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Guidelines

Guidelines for Efficient Utilization of Oxygen for Covid-19 Patients

Objective

To assure efficient utilization of oxygen in all healthcare facilities providing inpatient care to Covid-19 patients during this pandemic

Rationale

Approximately 14% of all patients infected with Covid-19 develop 'severe' respiratory failure with hypoxia and a further 5% may develop 'critical-illness' requiring intensive care and/or invasive mechanical ventilation. Oxygen therapy is recommended for all patients with severe to critical illness.
As demands for oxygenation dramatically escalate, hospitals and healthcare workers must be well-educated in its use and remain vigilant and fully compliant with a rationed and safe use of this precious resource.
In the setting of a pandemic, it is advised to preferentially reserve oxygen use for Covid-19 patients, thereby restricting use for non-Covid cases to emergency medical or surgical use only

Oxygen sources

Medical oxygen must contain at least 82% pure oxygen.

- **Liquid oxygen plant:** a central bulk storage liquid oxygen tank(s) located onsite at medical facility for Intra-hospital distribution of vaporized oxygen via a pipeline.

- **PSA oxygen plant:** A large, central source of oxygen generation using pressure swing adsorption technology (similar to concentrators) that can be located onsite at medical facility. Oxygen can be piped directly to terminal units or, with a booster compressor, be used to fill cylinders for distribution.

- **Oxygen concentrator:** self-contained, portable, electrically powered medical device designed to concentrate oxygen from ambient air. Uses PSA technology (draws in air from the environment, removes nitrogen to produce a continuous source of more than 90% concentrated oxygen) and should not be used if the oxygen concentration falls below 82%. Concentrators are portable and

can generate maximum flow rates of 5 to 10 L/min. Given a low pressure output they are usually not suitable for CPAP or ventilators.

Oxygen storage and Intra-hospital distribution

- Pipeline intra-hospital distribution system: supply vaporized oxygen at high pressure from central bulk storage liquid oxygen tank(s) located onsite at medical facility. Useful to supply oxygen to anesthetic machines and ventilators.

- Oxygen cylinders: Oxygen gas can be compressed and stored in cylinders (at a gas manufacturing plant or a PSA plant) and then transported to health facilities. Cylinders can be used in one of two ways; one, by installing them directly within patient areas or two by connecting groups of cylinders linked in parallel – to then pipe oxygen to specific areas at the ward level. When cylinders are the only source of oxygen in a health facility, a strong supply-chain is required to ensure ongoing availability.

Caution

- Oxygen supports combustion. The addition of concentrated oxygen to a fire increases its intensity considerably and can even support the combustion of materials that do not normally burn.
- Do not use near any open flames when using oxygen. Do not SMOKE near oxygen sources!
- Be vigilant with electrical wiring and potential short-circuiting/electrical sparks in busy hospital workspaces.

Devices for supplemental oxygen therapy*

Low flow therapy devices

- Nasal cannulas: O2 flow 1-6 L/min, FiO2 24-50%
- Simple masks: O2 flow 5-10 L/min, FiO2 40-60%

High flow therapy devices

- Non-rebreather (reservoir) masks: O2 flow 10-15 L/min, FiO2 60-90%. Used with a minimum flow of 10 L/min (to reduce rebreathing risk by making sure the bag is never totally deflated). Caution because of a unidirectional inspirational airflow (risk of suffocation if the gas flow is interrupted). The patient should never be left alone unless the one-way valves on the exhalation ports are removed. Before the pandemic, these were used for specific short-term, high oxygen requirements (such as pre-intubation and patient transport and were generally not available on general wards due to the risk of suffocation, chance of hyper-oxygenation, and their possible lack of humidity). However, in the setting of the pandemic and limited high-flow oxygen capabilities

– these have become the frontline device for use. They can be used in a well-informed, cautious practice.

- Venturi face masks: O2 flow 2-15 L/min, FiO2 24-60% (precise FiO2 delivered, helpful for type II respiratory failure patients who need controlled oxygenation)
- High flow nasal cannulas: O2 flow up to 70 L/min, FiO2 up to 100%
- Continuous Positive Airway Pressure (CPAP): O2 flow 15 L/min, FiO2 up to 100%

*Pure effortless hypoxemic respiratory failure (silent 'happy hypoxemics) benefit from any of the above (nasal cannula, face mask, venturi, non-rebreather or high-flow nasal cannula). However, patients with visible respiratory distress/effort, reduced ventilation and/or an increased mechanical work of breathing benefit from a positive airway pressure device such as CPAP or BiPAP (for airway splinting and reduction in the effort to breath).

Efficient utilization of oxygen

In order to ensure efficient utilization of oxygen in any hospital setting, all of the following must be strictly adhered to:

1. Before applying any of the devices used for oxygen therapy, make sure that:
    - Tubing, masks, and connections are all intact and not damaged or leaking.
    - Oxygen flow does not exceed the recommended range for the device.
    - Oxygen flow is monitored and titrated to clinician recommended target range (SpO_2 levels via pulse oximetry and/or PaO_2 via arterial blood gas measurements (ABGs) in cases of severe or worsening hypoxemia (where available)).
    - Turn off oxygen flow from source when not in use.
    - Follow manufacturer's recommendations for all oxygen delivery devices, particularly O_2 concentrators and high flow oxygen delivery devices.

2. For delivery of oxygen via high-flow devices: a piped oxygen supply or oxygen cylinders may be used. For delivery of oxygen via low-flow devices: oxygen concentrators or onsite oxygen generating systems using PSA (pressure-swing adoption) technology may be used.

3. Whenever oxygen concentrators or an onsite oxygen generating system is used, a continuous electrical supply must be ensured, and oxygen cylinders should be available as back-up in case of generation failure.

In the wake of increased oxygen demand and finite oxygen-generating capacity, all elective surgery should be deferred (see appendix).

Respiratory failure (definitions)

- **Type 1 respiratory failure (T1RF)** refers primarily to a problem of gaseous exchange resulting in hypoxia without hypercapnia; typically seen in severe Covid-19 infection.

- **Type 2 respiratory failure (T2RF)** refers to when there is reduced ventilation leading to an elevation in the dead space fraction and/or worsening of ventilation perfusion ratio (hypoventilation), with or without interrupted gas transfer, leading to hypercapnia and associated secondary hypoxia. This may be seen in patients with COPD, neuromuscular disorders, obesity hypoventilation etc. Although uncommon for Covid-19, T2RF may develop as a consequence of muscle fatigue.

Management

Goal of Oxygenation

- The optimal oxygen saturation (SpO_2) target goals in adults with COVID-19 remain uncertain.
- However, several clinical guidelines recommend targeting a range of SpO_2 90-94% for all patients. There is indirect evidence from experience in patients without COVID-19 to suggest that targeting SpO_2 > 96% may even be harmful.
- Patients with SpO_2 < 94% on room air at sea level, a ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO_2/FiO_2) < 300 mm Hg, respiratory frequency $\geq$ 30 breaths/min, or lung infiltrates > 50% require supplemental oxygen.
- Oxygen supplementation is recommended for pregnant patients if SpO_2 falls below 95% on room air at sea level to accommodate physiologic changes in oxygen demand during pregnancy and to ensure adequate oxygen delivery to the fetus.

Monitoring

- Monitor vital signs including respiratory rate.
- Oxygen levels are assessed using pulse oximeter to measure peripheral oxygen saturation (SpO2) or using PaO2 measurements via arterial blood gas sampling.

During the Covid-19 pandemic, clinicians are advised to:

- Target an SpO2 range of 88-92% for patients with T2RF
- Target an SpO2 90-94% (or PaO2 > 60-80 mmHg) for all T1RF patients.

Clinical trials have demonstrated that these lower oxygen target ranges sufficiently alleviate dyspnea and are safe for maintaining adequate tissue oxygenation without an increased risk for hypoxemia induced organ injury in patients. In addition, adherence to these specific ranges aids the conservation of precious hospital oxygen supplies.

Many patients with Covid-19 may not manifest obvious respiratory distress or visible ‘breathlessness’ despite severe hypoxemia (silent hypoxemia or ‘happy hypoxemic’). Hence, extra vigilance is needed to detect deterioration’ for instance, a decreasing SpO_2, increasing oxygen requirements or other subtle signs of early organ dysfunction such as delirium, reduced urine output may be the only markers of deterioration and a need to escalate treatment.

Note: The above recommendations are being regularly reviewed by the Ministry of National Health Services, Regulations & Coordination and will be updated based on the international recommendations and best practices.

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Appendix:

Deferring elective surgeries to decrease non-emergency oxygen demand

- According to Anesthesia Quality Institute definition, elective surgery is "a surgical, therapeutic or diagnostic procedure that can be performed at any time or date between the surgeon and patient"
- It is not possible to define the medical urgency of a case solely on whether a case is on an elective surgery schedule.
- While some cases can be postponed indefinitely, the vast majority of the cases performed are associated with progressive disease (such has cancer, vascular disease and organ failure) that will continue to progress at variable, disease-specific rates.
- As these conditions persist, and in many cases, advance in the absence of surgical intervention, the decision to cancel or perform a surgical procedure must be made in the context of numerous considerations, both medical and logistical.
- In the current scenario, oxygen demand is one of the important limiting factors

In order to assist in the surgical decision-making process to triage non-emergent operations, American College of Surgeons (ACS) suggests that surgeons look at the Elective Surgery Acuity Scale (ESAS) from St. Louis University

https://www.asahq.org/in-the-spotlight/coronavirus-covid-19-information/elective-surgery
https://www.facs.org/covid-19/clinical-guidance/triage

Elective Surgery Acuity Scale (ESAS)

HOPD – Hospital Outpatient Department
ASC – Ambulatory Surgery Center

Tiers/Description	Definition	Locations	Examples	Action
Tier 1a	Low acuity surgery/healthy patient Outpatient surgery Not life threatening illness	HOPD ASC Hospital with low/no COVID-9 census	Carpal tunnel release Penile prosthesis EGD Colonoscopy	Postpone surgery or perform at ASC
Tier 1b	Low acuity surgery/unhealthy patient	HOPD ASC Hospital with low/no COVID-19 census		Postpone surgery or perform at ASC
Tier 2a	Intermediate acuity surgery/healthy patient Not life threatening but potential for future morbidity and mortality. Requires in hospital stay	HOPD ASC Hospital with low/no COVID-19 census	Low risk cancer Non urgent spine Ureteral colic	Postpone surgery if possible or consider ASC
Tier 2b	Intermediate acuity surgery/unhealthy patient	HOPD ASC Hospital with low/no COVID-19 census		Postpone surgery if possible or consider ASC
Tier 3a	High acuity surgery/healthy patient	Hospital	Most cancers Highly symptomatic patients	Do not postpone
Tier 3b	High acuity surgery/unhealthy patient	Hospital		Do not postpone

For more information, please contact:

Expanded Program on Immunization, PM National Health Complex, Islamabad
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