EDITORIAL

Finding Cost-effective Solutions: Need of the Hour

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In many acutely ill hypoxemic patients, hypoxemia is caused by flooding and infiltration of alveoli and interstitium. This decreases the diffusion of gases across alveolocapillary membrane, leading to shunting of blood from the lung areas that are completely consolidated or collapsed. A decrease in pulmonary compliance leads to an increase in work of breathing, causing more negative intrapleural pressure. This leads to lung strain that can exacerbate the preexisting pulmonary insult. This is called Patient self-inflicted lung injury (P-SILI).[1,2] In some patients, hypoxemia may be due to collapse of the airway during inspiration or expiration.

Providing positive-end expiratory pressure (PEEP) in these conditions prevents the collapse of alveoli during expiration and thus improves the diffusion of gases and thus oxygenations. Positive-end expiratory pressure increases the functional residual capacity (FRC), leading to better lung compliance, which will reduce air hunger. Devices that give PEEP are high-flow nasal cannula (HFNC), continuous positive airway pressure (CPAP), and bilevel positive airway pressure (BiPAP). One can also titrate the concentration of oxygen while using these devices as required, depending on the patient's response.[3] Standard oxygen therapy (SOT), using nasal prong, face mask, and non-rebreathing masks provides higher concentration of oxygen in inspired air, which will improve oxygenation, depending on the severity and extent of pulmonary involvement. But these devices will not improve the root cause of the problem and therefore will not increase the FRC or decrease the air hunger.[4]

Standard BiPAP machines, which are the mainstay of noninvasive ventilatory support, also provide pressure support during inspiration. But these devices are expensive. Studies have shown that in acute respiratory failure, only CPAP can improve arterial oxygenation and reduce the need for endotracheal intubation, as compared with the Venturi mask.[5,6] Continuous positive airway pressure is equally effective than noninvasive pressure support ventilation in cardiogenic edema.[7] The recent coronavirus disease-2019 (COVID-19) pandemic showed that HFNC, which provides PEEP without pressure support, is also effective in mild acute respiratory distress syndrome (ARDS). But HFNC consumes a large amount of oxygen. In addition, both these devices need electricity to run.

In India, there exists a huge gap in availability of healthcare. Majority of the rural or underprivileged population remains deprived of affordable medicines and healthcare technology. To bridge the gap between availability and affordability of medicines, Government of India has taken important steps, such as the Jan Aushadhi stores and e-pharmacies to make medication accessibility, (a scheme launched in 2008) and drug price regulation of 347 essential medicines. However, availability of life-saving equipment is still an issue. In many parts of the country, there is a lack of technical support and reliable electricity supply. A study conducted in six Indian states in 2012 revealed that many of the primary health centers lacked regular, round-the-clock electricity supply.

This is a major limiting factor in economically weak countries, particularly in hospitals in remote areas and during transport. Devices that do not require high technology and can work without electricity play a crucial role in remote locations. Positive expiratory pressure devices (PEP devices) consisting of fixed orifice resistor, generate pressure during expiration, which ranges from 10 to 20 cm of water, that holds the airways open and thus prevents the collapse of alveoli and promotes collateral ventilation distal to the site of obstruction. These devices are used routinely as part of respiratory physiotherapy. Examples of this type of device include Resistex PEP Mask, Pari RC Cornet Mucus Clearing device, and TheraPEP.

Positive expiratory pressure oxygen therapy (PEP-OT) device is one such device that is prepared from different spare parts that are easily available. Positive expiratory pressure oxygen therapy device consists of a reservoir bag from non-rebreathing mask, face mask with airtight seal, and PEEP valve connected via a T- or Y-shaped connector. During expiration, this PEEP valve can generate pressures of the magnitude of 0–10 cm of water, against which the patient exhales. This device can deliver nearly 100% oxygen using higher oxygen flow (12–20 liter/min) and thus can be used in patients with mild-to-moderate ARDS.

In a feasibility trial by Dhochak N et al.,[8] the authors have shown that it is possible to use this device in hypoxemic patients with

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encouraging initial results. Twelve patients (80%) who completed the PEP-OT trial (45-minute trial) had a significant improvement in respiratory rate and heart rate. There was also a trend toward improved SpO_2 and perceived level of dyspnea at the end of the 45-minute PEP-OT trial. None of the patients had worsening of the symptoms. However, these results need to be interpreted with caution as the study period was only 45 minutes. To consider its use in hypoxemic patients as an alternative to HFNC or CPAP devices will require a much larger study for a longer period of time. However, if found, the device can be used safely with careful monitoring in remote hospitals, where HFNC or CPAP is unavailable.

Positive expiratory pressure oxygen therapy, if found effective, can be potentially used in parenchymal pathologies like pneumonia and pulmonary edema, as well as in airway diseases like bronchiectasis, chronic obstructive pulmonary disease (COPD), and acute asthma exacerbation. The parts of the PEP-OT devices are reusable and the cost is negligible as compared with HFNC and CPAP delivery devices. However, further studies which will compare PEP-OT as an alternative or as being superior to SOT, as well as being a non-inferior alternative to HFNC or CPAP therapy in patients with respiratory distress, are required. Positive expiratory pressure oxygen therapy appears to be an attractive and physiologically favorable oxygen delivery alternative with a wide range of potential applications.

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