail system became a ‘super spreader’ of the virus.¹⁸⁹ Given the interconnectivity between Mumbai and the MMR, it is critical to look at the larger region as a single entity and build virus containment strategies accordingly. Importantly, the MMR is home to about one-fifth of Maharashtra's population and

Table 9: Impact of COVID-19 on Mumbai and MMR

	FIRST WAVE				SECOND WAVE			
	MUMBAI		MMR*		MUMBAI		MMR*	
DATES	1 July 2020	11 Sept 2020	1 July 2020	11 Sept 2020	6 May 2021	7 Jun 2021	6 May 2021	7 Jun 2021
DAILY CASES	1,487	2,191	1,787	2,135	3,028	730	3,115	610
CUMULATIVE CASES	79,145	1,65,306	47,741	3,30,098	6,68,085	7,11,373	5,59,349	6,03,565
CUMULATIVE DEATHS	4,631	8,067	1,104	4,386	13,580	14,999	7,837	9,366

* MMR figures represent the total of the data of all municipal corporations in MMR except MCGM.

Source: Media Bulletin, State Surveillance Officer, Maharashtra

accounts for more than 40 percent of the state's GDP.¹⁹⁰ If the state is to get back on its feet quickly, ridding the MMR of the virus ought to be a prime concern.

COVID-19 WAVES IN MMR

The most noticeable feature of the first wave of the pandemic in the MMR was that it was urban-centric and almost coincided with the first case in Greater Mumbai.¹⁹¹ The first COVID-19 case in Mumbai was recorded on 11 March 2020, and in MMR on 14 March.¹⁹² Mumbai and the MMR were heavily impacted, with cases peaking around mid-September before declining.¹⁹³ By the end of September, Maharashtra has recorded

over 1.4 million infections and more than 36,000 deaths,¹⁹⁴ with Mumbai and the MMR contributing about 35 percent of cases and deaths (*see Table 9*).¹⁹⁵

In the second wave, COVID-19 ceased to be a primarily urban phenomenon as it spread to rural areas.¹⁹⁶ Despite this, data shows that Mumbai and the MMR continued to be the worst-hit regions in Maharashtra (*see Table 9*).¹⁹⁷ The MMR's vaccination efforts are more robust than most states. However, given existing vaccine shortages, a sizeable portion of the MMR population will likely remain unvaccinated when the predicted third wave arrives.

THE BIG IDEAS

THIRD WAVE AND MMR'S HEALTH INFRASTRUCTURE

The MMR's health infrastructure is decidedly better than in many parts of the country. The MMR's municipal corporations are equipped with reasonable medical facilities, private hospitals, doctors, labs, testing facilities, medical equipment, and delivery systems, including digital connectivity. The health infrastructure of the smaller councils and villages in the MMR, however, need strengthening. The MMR must concentrate on specific infrastructure, such as oxygen, medicines, ventilators, specialised paediatric beds and equipment. Maharashtra has also set up a paediatric task force for expert advice ahead of the predicted third wave,¹⁹⁸ and the MMR should heed its advice.

VACCINATION AVAILABILITY AND ROLLOUT

Global experts acknowledge that vaccinating people is the best preparation for future waves. As the vaccines become available in large numbers, the MMR should involve private-sector hospitals and medical practitioners to participate in administering jabs.

LEARNING FROM GLOBAL BEST PRACTICES



A citizen being administered the second dose of the vaccine at the District Nurses' Training Centre in Thane on 15 May 2021.

(Photo by PRAFUL GANGURDE/Hindustan Times via Getty Images)

The decision to focus on **the older population** in the initial phase of the vaccination drive was based on **the trends of the first wave**. Gathering **fresh data on the new variants** will help determine whether **the age-based prioritisation** should be pursued over **an area-based strategy**. Vaccination plans should prioritise the most vulnerable, including through geographic targeting.

NATIONAL, state and city level responses to the pandemic (including data and supply chain management), policies regarding vaccine procurement and rollout, and the effectiveness of public health governance systems are based on the local context at that specific time. Therefore, international best practices can only be a source of learning if the challenges can be identified as similar and remedies can be contextualised (or replicated in some cases) with the local resources available and applicable. There are two aspects of the pandemic where studying global examples could be useful—vaccination and transportation. Studying some examples will prove useful.

AREA-BASED VACCINATION CRITERIA (TORONTO, CANADA)

Mumbai has followed the Centre's guidelines and directions on the age-based criteria to vaccinate citizens, with exceptions such as vaccination drives for students traveling abroad for higher studies or people travelling for jobs.¹⁹⁹ Similar strategies have been followed in other countries as well.

However, the city of Toronto's vaccination plan differs from the more

conventional age-based vaccine rollouts as it focuses on prioritising and targeting postal code areas with high rates of COVID-19 cases. Mobile and pop-up vaccination clinics are sent to hotspot communities and neighbourhoods where all residents over the age of 18 are eligible to register and receive the vaccine.²⁰⁰ As of 1 June 2021, Toronto's 'Sprint Strategy' has had a sizable impact, with over 70 percent of the eligible adult population receiving at least one dose of the vaccine and the children over 12 years now eligible for the shot.²⁰¹ The 'Sprint Strategy 2.0,' which began on 10 June, refocused efforts to provide access to first and second vaccine doses in neighbourhoods with a) high incidence of COVID-19, b) low vaccine coverage, and c) where the Delta variant has been identified.²⁰² Mumbai can consider similar efforts once the vaccine rollout and acquisition is smoother to ensure the most vulnerable populations are inoculated as soon as possible.

In the geographically targeted versus age-based vaccination debate, a study comparing the US's states of California and Minnesota conclusively revealed that COVID-19 vaccination schedules based on age benefit older and white populations, at the expense of younger Black, indigenous, and

other people of colour, who statistically have a higher risk of death from COVID-19.²⁰³

Gathering fresh data on the new variant that is affecting younger people in India is needed to determine whether the age-based prioritisation should still be pushed over an area-based strategy. Strategies should prioritise the most vulnerable, which includes geographic targeting.

VACCINE MANAGEMENT (THE UK)

Despite a poor performance in containing and tracing the virus's outbreak, the UK became the first country to administer vaccines in December 2020 and by February 2021, 13.7 percent of its population had received at least one dose of the vaccine, a far quicker rate than that of the US and the European Union at the time.²⁰⁴

London's diverse population has played a role in the city's vaccination rates lagging behind the rest of the country by more than ten percentage points, as of May 2021.²⁰⁵ According to a survey, there is much greater vaccine hesitancy among ethnic minority populations.²⁰⁶ To combat the city's lagging vaccination rates, the Mayor of London and health officials have requested the UK government to allocate more vaccines recommended for the under-40 age group and increase the accessibility to shots.

More walk-in and pop-up clinics have been opened, alongside vaccination buses and large community vaccination centres. Although not an official policy, healthcare providers are encouraged to prioritise administering vaccines regardless of age and not turn people away from vaccination clinics.²⁰⁷

Under the leadership of venture capitalist Kate Bingham, the UK's Vaccine Taskforce (VTF) was praised for its procurement deals and the quick rollout of vaccines. The VTF developed a procurement strategy based on securing access to the most promising and rapidly developing vaccine candidates that would enter trials in 2020 and spread its candidates across four different categories—adenoviral, mRNA, protein-adjuvant, and whole viral—to minimise risk if one type failed to deliver.²⁰⁸ The UK also incentivised vaccine producers to provide early access by supporting companies with costs of upscaling manufacturing and offering resources to conduct vaccine trials. Through this strategy, the UK has secured 367 million vaccine doses by January 2021.²⁰⁹

VACCINE RECORDS AND PASSPORTS

With vaccinations underway, and countries charting post-COVID-19 plans for gatherings and travel, the concept of digitally-verifiable vaccine records and passports has gained traction. The US has taken a different approach; instead of depending on technology for its records, maintaining digital vaccine records are left to the state governments and the private sector over fears that people may be more reluctant to get vaccinated if there is federal overreach and apparent 'interference'.

Currently, those vaccinated in the US receive printed cards from the Center for Disease Control and Prevention (CDC) that has their name, date of birth, patient number (if applicable), vaccine received (Pfizer or Moderna), when and where the doses were taken, and the batch number of the vaccine administered. While the CDC also keeps records, these cards cannot be used for

With vaccinations underway, and countries charting post-COVID-19 plans for gatherings and travel, the concept of **digitally-verifiable vaccine records and passports** has gained traction. Indian states and cities must **start developing vaccine certification technology** as more people are inoculated and restrictions are slowly lifted.

verification purposes if records were to be made mandatory for entering establishments or travel, as forgery would be easy.²¹⁰

If a scannable QR code becomes the norm for airlines and establishments, even Indian vaccine certificates issued through the CoWIN app will not suffice. Therefore, third party applications that provide such digitally verified vaccination status will be required.

The state of New York released the first state-backed vaccine passport, called the Excelsior Pass, in March 2021. Built by IBM, the certificate allows people in the state who have been vaccinated and/or have recently tested negative to download their record onto an app that converts it into a QR code scannable by participating agents (venues, airlines, anyone who signs up for the programme).

Singapore is also digitising its vaccination records by using blockchain technology to develop a global standard for verifying COVID-19 test results and vaccinations, calling these records HealthCerts.²¹¹ Discussions are ongoing to create a similar system in other Southeast Asian countries as well. Built on a system of blockchain certificates, this cross-nation system will help standardise requirements regarding

COVID-19 vaccinations and tests and aim to facilitate travel between Singapore and Malaysia, with the possibility of more countries (like Indonesia) joining the system.²¹²

TECHNOLOGY FOR SAFE TRANSPORT

Mumbai was severely affected by the pandemic. In March 2020, all local/suburban trains, metros and monorails were closed to curtail the spread of the virus. In June 2020, Mumbai's local trains were resumed for essential and emergency workers,²¹³ including central, state and municipal government and nationalised bank employees. By May, various other categories of commuters, including women, were allowed during restricted hours. In February 2021, after a gap of nearly 320 days, the local trains were opened for use to the general public for limited hours.

In January 2021, before the second wave hit India, 2,985 local train services (about 95 percent of total service) were operational on the Mumbai suburban network. Additionally, 204 special suburban services were added on 9 April.²¹⁴ This leads to the reasonable inference that the reopening of urban mobility services in Mumbai was a major factor in the spike in number of cases during the second wave.

The COVID-19 pandemic has severely impacted urban mobility globally. Studies show that 70 percent of respondents were wary of going back to pre-pandemic levels of public transport usage.²¹⁵ To return to using public transport, participants expressed a desire for more buses on the road to lessen the chances of vehicles being uncomfortably crowded and for greater access to data on how packed vehicles are at different times. The WHO has also released guidelines for government, transport providers and commuters in the context of urban mobility to ensure hygiene, physical distancing, and other actions for safe travel.²¹⁶ Many administrations and transport operators around the world have begun to take measures to maintain higher hygiene standards.

In Azerbaijan's Baku, the Baku Transport Authority (BTA) played a significant role in the government's coordinated pandemic response plan. The BTA swiftly disinfected all buses, taxis and parking areas, drivers were requested to wear protective gear (face masks and gloves) while on duty, and hand sanitiser dispensers were installed on all buses. The BTA also conducted awareness raising campaigns; posters containing information

were placed at all stations and booklets were distributed to passengers at the city's main public transport interchange.²¹⁷

Following a steady decline in ridership, the Seoul Metro rebuilt passenger confidence through hygiene measures and strong staffing protocols, including a staff evacuation plan. If a staff member showed COVID-19 symptoms, they were immediately isolated in a dedicated room with an in-house nurse. If the staff member was confirmed to have COVID-19, all other workers in the team were evacuated and replaced by a backup team to keep operations running smoothly and safely.²¹⁸

Meanwhile, Hong Kong has introduced direct financial support to taxi minibus drivers and owners and has reimbursed 100 percent of regular repair and maintenance costs and insurance premiums for six months for its franchised bus and ferry operators. This has been done to cover any loss of income they may have faced during the pandemic when people did not use public transport. Much of the costs that transport vehicles incur are to do with insurance and maintenance of vehicles.²¹⁹

THE BIG IDEAS

VACCINE CERTIFICATES

As India inoculates more of its population and considers a post-COVID-19 roadmap, states and cities must start developing vaccine certification technology as restrictions are slowly lifted. Certificates on CoWIN and details of inoculation can go into a person's account on a trusted and government-verified third-party app that presents a scannable code.

SAFE TRANSPORT SERVICE

To reinstate people's trust in public transport services, India could create a COVID-19 green label that shows that operators have met standards and are ready to restart operations. Other interventions could include introducing temporary tax waivers, extending the validity of various documents, such as permits and insurance, improving the efficiency of services with dedicated bus lanes, developing digital payments, relaxing permit restrictions to mobilise private buses, and allocating a larger share of urban mobility resources to bus transport.²²⁰

RECOMMENDATIONS: PREPARING FOR THE THIRD WAVE



Mumbai's Bandra-Worli
Sea Link.

(Getty Images)

The pandemic caught Mumbai by surprise, compromising **the city's weakest link**—public health services infrastructure and management. Fifteen months and two waves on, **Mumbai managed to avert a far worse situation** due to its strong leadership, quick decision-making, and robust financial makeup.

LIKE the rest of the country, the pandemic caught Mumbai by surprise, compromising the city's weakest link—public health services infrastructure and management. It strained an already over-pressured system, and the rapidly rising COVID-19 cases forced the MCGM to immediately adopt a firefighting strategy. Fifteen months and two waves on, this report indicates that the city managed to avert a far worse situation due to its strong leadership, quick decision-making, and robust financial makeup.

The following action points will define the success of Mumbai's strategy in dealing with the predicted third wave:

A MUMBAI+ PLAN

The MCGM must adopt a 'Mumbai+' approach for vaccinations and reopening the city if it hopes to restore normalcy soon. Over 60 percent of Mumbai's working population comes from the MMR and the administrative boundaries of the MCGM are porous. Currently, the MCGM has extended few of its jumbo facilities at BKC, Dahisar and Mulund to MMR residents.

A special MMR task force consisting of health experts, administrators, transport specialists and spatial planners should be

able to drive this plan to ensure a uniform vaccination and unlock schedule.

THE MIGRANT STRATEGY

During the first and second waves, several experts pinned the spurt of cases to migrant movements from within and outside the state into Mumbai. Although the MCGM provided basic healthcare and shelter to the migrants at that time, the lack of a 'city migrant policy' (especially for a city that is so heavily dependent on migrants) was glaring. Such a policy should begin with creating a database of migrants, their state/city/town/village of origin and job description. The civic body could set up migrant resource centers to register them, and link and track the health, housing and livelihood needs of the migrant's family. This can help avert situations like that seen at the height of the nationwide lockdown in 2020, where scores of migrants were left to fend for themselves, and the administration had no count or identification system.

CHROME HELMETS

While the MCGM has prioritised their vaccinations, it is also important to provide the hidden frontline workers—such as ASHAs and crematorium and graveyard workers—enough financial protection

Appointed COVID champions will share **information** about the available services in the ward with their groups and **listen to any grievances** people may express, bringing this to the **authorities' attention for resolution**.

Pandemics are best fought when the entire civil society and its stakeholders are mobilised.

through health and life insurances from the state government. An extended list of high-exposure frontline workers should be created, and common comprehensive protection schemes should be offered by the MCGM or the state government to the worker and their families. While the MCGM has increased the compensation and allowances of ASHA workers, such insurance schemes will give them the required financial stability to fulfill their tasks.

COVID CHAMPIONS

A dedicated campaign to appoint citizens, including the youth, as 'COVID Champions' can ensure some adherence to COVID-19 appropriate behaviour. Currently, the MCGM is fining people for violating norms, but this method must be complemented by deputising COVID champions in all communities (such as schools, colleges and offices, recreation groups and the like) and across all economic and social levels. COVID champions will share information about the available services in the ward with their groups and listen to any grievances people may express, bringing this to the authorities' attention for resolution. Pandemics are best fought when the entire civil society and its stakeholders are mobilised.

STRENGTHENING DISASTER MANAGEMENT ACTS AND PROTOCOLS

While the MCGM has a robust disaster management system, the newly created standard operating procedures for the pandemic at the municipal headquarters and ward levels need to be institutionalised. The ward management plan, including its war room and repurposed staff strategy, should be kept in readiness to be rolled out at a short notice. This could be done by initiating an alternate workforce creation system where a new batch of people from within the administration and outside (such as teachers, government bank staff and citizen volunteers, including those from the National Cadet Corps) are repurposed in emergencies like a pandemic.

THE 'PHYGITAL' APPROACH

A data-driven approach helped the MCGM in hospital bed management in the city and avert crisis situations as seen in other parts of the country. Machine learning and AI can be used to produce modelling patterns and forecast surges in caseloads, but these are limited capacities and several variable human factors are involved. Instead, a 'phygital' approach (digital tools plus on-ground

Real-time data on **emerging diseases must be tracked** and **a robust warning system** established to help the MCGM respond more quickly in the event of another disease outbreak. This could be done by creating **a network of labs, public and private hospitals, and other testing agencies** to monitor and identify trends that could transform into disease outbreaks or pandemics.

implementation and monitoring) must be considered.

EARLY HEALTH WARNING SYSTEMS

Real-time data on emerging diseases must be tracked and a robust warning system established to help the MCGM respond more quickly in the event of another disease outbreak.

This could be done by creating a network of labs, public and private hospitals, and other testing agencies to monitor and identify trends that could transform into disease

outbreaks or pandemics. Such a system will be particularly crucial to stay ahead of the predicted third wave and any others that may occur.

In addition to the recommended measures, the MCGM must adopt a long term strategy that reassesses its governance role in the public health delivery system, strengthens existing mechanisms and creates new health infrastructure, and builds the capacities of frontline workers and medical professionals. It is only with a robust response system backed by a resilient workforce that Mumbai will truly be pandemic ready.

ABOUT THE AUTHORS

SAYLI UDAS-MANKIKAR *is Senior Fellow at ORF Mumbai, working on urban policy.*

RAMANATH JHA *is Distinguished Fellow at ORF Mumbai, working on urban policy.*

JYOTI SHELAR *is a Mumbai-based health journalist.*

DHAVAL DESAI *is Vice-President and Senior Fellow at ORF Mumbai, working on urban policy.*

SHASHIDHAR KJ *is Associate Fellow at ORF Mumbai, working on technology policy.*

ADITI RATHO *is a former Associate Fellow at ORF Mumbai, working on gender and workforce participation.*

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20, Rouse Avenue Institutional Area,
New Delhi - 110 002, INDIA
Ph. : +91-11-35332000. Fax : +91-11-35332005
E-mail: contactus@orfonline.org
Website: www.orfonline.org

