

Anaesthesiology as an oasis amid the crisis of the vital medicine 'Oxygen'- innovations and local modifications

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The coronavirus disease (COVID)-19 pandemic has presented unprecedented challenges to the healthcare system.^[1] Pertinent to this milieu, the second wave of this pandemic further glorified the lacunae in the medical healthcare system in India and other parts of the world. The scenario was eerie in India, with 26 million counts in April 2021, which was twice that reported in the first peak. The world was witnessing India as a new epicentre of the global pandemic. A prodigious increase in the demand for indispensable things, including oxygen, in the management of COVID-19 patients was witnessed worldwide. Furthermore, the crippling shortage of the vital medicine called 'oxygen' in the management of COVID-19 led to a rise in avertible deaths.^[2]

There exists substantial data, ever since the outbreak of the COVID-19 pandemic, emphasising the role of anaesthesiologists as frontline leaders in organising, planning, and coordinating the deployment of medical resources efficiently and effectively.^[3] The percipience to estimate or judge the requirement of oxygen and duration of its availability is a part of training in the speciality and has further helped the anaesthesiologists to navigate the ship as leaders during the second storm of the pandemic.

OXYGEN CRISIS AND STRATEGIES TO BEAT IT!

Even before the pandemic, a trial estimated the lack of access to oxygen therapy (only one-fifth of patients received medical oxygen), in middle-and low-income countries (nine in ten hospitals).^[4] Nevertheless, the first warning signals regarding the upcoming oxygen shortage came from the Indian Society of Anaesthesiologists (ISA) National Advisory and Position Statement regarding COVID-19, which predicted a sudden surge of patients and exhaustion of medical resources. The advisory advised judicious use of oxygen, cautioned against oxygen wastage, advocated the use of regional anaesthesia techniques and stressed on ensuring an adequate supply of oxygen.^[5]

Approximately 20% of COVID-19 patients were in need of hospitalisation for oxygen therapy.^[6] As such, various modalities were adopted in anaesthesia practice for better oxygenation and reducing the requirement of oxygen.^[7] The clinical results of large randomised controlled trials in patients with acute respiratory distress syndrome advocated that prone positioning during spontaneous and controlled breathing improves oxygenation and reduces the requirement of oxygen.^[8] Prone positioning became a routine norm in the management of the

COVID-19 patient. Many recommendations were followed by the anaesthesiologists for the rational use of oxygen in the perioperative and intensive care unit. Peripheral nerve blocks, neuraxial anaesthesia and total intravenous anaesthesia were advocated over general anaesthesia in COVID-19 patients for saving vital resources, including oxygen, and decreasing the risk of contamination through the infected aerosol.^[9] Literature and clinical experience also suggested the safety of central neuraxial blocks for COVID-19-positive obstetric patients posted for caesarean section.^[10,11] A case report of a COVID-19-positive parturient suggested the modification of standard procedure to ensure patient care. A minor operation theatre having no central pipeline supply was prepared with oxygen cylinders, an anaesthesia workstation, and other resources. The patient was given subarachnoid block, reducing the requirement of oxygen with spontaneous breathing and safe delivery of the baby took place.^[12]

Articles cautioning against the routine use of pre-oxygenation, high flows and increased concentration of oxygen after extubation were published.^[13] An expert consensus statement suggested target oxygen saturation not more than 90% in a hospitalised COVID-19 patient with acute respiratory failure.^[14]

The second wave saw an exponentially increased demand for medical oxygen, leading to its crisis. Our nation was gasping for oxygen on a minute-to-minute basis, and oxygen had become a life-saving drug equivalent to the mythological 'amrut' (immortal nectar) for mankind. The old saying goes 'Drop by drop fills the ocean'; nevertheless, action started to be taken at different levels to save and supply oxygen in an oxygen-torn nation. The ISA issued an advisory highlighting the utilisation of medical oxygen (93%±3%) through medical oxygen generator plants working on the principle of pressure swing adsorption involving zeolite. Furthermore, the advisory stated that anaesthesiologists should guide and ensure the judicious use of oxygen by training all hospital personnel for ensuring zero leaks at all oxygen ports.^[15]

Engineering and technology came to the rescue to help in improving oxygen production and delivery.^[16] The Indian Railways operated the 'Oxygen Express' to transport medical liquid oxygen and carried 16 tonnes of medical oxygen to different parts of the country requiring oxygen for patients struggling

between life and death.^[17] Oxygen generation plants and oxygen concentrators became very popular. The ISA national and several ISA state branches organised webinars and seminars on the utilisation of oxygen during the pandemic. Anaesthesiologists were given the responsibility of continuing medical education on various electronic platforms and they accomplished this very well. Healthcare workers were educated online by anaesthesiologists on oxygenation and ventilation strategies in COVID-19 patients. This issue of the Indian Journal of Anaesthesia (IJA) has a study wherein the authors have concluded that virtual training for medical officers in COVID-19 patient management strategies is very useful.^[18] Simulation-based teaching of ventilatory management to non-anaesthesiology residents to manage the COVID-19 pandemic was found to be very effective.^[19]

OXYGEN CRISIS AS A PERFECT BACKDROP FOR LOCAL INNOVATIONS IN OXYGEN DELIVERY

The old saying goes 'Necessity is the mother of invention'. The oxygen shortage forced people to devise new strategies and innovations to tide over the crisis. Anaesthesiologists contributed to many of these innovations. Technological modifications in the operation theatre were advised immediately after the pandemic onset by the ISA national guidelines published in the IJA.^[20] Researchers conducted multiple studies, including randomised controlled trials, on the technological innovations of the first wave especially the aerosol box.^[21,22]

Globally, many innovations were made to counter this crisis of oxygen shortage. To name a few, Dikensoy *et al.*^[23] developed a new oxygen delivery method during the COVID-19 pandemic of wearing a mask (surgical) over the nasal cannula. They concluded that wearing a mask over the nasal prongs/cannula (2 cm higher than nostrils) worked efficiently as a non-rebreathing oxygen mask. Furthermore, this simple mask technique was recommended to be useful in limited oxygen source settings.

In a research article, the authors tested the effect on the choice of the circuit and different peak inspiratory flow rates on the fraction of inspired oxygen (FiO₂) during continuous positive airway pressure and simulation of ventilation using domiciliary ventilators. They found FiO₂ to be highly dependent upon the type of circuit used. Furthermore, circuits with an exhalation valve (active) achieved similar FiO₂ at less

oxygen flow rates than circuits with an exhalation port. They inferred a 50% reduction of oxygen during supported and controlled ventilation with an active exhalation valve breathing circuit, thereby explaining its connotation during the resource limitation era of the COVID-19 pandemic.^[24]

Indian anaesthesiologists also contributed their share to these local innovations. A local innovation was done by a group of doctors and the technique was named as 'Co Bain circuit'. In this technique, a non-vented bilevel positive airway pressure (BiPAP) mask is added to the existing device and fixed on the head of the patient with a circuit on the forehead. Due to this, the exhaled carbon dioxide vents through the airway pressure limiting (APL) valve, and on the contrary, the patient inhales the humidified oxygen. This technique curtailed the overall requirement of oxygen by creating positive end-expiratory pressure and saved many lives at the time of crisis.^[25]

In another study published in the IJA, the researchers worked on a novel innovation in the management of ventilator shortage in India during the pandemic.^[26,27] They prepared this device to ventilate five patients at a time with nominal damage to lung mechanics.^[27]

To soothe this monster wave of the pandemic, it became paramount to 'break the chain' of patients. In this context, a simple modification of the Bains circuit for preventing the spread of infection during the transportation of patients was made during the COVID-19 crisis. In this technique, the APL valve is shifted towards the operator end, keeping the fresh gas flow inlet through the inner tube, at the patient end (conversion of coaxial Mapleson D to coaxial Mapleson B circuit).^[28] Nonetheless, this issue of the IJA brings forth a bag full of practically useful clinical innovations and local strategies devised by our anaesthesiologists. These include the 'Aahana Pradhi' (first ray of life) technique, the use of oxygen concentrators as an altered source of oxygen in BiPAP, the strategy of deployment of anaesthesia technicians and another innovative apparatus for domiciliary oxygen delivery.^[29-31]

To conclude, the second wave of the pandemic was a battle for breath along with other challenges. The COVID-19 crisis is a tale of adaptation, innovations, change and leadership. As anaesthesiologists, it is our inherent quality to adorn leadership, adjust to difficult

situations and improvise locally in demanding situations. The COVID-19 pandemic gave us an opportunity to showcase our talents. Nevertheless, the time has come for us to focus on the basic needs of our medical infrastructure and strengthen our preparedness for the future.

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Conflicts of interest

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