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Oxygen Supply of Skims Soura Before and After COVID-19 Pandemic; Skims Experience and Lessons Learnt

Dr Saif Ul Yamin[1], G H Yatoo[2]

Abstract: ***Since more than a century ago, oxygen therapy has been a standard of care and a critical part of hospital infrastructure. The majority of hypoxemic hospital patients will not receive oxygen, increasing their risk of dying, because access to oxygen therapy is restricted in many low-resource settings. The COVID-19 coronavirus pandemic has exposed the size of this "oxygen gap" and sparked long overdue attention in enhancing oxygen delivery systems. 20% of COVID-19 patients need to be admitted to the hospital for oxygen therapy (with or without additional respiratory assistance). Although intensive care unit and ventilator capacity have received a lot of attention, enhancing fundamental hospital oxygen systems must come first. We saw during COVID-19 Pandemic how much shortage of oxygen hospital had to face because this hospital did not build systems to produce or store oxygen. Increasing indigenous oxygen generating capacity of hospital is need of hour.***

Keywords: Oxygen therapy, Hypoxemic, COVID-19, Pandemic, oxygen gap, oxygen supply

1. Introduction

Supplemental oxygen is a crucial component of treating many respiratory illnesses. The COVID-19 epidemic has brought to light its significance. Oxygen therapy is used to treat COVID-19's acute and severe symptoms. Oxygen can be supplied in a number of ways, including liquid oxygen, oxygen concentrators, and oxygen cylinders. Oxygen cylinders can be of conventional steel and presently of Aluminium which are light weight and safe in Magnetic resonance imaging environment [5, 6, 7, 8]. Approximately 20% of patients with COVID-19 need oxygen assistance, despite the fact that most have mild or uncomplicated symptoms.

For the predicted 500, 000 [1] COVID-19-infected individuals in low-and middle-income countries (LMICs) during the pandemic's mid-2021 wave, 1.1 million cylinders per day were required. Despite this, a significant portion of patients lacked access to oxygen [3]. LMICs, particularly Asia, have reported a medical oxygen shortage because of the region's 100-200 fold rise in oxygen demand.

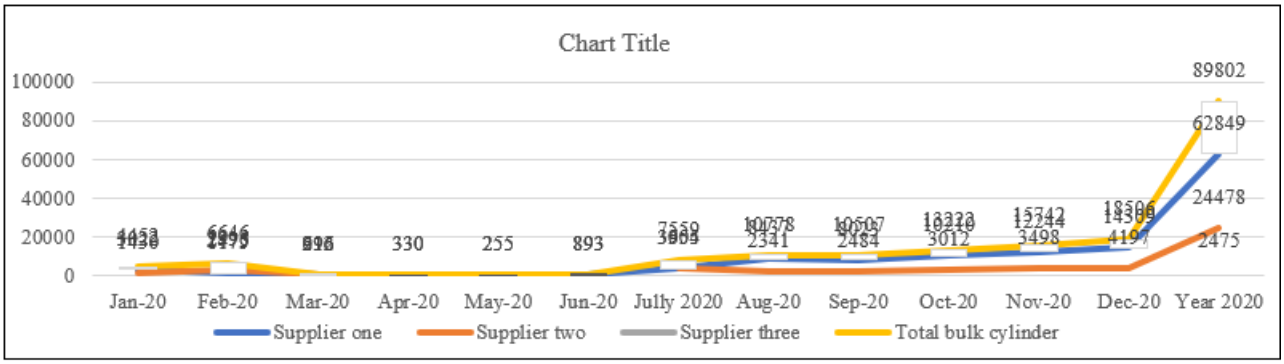
The death rates from COVID-19 among LMICs was as high as 19%, and these countries have reported a medical oxygen crisis. The COVID-19 outbreak in low-resource areas have clearly revealed the imbalance between oxygen supply and demand. There is a finite supply of oxygen.

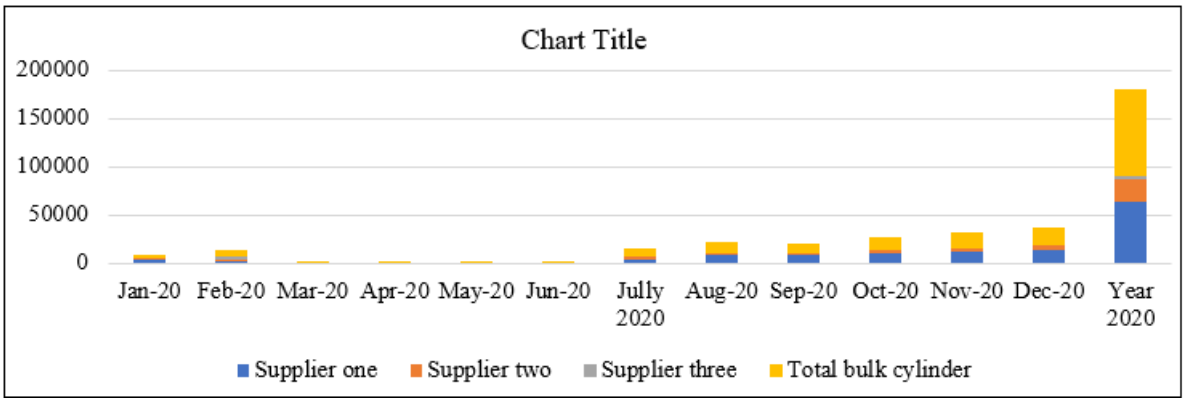
2. Case Study

We want to raise awareness of the difficulties SKIMS Soura encountered during COVID 19 pandemic. How we tackled shortage of oxygen in COVID 19 pandemic and presently we are having excess of oxygen. Before pandemic we had oxygen generating plant with capacity of only 750 litres per minute and central oxygen supply through pipes only to around less than 20% of hospital beds but after pandemic is over, we at SKIMS are having six oxygen generating plants with capacity of 6750 litres per minute with 100% central oxygen supply through pipes system. Even though SKIMS also have 964 Bulk oxygen cylinders they are mostly used in transportation of patients from one department to another. SKIMS presently is using only four oxygen plants to meet its oxygen requirements. Which not only shows that SKIMS at present have Oxygen surplus but by using only four oxygen generating plants we at SKIMS are able to give complete down time and also able to do necessary repair work of oxygen generating plants whenever necessary without interrupting the oxygen supplies to hospital beds. Before pandemic as already said SKIMS had only one central oxygen generating plant, with only one oxygen output piping going towards wards, OTs and ICU, due to which there was significant drop in oxygen pressure at bedside of patients but with addition of new plants during first and second wave of COVID 19 pandemic separate oxygen piping was done to ICUs, OTs and Wards due to which oxygen pressure is maintained. Only drawback of oxygen generated by oxygen generating plants is that its purity revolves around 90 to 95%. What COVID 19 pandemic has taught us is that we should have excess of oxygen rather than its shortage but at the same time we should have proper servicing and shut down time of machinery to keep them in proper working conditions.

SKIMS soura and Union Territory of Jammu and Kashmir was fortunate enough due to policies of government that we were able to handle COVID 19 pandemic much better then rest of the country. Before 2020 SKIMS Soura had just one oxygen generating plant having capacity of 750 litres/minute and few hundred bulk, medium and small oxygen cylinders. SKIMS commissioned its second and third oxygen plant in 2020 exactly before and during first wave of COVID 19 each having capacity of 1250 litres per minute. Demand for these oxygen plants were made even before COVID 19 Pandemic started. With first COVID wave in 2020 SKIMS also started getting bulk oxygen cylinder from private companies in order to meet oxygen requirement of patients. In Union territory of Jammu and Kashmir there were only few private companies who were able to supply bulk cylinders that too with limited quantities. Number of bulk cylinders that SKIMS received in 2020 is given below

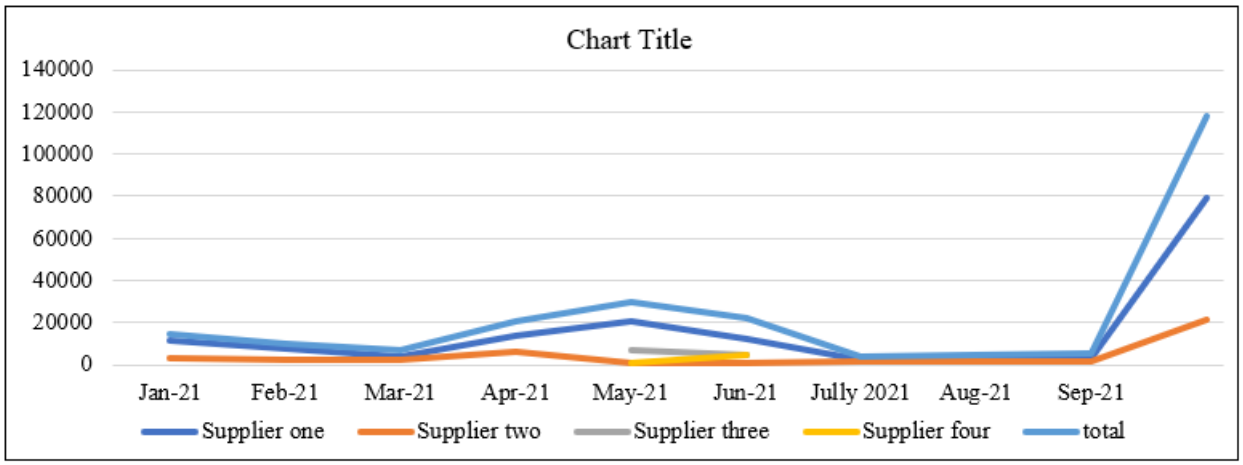
Month/year	Supplier one	Supplier two	Supplier three	Total bulk cylinder
Jan 2020	3022	1430		4452
Feb 2020	1175	2996	2475	6646
March 2020	296	616		912
April 2020	330			330
May 2020	255			255
June 2020	893			893
Jully 2020	3655	3904		7559
August 2020	8437	2341		10778
September 2020	8023	2484		10507
October 2020	10210	3012		13222
November 2020	12244	3498		15742
December 2020	14309	4197		18506
Year 2020	62849	24478	2475	89802

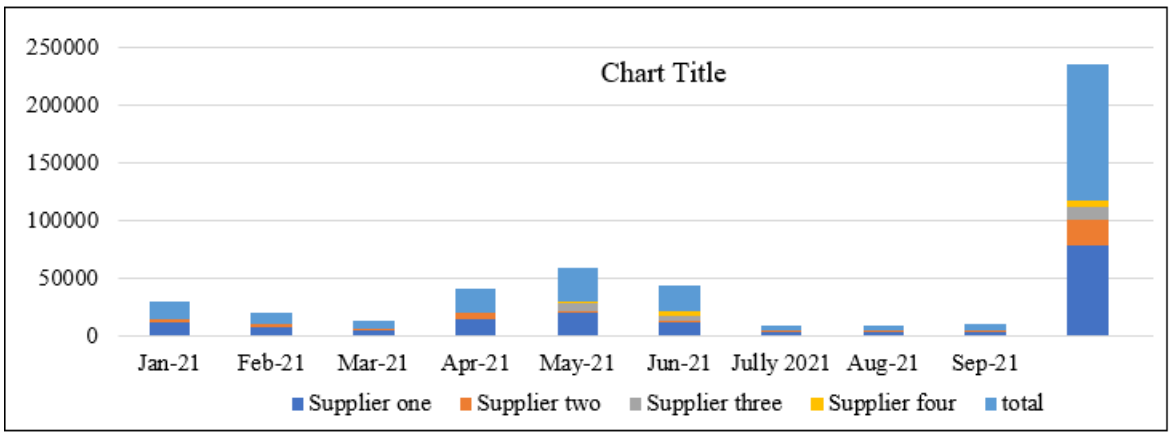




Second COVID 19 wave was more harsh and SKIMS had to stop all elective surgical procedure and hospital was catering only to emergencies including COVID 19 patients. In spite of commissioning two oxygen generating plants in 2020 with capacity of 1250 each dependence on bulk oxygen cylinders continued to increase. The number of bulk oxygen cylinders received from private companies in year 2021 were

Month/year	Supplier one	Supplier two	Supplier three	Supplier four	total
Jan 2021	11826	3078			14904
Feb 2021	7824	2444			10268
March2021	4198	2552			6750
April 2021	13777	6597			20374
May 2021	20338	1059	7092	1145	29634
June 2021	11978	930	4582	4433	21923
Jully 2021	2800	1380			4180
August2021	3000	1440			4440
September2021	3200	2024			5224
	78941	21504	11674	5578	117697





Besides these number of bulk oxygen cylinders two more oxygen generating plants were commissioned in year 2021 on 05/05/21 and 12/05/21 again with oxygen generating capacity of 1250 litres per month each. SKIMS was fortunate enough to get one oxygen plant of capacity 1000 litres per minute through PM Cares Fund in 2021 giving total capacity of oxygen generation through oxygen plants to 6750 litres per minute.

3. Discussion

India was the site of the COVID-19 pandemic's worldwide epicentre in May 2021. As the second wave hit, the need for medical oxygen more than doubled, and horrific scenes played out as people fought to get their hands on the life-saving supply.

The concentration of oxygen generating facilities in eastern India's industrial belt added to the unexpected spike in demand. Only a small number of hospitals had the ability to create this priceless gas on-site; the majority relied on oxygen cylinders or liquid medical oxygen (LMO) [8, 14] that was sent in from another location. Additionally, there weren't enough cryogenic tankers available to handle the sudden increase in demand for LMO [15].

The government responded in a number of ways, including by airlifting more tankers from abroad, converting liquid argon and nitrogen tankers to carry oxygen, and innovating on the railroads to develop special Oxygen Express trains. Additionally, hospitals in more than 550 cities and districts were geo-mapped, and a website tracking system was created to monitor the movement of the commodity in real time.

Hospitals received industrial oxygen that was intended for steel mills. The installation of pressure swing adsorption (PSA) plants, which draw oxygen from the air, was stepped up by the government, along with the purchase and distribution of oxygen concentrators [18].

How should we prepare for the next oxygen emergency, especially when demand for the gas is unpredictable and the cost of infrastructure to produce, store and transport it is higher than the cost of the product itself?

This experience raises the following questions: How should we prepare for the next oxygen emergency, especially when demand for the gas is unpredictable and the cost of infrastructure to produce, store and transport it is higher than the cost of the product itself? Equally important, how can we ensure better distribution so that oxygen is available wherever it is needed, even during non-emergency times, so that no one is deprived of this life-saving product?

India has been developing a medium-term strategy to achieve oxygen self-sufficiency and national and state governments have made considerable progress

Increasing the rate of production

Through the PM Cares fund, the central government has supported 1, 222 PSA plants, which generate 1, 750 metric tonnes of captive oxygen every day. In addition, a large

number of plants have been established in states, thanks to government initiatives and business sponsorship.

In the future, it will be crucial for the government to use the production, storage, and transportation capabilities of the private sector for LMO [14] and to create plans for doing so as and when necessary. Due to the significant capital outlay necessary to build oxygen plants at their own facilities, many medium to large private hospitals (100–200 beds) have been hesitant to accomplish this up until recently. Even so, some sizable private hospitals did put up their own oxygen production facilities during the height of the second wave when the government reduced requirements for the establishment of medical oxygen facilities on their campuses. It can be difficult to access medical treatments in complicated and distant regions. Patients with complicated diseases are referred to healthcare facilities, which only have a few more resources besides doctors on staff. Patients who need more complex care are hence frequently sent to tertiary care facilities.

Referrals for complex patients and oxygen support come frequently from rural areas. Despite local and central governments providing equipment like oxygen concentrators and ventilators in some remote locations, take-up has been constrained there due to a lack of trained staff and resources, including a lack of technical support to sustain use and maintenance. Mechanical life support systems face additional difficulties due to a lack of a consistent, dependable electrical power source.

The surge of COVID-19 instances has shown systemic flaws that have existed for a while. The medical facilities were overrun with patients as the number of COVID-19 cases skyrocketed. Even specialised hospitals experienced oxygen supply shortages for the in-patients, which made matters worse. As a result, the market responded by overcharging, overstocking, and black-marketing oxygen cylinders, which limited their accessibility even to individuals in extreme need.

There have been some admirable initiatives to lessen the effects the pandemic has had during the most recent peak.

Utilising pressure swing adsorption oxygen plants [18] is one approach to guarantee that oxygen plants in hospitals provide oxygen at the point of demand. These come in the form of systems that are relatively portable and can be implemented on-site in hospitals. Pressure swing adsorption facilities are a sustainable local solution that can be accomplished by forging alliances between local governments and the private sector, while needing a sizable, upfront operational investment.

All plants, storage facilities, and delivery systems must be included in the same AMC agreements in order to assure long-term sustainability. maintaining the system for supplying oxygen.

Some government hospitals once had their own oxygen plants, but they were not maintained, therefore they were left unused. The incredible work that has gone into building captive oxygen plants must now be protected from suffering the same fate due to a lack of money for their operation and maintenance will be crucial to ensure efficient O&M of the entire oxygen supply chain, from plant to bedside, in addition to ensuring that these plants continue to operate at high productivity levels.1, 222 of the 3, 500+ units being purchased in India are covered by annual maintenance contracts (AMCs) for a period of five years.

Another difficulty may be a lack of expertise to run and maintain these new plants. An admirable attempt to train 8, 000 specialists to operate and maintain these facilities has already been started in India. Now, practical training is required to finish these online courses. keeping an eye on consumption and predicting demand.

The government, technical partners, and business organisations collaborated closely to forecast India's future demand for oxygen based on the experiences and lessons of earlier COVID-19 waves. To gain a better understanding of production, demand, and storage needs, numerous forecasting and modelling techniques have been developed.

Today, with the aid of systems like the Oxygen Demand Aggregation Systems (ODAS) and Oxygen Digital Tracking Systems (ODTS), states can monitor and guarantee the delivery of oxygen at various points throughout the supply chain. Artificial intelligence and digital connectivity can also be used to track consumption, anticipate demand, and manage the challenging last mile logistics. This enables a quick response to any possible spikes.

4. Conclusion

The availability of oxygen is just one extremely significant and specific example of how the epidemic has painfully highlighted the weaknesses of the health system. The difficulty of providing healthcare in the face of limited resources and a challenging geographic location highlights the need of supply chain logistics for providing safe and efficient care. A detailed analysis of current supply management systems utilising frameworks like the WHO health system building blocks may aid in the development of efficient and long-lasting oxygen delivery chains that include both provider-side technical competency and physical material. The COVID-19 epidemic and its effects on hospital oxygen management present both a problem and an opportunity for us to learn valuable lessons. Doing the fundamentals well is always key to improving patient outcomes. With the knowledge that advances in oxygen (as well as infection control, triage, laboratory testing, etc.) will benefit patients both now and in the future, the COVID-19 pandemic presents an opportunity to refocus efforts on the fundamentals of acute care.

The improvement of oxygen systems should be a hospital's first goal in LMICs. During the COVID-19 pandemic, we suggest doable approaches to enable efficient and long-lasting upgrades to hospital oxygen systems. We expect that by disseminating these lessons, medical professionals, technicians, hospital administrators, and policy makers will be able to act right now to improve oxygen access.

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