COVID-19 and increasing demand for medical oxygen: can impurity be a problem?

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Introduction

The COVID-19 pandemic in 2021 has accelerated the demand for oxygen supplies globally. Many countries have not seen such high demand before the pandemic to meet their daily oxygen requirement (Usher 2021). Worldwide, governments are scaling up their existing facilities to fill the oxygen demand. In the healthcare system, oxygen is an essential medicine required at all levels. It is estimated that 20–40% of deaths due to pneumonia could be prevented using oxygen therapy (WHO 2021). Medical air in hospital settings is widely used for mechanical ventilation, infant resuscitation, aerosol drug delivery, and neonatal environment control (Edwards et al. 2018).

Oxygen cylinders, oxygen concentrators, liquid oxygen, and membrane separator oxygen enrichers are commonly used for oxygen therapy (Rees and Dudley 1998). In the current COVID-19 pandemic, long-term oxygen therapy is required at both hospitals and in-home settings that the respiratory physician should supervise for optimal treatment (Rees and Dudley 1998). Unprecedented production of oxygen and refilling of cylinders can give rise to the risk of impurities, which could lead to an increase in hidden mortality. However, it would be difficult to assess the increase in mortality due to the impurity of the oxygen gas. Hence, the purity of the oxygen needs to be regulated by the respective authorities (Edwards et al. 2018). Higher oxygen production can give rise to a possibility of contamination.

In a recent study, the CO₂ impurity was reported in oxygen cylinders above the recommended threshold level (Edwards et al. 2018). In previous studies, various health effects were reported due to the common air pollutants (WHO 2005). It was also observed that unintentional inhalation of NO in industrial regions might change the PaO₂ (Benzing et al. 1999). Edwards et al. (2018) also mentioned onsite production of medical air poses a risk of raising the CO₂ and NOx (nitric oxides) concentration above the United States Pharmacopeia (USP) threshold (Edwards et al. 2018). This rise of these trace gases may be due to the dryer that is used to capture the CO₂ contaminant and humidity.

Impurity sources can be arising due to the production and delivery systems, as well as from the environmental pollution levels near the regions. According to the FDA guidelines, medical gases should be checked for any adulteration during production, packaging, delivery, and manufacturing facilities (FDA 2015). Here, we would like to highlight few points for policymakers/local authorities (Table 1) and for the general public (Table 2) to create awareness and recommendations to improve the quality of oxygen.

Another reason for the increase in the COVID-19 mortality can also be due to the black fungus, which are present in the environment (Richardson 2009). This could lead to mucormycosis, which could be a fatal disease for people who have weakened immune systems (Spellberg et al. 2005). In the nasal tract, black fungus develop due to the poor quality of water used to hydrate the oxygen in a hospital setting (piped and cylinders). This fungus grows in the nostril, travels towards the eyes (Klotz et al. 2000), and then towards the brain, which can paralyze the nerves (Escobar and Del Brutto 1990), cause permanent damage to the eye, or even could lead to a heart attack (Naik et al. 2021; Jackman and Simonsen 1992).

An evidence-based advisory for screening, diagnosis, and management of mucormycosis developed by Cornely et al. (2019) should be followed and need to be updated considering the recent evidence of mucormycosis in the COVID-
using it in oxygen therapy devices (Cahill and Heath 1990). To monitor any misuse of other cylinders (i.e., helium, hydrogen, acetylene, argon) for refilling oxygen without proper cleaning and conditioning Monitoring for the sanitization of oxygen supply (pipeline and tubes) for unwanted fungal growth Special attention should be given to test “black fungus” (mucormycosis) infection among recovered patients Checking/advisory for black fungus on patients on oxygen support should be made an essential part of the COVID-19 control protocol at every level Special attention/care should be given to comorbid and patients using the steroid to check the fungal infection for the hidden cause of death

19 pandemic (Cornely et al. 2019). In a hospital setting, constantly monitor distilled water for oxygen hydration before using it in oxygen therapy devices (Cahill and Heath 1990). Use of tap water even after boiling is not recommended in the humidifier as after some time; impurities (micro-metals and contaminants) start to buildup, leading to severe health issues even after using life-saving precious oxygen therapy.

| Table 1 | Interventions required by policymakers or local authorities |
|------------------|------------------------------------------------------------|
| Monitor gas testing facilities, laboratories, and calibration facilities at the site |
| To ensure compliance and procedures of finished gas for its quality |
| Purity and grade (ultra-pure, 99.999% minimum) should be maintained |
| A random check of tankers and especially cylinders for chemical analysis of oxygen gases |
| Impurity parameters certificate should be provided for the levels (i.e., carbon monoxide/carbon dioxide, moisture, arsenic, oil, halogen, oxidizing substances, acidity or alkalinity, argon, hydrocarbons) |
| Test results can be cross-checked by the local authority for any foreign materials, moisture, and contaminants |
| To monitor any misuse of other cylinders (i.e., helium, hydrogen, acetylene, argon) for refilling oxygen without proper cleaning and conditioning |
| Monitoring for the sanitization of oxygen supply (pipeline and tubes) for unwanted fungal growth |
| Special attention should be given to test “black fungus” (mucormycosis) infection among recovered patients |
| Checking/advisory for black fungus on patients on oxygen support should be made an essential part of the COVID-19 control protocol at every level |
| Special attention/care should be given to comorbid and patients using the steroid to check the fungal infection for the hidden cause of death |

Globally, we are facing an emergency that needs support from authorities and the community to minimize the suffering and improve the well-being of all. In lower- and middle-income countries, oxygen purity can be a significant issue that requires local interventions at the earliest. Countries where there is prevalence of malaria, sepsis, pneumonia, and other ailments should also prioritize where oxygen therapy requires at large (Usher 2021).

| Table 2 | Recommendation/awareness needed for the general public |
|------------------|------------------------------------------------------------|
| Oxygen gas cylinder should be kept at normal room temperature |
| Always use distilled water to make oxygen hydrated before use |
| Never use poor-quality water such as tap water, boiled water, or purified RO water |
| Masks, nasal cannulae should be cleaned and checked for any leakage by the attendee |
| If using an oxygen concentrator, attendee should adhere to manufacturer guidelines for proper cleaning as and when required |
| The oxygen concentrator should be placed in a well-ventilated and clean area |
| Oxygen filters should be properly cleaned from time to time |
| Avoid smoking (wood, cigarette, sticks) in any form, active or passive, near to oxygen concentrator |
| Attendee can monitor patient nostril for any black pigmentation, as soon as it is noticed even as the smallest spot contact doctor immediately for further treatment |
| Avoid irrational use of steroids without recommendations |

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Declarations

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