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AN EMPIRICAL STUDY TO UNDERSTAND THE FAILURE OF OXYGEN SUPPLY IN INDIA DURING 2ND WAVE OF COVID-19 VIRUS

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Abstract

This is a study to understand the vast effects that took place due to the exponential surge in coronavirus infections during the 2nd wave of COVID-19 battling for oxygen since hospitals in numerous states had run out of medical oxygen. Hundreds of hospitals throughout India were running low on oxygen, forcing relatives of patients to scramble for oxygen cylinders, often in vain. During the peak of the second Covid-19 wave, India experienced a surge in demand for medical oxygen, disrupting the country's supply system. Due to a scarcity of oxygen plants, the country had an oxygen-producing crisis.

Keywords

COVID-19, Oxygen supply, Second wave , India , Oxygen Shortage , Supply Chain , Hospitals, Government

Introduction

The Covid-19 wave, which originated from China, was initially called an epidemic, but soon it was declared as a pandemic by the World Health Organization. For moderate and severe instances of COVID-19, medical oxygen is the single most significant intervention. Patients can suffocate and die if they don't have it. In

India, both hospitals that treat COVID-19 and those that do not have run out of medical oxygen in the first year and a half of the pandemic. The issue was initially noticed at the first wave's high in September 2020, and then resurfaced on a much bigger scale during the second wave's peak in April and May 2021. According to some monitors, 512 lives may have been lost across the country owing to an oxygen shortage or deprivation. The problem isn't a scarcity of medical oxygen per say, but rather an insufficient tanker distribution network for transporting liquid oxygen from the place of manufacturing to hospitals. Medical oxygen distribution is, indeed, a difficult task. Large hospitals are often supplied directly by manufacturers, who deliver the oxygen through tankers. Meanwhile, medium and small hospitals, as well as nursing homes, rely heavily on intermediaries: manufacturers deliver liquid oxygen to filling stations via tankers; gas agencies, which own cylinders, fill them at filling stations and then deliver them to nursing homes via "jumbo cylinders" or "dura cylinders." Due to the steep and sudden rise in demand across the country—from 3,842 MT per day on 12 April 2021 to 8,400 MT per day by 25 April, and further up to 11,000 MT per day by the beginning of May—the entire supply chain was severely disrupted at multiple levels. Desk, I. T. W. (2021a, April 22)

The Second COVID-19 wave in India was severe; lack of oxygen and disrupted supply of oxygen led to loss of many lives. It almost created a massive panic situation in the country; the country being called World Pharmacy struggling to provide basic medical requirements, which is oxygen. As per the tender released by the government of India the planning of the production was right in place, but the vendors didn’t complete and even when the production was more than the actual demand the problem wasn’t solved. As it was the disruptive supply chain as the supply to the states was decided by the central government it became a challenge to meet the real demand at a given place. To add, logistical issues in supplying oxygen have also become a major issue for companies that manufacture liquid oxygen. The 24×7 availability of cryogenic tankers which are necessary for transporting liquid oxygen — is difficult given the fact that many hospitals are facing a shortage at the same time. The need of the hour was to manufacture more cryogenic tanks, which could take up to four months. The shortage of such tankers has led to a significant delay in interstate transportation of oxygen from manufacturers to hospitals. It may be noted that medical facilities and healthcare centers located in remote areas face a bigger crisis due to longer transportation time. Thadhani, A.

(2021, June 29)

In this paper we investigate the reasons which led to the failure of oxygen supply in India during the 2nd wave of Covid 19 virus. It was hypothesized that the reason for this shortage is uneven distribution through supply and logistic chains. This paper is divided into six sections. Section 1 is the introductory section, In Section II, we have explained the research methodology used for conducting this study. In Section III, we presented our findings. In Section IV, we have discussed the results we got in detail. In Section V, we have discussed the implications. Lastly, in Section VI we have concluded our research.

Literature Review

Infected patients were struggling for oxygen in the second wave of Covid-19, as hospitals in several states had run out of medical oxygen. Due to this, several hospitals in Delhi and a few other states were functioning on the verge of collapse. The Indian Railways announced the launch of the 'Oxygen Express,' which would transport oxygen cylinders across the country along a green corridor. People were criticizing the government for failing to fulfill the demand for oxygen. Even though the central leadership mobilized all of its resources and logistics to optimize the supply chain, the reaction to the ongoing crisis was insufficient owing to a disproportionate increase in the cases. Dozens of hospitals in several Indian cities and towns had run short of oxygen, sending relatives of patients scrambling for oxygen cylinders, sometimes in vain. The Indian Air Force had also been airlifting oxygen from military bases. Cryogenic tankers convey liquid oxygen at extremely low temperatures to distributors, who subsequently convert it to gas for filling cylinders. As a result, the logistics of refilling them and transporting them to their destination posed a significant bottleneck. Most of the oxygen production is in India's east, whereas the country's

western and northern cities have seen a surge in demand. The lack of a centralized system for supply and delivery of oxygen had delayed many timely deliveries. “World Pharmacy” was a tag given to India in March between the pandemic for supporting and supplying essential medical resources to many parts of the world. In 2 months, the world pharmacy faced an oxygen shortage and lack of supply. This oxygen crisis happens to be multi-dimensional. The oxygen shortage had been a huge problem not only in cities, but also in small towns and villages where the health infrastructure was extremely weak. The Central Government had floated

a tender in October to set up oxygen plants in the district Hospital. It was later observed that the vendors who had the contracts never showed up or the hospitals didn't provide land or State administration didn't come up with proper electricity and other resources. Later the required production of oxygen was controlled by diverting the industrial oxygen from industries. The allocation for states was taken care of by the central government based on the number of beds and ICU beds in the state. Cryogenic containers used to transport liquid oxygen were also not available due to increase in demand which led to delay in delivery of oxygen.

In future, to avoid such crises of medical supplies and oxygen during emergencies, the experts have recommended a nested nodal allocation model which could help solve the planning for such emergencies and overcome the challenges during the time of crisis.

Objective

The research aims to identify the various aspects of the multi-dimensional problem causing shortage of the oxygen during the 2nd wave of COVID-19 in India. Identifying the supply chain and other important problems which led to the oxygen crisis.

Research Methodology

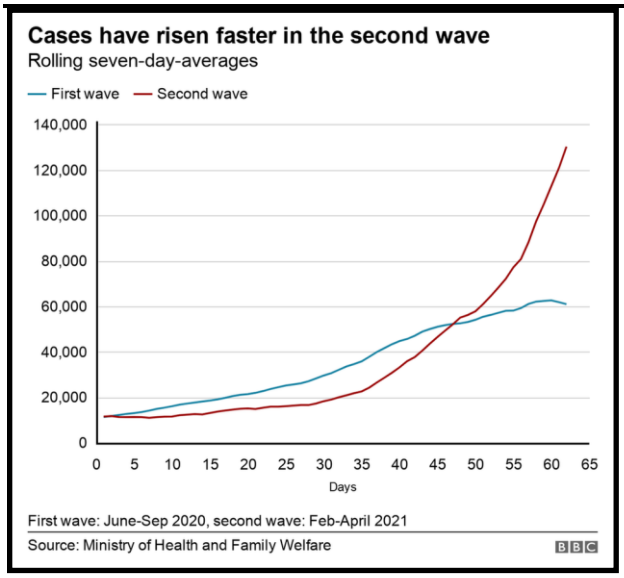
We went forward with secondary research for our paper from already published sources such as WHO, BBC and other health portals.

Public libraries, websites, and data from previously completed surveys, among other sources, can make these materials available. Secondary research is far more cost-effective than primary research because it uses data that already exists, as opposed to primary research, which requires organizations or enterprises to collect data themselves or hire a third party to do it on their behalf.

The Central Government had floated a tender in October to set up oxygen plants in the district Hospital. It was later observed that the vendors who had the contracts never showed up or the hospitals didn't provide land or State administration didn't come up with proper electricity and other resources. Out of 162 plants,

only 33 were set up as per the Federal health ministry. This led to the manufacturing crisis of oxygen in the country, but the required production of oxygen was controlled by diverting the industrial oxygen from industries. Allocation of oxygen to different states was determined based on the number of beds and ICU beds in the state. The allocation for states was taken care of by the central government. Later the state government allocated it to the hospitals. The requirements of different states were different at different times as Covid cases couldn't be predicted, due to such centralized allocation and absence of proper planning it created a panic situation. Cryogenic containers used to transport liquid oxygen were also not available due to increase in demand which led to delay in delivery of oxygen. There was also a shortage of oxygen cylinders which could not be refilled fast enough to meet the ever-increasing demand. Later, containers were imported, and special railways and the Indian air force were deployed for transportation. Oxygen cylinder refill plants were also allowed to function 24 x 7, tankers and oxygen carrying vehicles were given green corridors across the country. The government promised to produce 10,000 metric tonnes per day of oxygen, but it was already too late. In future, to avoid such a crisis of medical supplies and oxygen during an emergency, the experts have recommended a nested nodal allocation model which could help solve the planning for such emergencies and overcome the challenges during the time of crisis. The government should put the system into place, have strict operating norms for vendors, and indulge in proper crisis management planning with the right investment and resources**.**

In an interview with WHO Dr Janet Diaz mentioned that Technology is required for medical oxygen. It implies that you must be able to extract oxygen from the air, as oxygen is present in the atmosphere. Oxygen makes up around 21% of the air we breathe. However, we must concentrate it into medicinal oxygen, which necessitates the use of technology. The distribution of medicinal oxygen is the other issue. So, one option is to concentrate the oxygen and provide a hospital or an area with it. As a result, be sure that the oxygen you've provided, as well as the oxygen you're making, can reach the patients. The third obstacle, in her opinion, is learning how to utilize medical oxygen, which entails maintaining the technology up to date, mending any broken parts, and ensuring that the piping is in working order.



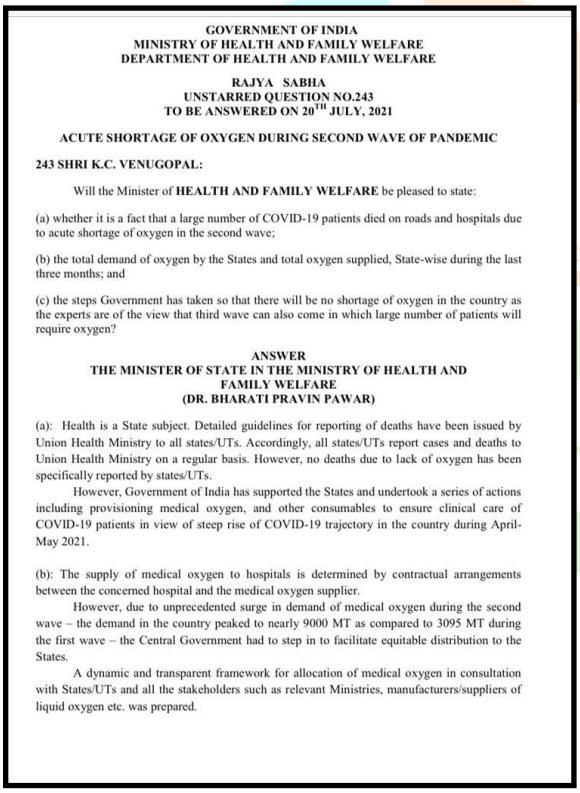
According to Dr Amit Thadhani who is a practicing general surgeon and Director, Niramaya Hospital, Kharghar Navi, Mumbai, a 75-bed hospital that has been a Dedicated COVID-19 Hospital in the past year. He says that due to the steep and sudden rise in demand across the country—from 3,842 MT per day on 12 April 2021 to 8,400 MT per day by 25 April, and further up to 11,000 MT per day by the beginning of May—the entire supply chain was severely disrupted at multiple levels, before gradually reducing as the number of fresh cases declined.

When the demand for medical oxygen unexpectedly rose in April 2021, more tankers were required to be put into action. However, India only has about 1,200 cryogenic oxygen tankers across the country, which is insufficient to meet the demand. To address the issue, several state governments, such as Uttar Pradesh's, repurposed tankers formerly used to transport other liquid gas to transport medical oxygen; they also deployed technology, tagging tankers to obtain real- time data on their position. Reliance Industries, Adani Group, and Tata Companies have all stepped in to move industrial oxygen from their factories to hospitals around the country.

For the quick transfer of liquid oxygen from big industrial sites, the central government flew tankers from other nations and has been conducting Oxygen Express trains to impacted areas. In the last week of April, the Delhi state administration stated that it will import cryogenic tankers from Bangkok as well as oxygen plants from France. In addition, the federal government flew in ready-to-use plants for installation at many government hospitals. According to the federal government, there are presently around 2,000 oxygen tankers

on the road, carrying over 30,000 MT of liquid oxygen.

The Ministry of Commerce's Department of Promotion of Industry and Industrial Trade organized an "oxygen monitoring committee" in the beginning of 2020 and undertook numerous rounds of conversations with oxygen makers' organizations on capacity expansion based on future needs. In January 2021, state governments were informed of the need to install oxygen plants in larger hospitals in their territories, and monies were provided from the PM CARES Fund for 162 oxygen plants. However, at that time, it looked like the pandemic's first wave had passed, and the sense of urgency had faded. Majority of states did not proceed with the construction of the oxygen plants, and as a result, they would face severe challenges during the second wave.



GOVERNMENT OF INDIA
MINISTRY OF HEALTH AND FAMILY WELFARE
DEPARTMENT OF HEALTH AND FAMILY WELFARE

RAJYA SABHA
UNSTARRED QUESTION NO.243
TO BE ANSWERED ON 20TH JULY, 2021

ACUTE SHORTAGE OF OXYGEN DURING SECOND WAVE OF PANDEMIC

243 SHRI K.C. VENUGOPAL:

Will the Minister of **HEALTH AND FAMILY WELFARE** be pleased to state:

(a) whether it is a fact that a large number of COVID-19 patients died on roads and hospitals due to acute shortage of oxygen in the second wave;

(b) the total demand of oxygen by the States and total oxygen supplied, State-wise during the last three months; and

(c) the steps Government has taken so that there will be no shortage of oxygen in the country as the experts are of the view that third wave can also come in which large number of patients will require oxygen?

ANSWER
THE MINISTER OF STATE IN THE MINISTRY OF HEALTH AND FAMILY WELFARE
(DR. BHARATI PRAVIN PAWAR)

(a): Health is a State subject. Detailed guidelines for reporting of deaths have been issued by Union Health Ministry to all states/UTs. Accordingly, all states/UTs report cases and deaths to Union Health Ministry on a regular basis. However, no deaths due to lack of oxygen has been specifically reported by states/UTs.

However, Government of India has supported the States and undertook a series of actions including provisioning medical oxygen, and other consumables to ensure clinical care of COVID-19 patients in view of steep rise of COVID-19 trajectory in the country during April-May 2021.

(b): The supply of medical oxygen to hospitals is determined by contractual arrangements between the concerned hospital and the medical oxygen supplier.

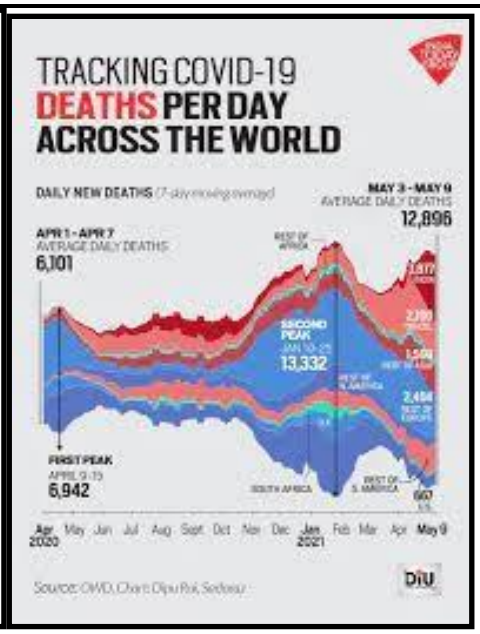
However, due to unprecedented surge in demand of medical oxygen during the second wave – the demand in the country peaked to nearly 9000 MT as compared to 3095 MT during the first wave – the Central Government had to step in to facilitate equitable distribution to the States.

A dynamic and transparent framework for allocation of medical oxygen in consultation with States/UTs and all the stakeholders such as relevant Ministries, manufacturers/suppliers of liquid oxygen etc. was prepared.

Only a few states, like Assam and Uttar Pradesh, have installed oxygen plants in critical hospitals. Kerala, too, increased its capacity and claimed to be oxygen-surplus; nevertheless, when the situation in the state worsened, they demanded greater oxygen allocation. Odisha, which had lower infection rates at the start of the second wave, stepped in to provide 345 tankers of oxygen to the worst-affected states since it has numerous huge industrial sites that produce vast amounts of oxygen. The state was able to meet its own needs without difficulty.

MORE NEED OXYGEN

Infected	1st wave	2nd wave
<30 years	31%	32%
30-40	21%	21%
Seriousness Of Infection		
Shortness of breath	41.7%	47.5%
Needing oxygen	41.1%	54.5%



However, the second wave presented a significant difficulty, since numerous big states throughout the country had substantial increases in cases in a short period of time. This revealed the insufficiency of the medical oxygen distribution network. Even huge hospitals were unable to get deliveries from manufacturers. Smaller hospitals ran out of supplies, which had disastrous results in certain cases. To deal with the crisis, the smaller hospitals loaned each other a few cylinders, which were useful for a few hours until their own supply came. Suppliers' cars would frequently spend several hours in line for oxygen cylinder refills, only to be sent back when supplies were soon depleted.

Adding to the problems:

1. Black Marketing - Medical oxygen became 10 times more expensive than it was before the epidemic. Individuals and black marketeers alike began hoarding cylinders, which gradually vanished from circulation. Though black-marketing was common across most of North, West, and Central India, it was considerably less prevalent in places like Kerala,

Tamil Nadu, and Karnataka, where improved public health facilities may have resulted in significantly fewer people on home oxygen. Furthermore, the second wave peaked two weeks later in several Southern states, such as Karnataka and Tamil Nadu, than it did in Maharashtra and Delhi, by which time a large portion of the supply problem had been resolved. The government stepped in in certain states, such as Maharashtra, to place a restriction on the price of oxygen per cylinder. As hospital beds grew limited and home care became the

sole alternative for thousands of patients, the illicit market for oxygen cylinders flourished throughout multiple states. Oxygen concentrators soon sold out, with prices rising from INR 35,000 to 40,0000 before COVID-19 to more than INR 100,000 in April and May 2021.

2. The needs of patients change with time. They can fluctuate from minute to minute, ranging from 2 to 15 lit/min in just a few hours (Thadhani, 2021). Because it takes significantly longer for requirements to reduce than for them to grow, even attempting to average the requirements may not be effective. The oxygen consumption in the ICU is substantially more than 20 liters per minute. Because non-invasive ventilation (NIV) or BiPap is the primary treatment method in COVID-19, the typical consumption is 30-40 lit/min.Vendors may under-fill oxygen cylinders on purpose or owing to a lapse in the filling procedure. As a result, there's no assurance that the quota will contain the declared amount of oxygen.

In June 2021, the Central Government began "Project O2 For India" under the direction of the Principal Scientific Advisor's office. A National Consortium of Oxygen, made up of enterprises, Indian Institutes of Technology (IITs), and non-profit organizations, is assisting the government in establishing a supply chain for crucial materials and parts for oxygen plants. Plant financing is provided through PM CARES, as well as business sponsorships through CSR money.

Company	State	Number of plants
Maruti Suzuki	J&K, Haryana & others	22
HCL	Delhi	17
IGL	Delhi	1
Tata Sons and DRDO	Multiple	500
Oil PSUs	Multiple	100
DCM Shriram	Gujarat	2
Tech Mahindra	Multiple	50
Northern Coalfields	Madhya Pradesh	5
Western Coalfields	Maharashtra	2
Powergrid Corporation	Rajasthan	3

Problem identification:

1. Firstly, it is difficult to predict the demand for oxygen at any level (national, state, district) that may arise in a future emergency
2. Secondly, logistics of distribution from supply sources to state capitals, then to district headquarters, and finally to community and primary health care center levels are extremely difficult
3. Information flow and compliance with planning authorities take time.
4. It was found that one-third of the oxygen production is concentrated in the East of India, while 60% of demand for oxygen is in North and South India which results in the inevitable delay of supply and distribution challenges.

Suggestions

1. It is suggested that a central distribution strategy should not be followed as there should be decentralised strategy to ensure efficient supply and distribution of oxygen.
2. State Government should ensure the availability of the resources to the district hospitals which lacked several resources required to install an oxygen plant as advised by the centre.
3. Non-medical private sector producing oxygen should contribute their produce in emergency medical situations and proper guidelines shall be drafted for the same.
4. Create operational plans to exchange resources across states
5. Relax enforcement of some state and federal restrictions relating to the transport of oxygen at the state and federal levels, if needed, to allow for simpler resource sharing.
6. Conduct an immediate investigation of the production capacity and supply chain of oxygen cylinders,

concentrators, regulators, and related supplies.

7. Improving the oxygen production India is vital. This will help in achieving oxygen self- sufficiency
8. Enhancing tanker availability to optimize logistics and ease in distribution.
9. Oxygen storage at the last mile is necessary, and this can only be achieved with more production facilities
10. Harnessing the private sector capacities to produce, store and transport Liquid Medical Oxygen

Conclusion

During the peak of second covid-19 wave India saw a sudden rise in demand for medical oxygen across the country which disrupted supply chain across the country. There was also a manufacturing crisis of oxygen in the country due to the lack of oxygen plants. Out of 162 plants only 33 were set up as per the Federal health ministry, this led to a panic situation. There was also a shortage of oxygen cylinders which could not be refilled fast enough to meet the ever-increasing demand. The government tried to navigate through this crisis by diverting industrial oxygen to hospitals. Oxygen cylinder refill plants were also allowed to function 24 x 7, tankers and oxygen carrying vehicles were given green corridors across the country. To address supply chain issues several state governments repurposed tankers formerly used to transport other liquid gas to transport medical oxygen they also deployed technology like tagging tankers to obtain real-time data on their position. To reduce time required to supply oxygen to critically affected areas government flew in oxygen from other nations and used “Oxygen Express” in some areas federal government flew in ready-to-use plants for installation at many government hospitals. To deal with the crisis, the smaller hospitals loaned each other a few cylinders, which were useful for a few hours until their own supply came. Despite all the efforts taken by the central and state government to mitigate the crisis it still fell short to handle the crisis adequately much of the efforts taken were hampered by unexpected increases in demand and other factors like hoarding, black market sales,etc.

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