CDDEP THE CENTER FOR Disease Dynamics, Economics & Policy
WASHINGTON DC • NEW DELHI

State-wise estimates of current hospital beds, intensive care unit (ICU) beds and ventilators in India: Are we prepared for a surge in COVID-19 hospitalizations?

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Abstract

Background

The rapid spread of COVID-19 globally has prompted policymakers to evaluate the capacity of health care infrastructure in their communities. Many hard-hit localities have witnessed a large influx of severe cases that strained existing hospitals. As COVID-19 spreads in India, it is essential to evaluate the country's capacity to treat severe cases.

Methods

We combined data on public and private sector hospitals in India to produce state level estimates of hospital beds, ICU beds, and mechanical ventilators. Based on the number of public sector hospitals from the 2019 National Health Profile (NHP) of India and the relative proportions of public and private health care facilities from the National Sample Survey (NSS) 75th round (2017-2018), we estimated capacity in each Indian state and union territory (UT). We assumed that 5% of all hospital beds were ICU beds and that 50% of ICU beds were equipped with ventilators.

Results

We estimated that India has approximately 1.9 million hospital beds, 95,000 ICU beds and 48,000 ventilators. Nationally, resources are concentrated in the private sector (hospital beds: 1,185,242 private vs 713,986 public; ICU beds: 59,262 private vs 35,699 public; ventilators: 29,631 private vs. 17,850 public). Our findings suggest substantial variation in available resources across states and UTs.

Conclusion

Some projections shave suggested a potential need for approximately 270,000 ICU beds in an optimistic scenario, over 2.8 times the estimated number of total available ICU beds in India. Additional resources will likely be required to accommodate patients with severe COVID-19 infections in India.

Introduction

COVID-19 was declared a global pandemic by the World Health Organization on 11th March 2020. This novel disease has been characterized in a variety of country contexts by a low number of initial cases followed by a sudden, "bomb-like" explosion in infections[1]. Despite widespread lockdowns to reduce transmissions, many countries' healthcare systems have been overwhelmed by the demand for hospitals, beds, and supportive equipment needed to treat severe cases of the disease. India has already reported over 20,000 COVID-19 cases as of 22nd April 2020[2]. Although this number indicates low prevalence of COVID-19 in India's total population, low testing rates of 0.0003 per capita (as of 22nd April 2020)[3] may obscure the full extent of COVID-19 infections in the country. Public health experts have warned that sharp increases in community transmission of COVID-19 in the upcoming months will lead to a large influx of critically ill patients and subsequent demand for ICU care and mechanical ventilation.

Indian health protocols [4] dictate that anyone who tests positive for COVID-19 is placed in an isolation ward or, for critical patients, in an ICU. In addition, all suspected cases of COVID-19 are referred to government hospitals for testing[3]. The number of public hospital beds in India has been estimated at 0.55 per 1000 people, representing 12 states comprising 70% of India's total population[5]. Of available beds, fewer than 5% of beds in public hospitals are estimated to be ICU capable.[6] Although current COVID-19 cases are being managed primarily through these public facilities, a large increase in severe infections will likely necessitate utilization of private sector resources, as well. However, the cost of private healthcare is a barrier for many Indians[7][5]. In rural India, where approximately 80% of the population live, ICU care is poor or absent at the district level, as is access to speciality care such as ventilation[6].

We estimated the number of hospital beds, Intensive Care Unit (ICU) beds, and ventilators across states and Union Territories (UTs) for both public and private facilities. These estimates, evaluated alongside projected future COVID-19 infections, may equip policy makers and healthcare professionals to tackle the COVID-19 pandemic.

Methods

We obtained estimates of government hospital beds at national and state levels from the 2019 National Health Profile (NHP) of India.[8] These data were not available for the private sector, but we obtained the proportions of public (including charitable or NGO) and private health care facilities from the National Sample Survey (NSS) 75th round

(2017-2018)[9]. NSS 75th, a nationally representative health survey of 113,823 households in India, collected self-reported information on hospitalizations during 365 days preceding the survey. Based on these proportions and the number of public hospital beds from the NHP, we estimated the number of private hospital beds in each state. The state level estimates were then aggregated to produce a national estimate of private hospital beds.

It is estimated that ICU beds constitute 5-8% of total beds available in large public teaching hospitals. We assumed that 5% of all hospital beds in both public and private facilities were ICU beds, and that 50% of all ICU beds were equipped with ventilators.

Results

We estimated that India has approximately 1.9 million hospital beds, 95,000 ICU beds and 48,000 ventilators. Nationally, hospital beds are concentrated in the private sector (hospital beds: 1,185,242 private vs 713,986 public). ICU beds and ventilators follow a similar trend (ICU beds: 59,262 private vs 35,699 public; ventilators: 29,631 private: 17,850 public).

Most hospital beds and ventilators in India are concentrated in seven States - Uttar Pradesh (14.8%), Karnataka (13.8%), Maharashtra (12.2%), Tamil Nadu (8.1%), West Bengal (5.9%), Telangana (5.2%) and Kerala (5.2%) (Figure 1 and 3, Supplemental Tables 1 and 2). Our findings suggest substantial variation in available resources across states and UTs. Small UTs such as Daman and Diu, Chandigarh, and Puducherry have among the most estimated hospital beds per capita, with 906, 510, and 375 beds per 100,000 population, respectively, while Karnataka also has a relatively large capacity at 392 beds per 100,000 (Supplemental Tables 3 and 4). Conversely, Bihar, Odisha, and Chhattisgarh are estimated to have the fewest beds per population, with 26, 55, and 56 beds per 100,000, respectively. Number of ICU beds and ventilators per 100,000 population follows similar trends (Supplemental Tables 3 and 4).

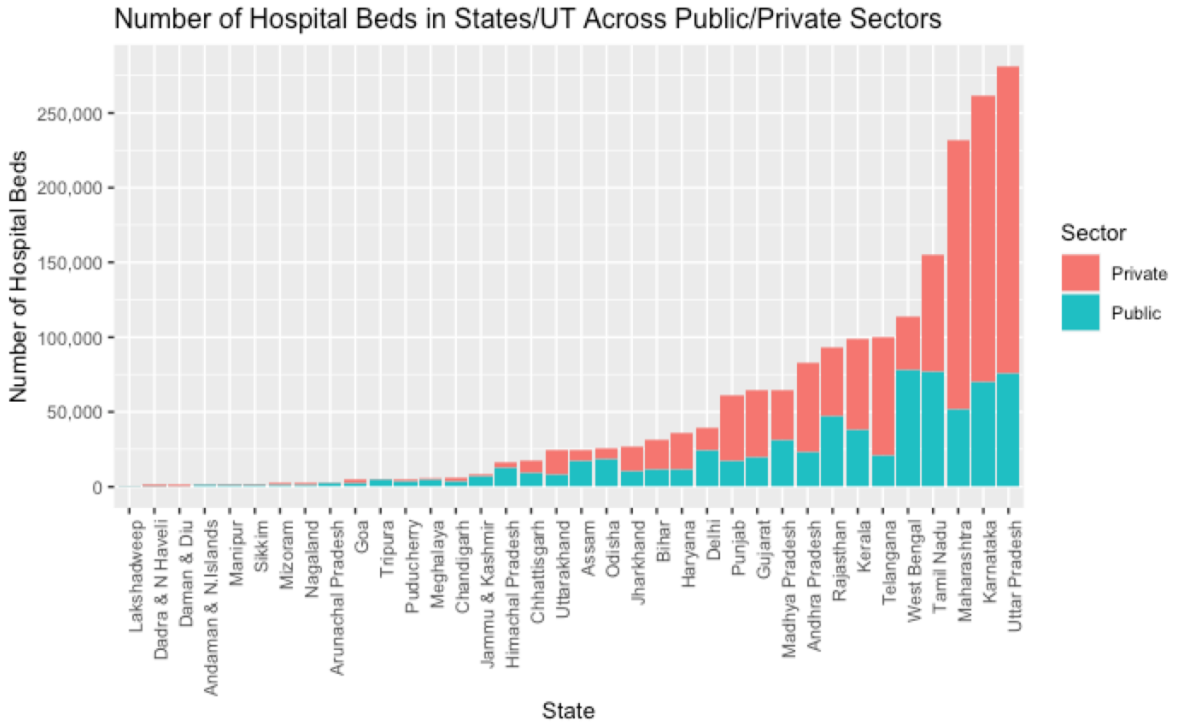

Figure 1: Number of hospital beds in both public and private sector, where private sector numbers are estimated values. States/UTs have been arranged in increasing order of total number of hospital beds. Height of column represents total number of hospital beds in that State.

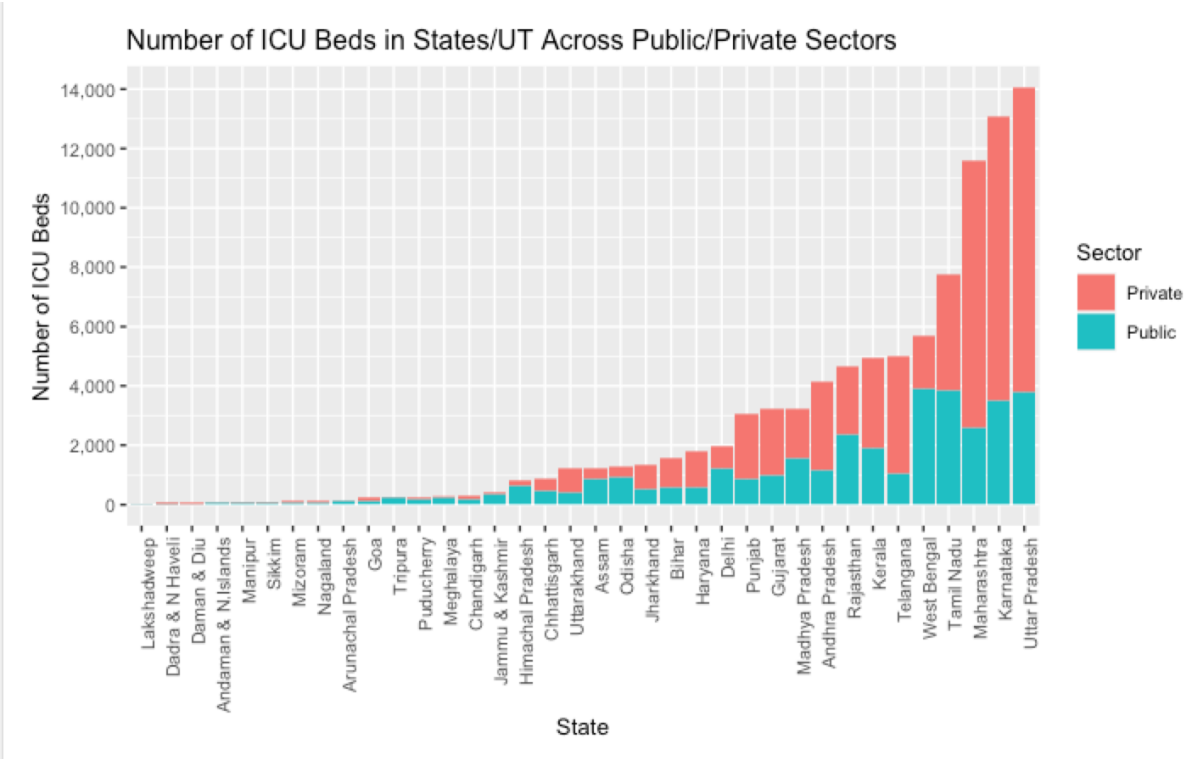

Figure 2: Numbers of ICU beds (both in public and private sectors), are estimated values. States/UTs have been arranged in increasing order of total number of ICU beds. Height of column represents total number of ICU beds in that State.

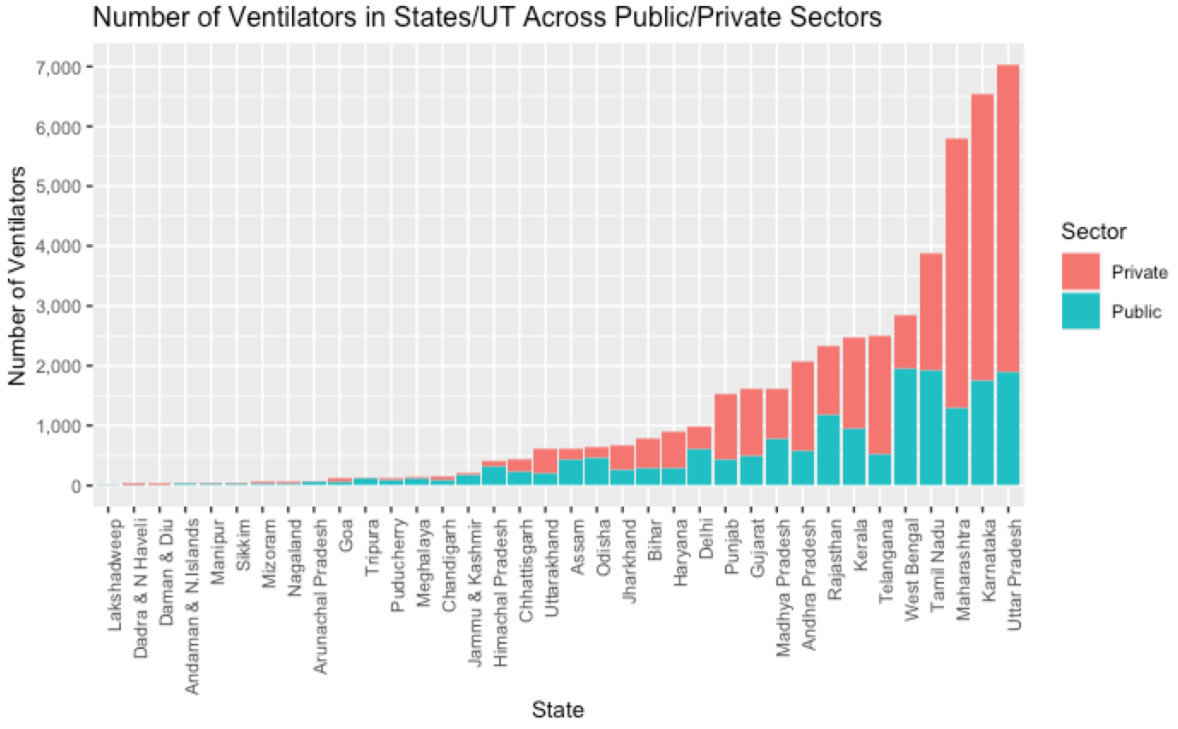

Figure 3: Numbers of ventilators (both in public and private sectors), are estimated values.
States/UTs have been arranged in increasing order of total number of ventilators. Height of column represents total number of ventilators in that State.

Discussion

Depending on the effectiveness of interventions, severe COVID-19 infections in India that require hospitalization are projected to peak between 673,822-2.8 million before July 2020.[10] Due to the critical nature of severe COVID-19 infection, including severe pneumonia and/or multiple systems failure, we estimate that 40-50% of hospitalized infections from COVID-19 will require ICU beds. This implies a potential need for approximately 270,000 ICU beds in the most optimistic scenario, over 2.8 times the estimated number of total available ICU beds in India, and a large portion of these will further require ventilators.

Some of the hardest hit and richest nations have been overwhelmed by the surge in demand for hospital beds, ventilators and other essentials of acute care. The World Health Organizations does not have a global recommendation for the number of hospital beds per 1000 population, leaving policymakers to make educated guesses based on currently known data on the disease.[11] For reference, the United States has 2.77 beds per 1000 people and 29.4 ICU beds per 100,000, with 18.8 ventilators per 100,000 people. Italy has 3.17 beds per 1000 and 12.5 ICU beds per 100,000 with 8.3 ventilators per 100,000 people.[12] China, which is the largest middle income country, has 4.05 beds per 1000 people and 3.6 ICU beds/100,000 and unknown numbers of ventilators.[12]

It is expected that elderly COVID-19 patients and those with pre-existing conditions will require all existing hospital resources, as they will be more severely affected by COVID-19 than younger segments of the population. These patients will likely require critical care and potentially require supportive/mechanical ventilation. Historic ICU utilization rate trends across India suggest that during monsoon seasons (which differ between the north and south of the country), 70-80% of admitted patients have an infectious disease (malaria, dengue), with the remaining patients affected with metabolic diseases such as diabetes or severe cardiac conditions[6]. Concurrently, 30-40% of long-term ICU patients are elderly (>80 years old) and are at an extreme risk for nosocomial infection within ICU treatment wards, including COVID-19[6].

Public mass testing could provide a more complete picture of the spread of COVID-19 in India but has yet to be rolled out due to limitations regarding testing facilities, equipment, trained personnel, availability of effective tests and high associated costs. Per existing guidelines, only a doctor can recommend a patient for a COVID-19 test after a suspected case presents at a facility or through the home care network, although some private labs began to offer tests to private citizens for INR 3500-4500 ($46-59.15 USD) as of April 20, 2020.[13] At the time of writing this report, 235 government and 86 private laboratories are authorized to test for COVID-19 in India.[3] This expansion in access to testing will provide useful data to inform the Indian health response to COVID-19; additionally, mass testing, facilitated by the pooling of multiple tests to minimize resource consumption[14], is necessary to monitor COVID-19 spread across India and identify hotspots of infection.

Health policy is generally relegated to Indian state governments rather than the national government; therefore, our estimates seek to fill the gap in existing data sources to estimate the total resources available for critically ill patients in each Indian state and union territory. This analysis suggests that the availability of total beds, ICU beds, and ventilators in India is insufficient to handle a large influx of severely ill COVID-19 patients in addition to their utilization for other acute illnesses. Estimates on expected

demand for critical care services will enable policymakers to prepare health facilities for a sharp rise in severe COVID-19 cases.

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Supplemental Tables

Supplemental Table 1: Hospitals and hospital beds in India, in descending order of total hospital beds

State or Union Territory	Public Hospitals	Private Hospitals (Estimated)	Total Hospitals (Estimated)	Public Hospital Beds	Private Hospital Beds (Estimated)	Total Hospital Beds (Estimated)
All India	25,778	43,487	69,265	713,986	1,185,242	1,899,228
Uttar Pradesh	4,635	12,468	17,103	76,260	205,142	281,402
Karnataka	2,842	7,842	10,684	69,721	192,388	262,109
Maharashtra	711	2,492	3,203	51,446	180,293	231,739
Tamil Nadu	1,217	1,222	2,439	77,532	77,843	155,375
West Bengal	1,566	697	2,263	78,566	34,969	113,535
Telangana	863	3,247	4,110	20,983	78,936	99,919
Kerala	1,280	2,062	3,342	38,004	61,223	99,227
Rajasthan	2,850	2,794	5,644	47,054	46,122	93,176
Andhra Pradesh	258	670	928	23,138	60,092	83,230
Madhya Pradesh	465	506	971	31,106	33,833	64,939
Gujarat	438	970	1,408	20,172	44,690	64,862
Punjab	682	1,638	2,320	17,933	43,064	60,997
Delhi	109	67	176	24,383	15,072	39,455
Haryana	668	1,480	2,148	11,240	24,901	36,141

Bihar	1,147	1,887	3,034	11,664	19,193	30,857
Jharkhand	555	809	1,364	10,784	15,712	26,496
Odisha	1,806	695	2,501	18,519	7,131	25,650
Assam	1,226	503	1,729	17,142	7,036	24,178
Uttarakhand	460	829	1,289	8,512	15,331	23,843
Chhattisgarh	214	182	396	9,412	8,018	17,430
Himachal Pradesh	801	235	1,036	12,399	3,641	16,040
Jammu & Kashmir	143	14	157	7,291	704	7,995
Chandigarh	9	4	13	3,756	1,875	5,631
Meghalaya	157	28	185	4,457	787	5,244
Puducherry	14	6	20	3,569	1,603	5,172
Tripura	156	8	164	4,429	238	4,667
Goa	43	22	65	3,012	1,572	4,584
Arunachal Pradesh	218	20	238	2,404	220	2,624
Nagaland	36	13	49	1,880	681	2,561
Mizoram	90	23	113	1,997	499	2,496
Sikkim	33	8	41	1,560	392	1,952
Manipur	30	8	38	1,427	363	1,790
Andaman & N. Islands	30	6	36	1,075	219	1,294
Daman & Diu	5	21	26	240	1,010	1,250
Dadra & N Haveli	12	6	18	619	322	941
Lakshadweep	9	4	13	300	126	426
Ladakh	NA	NA	NA	NA	NA	NA

Supplemental Table 2: Estimated ICU beds and ventilators in India, in descending order of total ICU beds

State or Union Territory	Estimated ICU beds in public sector	Estimated ICU beds in private sector	Estimated total ICU beds	Estimated ventilators in public sector	Estimated ventilators in private sector	Estimated total ventilators
All-India	35,699	59,262	94,961	17,850	29,631	47,481
Uttar Pradesh	3,813	10,257	14,070	1,907	5,129	7,035
Karnataka	3,486	9,619	13,105	1,743	4,810	6,553
Maharashtra	2,572	9,015	11,587	1,286	4,507	5,793
Tamil Nadu	3,877	3,892	7,769	1,938	1,946	3,884
West Bengal	3,928	1,748	5,677	1,964	874	2,838
Telangana	1,049	3,947	4,996	525	1,973	2,498
Kerala	1,900	3,061	4,961	950	1,531	2,481
Rajasthan	2,353	2,306	4,659	1,176	1,153	2,329
Andhra Pradesh	1,157	3,005	4,162	578	1,502	2,081
Madhya Pradesh	1,555	1,692	3,247	778	846	1,623
Gujarat	1,009	2,234	3,243	504	1,117	1,622
Punjab	897	2,153	3,050	448	1,077	1,525
Delhi	1,219	754	1,973	610	377	986
Haryana	562	1,245	1,807	281	623	904
Bihar	583	960	1,543	292	480	771
Jharkhand	539	786	1,325	270	393	662
Odisha	926	357	1,282	463	178	641
Assam	857	352	1,209	429	176	604

Uttarakhand	426	767	1,192	213	383	596
Chhattisgarh	471	401	871	235	200	436
Himachal Pradesh	620	182	802	310	91	401
Jammu & Kashmir	365	35	400	182	18	200
Chandigarh	188	94	282	94	47	141
Meghalaya	223	39	262	111	20	131
Puducherry	178	80	259	89	40	129
Tripura	221	12	233	111	6	117
Goa	151	79	229	75	39	115
Arunachal Pradesh	120	11	131	60	6	66
Nagaland	94	34	128	47	17	64
Mizoram	100	25	125	50	12	62
Sikkim	78	20	98	39	10	49
Manipur	71	18	90	36	9	45
Andaman & N. Islands	54	11	65	27	5	32
Daman & Diu	12	51	63	6	25	31
Dadra & N Haveli	31	16	47	15	8	24
Lakshadweep	15	6	21	8	3	11
Ladakh	NA	NA	NA	NA	NA	NA

Supplemental Table 3: Hospital beds per 100,000 in India, in descending order of total hospital beds

State	Public Hospital Beds per 100,000 Population	Private Hospital Beds per 100,000 Population	Total Hospital Beds per 100,000 Population
All India	51.74	85.89	137.62
Daman & Diu	173.91	731.88	905.79
Chandigarh	340.22	169.85	510.07
Karnataka	104.17	287.45	391.62
Puducherry	258.62	116.19	374.82
Sikkim	282.61	71.09	353.70
Andaman & Nicobar Island	259.66	52.81	312.47
Lakshadweep	217.39	91.40	308.79
Goa	181.88	94.96	276.84
Kerala	96.97	156.21	253.18
Arunachal Pradesh	217.75	19.97	237.72
Telangana	49.69	186.93	236.62
Dadara & Nagar Havelli	149.52	77.71	227.23
Mizoram	180.89	45.22	226.11
Himachal Pradesh	166.38	48.86	215.24
Uttarakhand	75.22	135.48	210.70
Punjab	60.16	144.47	204.63
NCT of Delhi	120.20	74.30	194.49
Tamil Nadu	87.24	87.59	174.83
Maharashtra	38.39	134.55	172.94
Meghalaya	140.42	24.78	165.20
Nagaland	113.53	41.14	154.67
Andhra Pradesh	40.40	104.93	145.33
Uttar Pradesh	35.20	94.68	129.88
Rajasthan	62.22	60.99	123.21
Tripura	110.67	5.95	116.62
Haryana	36.04	79.84	115.88
West Bengal	75.81	33.74	109.55
Gujarat	30.58	67.75	98.33

Assam	51.97	21.33	73.31
Madhya Pradesh	34.89	37.95	72.84
Manipur	57.45	14.63	72.08
Jharkhand	29.27	42.64	71.91
Jammu & Kashmir	56.21	5.42	61.63
Chhattisgarh	30.05	25.59	55.64
Odisha	39.47	15.20	54.67
Bihar	9.66	15.89	25.55

Supplemental Table 4: Estimated ICU beds and ventilators per capita in India, in descending order of total ICU beds

State	Public ICU Beds Per 100,000	Private ICU Beds per 100,000	Total ICU Beds per 100,000	Public Ventilators per 100,000	Private Ventilators per 100,000	Total Ventilators per 100,000
All India	2.59	4.29	6.88	1.29	2.15	3.44
Daman & Diu	8.70	36.96	45.65	4.35	18.12	22.46
Chandigarh	17.03	8.51	25.54	8.51	4.26	12.77
Karnataka	5.21	14.37	19.58	2.60	7.19	9.79
Puducherry	12.90	5.80	18.70	6.45	2.90	9.35
Sikkim	14.13	3.62	17.75	7.07	1.81	8.88
Andaman & Nicobar Island	13.04	2.66	15.70	6.52	1.21	7.73
Lakshadweep	10.87	4.35	15.22	5.80	2.17	7.97
Goa	9.12	4.77	13.89	4.53	2.36	6.88
Kerala	4.85	7.81	12.66	2.42	3.91	6.33
Arunachal Pradesh	10.87	1.00	11.87	5.43	0.54	5.98
Telangana	2.48	9.35	11.83	1.24	4.67	5.92
Dadara & Nagar Havelli	7.49	3.86	11.35	3.62	1.93	5.56
Mizoram	9.06	2.26	11.32	4.53	1.09	5.62
Himachal Pradesh	8.32	2.44	10.76	4.16	1.22	5.38
Uttarakhand	3.76	6.78	10.54	1.88	3.38	5.27
Punjab	3.01	7.22	10.23	1.50	3.61	5.12
NCT of Delhi	6.01	3.72	9.73	3.01	1.86	4.87
Tamil Nadu	4.36	4.38	8.74	2.18	2.19	4.37
Maharashtra	1.92	6.73	8.65	0.96	3.36	4.32

Meghalaya	7.03	1.23	8.25	3.50	0.63	4.13
Nagaland	5.68	2.05	7.73	2.84	1.03	3.86
Andhra Pradesh	2.02	5.25	7.27	1.01	2.62	3.63
Uttar Pradesh	1.76	4.73	6.49	0.88	2.37	3.25
Rajasthan	3.11	3.05	6.16	1.56	1.52	3.08
Tripura	5.52	0.30	5.82	2.77	0.15	2.92
Haryana	1.80	3.99	5.79	0.90	2.00	2.90
West Bengal	3.79	1.69	5.48	1.90	0.84	2.74
Gujarat	1.53	3.39	4.92	0.76	1.69	2.46
Assam	2.60	1.07	3.67	1.30	0.53	1.83
Madhya Pradesh	1.74	1.90	3.64	0.87	0.95	1.82
Jharkhand	1.46	2.13	3.60	0.73	1.07	1.80
Manipur	2.86	0.72	3.58	1.45	0.36	1.81
Jammu & Kashmir	2.81	0.27	3.08	1.40	0.14	1.54
Chhattisgarh	1.50	1.28	2.78	0.75	0.64	1.39
Odisha	1.97	0.76	2.73	0.99	0.38	1.37
Bihar	0.48	0.80	1.28	0.24	0.40	0.64