

Strengthening capacity to effectively manage medical oxygen systems in India

Every country's preparedness and resilience have been put to test by the extraordinary scale and severity of COVID-19. The onset of the disease was sudden, and the spread was rapid. Besides, the demand for medical oxygen increased exponentially as patients infected with the Delta variant of the SARS-CoV-2 virus experienced shortness of breath. In a step toward alleviating the unravelling crisis, the government along with entities such as corporates, development partners, and individuals, among others, started procuring and donating oxygen equipment to the health facilities.

Although these oxygen sources reduced the demand–supply chasm, the challenge was to administer oxygen to the patients. Delivery of oxygen to patients is a critical care intervention that requires appropriate knowledge and skills to treat patients requiring oxygen therapy. Hence, upskilling and training were required for the health care providers on a wide range of oxygen care topics such as oxygen sources, maintenance, use of oxygen delivery equipment, determining the need for oxygen therapy, and monitoring patients on oxygen therapy to avoid wastage. Additionally, trainings were also required for technicians and other nonmedical health care service providers regarding the operations, maintenance, and troubleshooting of various oxygen equipment such as Pressure Swing Adsorption (PSA) plants, manifolds, and oxygen concentrators, among others. Apart from trainings, documentation such as standardized clinical management guidelines, standard operating procedures, and training modules for health care service providers was required.

This health emergency established that strengthening the capabilities of the health care service providers is essential not only during the pandemic but also beyond the crisis.

Google and Give India's grant for strengthening the oxygen ecosystem

The Google grant was extended to PATH from June 2021 till December 2021 to set up 76 PSA oxygen generation plants across the country and respond without restriction to request from the states for support in their journey to become self-sufficient in the production and rational use of oxygen. Adopting a system-wide approach in strengthening efforts to combat COVID-19, PATH works closely with the state and nongovernment stakeholders engaged in the procurement, deployment, operation, and maintenance

of oxygen supplies. Training and capacity strengthening of health care providers are also conducted as part of this project to upskill and prepare the service providers for existing requirements and any potential health emergency arising in the future.

PATH's capacity-building assistance for respiratory care management

PATH is providing end-to-end technical assistance in building capacity of public health systems as well as nongovernment health systems for effective medical oxygen management.

Capacity building plays an instrumental role in ensuring effective utilization of resources such as oxygen and related biomedical equipment by the facilities.

Developing training content and training materials

PATH's respiratory care management program team and knowledge management team developed training resources for various medical and nonmedical health care service providers. These resources were reviewed and updated by technical experts from leading global and Indian institutions working in the field of medical oxygen. These resources also contain updated guidelines from the Indian government and various state governments.

The training resources cover a wide range of topics, ranging from oxygen equipment, oxygen systems, medical gas pipeline system, oxygen inventory management, to medical oxygen handling and safety.

Building a resource pool of medical and technical experts

PATH has an in-house pool of clinical experts and biomedical engineering subject matter experts, as well as external consultants, who support the delivery of training in various states. In addition, PATH has partnered with leading medical centers, such as the Critical Care & Trauma Center, All India Institute of Medical Sciences (AIIMS) Delhi, and other leading medical colleges and engineering colleges in the country to conduct training on oxygen device operations and maintenance.

Training public and private health care providers and engineers on medical oxygen

PATH has facilitated and supported training on various aspects of medical oxygen management, such as oxygen therapy, oxygen ecosystem, delivery solutions, operations and management of PSA oxygen plants and oxygen concentrations, medical gas pipeline systems, and oxygen audit, across its intervention states.



Figure 1: Training of health care providers in Rajshree Medical College, Bareilly, Uttar Pradesh, India

In collaboration with the state nodal officer, and the health, family welfare, and medical education departments of various state governments, PATH has organized virtual training sessions for facility in-charges, facility-level nodal officers, paramedical staff, and PSA plant operators. These training resources were further upgraded to impart technical knowledge on oxygen equipment among the participants.

In addition to the virtual trainings, PATH had conducted on-site training for biomedical engineers and other health professionals in various states. These trainings were on handling and maintenance of PSA and on other oxygen delivery equipment. Apart from the aforementioned participants, PATH-supported trainings were also attended by the chief medical officers of the districts, district health officers, administrative medical officers, nursing superintendents, paramedical staff, and engineering teams from all Google project supported states.

Testimonies on training on operation and maintenance of oxygen equipment and its benefits

“We are plant operators. We deal with all the oxygen systems on a daily basis. Initially, we were running the machine as per our own knowledge and little knowledge from on-the-job experience. We needed training on PSA operation and maintenance, and rational use of oxygen.

This document captures statements from participants of the training, such as oxygen program managers,



Figure 2: Training on PSA plant operations at Women's Hospital, Kudal, Sindhudurg district, Maharashtra, India

health facility officials, health care service at various levels, and oxygen device operators and their supervisors, endorsing the benefits of the training exercise. These testimonies provide insights into the training they received, the contributions of the training in improving oxygen equipment management and delivering oxygen therapy, the associated challenges, and the need for similar sessions in the future. The document also provides a perspective from patients and their caregivers, who benefited from the oxygen equipment installed in the health facilities and better case management by the trained human resources.



Figure 3: Training on PSA operations at VishwaRaj Hospital, Pune, Maharashtra, India

PATH provided us training over two days, virtually. The training covered a wide range of topics such as OC (oxygen concentrators), cylinder, PSA plant, liquid Medical Oxygen (LMO) with manifold and Medical Gas Pipeline System (MGPS), and bedside oxygen masks. It provided briefs about electrical, civil, cleaning and operation of all oxygen source equipment, and regulation of oxygen generated for the rational use of oxygen. We received an important training on fire safety measures at the plant site, patient side, manifold area, and pipeline system. We also received

handholding support from PATH at the site from time to time.

Now that we know that we should focus on the oxygen purity above 93%, it is easy and more meaningful for us to work on a daily basis. The technical training helped us the most as we are now able to handle many minor troubles. Mock drills helped us get better oriented on the standard operating procedure for plant operations.”

- Sambit Nayak, Plant Operator, District Hospital, Keonjhar, Odisha

“Clara Swain is a 250-bedded hospital. All our beds, even those in the general ward, are oxygenated beds. Prior to the pandemic, our oxygen need was catered through the LMO storage tanks installed in the facility. We faced procurement challenges during COVID-19. Now we have our own plant in the facility, which can cater to 200 patients at a time.

Initially, the facility was charging patients for oxygen services. After the plant was installed, the patients also benefitted as we started offering oxygen therapy free-of-cost.

We received two trainings from PATH, one in-person training at the time of installation and the other, a virtual session, on the operation and maintenance of PSA. The physical training was a day-long training, whereas the virtual session was for about one-and-a-half hours followed by a question and answer session. The biomedical engineers, nursing staff, and emergency staff, including the doctors deployed in the ICU, attended both the trainings. PATH demonstrated functioning of various oxygen equipment during the in-person training and showed how to troubleshoot technical issues and how to rationally use oxygen and fire safety guidelines. They also oriented us on how to check the filters and valves and how to maintain pressure flow.

Initially, when the plant was installed, we were not checking the purity of oxygen from the plant, but after the trainings, we understood the importance of checking oxygen quality from the plant. We started checking the oxygen purity meter daily, along with other technical aspects of the plant. The trainings were very effective and helped us improve our understanding of oxygen management.”

- Harshul Yadav, Hospital Manager, Clara Swain Hospital, Bareilly, Uttar Pradesh

“Before joining here, I did not have any prior work experience. The training sessions that were organized by the government with the trainers from PATH helped me get hands-on experience in managing the oxygen equipment. I learnt how to operate the PSA plant and how to resolve some minor problems.”

- Gurdit, PSA Plant Operator, District Hospital, Faridkot, Punjab

“When the PSA plant was installed, we had difficulty in operating the machine at first as we had limited knowledge and a lot of confusion. After some training, we learnt the basics and started to focus on supplying oxygen to the patient and maintaining the necessary oxygen pressure as well. While the training was virtual and was satisfactory, the on-site mentoring support by PATH was exceptional. It gave us a lot of confidence as they made us comfortable with technical aspects of the devices and interacted with us in our local languages and not in English or Hindi.”

- Pradeep Kumar Pattnaik, Plant Operator, District Hospital, Rayagada, Odisha

“During COVID-19 first wave, our 500-bedded hospital was catering to more than 500 patients, and the demand for oxygen in our health facility increased further due to high caseload. PATH supported us with an 800-LPM plant in the month of December 2021. Looking at the need for technical handholding for the PSA plant operation and maintenance, the PATH team organized virtual training in the month of January 2022, which was attended by 40 staff nurses and PSA operators. Besides bringing clarity on PSA operation and maintenance, the training also gave us a clear understanding of the day-to-day monitoring of the PSA plant. We now know the need to check the air compressor oil levels, filter and dryer drainages, cross airflow and ventilation with exhaust fans, monitor the secondary gas source stock and auto changeover valve functioning when the plant is in an abnormal condition, and also ensure diesel stock for a secondary power source as a generator. We are grateful to PATH for organizing such in-depth trainings, which was the need of the hour and has helped us immensely.”

- Kundan Singh, Biomedical Engineer, Hind Institute of Medical Sciences, Barabanki, UP

Testimonies on Training on oxygen therapy and rational use of oxygen and its benefits

“Earlier, our facility had a oxygen plant with low capacity. Now, an additional oxygen plant has been installed with higher oxygen generation capacity. Today, our facility is handling non-COVID patients as well. On average, seven to eight patients are admitted in the respiratory ICU. Besides this, the general ward beds also have oxygen supply. Initially, we had some challenges in delivering oxygen therapy as it had been long since we had learnt the procedure and applied them.

With these trainings, our understanding of oxygen therapy and oxygen maintenance has improved. For example, a patient was brought to the hospital with mild respiratory condition and was diagnosed with carbon dioxide narcosis. Based on CBC investigation and ABG monitoring, we put the patient on oxygen therapy

through piped oxygen that was delivered through the from PATH.”

- Somnath, Staff Nurse, Hind Institute of Medical Sciences, Barabanki, Uttar Pradesh

“When PATH trained us on the operations of the newly installed PSA plant in our facility and the government conducted mock drills, we gained a better understanding of oxygen management with these trainings. As COVID-19 caseload is decreasing, non-COVID patients are also getting benefited from this service now.”

- Kundan Singh, Biomedical Engineer, Hind Institute of Medical Sciences, Barabanki, UP

Insights of health managers into the contribution of oxygen management trainings

“The second wave of COVID-19 pandemic had stretched our health systems beyond their capacities. We have tried to cope with the growing challenges through multiple steps at strategic, tactical, and operational levels.

Our operators were a little hesitant to handle PSA plants as they were new equipment. The training organized by the District Health and Family Welfare Services and PATH oriented our facility staff in detail on oxygen ecosystem, PSA operations and management, and LMO management.

This training helped our doctors and administrative medical officers better manage oxygen sources. With the hands-on training, they are well versed with operation and maintenance of the plant and troubleshooting process. Hands-on training on ventilators and other respiratory equipment has instilled confidence with doctors and staff nurses on utilization of these equipment at their facilities.”

- Dr. Janardhan, District Health & Family Welfare Officer, Bellary & Vijayanagar, Karnataka

“COVID-19 pandemic exposed our weaknesses, in terms of adequate availability of oxygen resources in medical establishments. Oxygen was the only proven treatment in saving lives, whereas all other drugs proved controversial, contributing to deaths rather than saving lives. In this context, the Oxygen Stewardship Program was the need of the hour. As the president of the Indian Medical Association (IMA), Karnataka State Branch, I congratulate the Karnataka Government's Health and Family Welfare Department and PATH for the Oxygen Stewardship Program for private medical establishments. PATH and the state government brought in the best of the experts in their field to conduct the training sessions.”

- Dr. K Suresh Kudva, President, Indian Medical Association, Karnataka State Branch

Patients' and their caregivers' insights into the benefit of oxygen systems

“My grandmother was unable to breathe normally for nearly 10-15 days. We admitted her to the Hind Institute of Medical Sciences in a very serious condition in March 2022. The health staff was very supportive. They provided oxygen of about 4 LPM with the support of a BiPAP machine. Within one to three days of this line of treatment, my grandmother became stable and is now slowly recuperating from her serious illness. I am immensely grateful for the timely support in this health facility that restored her health back to normal.”

Amit Singh, Grandson of the patient, Hind Institute of Medical Sciences, Barabanki, UP

“In June last year (2021), I was diagnosed with COVID-19 with a positive RTPCR report. I had mild headaches, high temperature, cough, and body ache. Although we expected that I will be able to recover in –two to three days, it was very difficult to get an oxygen bed those days. When we reached here, I was put on an oxygen concentrator. A team of nurses and a doctor routinely reviewed my condition. I received counseling on good diet and nutrition to improve immunity and did yoga and proning regularly. I survived but I was anxious seeing so many people from our residential areas going to ICU and dying...I wish we had better access to oxygen then.”

Anonymous [kept anonymous on request], 38 years, treated at District Headquarters Hospital, Keonjhar, Odisha

On emerging need for additional training and support

“In future, it would be good if more on-site trainings were given.”

Kundan Singh, Biomedical Engineer, Hind Medical College, Barabanki, Uttar Pradesh

“Many operators who received the training have left the hospital. In addition, we need refresher training from time to time, more so on handling fire safety equipment. I feel on-site trainings are better. Supportive supervision visits and handholding support should be part of the regular refresher trainings.”

- Sambit Nayak, Plant Operator, District Headquarters Hospital, Keonjhar, Odisha

“It would be more helpful if we get more physical sessions, which include on-site practical demonstration on operation and troubleshooting of plant as many of the operators from the adjoining districts are freshers like me, without any prior experience on how to handle and operate these PSA plants.”

- Gurpreet, PSA Plant Operator, District Hospital, Faridkot, Punjab

“We need on-site training with mentoring support during refresher training. It will be better if the trainers speak in the local language, show more videos, and we have more time for answering our questions for issues.”

- *Pradeep Kumar Pattnaik, Plant Operator, District Headquarters Hospital, Rayagada, Odisha*

“I request the Health and Family Welfare Department and PATH to come out with many more such training programs in essential fields for all medical establishments, both private and government. The Indian Medical Association, Karnataka State Branch, can disseminate the recording of all training programs to all its district branches so that the key lessons reach every IMA member. We are willing to collaborate with the state government and extend all possible support.”

- *Dr. K Suresh Kudva, President, Indian Medical Association, Karnataka State Branch*

ourselves and the health systems not only for pandemics like these but also for the overall strengthening of the primary and critical health care needs of the country.

Way Forward

- The training conducted by PATH in partnership with Google and Give India enhanced the knowledge and skills of health care service providers. Such trainings on oxygen equipment and therapy provided to the health care service providers can be used beyond COVID-19 and can prove beneficial to patients with medical conditions such as heart ailments and respiratory ailments, among others.
- A hands-on demonstration of using or practising oxygen equipment is more effective as supervision and interaction with the trainer are required. It is extremely difficult for trainers to replicate the same level of interaction and relationship in a virtual environment. Virtual training must be augmented with hands-on training sessions, learning videos for regular reference, and, wherever possible, classroom training and demonstrations.
- The private health care sector has also expressed the need for such trainings, as these are often not available for nonmedical personnel. By providing similar training on oxygen therapy to private health care facilities, the overall health care sector can be strengthened.
- Apart from training and capacity building, it is important to invest in human resources for the operation and maintenance of this oxygen equipment. Training on all aspects of the oxygen ecosystem should be plugged into various upskilling plans of health care service providers and should be conducted and upgraded periodically. It is critical to prepare



PATH is a global nonprofit dedicated to achieving health equity. With more than 40 years of experience forging multisector partnerships, and with expertise in science, economics, technology, advocacy, and dozens of other specialties, PATH develops and scales up innovative solutions to the world's most pressing health challenges.

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