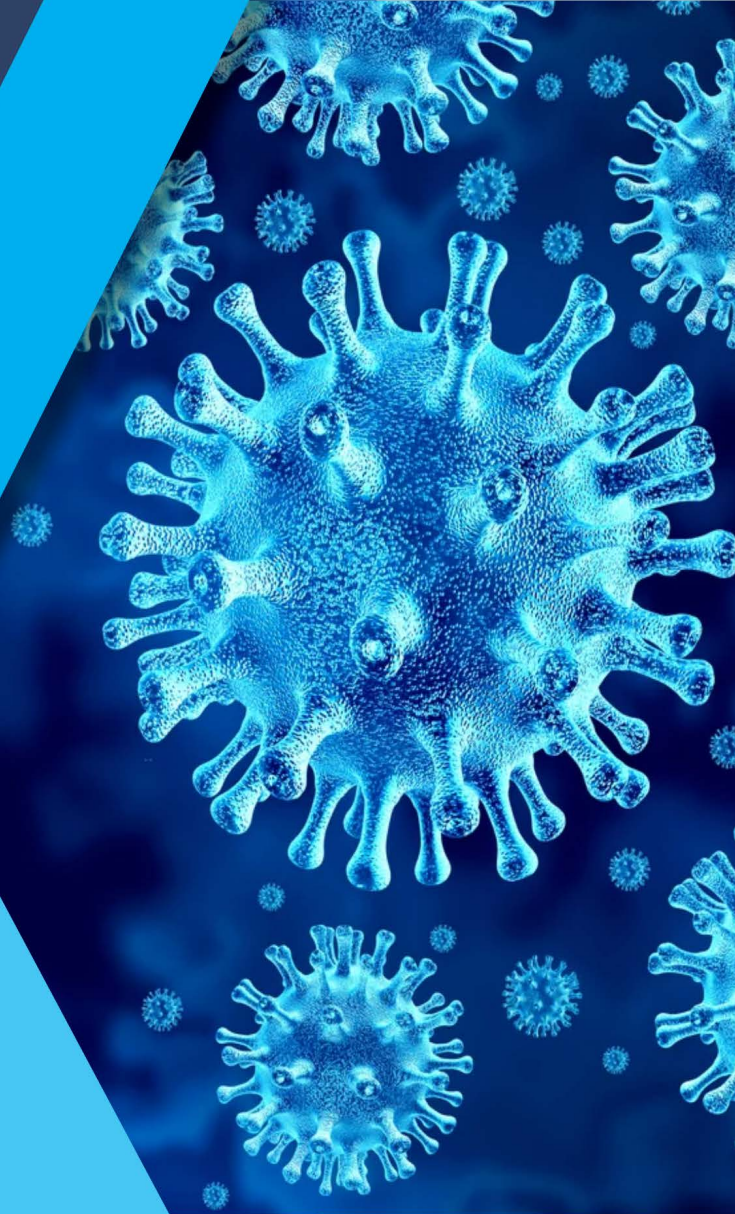




Institute of Actuaries of India

**Covid19**  
**A Study &  
Projections  
for India -  
An update**



**IAI PANDEMIC RESEARCH GROUP**  
**INSTITUTE OF ACTUARIES OF INDIA**  
July 24, 2020

[IAIPandemicresearchgrp@actuariesindia.org](mailto:IAIPandemicresearchgrp@actuariesindia.org)

## Table of Contents

<b>1. Executive Summary</b> .....	2
<b>2. Introduction</b> .....	3
<b>3. Development of cases during different phases of Lockdown and Unlock</b> .....	5
<b>4. Projections – India and States</b> .....	6
4.1. Pan India.....	6
4.2. Maharashtra.....	8
4.3. Tamil Nadu.....	10
4.4. Delhi.....	12
4.5. Gujarat.....	14
4.6. Rajasthan .....	16
4.7. Limitations of Model.....	18
<b>5. Key aspects of India’s fight against COVID -19</b> .....	19
5.1. Early lockdown .....	19
5.2. Testing rate.....	19
5.3. Low mortality rate .....	19
<b>6. Learnings from overseas - How the battle was won.</b> .....	20
6.1. Early and rapid response.....	20
6.2. Identification.....	20
6.3. Tracing & Isolation.....	21
6.4. Lockdown.....	21
6.5. Medical readiness .....	21
6.6. Other measures .....	21
<b>Appendix A: IAI Office order</b> .....	23
<b>Appendix B: Back Testing Results</b> .....	24
<b>Appendix C: Disclaimer</b> .....	26

# 1. Executive Summary

This is the second bulletin produced by the Research Group (Group) constituted by the Institute of Actuaries of India (IAI) vide Office Order dated April 16, 2020 (attached in Appendix A.

In the first research report<sup>1</sup> published by the Group on May 12, 2020, the Group:

- Provided an in-depth study of the progression of Covid-19 across five countries
- Considered two different models: HIRD and SEIR for projecting the confirmed cases, recoveries, deaths and active cases for pan-India;
- Presented the results up to end of June 2020 for pan-India; and
- Deliberated on various product ideas and constructs that can be offered under the current scenario to address the emerging insurance needs of the consumers

The introduction (Section 2) to this bulletin reviews the results of the previous report against the actual experience up to June 2020, and lists the subsequent enhancements made to the model for better accuracy. Since the previous report, the confirmed cases per day have seen a significant increase, as can be expected, given the easing of the lockdowns, and the significant relaxations from the State Governments.

To understand the impacts of these, the Group has analysed and presented the results as at, August-end and September-end for:

- Pan India
- Individual states: Maharashtra, Tamil Nadu, Delhi, Gujarat and Rajasthan,

For each of the above, three different scenarios have been presented: Ideal Scenario, Best Estimate and Worst-Case scenario. In order to generate these scenarios for each of these regions, transmission rates, i.e. the rate at which every infected, non-diagnosed individual may transmit the disease and the mortality rates which is the probability of death of an individual who has been diagnosed as COVID-19 positive have been varied to reflect the actual experience until June 30, 2020 and to project possible experiences in the future. We have also validated the projections against the actual experience up till and including July 21, 2020.

We are unable to observe a plateau in the confirmed cases emerging prior to September 2020 in any of the scenarios considered for all the regions (Pan India as well as each of the States), other than Delhi. In Delhi, a plateau seems to emerge by early Sep'20. The Group notes that 70% of the current cases in Delhi come from Rapid Tests and some of the experts believe that these tests could be causing false negatives, raising questions about the emerging plateau. However, there has been a consistent drop in new confirmed cases in last 3 weeks.

Looking at India's fight with the virus, the Group raises concerns about the new emerging hotspots in Tier 2 and Tier 3 cities, that lack the infrastructure to cope with a wide spread of the Pandemic. However, measures such as Early Lockdown, increase in testing rates and a low case fatality rate define the positive aspects of India's story against Covid-19.

The Group reiterates in Section 6, the lessons from the global fight against the pandemic, emphasising the benefits of early and rapid responses, focus on identification through rigorous testing, ensuring tracing and isolation, lockdowns and increased medical readiness in being able to have a sustained suppression of the pandemic.

---

<sup>1</sup> <http://www.actuariesindia.org/subMenu.aspx?id=179&val=Completed>

## 2. Introduction

In our last report on COVID-19 which was published in May'20, IAI Pandemic Research Group presented its global studies, modelling approaches – both HIRD and SEIR models, parameterization and projections as at end May'20 and end Jun'20.

Actual confirmed cases as at Jun'20 stood at ~5.85 lakhs. This compared well with our projection of ~ 5.28 lakhs under “Lock Down – Ceases” scenario which was projected based on data available till April 15, 2020 data. While in the worst-case scenario, the numbers were projected to be much higher, the population seems to be maintaining social distancing and hygiene standards.

As a next step, the Group has recalibrated the HIRD model as at end June'20 and has come up with monthly projections for end of August and September 2020.

Further, these projections are done at a more granular level for the key states. The key states were chosen based on the total number of confirmed cases state wise (as at June 30, 2020), as detailed below.

State/Union Territory	Recovered	Deaths	Confirmed	CFR
Maharashtra	88,960	7,610	1,69,883	4.5%
Tamil Nadu	47,749	1,141	86,224	1.3%
Delhi	56,235	2,680	85,161	3.1%
Gujarat	23,240	1,827	31,938	5.7%
Rajasthan	13,618	405	17,660	2.3%
Pan India	3,34,822	16,893	5,66,840	3.0%

CFR – Case Fatality Rate that is total deaths/total confirmed cases

The analysis is covered in detail in Section 4.

- Pan India
- States - Maharashtra, Tamil Nadu, Delhi, Gujarat and Rajasthan

While calibrating the model, the Group made a few model enhancements to the existing model. While the projected “Confirmed cases” were in between the two worst case scenarios, the actual active cases were lower than those projected under these scenarios i.e. both the recoveries and deaths were higher than we estimated.

This implied that though the mortality rate assumption might be correct, the time taken for the recovery and the time taken for deaths as estimated in the model (determined by the mean used for the Poisson distribution for “lag in recovery” and “lag in death”) was possibly diverging from the initial estimates.

The time taken and the rate at which deaths and recoveries happen are likely to vary as hospitals and doctors understand the pandemic better, and / or as government policies change. In order to have the ability to reflect the above practical learnings in the HIRD model, we made the following changes:

1. Creating additional inputs to allow the mean of the Poisson distribution for the time taken in recoveries and deaths to vary with time.
2. Creating a new input of a “minimum” number of days that a life spends in the state “1” i.e. after diagnosis as a confirmed case of COVID-19, and before recovery / death.
3. Allowing the mortality rate to also vary with time, to reflect any improvements or deteriorations in mortality experience with time.

The Projections made and discussed in the subsequent sections below allow for the above changes.

In Section 5, we have listed the key aspects observed in India's fight against this pandemic and what are the focus points needed/implemented which will help in controlling this pandemic.

In Section 6, as in the previous report, we capture the key aspects that have played a role in various countries being able to bring this pandemic under control and what India can learn from others' experiences (both positive and negative).

### 3. Development of cases during different phases of Lockdown and Unlock

When the Group released the last version of this Report, it was towards the end of Lockdown Phase 3 which ended on May 17, 2020. Since then there has only been 1 additional lockdown (phase 4) where Central government gave more relaxations and also power to States to manage this pandemic. Since then every State has managed this pandemic in their own way through mini lockdowns but every State has also given significant relaxation to ensure that the economic impact can be minimized.

These relaxations have had their impact, as can be seen in the confirmed cases in the below table, along with the daily average of recoveries and deaths observed since May 18, 2020.

Confirmed						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	95,759	31-May-20	1,82,143	86,384	6,645
UnLock 1.0	01-Jun-20	1,90,535	30-Jun-20	5,66,840	3,76,305	12,976
UnLock 2.0	01-Jul-20	5,85,493	21-Jul-20	11,55,191	5,69,698	28,485

Recoveries						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	36,824	31-May-20	86,984	50,160	3,858
UnLock 1.0	01-Jun-20	91,819	30-Jun-20	3,34,822	2,43,003	8,379
UnLock 2.0	01-Jul-20	3,47,979	21-Jul-20	7,24,578	3,76,599	18,830

Deaths						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	3,029	31-May-20	5,164	2,135	164
UnLock 1.0	01-Jun-20	5,394	30-Jun-20	16,893	11,499	397
UnLock 2.0	01-Jul-20	17,400	21-Jul-20	28,084	10,684	534

*UnLock 2.0 will end on July 31, 2020.*

The number of confirmed cases has risen significantly, as can be observed from per day cases (for that given period) but so have the recoveries. The increase in the former was expected, given that the greater relaxations would increase the movement of the population and hence add to the numbers. With time, population in general, and doctors, have a better understanding of the disease, which is getting reflected in both higher rates of recoveries as well as observed lower death rates.

## 4. Projections – India and States

Different phases have seen increasing level of relaxation and with every State forming its own plans to tackle the pandemic, besides looking at Pan India, the Group has also looked at some of the key States.

The model used for all these projections is HIRD, with transition, death and recovery rates for each of the States being calibrated based on their respective historical data.

### 4.1. Pan India

In the last report, data only up till April 15, 2020 was used. For the current exercise, data up till June 30, 2020 has been used for model parameter calibration. Based on the calibration, the following transition and death rate assumptions are used.

#### Transition Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	14 Apr - 02 May	03 May - 16 May	17 May - 28 May
Worst-case	1.7366	1.2912	1.1782	1.1321	1.1385	1.1280
Best Estimate	1.7366	1.2912	1.1782	1.1321	1.1385	1.1280
Ideal Scenario	1.7366	1.2912	1.1782	1.1321	1.1385	1.1280

From 29 Feb 20	29 May - 30 Jun	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	1.1220	1.1255	1.1280	1.1305
Best Estimate	1.1220	1.1230	1.1230	1.1230
Ideal Scenario	1.1220	1.1205	1.1180	1.1155

While social distancing norms are being maintained, but given the Unlock and the extent of relaxation, we have introduced an increase of 0.1% (12.20% to 12.30%) in the transmission rates to factor in the increases being observed due to the emergence of fresh hotspots.

#### Death Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	17 May - 28 May	29 May - 30 Jun
Worst-case	10.00%	7.41%	4.90%	4.46%	3.36%
Best Estimate	10.00%	7.41%	4.90%	4.46%	3.36%
Ideal Scenario	10.00%	7.41%	4.90%	4.46%	3.36%

From 29 Feb 20	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	3.36%	3.36%	3.36%
Best Estimate	2.91%	2.61%	2.36%
Ideal Scenario	2.46%	1.86%	1.36%

Recoveries will be 1 – Death rate as given above.

Further, while the 10% death rate assumption applicable for the initial few days may look abnormally high, it is primarily because of the small base effect of the number of confirmed cases. This rate subsequently settles towards a more appropriate rate. This anomaly is observed while back solving the death rates for different states as well, as seen in the subsequent sections.

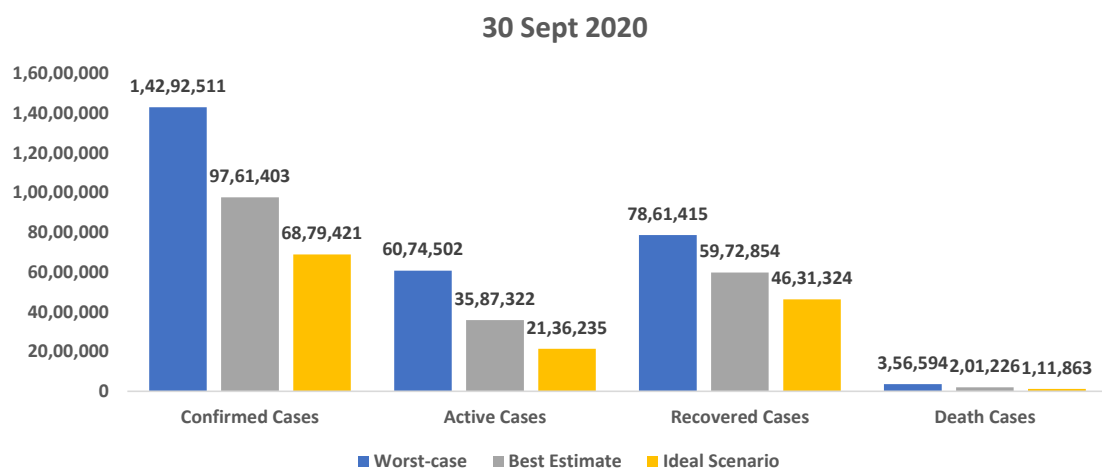
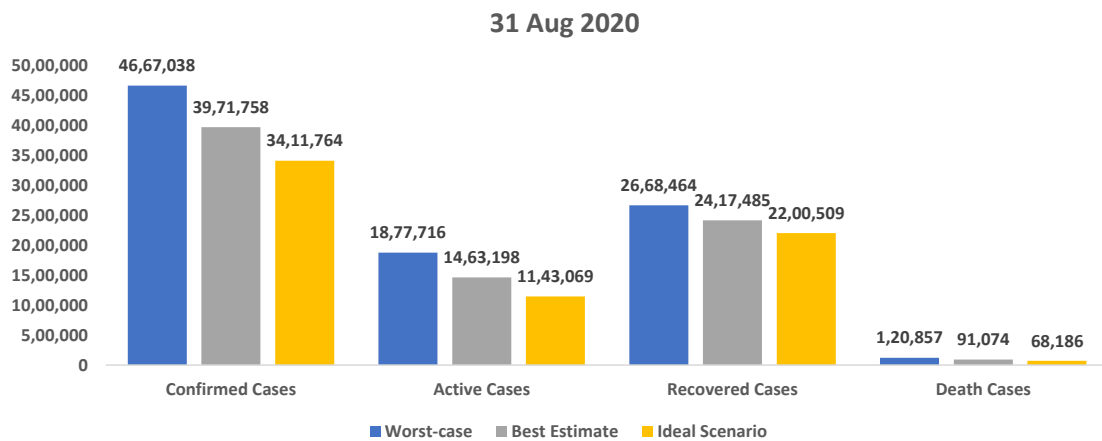
The above values are different from the earlier version of the Report. These have been recalibrated to appropriately reflect the emerging experience for the latter half of June'20 and with transmission rates varying, based on the tenor of lockdown and back testing results.

In addition to Best Estimate, two projection scenarios are modelled – Optimistic and Pessimistic. Transition rates have been kept constant under Base (Best Estimate Scenario), whereas in Optimistic (Ideal Scenario) we expect the transition rates to start falling and the reverse is expected under Pessimistic (Worst Case Scenario).

We have observed a decreasing trend in the death rate for India. This could be because of better understanding of the disease by doctors as well as improved behaviour and awareness of population in general. This has been factored in the projections. Additionally, the death rate differs under different scenarios, to reflect how those scenarios may pan out.

**Projections:**

The projections below have been provided for at end of August and end of September.



Based on the current trend, we do not see the cases decreasing at least till September 30, 2020, which is the end of our projection period.



## 4.2. Maharashtra

### Movement in different phases:

Confirmed						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	33,053	31-May-20	65,168	32,115	2,470
UnLock 1.0	01-Jun-20	67,655	30-Jun-20	1,69,883	1,02,228	3,525
UnLock 2.0	01-Jul-20	1,74,761	21-Jul-20	3,18,695	1,43,934	7,197

Recoveries						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	7,688	31-May-20	28,081	20,393	1,569
UnLock 1.0	01-Jun-20	29,329	30-Jun-20	88,960	59,631	2,056
UnLock 2.0	01-Jul-20	90,911	21-Jul-20	1,75,029	84,118	4,206

Deaths						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	1,198	31-May-20	2,197	999	77
UnLock 1.0	01-Jun-20	2,286	30-Jun-20	7,610	5,324	184
UnLock 2.0	01-Jul-20	7,855	21-Jul-20	12,030	4,175	209

*UnLock 2.0 will end on 31<sup>st</sup> July 2020.*

The cases in Maharashtra are predominantly coming from the big cities - Mumbai, Thane and Pune. These 3 cities contribute to ~75% of the total cases. Since start of July, the confirmed cases have doubled to close to ~7K daily cases. Per day cases though have seen a constant rise since start of Jul'20 (5k to 8k).

The Government has taken steps to put hotspots like Thane and Pune under intermittent lockdown. Daily average testing rates have also increased. These steps are expected to break the infection chain. Recoveries are also increasing, and deaths have remained stable indicating early signs of pandemic slowing down.

### Transition Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	14 Apr - 02 May	03 May - 16 May	17 May - 28 May
Worst-case	1.3489	1.3489	1.1917	1.1490	1.1341	1.1184
Best Estimate	1.3489	1.3489	1.1917	1.1490	1.1341	1.1184
Ideal Scenario	1.3489	1.3489	1.1917	1.1490	1.1341	1.1184

From 29 Feb 20	29 May - 30 Jun	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	1.1184	1.1209	1.1234	1.1259
Best Estimate	1.1184	1.1184	1.1184	1.1184
Ideal Scenario	1.1184	1.1159	1.1134	1.1109

## Death Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	17 May - 28 May	29 May - 30 Jun
Worst-case	10.00%	10.00%	5.41%	5.40%	5.40%
Best Estimate	10.00%	10.00%	5.41%	5.40%	5.40%
Ideal Scenario	10.00%	10.00%	5.41%	5.40%	5.40%

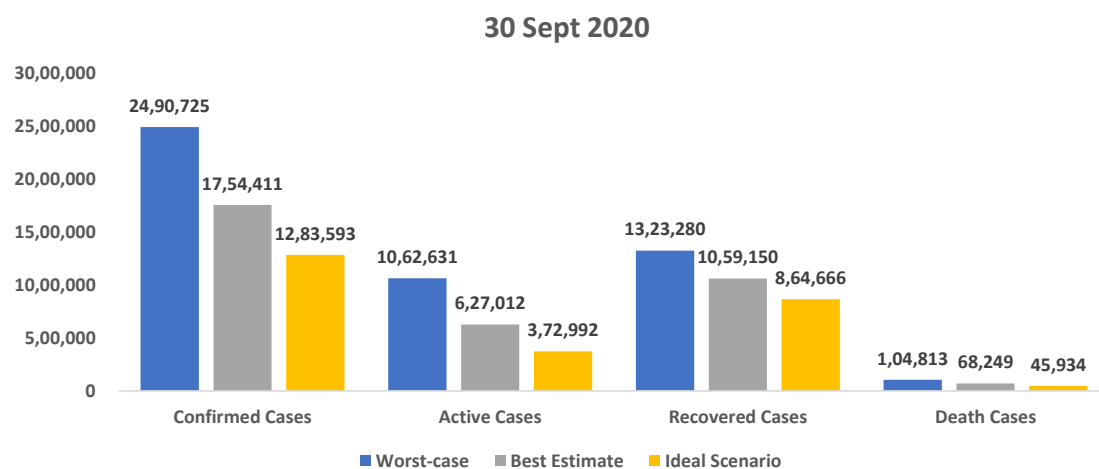
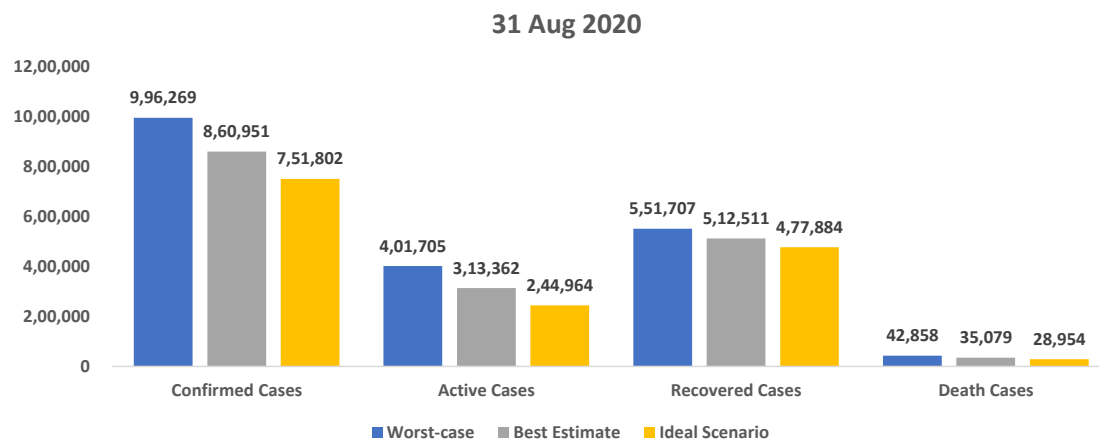
From 29 Feb 20	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	5.40%	5.40%	5.40%
Best Estimate	4.95%	4.65%	4.40%
Ideal Scenario	4.50%	3.90%	3.40%

Recoveries will be 1 – Death rate as given above.

Observed death rates for Maharashtra are higher than those for Pan India. It is aligned with overall State and Pan India level experience. Like in Pan India projections, Death and Transition Rate change under different scenarios, to reflect how those scenarios may pan out.

## Projections:

The below projections have been provided for as at end of August and end of September.



Based on the current trend, we do not see cases plateauing till September 30, 2020.

### 4.3. Tamil Nadu

#### Movement in different phases:

Confirmed						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	11,224	31-May-20	21,184	9,960	766
UnLock 1.0	01-Jun-20	22,333	30-Jun-20	86,224	63,891	2,203
UnLock 2.0	01-Jul-20	90,167	21-Jul-20	1,75,678	85,511	4,276

Recoveries						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	4,172	31-May-20	12,000	7,828	602
UnLock 1.0	01-Jun-20	12,757	30-Jun-20	47,749	34,992	1,207
UnLock 2.0	01-Jul-20	50,074	21-Jul-20	1,21,776	71,702	3,585

Deaths						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	78	31-May-20	160	82	6
UnLock 1.0	01-Jun-20	173	30-Jun-20	1,141	968	33
UnLock 2.0	01-Jul-20	1,201	21-Jul-20	2,551	1,350	68

UnLock 2.0 will end on 31<sup>st</sup> July 2020.

Tamil Nadu saw a sudden surge in cases since UnLock 1.0 was implemented. Chennai comprises of ~50% of the total State's confirmed cases and has been the hardest hit. Chennai was under lockdown during the UnLock 1.0 period in order to curb the spread of virus. The state has also increased the testing rate.

At 20L tests, the state tops the list of most tests done. Besides this, the state has also set up a Plasma Bank. Even with these measures, the State continues to see a daily average ~4.5k cases and an increase in Confirmed cases.

Case Fatality Rate (CFR) for the state is 1.5% which is much below the national average of 2.4%. Even though it is the state with second highest confirmed cases, Tamil Nadu has done well to limit the number of deaths.

#### Transition Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	14 Apr - 02 May	03 May - 16 May	17 May - 28 May
Worst-case	1.2507	1.2504	1.1894	1.1703	1.1605	1.1592
Best Estimate	1.2507	1.2504	1.1894	1.1703	1.1605	1.1592
Ideal Scenario	1.2507	1.2504	1.1894	1.1703	1.1605	1.1592

From 29 Feb 20	29 May - 30 Jun	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	1.1200	1.1225	1.1250	1.1275
Best Estimate	1.1200	1.1200	1.1200	1.1200
Ideal Scenario	1.1200	1.1175	1.1150	1.1125

Transition rates are higher than Pan India level to reflect the higher rate of spread in the State. Further, given the recent surge in cases, the scenario projections reflect a wider range.

## Death Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	17 May - 28 May	29 May - 30 Jun
Worst-case	10.00%	1.98%	2.08%	2.04%	2.00%
Best Estimate	10.00%	1.98%	2.08%	2.04%	2.00%
Ideal Scenario	10.00%	1.98%	2.08%	2.04%	2.00%

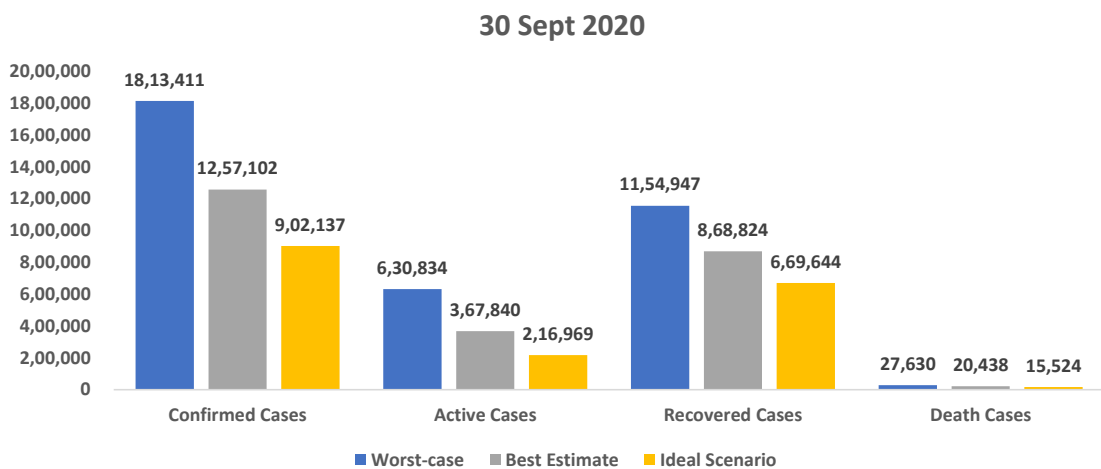
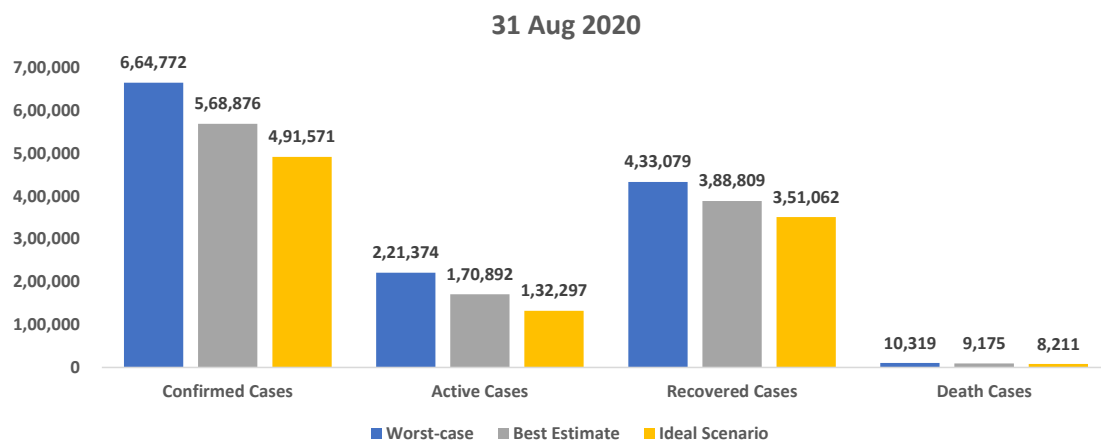
From 29 Feb 20	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	2.00%	2.00%	2.00%
Best Estimate	2.00%	2.00%	2.00%
Ideal Scenario	2.00%	2.00%	2.00%

Recoveries will be 1 – Death rate as given above.

For Tamil Nadu, Death rate has been kept constant between different scenarios as the State's Death rate is significantly lower than Pan India average and there is no experience to assume that it will increase with time.

## Projections:

The below projections have been provided for as at end of August and end of September..



Based on the current trend, we do not see cases plateauing till September 30, 2020.

## 4.4. Delhi

### Movement in different phases:

Confirmed						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	10,054	31-May-20	18,549	8,495	653
UnLock 1.0	01-Jun-20	19,844	30-Jun-20	85,161	65,317	2,252
UnLock 2.0	01-Jul-20	87,360	21-Jul-20	1,23,747	36,387	1,819

Recoveries						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	4,485	31-May-20	8,075	3,590	276
UnLock 1.0	01-Jun-20	8,478	30-Jun-20	56,235	47,757	1,647
UnLock 2.0	01-Jul-20	58,348	21-Jul-20	1,04,918	46,570	2,329

Deaths						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	160	31-May-20	416	256	20
UnLock 1.0	01-Jun-20	473	30-Jun-20	2,680	2,207	76
UnLock 2.0	01-Jul-20	2,742	21-Jul-20	3,663	921	46

UnLock 2.0 will end on 31<sup>st</sup> July 2020.

As per the emerging data, Delhi is showing signs of plateauing. New cases have dropped from an average of 3,400 per day during the week beginning June 19, to an average of just 1,400 per day in the past week.

Meanwhile, number of tests have increased almost threefold, from an average of about 7,000 per day during the week beginning June 12 to an average of nearly 20,000 per day in the last week. In 3<sup>rd</sup> week of June, Delhi began to use Rapid Antigen Tests alongside RT-PCR, CBNAAT and TrueNat tests to identify COVID-19 cases which led to increase in daily testing.

It should be noted that Rapid tests now accounts for 70% of the daily new tests. A few experts believe that rapid tests tend to miss positive cases and there could be a resurgence in future. Now whether it stands the test of time and the cases plateau soon enough, is something that all of us looking forward to.

Delhi's CFR stands at 3% which is higher than the national average of 2.4%.

### Transition Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	14 Apr - 02 May	03 May - 16 May	17 May - 28 May
Worst-case	1.3515	1.3515	1.1485	1.1382	1.1382	1.1382
Best Estimate	1.3515	1.3515	1.1485	1.1382	1.1382	1.1382
Ideal Scenario	1.3515	1.3515	1.1485	1.1382	1.1382	1.1382

From 29 Feb 20	29 May - 17 Jun	18 Jun - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	1.1350	1.0940	1.0965	1.0990
Best Estimate	1.1350	1.0940	1.0940	1.0940
Ideal Scenario	1.1350	1.0940	1.0915	1.0890

Transition rate has been reduced from 18th Jun (1.0940) to capture the impact of changes in COVID-19 management strategy of the governments for National Capital Territory of Delhi.

Given the recent trends being observed, the future rates of transmission are assumed low.

## Death Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	17 May - 28 May	29 May - 30 Jun
Worst-case	9.00%	7.00%	5.00%	4.00%	3.40%
Best Estimate	9.00%	7.00%	5.00%	4.00%	3.40%
Ideal Scenario	9.00%	7.00%	5.00%	4.00%	3.40%

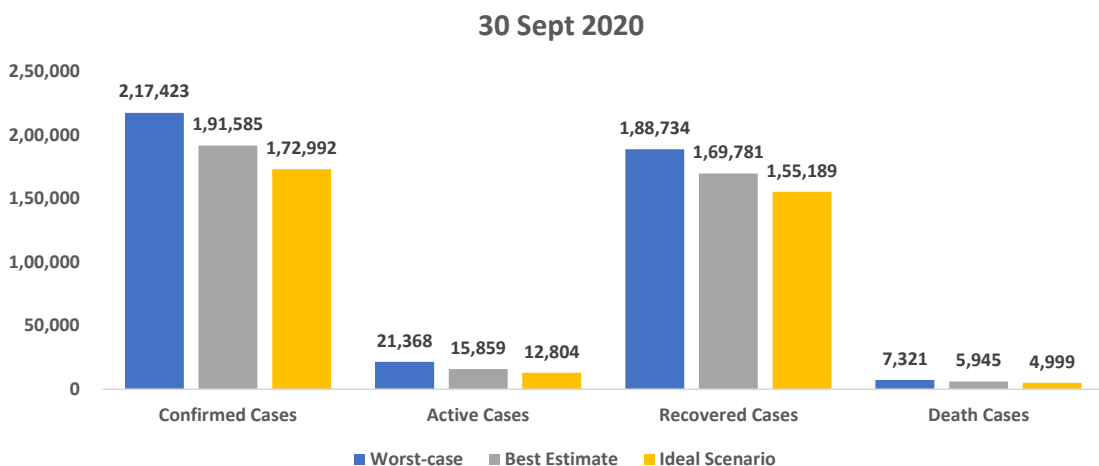
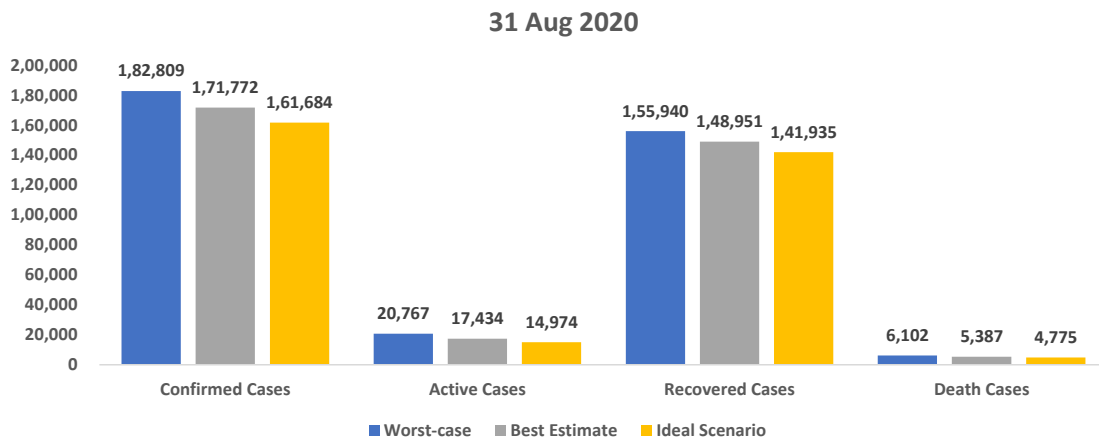
From 29 Feb 20	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	3.40%	3.40%	3.40%
Best Estimate	2.95%	2.65%	2.40%
Ideal Scenario	2.50%	1.90%	1.40%

Recoveries will be 1 – Death rate as given above.

We expect that Death rate in Delhi will improve with time under Best Estimate and Ideal scenario, while it is kept constant at current levels under Worst case to align with the expected experience, both in respect to higher transmission rate and deaths.

## Projections:

The below projections have been provided for as at end of August and end of September.



Based on the current trend, cases expected to plateau in early Sep'20.

## 4.5. Gujarat

### Movement in different phases:

Confirmed						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	11,379	31-May-20	16,343	4,964	382
UnLock 1.0	01-Jun-20	16,779	30-Jun-20	31,938	15,159	523
UnLock 2.0	01-Jul-20	32,557	21-Jul-20	49,353	16,796	840

Recoveries						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	4,499	31-May-20	9,230	4,731	364
UnLock 1.0	01-Jun-20	9,919	30-Jun-20	23,240	13,321	459
UnLock 2.0	01-Jul-20	23,662	21-Jul-20	35,678	12,016	601

Deaths						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	659	31-May-20	1,007	348	27
UnLock 1.0	01-Jun-20	1,038	30-Jun-20	1,827	789	27
UnLock 2.0	01-Jul-20	1,846	21-Jul-20	2,162	316	16

UnLock 2.0 will end on 31<sup>st</sup> July 2020.

Since the start of UnLock 1.0, the State has seen a continuous rise in the number of cases. From ~ 400 new cases in first week of June, currently the state is seeing ~ 950 new cases a day. Surat and Ahmedabad are the worst 2 hit cities. These two cities combined account for ~ 80% of the total cases.

Gujarat's CFR (Case Fatality Rate) stands at 4.4% and is the highest across all states and is also much higher than the national average of 2.4%. Some reports suggest that poor health infrastructure, low testing rate, reluctance to go to government hospital and stigma attached to COVID-19 could be a few of the reasons for delayed treatment or people continuing to stay at home leading to relatively high CFR for the state.

### Transition Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	14 Apr - 02 May	03 May - 16 May	17 May - 28 May
Worst-case	1.2631	1.2555	1.2555	1.1341	1.1083	1.1083
Best Estimate	1.2631	1.2555	1.2555	1.1341	1.1083	1.1083
Ideal Scenario	1.2631	1.2555	1.2555	1.1341	1.1083	1.1083

From 29 Feb 20	29 May - 30 Jun	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	1.1100	1.1125	1.1150	1.1175
Best Estimate	1.1100	1.1100	1.1100	1.1100
Ideal Scenario	1.1100	1.1075	1.1050	1.1025

## Death Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	17 May - 28 May	29 May - 30 Jun
Worst-case	10.00%	8.99%	8.99%	5.40%	5.00%
Best Estimate	10.00%	8.99%	8.99%	5.40%	5.00%
Ideal Scenario	10.00%	8.99%	8.99%	5.40%	5.00%

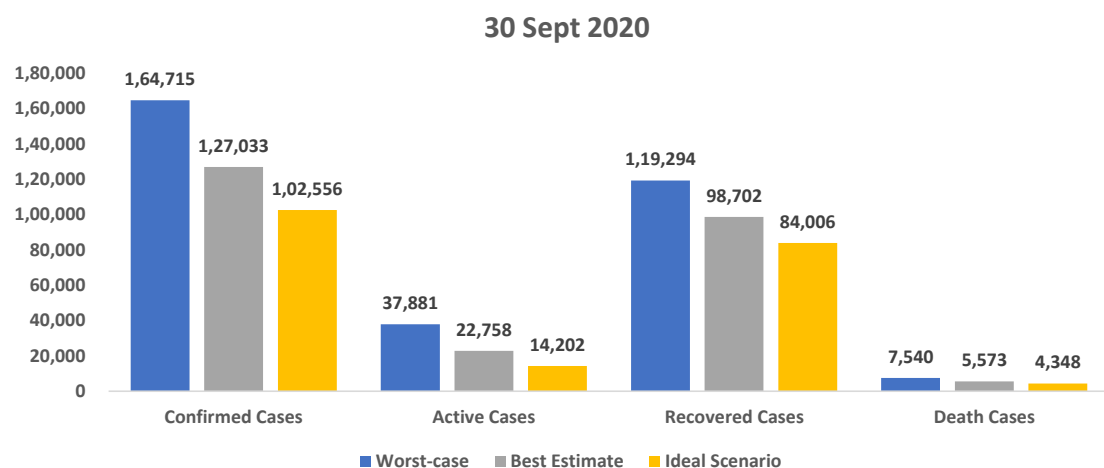
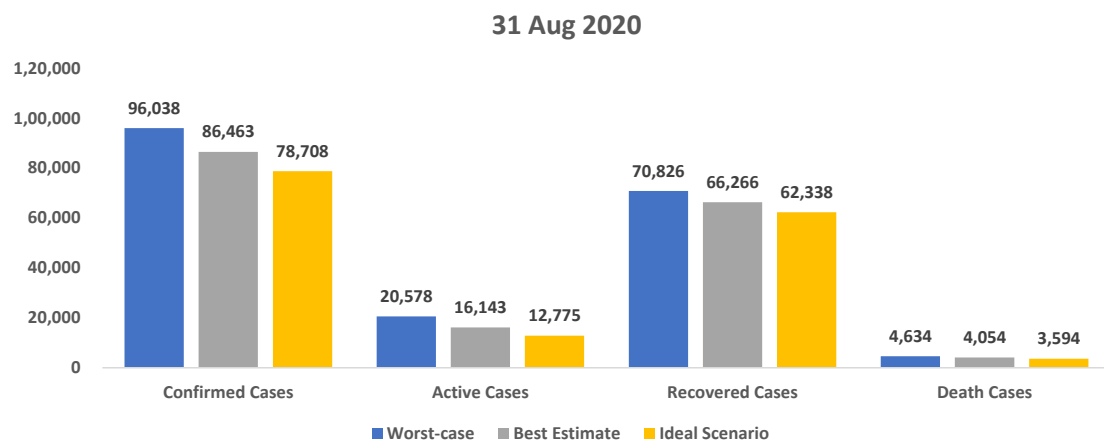
From 29 Feb 20	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	5.00%	5.00%	5.00%
Best Estimate	4.55%	4.25%	4.00%
Ideal Scenario	4.10%	3.50%	3.00%

Recoveries will be 1 – Death rate as given above.

Death rates for Gujarat are higher than Pan India average and same is reflected in projections. Deaths rates are showing improvements under Best Estimate and Ideal scenario and it have been factored in the projections.

## Projections:

The below projections have been provided for as at end of August and end of September.



Based on the current trend, we do not see cases plateauing till September 30, 2020.



## 4.6. Rajasthan

### Movement in different phases:

Confirmed						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	5,202	31-May-20	8,617	3,415	263
UnLock 1.0	01-Jun-20	8,831	30-Jun-20	17,660	8,829	304
UnLock 2.0	01-Jul-20	18,014	21-Jul-20	30,390	12,376	619

Recoveries						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	2,992	31-May-20	5,739	2,747	211
UnLock 1.0	01-Jun-20	5,927	30-Jun-20	13,618	7,691	265
UnLock 2.0	01-Jul-20	14,220	21-Jul-20	22,195	7,975	399

Deaths						
	State Date	Cases	End Date	Cases	Total Increase	Average Per Day
Phase 4	18-May-20	131	31-May-20	193	62	5
UnLock 1.0	01-Jun-20	194	30-Jun-20	405	211	7
UnLock 2.0	01-Jul-20	413	21-Jul-20	568	155	8

UnLock 2.0 will end on 31<sup>st</sup> July 2020.

With ~ 600 new cases, relative to the other States covered in the report, the state has lowest per day average increase in new cases. It is though still among the top 10 states in terms of total confirmed cases. The cases have seen a gradual increase to ~ 850 new cases a day in 3rd week of July up from ~ 500 during the first 2 weeks of July. With ~ 12.4 lakh tests done, the state though ranks 5th among the total tests done.

Since start of July, the state has seen a steady increase in total test done to ~ 20K per day increase to ~ 27k as on 19th July 2020. Rise in testing can also be attributed to increase in cases. State's CFR is at 1.9% which is lower than the national average of 2.4%. Even though the cases have increased, number of deaths have remained among the lowest in the country.

### Transition Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	14 Apr - 02 May	03 May - 16 May	17 May - 28 May
Worst-case	1.3157	1.3157	1.1715	1.1201	1.1201	1.1150
Best Estimate	1.3157	1.3157	1.1715	1.1201	1.1201	1.1150
Ideal Scenario	1.3157	1.3157	1.1715	1.1201	1.1201	1.1150

From 29 Feb 20	29 May - 30 Jun	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	1.1140	1.1165	1.1190	1.1215
Best Estimate	1.1140	1.1140	1.1140	1.1140
Ideal Scenario	1.1140	1.1115	1.1090	1.1065

## Death Rates:

From 29 Feb 20	29 Feb - 09 Mar	10 Mar - 24 Mar	25 Mar - 13 Apr	17 May - 28 May	29 May - 30 Jun
Worst-case	3.55%	3.55%	3.23%	2.39%	2.39%
Best Estimate	3.55%	3.55%	3.23%	2.39%	2.39%
Ideal Scenario	3.55%	3.55%	3.23%	2.39%	2.39%

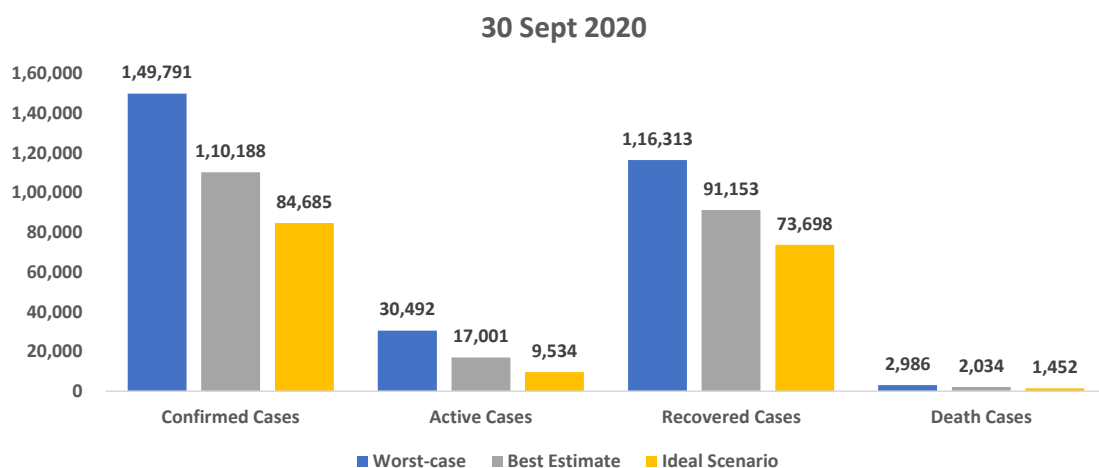
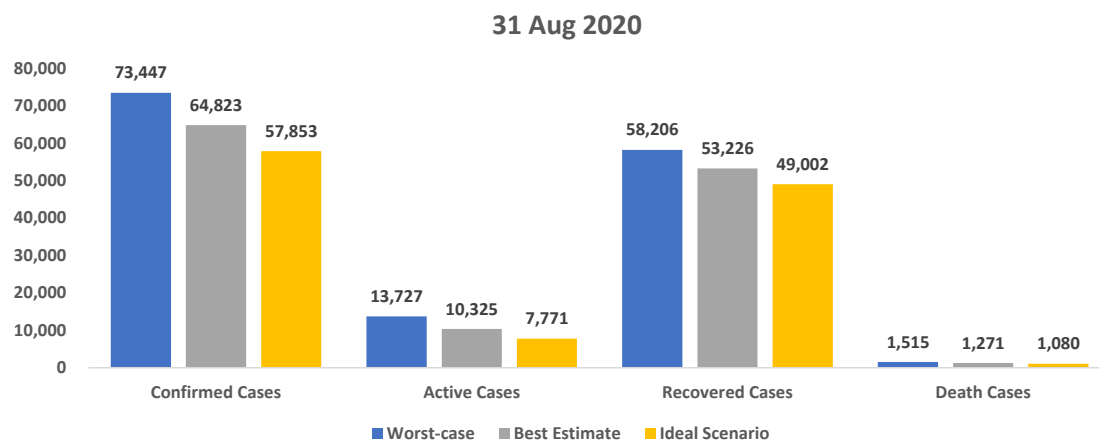
From 29 Feb 20	01 Jul - 31 Jul	01 Aug - 31 Aug	01 Sep Onwards
Worst-case	2.39%	2.39%	2.39%
Best Estimate	2.16%	2.01%	1.89%
Ideal Scenario	1.94%	1.64%	1.39%

Recoveries will be 1 – Death rate as given above.

For Rajasthan, both Transition and Death rate are lower than Pan India. Further improvement in Death rate is assumed as the State's death rates is significantly lower than Pan India average and there is no experience to assume that it will increase with time.

## Projections:

The below projections have been provided for as at end of August and end of September.



Based on the current trend, we do not see cases plateauing till September 30, 2020.

#### 4.7. Limitations of Model

- The model assumes that the individuals at an overall level continue to behave responsibly and maintain social distancing norms, albeit to different levels.
- The model does not consider “re-infection” as a possibility for now, since data around repeat infections is scarce and unreliable at the time of creating this model and generating the results
- The model does not attempt to anticipate or project the impact on economic conditions.
- The model does not consider the differences in density of populations in urban India and rural India.
- The model does not attempt to project second order impacts of COVID-19 on mortality, such as lack of availability of medical facilities, or increase in suicides etc.
- Though the model makes an assumption with regards to the expected number of days spent in hospital due to COVID-19, this is purely with the intention of calculating the number of live cases on any given day. This assumption has not yet been evaluated or rigorously tested for use in health plans that require morbidity assumptions.
- The model is based on assumptions regarding possible parameters that might reflect the spread of COVID-19. Therefore, it does not “predict” the future, it only details a funnel of possible outcomes.
- The model assumes there are no “super spreaders” people or events, that are outliers and due to which the virus spreads to a lot more people than the average transmission rate indicates.

## 5. Key aspects of India's fight against COVID -19

With the total number of cases exceeding 1 million and new active cases increasing by circa 3% daily, India's COVID -19 story is far from over. There is no clear indication that the peak is reached. In fact, the new hot spots are emerging from Tier 2 and Tier 3 cities, which do not have a very strong health infrastructure.

While there are speculative reports indicating selective community transmission may have begun there is no official confirmation on this. If that were true, the number of cases should start increasing significantly. However, we are not seeing any such alarming increase, but the actual scenario would unfold over the next few months. Having said that, there are various positives in India's fight against this deadly virus.

### 5.1. Early lockdown

India was one of the first few countries to go in for complete lockdown even when the number of cases were relatively low. While the benefit is not fully known, we believe it helped by:

- Creating awareness – the government used the lockdown as an opportunity to create awareness about the disease and related preventive care.
- Developed tech infrastructure like Aarogyasetu to track
- Developed guidelines for testing as well as increase capacity
- Manufactured / imported medical supplies as well as equipment
- Created quarantine facilities in key locations
- Developed a better understanding about the disease and learn from experience of other countries

### 5.2. Testing rate

The testing strategy has been evolving over time. The testing rate per million population has been continuously increasing as the government is ramping up the infrastructure. It has been well understood by now that aggressive testing is very important in containing the spread.

From 5,000 tests per day to more than 100,000 tests per day, India's testing rate has significantly improved. This is also one of the reasons for the increase in the number of new cases. Early detection not only reduces the spread, but also increases the chances of survival. This has been successfully shown by Germany. It also helps in improving the recovery rate.

### 5.3. Low mortality rate

India's mortality rate is amongst one of the lowest in the world. While one of the reasons could be related to the relatively young population, another aspect could be the early detection. There could be differences in approaches as well. It is not fully known if death count includes death due to COVID or death with COVID (co-morbidities).

There could be issues of underreporting as well, especially if the patient has been discharged or is under home quarantine. We are not able to pin-point the reasons behind low mortality rate. Low mortality rate would mean high recovery rate. One of the reports indicated that the diagnostic tests do produce false positives which means the individual who does not have the disease may be tested positive

Given the ground realities and challenges peculiar to a country with the world's second largest population, we believe both Central and State governments have done a commendable job in managing the situation so far.

## 6. Learnings from overseas - How the battle was won.

With most of the countries around the world being affected due to COVID-19, various countries are fighting the pandemic in different ways. We have witnessed that the virus has the ability to spread explosively and has overwhelmed countries even with the most resilient and the best quality health systems. While some countries have successfully tamed the widespread transmission and stabilised it to a low/nil level, there are countries still overburdened with the situation.

The Group has studied the response of these successful countries and explained the findings in this section. Although there are some measures which are specific to particular countries, the most prevalent pandemic control strategies include limiting public movement, careful planning of identification & isolation, scaling up of medical facilities and proactive governance. It would help other countries to try and replicate this noteworthy success based on their own population density, weather conditions, infrastructure and governance model.

The expression 'flattening the curve' is a cliché by now however, it is a serious consideration for every country or region in their attempt to attain a sustainable suppression of virus transmission. Without a well-planned strategy and inadequate scaling up of health care systems, not imposing a lockdown or early lifting of lockdown will result in a recurrence of virus transmission, with mostly uncontrollable and magnified second waves.

We have studied various countries like Taiwan, Germany, Norway, Finland, New Zealand, Thailand, Malaysia and South Korea. Some of these countries are in close proximity to China, where the outbreak started and in spite of that, they have managed to limit the spread efficiently.

On the other hand, we have also studied Italy, Singapore and U.S.A (which were also part of our previous Report). Let us look at the measures that have enabled the successful countries to shift from widespread transmission to steady-state or very low transmission.

### 6.1. Early and rapid response

Countries like Thailand and Taiwan acted very quickly and decisively. They recognised the nature of transmission i.e., human to human transmission early on, well before other countries and organisations did.

Some of such early responders even performed retrospective screening of patients who suffered from flu like symptoms or pneumonia in weeks before their first few cases.

### 6.2. Identification

By now, it is a widely known fact that the single most important measure has been to test. Not only is it important to test rapidly but we need to have a well-planned testing strategy. After an initial roll out, some countries have optimised their testing plans to make them more efficient and easily accessible.

For example, we have seen in our earlier report that South Korea pioneered several ways of testing which included drive-through testing facilities. As a result, their testing capacity increased manifold within a noticeably short period. It was their vital measure in identifying many silent carriers.

Other regions like Wuhan and Germany have also adopted a 'test, test, test – and test again' model as well.

### 6.3. Tracing & Isolation

The two most vital measures that go in tandem with testing are contact tracing and effective isolation. Even after a massive surge in cases in countries like South Korea, their technology driven location tracking and aggressive back tracing abilities helped them get control of the virus. Norway and Germany also ensured early access to reliable tests.

It has been learnt that the faster the cases are isolated – both symptomatic and asymptomatic, the harder it will be for the virus to transmit itself. Another important aspect is to stop clusters from becoming explosive outbreaks.

The implementation of such effective measures can happen only upon rapidly scaling up workforce and resources and by using innovative technology.

### 6.4. Lockdown

Most of the countries in the world have placed varying levels of lockdown. Some countries adopted aggressive closures including military enforcement while others have opted for partial or nil formal lockdown.

But the most impact in flattening the curve came from restricting public movement – either formally imposing it or by self-disciplined citizens. For example, Malaysia, with a recovery rate amongst highest in the world, and New Zealand have witnessed good cooperation from their public. New Zealand was also among the earliest to self-isolate and impose a complete lockdown.

It has been learnt that regions with well-organised governance and a robust response to the lockdown by the citizens have had a tendency to exhibit “first to close – first to flatten curve – first to re-open” order of events.

However, such widespread lockdowns need to transition slowly into resumption of social and economic activity without risking the resurgence of the transmission.

### 6.5. Medical readiness

Some countries were able to act very rapidly in asserting control of medical supply lines. Innovative technology was used to mitigate over burdening of health care systems and thus save lives. For example, citizens were provided with an online mask ordering system, which also helped streamline purchases through GPS guided maps to locate nearest pharmacies and their stock availability.

In Scandinavia also, technological solutions were adopted to swiftly ramp up access to medical facilities. While Finland launched a COVID-19 specific online symptom checker and education tool in less than week, Norway promptly set up specialist video consultations within two weeks of the outbreak.

With regard to the availability of hospital beds and ventilators, successful countries ensured substantial increase in capacity. Most of them repurposed stadiums and other buildings by turning them into care and quarantine facilities.

### 6.6. Other measures

- **Early Travel Restrictions & Surveillance:** Taiwan and Thailand instituted prompt restrictions on travel and raised their travel advisory to high-risk level. Some countries decisively took measures for active case identification at various points of entry.

- **Cancellation of Events:** Many Governments have announced cancellation of nation-wide festival gatherings and sports events where large gathering would have otherwise been normal.
- **Hygiene Protocols and Awareness:** Public Health Ministries across the world worked towards educating the public on hand hygiene and respiratory etiquette. Several countries launched campaigns to make the public aware of personal hygiene at public places, home and workplace. Additional cleanliness and disinfection drives have also been carried out across public places, offices and public transportation.
- **Penalties:** In most countries, people who breached quarantine and/or lockdown restrictions had a strict fine imposed.

While we have already seen that a delayed response to the outbreak and non-compliance to social distancing protocols have led to explosion of cases, strategies that are proactive and holistic have achieved a clear shift from widespread transmission to low and stable state.

Most of the countries that we have discussed here have been universally praised as perfect models for their COVID-19 pandemic control strategies. By now, the entire world has witnessed that this pandemic is much more than a health calamity and therefore for those regions that are still battling the pandemic, a good course of action would be to apply these lessons and mitigate any further impact.

## Appendix A: IAI Office order

16th April 2020

### Office Order

#### Constitution of IAI Pandemic Research Group

##### (Research work relating to COVID-19 Pandemic)

The Current Pandemic resulting from COVID19 is resulting into massive loss of lives and financial losses across the world. In line with the IAI objective to promote, in public interest, knowledge and research in matters related to Actuarial science its application, the IAI Pandemic research group has been constituted to conduct research based on the COVID19 related data available in India and Globally. The Research will be useful for various stakeholders for developing solutions for serving the public cause.

#### Composition of the Group:

The group is consisting of the following members.

Sr.No	Name	Designation	Mem.ID	Email_ID
1	Mr. Heerak Basu	Chair & Reviewer	11	Heerak.Basu@milliman.com
2	Mr. Kailash Mittal	Co-Chair	4043	kailashmittal@kpmg.com
3	Mr. Abhijit Pal	Member	4451	abhijitpal83@gmail.com
4	Ms. Archana Anoor	Member	700	archana.anoor@gmail.com
5	Mr. Manish Sen	Member	5509	manish.sen@hdfcergohealth.com
6	Ms. Megha Garg	Member	3038	meghagarg.fia@gmail.com
7	Mr. Palash Shah	Member	27228	palashshah39@gmail.com
8	Ms. Swati Gupta	Member	2463	swatigu@deloitte.com
9	Mr. Tanay Chandra	Member	1380	tanay.chandra@gmail.com

Mr. Vinod Kumar (HOET@actuariesindia.org) from IAI will be act as an IAI support to the Group.

#### Objectives:

- Analyzing the experience emerging from Covid19 pandemic in India and others relevant markets.
- What inference can we draw from the analysis about the Incidence rates and mortality rates
- What Life/ Health products can be offered in India to cover Covid19

This Group will submit its analysis report to President by 3<sup>rd</sup> May, 2020.

**Sunil Sharma**  
(President)



## Appendix B: Back Testing Results

The data used for HIRD model calibration was up till June 30, 2020. The Group has validated the model results starting July 1, 2020.

In the below tables, we have provided back testing results for few dates. We have kept more recent dates and have picked few dates from first two weeks to give a snapshot of how the validation results compare.

Validation against actual is done against our “Best Estimate” projections.

### Pan India:

	01-07-2020		05-07-2020		10-07-2020		15-07-2020		16-07-2020	
	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
Confirmed Cases	5,89,817	5,85,493	6,73,362	6,73,165	7,92,790	7,93,802	9,31,296	9,36,181	9,61,541	9,68,876
Deaths	17,444	17,400	19,684	19,268	22,668	21,604	25,870	24,309	26,565	24,915
Recoveries	3,38,841	3,47,979	3,91,027	4,09,083	4,65,089	4,95,513	5,50,385	5,92,032	5,68,961	6,12,815
Active Cases	2,33,532	2,20,114	2,62,652	2,44,814	3,05,033	2,76,685	3,55,042	3,19,840	3,66,015	3,31,146

	17-07-2020		18-07-2020		19-07-2020		20-07-2020		21-07-2020	
	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
Confirmed Cases	9,92,695	10,03,832	10,24,785	10,38,716	10,57,839	10,77,618	10,91,887	11,18,043	11,26,958	11,55,191
Deaths	27,282	25,602	28,021	26,273	28,781	26,816	29,565	27,497	30,371	28,084
Recoveries	5,88,088	6,35,757	6,07,788	6,53,751	6,28,079	6,77,423	6,48,982	7,00,087	6,70,516	7,24,578
Active Cases	3,77,324	3,42,473	3,88,976	3,58,692	4,00,979	3,73,379	4,13,340	3,90,459	4,26,071	4,02,529

### Maharashtra:

	01-07-2020		05-07-2020		10-07-2020		15-07-2020		16-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	1,77,240	1,74,761	1,98,877	2,00,064	2,28,850	2,30,599	2,62,441	2,67,665	2,69,631	2,75,640
Deaths	7,632	7,855	8,606	8,671	9,905	9,667	11,296	10,695	11,593	10,928
Recoveries	94,201	90,911	1,07,439	1,08,082	1,25,777	1,27,259	1,46,328	1,49,007	1,50,727	1,52,613
Active Cases	75,408	75,995	82,832	83,311	93,168	93,673	1,04,816	1,07,963	1,07,310	1,12,099

	17-07-2020		18-07-2020		19-07-2020		20-07-2020		21-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	2,76,986	2,84,281	2,84,512	2,92,589	2,92,210	3,00,937	3,00,087	3,10,455	3,08,145	3,18,695
Deaths	11,897	11,194	12,208	11,452	12,525	11,596	12,851	11,854	13,183	12,030
Recoveries	1,55,228	1,58,140	1,59,832	1,60,357	1,64,542	1,65,663	1,69,361	1,69,569	1,74,291	1,75,029
Active Cases	1,09,862	1,14,947	1,12,472	1,20,780	1,15,143	1,23,678	1,17,875	1,29,032	1,20,670	1,31,636

### Delhi:

	01-07-2020		05-07-2020		10-07-2020		15-07-2020		16-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	85,979	87,360	94,515	97,200	1,04,435	1,07,051	1,13,593	1,15,346	1,15,339	1,16,993
Deaths	2,513	2,742	2,844	3,004	3,205	3,258	3,514	3,446	3,573	3,487
Recoveries	58,677	58,348	67,743	68,256	78,153	82,226	87,782	93,236	89,618	95,699
Active Cases	24,789	26,270	23,928	25,940	23,077	21,567	22,297	18,664	22,148	17,807

	17-07-2020		18-07-2020		19-07-2020		20-07-2020		21-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	1,17,057	1,18,645	1,18,748	1,20,107	1,20,412	1,21,582	1,22,050	1,22,793	1,23,662	1,23,747
Deaths	3,631	3,545	3,687	3,571	3,743	3,597	3,798	3,628	3,852	3,663
Recoveries	91,425	97,693	93,203	99,301	94,952	1,01,274	96,674	1,03,134	98,369	1,04,918
Active Cases	22,002	17,407	21,858	17,235	21,717	16,711	21,578	16,031	21,441	15,166

## Tamil Nadu:

	01-07-2020		05-07-2020		10-07-2020		15-07-2020		16-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	91,203	94,049	1,05,062	1,11,151	1,24,473	1,30,261	1,46,494	1,51,820	1,51,242	1,56,369
Deaths	1,358	1,264	1,585	1,510	1,902	1,829	2,263	2,167	2,340	2,236
Recoveries	55,648	52,926	65,314	62,778	78,853	82,324	94,212	1,02,310	97,523	1,07,416
Active Cases	34,197	39,859	38,163	46,863	43,718	46,108	50,020	47,343	51,378	46,717

	17-07-2020		18-07-2020		19-07-2020		20-07-2020		21-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	1,56,110	1,60,907	1,61,104	1,65,714	1,66,224	1,70,693	1,71,476	1,75,678	1,76,862	1,80,643
Deaths	2,420	2,315	2,502	2,403	2,586	2,481	2,672	2,551	2,760	2,626
Recoveries	1,00,919	1,10,807	1,04,401	1,13,856	1,07,973	1,17,915	1,11,636	1,21,776	1,15,392	1,26,670
Active Cases	52,772	47,785	54,201	49,455	55,666	50,297	57,169	51,351	58,710	51,347

## Gujarat:

	01-07-2020		05-07-2020		10-07-2020		15-07-2020		16-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	33,688	33,318	36,244	36,123	39,588	40,155	43,105	44,552	43,830	45,481
Deaths	1,885	1,869	2,003	1,945	2,151	2,024	2,299	2,079	2,330	2,089
Recoveries	24,073	24,038	26,117	25,900	28,790	28,183	31,602	31,286	32,181	32,103
Active Cases	7,730	7,411	8,125	8,278	8,647	9,948	9,204	11,187	9,319	11,289

	17-07-2020		18-07-2020		19-07-2020		20-07-2020		21-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	44,562	46,430	45,302	47,390	46,049	48,355	46,804	49,353	47,566	50,379
Deaths	2,360	2,106	2,391	2,122	2,423	2,142	2,454	2,162	2,486	2,196
Recoveries	32,767	32,973	33,358	34,035	33,955	34,901	34,559	35,678	35,168	36,423
Active Cases	9,435	11,351	9,552	11,233	9,671	11,312	9,790	11,513	9,911	11,760

## Rajasthan:

	01-07-2020		05-07-2020		10-07-2020		15-07-2020		16-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	19,363	18,312	21,166	20,164	23,591	23,174	26,221	26,437	26,773	27,174
Deaths	431	421	469	456	518	497	568	530	578	538
Recoveries	15,220	14,574	16,728	15,928	18,755	17,620	20,954	19,502	21,415	19,970
Active Cases	3,711	3,317	3,969	3,780	4,318	5,057	4,699	6,405	4,779	6,666

	17-07-2020		18-07-2020		19-07-2020		20-07-2020		21-07-2020	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Confirmed Cases	27,334	27,789	27,904	28,500	28,484	29,434	29,073	30,390	29,671	31,373
Deaths	589	546	600	553	611	559	622	568	633	577
Recoveries	21,884	20,626	22,361	21,144	22,846	21,730	23,338	22,195	23,839	22,744
Active Cases	4,861	6,617	4,943	6,803	5,027	7,145	5,113	7,627	5,200	8,052

## Appendix C: Disclaimer

The information in the document has been printed on the basis of publicly available information; internal data and other external referenced sources believed to be true and are for general guidance only but which may have not been verified independently. While all the efforts are made to avoid errors or omissions in this publication, errors or mistakes, if any, are unintentional.

This paper has been prepared by IAI Pandemic Research Group and is not an authoritative pronouncement of the IAI or any of its committees. Neither the Preparers, publisher of this material nor anyone else involved in creating, producing or delivering the Research Report or the materials contained therein, assumes any liability or responsibility for the accuracy, completeness, or usefulness of any information provided in the Research Report, nor shall they be liable for any direct, indirect, incidental, special, consequential or punitive loss/damages arising out of the use of the Research Report.

© THE INSTITUTE OF ACTUARIES OF INDIA

All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form, or by any means, electronic, mechanical, photocopying, recording, or otherwise without prior permission, in writing, from the publisher