WHO technical consultation on oxygen scale-up
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenter</th>
</tr>
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</table>
| 16:00–16:05  | Welcome remarks                                                          | Mike Ryan  
Executive Director General  
WHO Health Emergency Programme                                               |
| 16:05–16:20  | Introduction:  
Meeting objectives, review of agenda, ToR, introduction of participants | Janet Diaz  
Lead, Clinical Management for COVID-19  
WHO Health Emergency Programme                                               |
| 16:20–16:40  | Background:  
• Oxygen timeline and map  
• Oxygen scale up                                                           | Adriana Velazquez  
Lead Medical Devices and Diagnostics  
Access to Medicines and Health Products Division  
Janet Diaz                                               |
| 16:40–17:00  | Assumptions:  
• Estimate of oxygen demand  
• Assumptions on baseline oxygen availability and access  
• Assumptions on oxygen supply mix solutions                         | Alejandra Velez  
Focal point, Oxygen scale-up,  
WHO Health Emergency Programme                                               |
| 17:00–17:05  | Leg stretch                                                              |                                                                         |
| 17:05–17:50  | Structured discussion                                                    | Fetnah Ramirez (co-chair)  
Edgardo Diaz (co-chair)                                                  |
| 17:50–18:00  | Wrap-up and next steps                                                   | Janet Diaz                                                             |
Oxygen scale-up during the COVID-19 pandemic

✓ Oxygen is an essential medicine used to care for patients at all levels of the health care system, including in surgery, trauma and maternal and child care.

✓ The COVID-19 pandemic has highlighted the gaps and needs for oxygen globally.

✓ As of 14 October 2020, there have been over 38 million confirmed cases and over 1 million deaths. Severe pneumonia from COVID-19 has resulted in a surge in oxygen demand globally.

✓ Scale-up intends to promote equitable access to quality oxygen by reaching more patients, at the right time and in a more sustainable way.

✓ Scale-up requires a multidisciplinary effort that requires stakeholders to develop strategic planning, tools, advocacy and technical support to achieve the intended outcome.

✓ Scale-up needs to be integrated into longer term sustainability, requiring implementation programmes, resource allocation, local capacity building and, in some situations, cultural change.

*Use the lessons from the Biomedical Consortium in developing operational guidance documents to support scale-up*
The aim of this technical consultation is to achieve the following core objectives across four teleworking sessions:

- **Needs assessment**: taking stock of existing guidance to forecast oxygen needs; identification of shared challenges; formalizing baseline assumptions and framework methodologies that apply for a high-level oxygen needs estimation for LMICs.

- **Technical guidance**: finalizing operational elements and inputs for WHO consideration in producing interim guidance documents for oxygen production from PSA oxygen generator plants and subsequent distribution (e.g. cylinder manifolds, oxygen piping) at the facility level.

- **Global scale-up mapping**: establishing live mapping updates and/or networking resources to leverage previous accomplishments, to foster collaborations, and to avoid duplication of activities.

Identification of other work areas could result in the addition of further working sessions.
Oxygen timeline: identifying technical guidance for LMICs

1770s
Discovery of oxygen as an element and first publications.

1970s
PSA started being used commercially for medicinal use.

2006
NHS/DoH “HTM 02-01: Medical Gases”.

2015
WHO:
• Int’l Pharmacopoeia (O₂ included).
• “Tech. Guidance & Specs. for O₂ Concentrators”.

2017
• WHO Model List of Essential Medicines: adds O₂.
• Nigeria: National O₂ Policy and Scale-up Strategy (published A₂O₂ event).
• Formal EBC launch.

2019
• First documented case of SARS-CoV-2.

2020
• Declaration of pandemic.
• Publication of various interim tech. guidance documents.

1902
First application of an air separation process by fractional distillation. Carl Linde.

1980
Oxygen included in European Pharmacopoeia (2nd ed.).

2012
WHO: “The Clinical Use of O₂ in Hospitals with Limited Resources”.

2016
• WHO: “O₂ Therapy for Children”.
• Ethiopia: first LMIC to publish “National O₂ Scale-up Roadmap”.

2017
• WHO Model List of Essential Medicines: adds O₂.
• Nigeria: National O₂ Policy and Scale-up Strategy (published A₂O₂ event).
• Formal EBC launch.

2020
• Declaration of pandemic.
• Publication of various interim tech. guidance documents.
The Biomedical Consortium led by WHO requires a comprehensive package of leadership, guidance, field support and procurement due to the complexity of biomedical equipment. All external partners depend upon WHO’s work to ensure proper biomedical use.

**Technical guidance**
The global community depend on WHO technical guidance

**Market access**
WHO continues outreach to over 80% of the market

**Health OPs**
WHO provides technical and operational guidance for COVID-19 health facilities

**Procurement**
WHO manages the majority of purchasing of the consortium

- **50 Technical guidance & specification packages**
- **Education platform & multiple webinars**
- **US$ 1.25 billion**
  - Biomedical equipment sourced
- **US$ 250 million+**
  - Biomedical equipment validated and available
- **2000 beds**
  - Supported for COVID-19 across 20+ countries
- **Services:**
  - Facility design
  - Oxygen assessments
  - Procurement of PSA plants
- **US$ 55 million+**
  - and expanding
- **47 000 units**
  - 14k+ Concentrators
  - 11k+ Pulse oximeters
  - 5k+ Monitors
  - 1k+ Ventilators
  - 15k+ Thermometers
Countries where WHO and technical entities have oxygen scale-up activities


Data Source: World Health Organization
Map Production: WHO Health Emergencies Programme

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.
Global presence of industrial oxygen in countries, according publicly available information*


Companies
- None
- 1 company
- 2 companies
- 3 companies

* Not exhaustive, data captured from Linde.com, AirLiquide.com, and AirProducts.com

Data Source: World Health Organization
Map Production: WHO Health Emergencies Programme

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.
The COVID-19 pandemic has brought the lack of oxygen availability, particularly in LMICs, into the spotlight. A complex technical framework – not medical devices alone – will be necessary to support requisite surge.

<table>
<thead>
<tr>
<th>SCALE-UP IN RELATION TO…</th>
<th>CLEAR ACTIONS</th>
<th>COVERED IN THIS CONSULTATION</th>
</tr>
</thead>
</table>
| Production of medical O₂ | • O₂ purity - according to the source  
• International Pharmacopeia | No |
| Availability             | • Market assessment: considerations for the supply chain and long-term service agreements | No |
| Accessibility            | • Readiness and availability of resources | Yes (except financial) |
| Appropriateness          | • Aligned to a specific context | Yes |
| Affordability            | • Global advocacy | No |
Entities present have notable track records in implementing actions associated with the scale-up of and access to medical oxygen in LMICs.

Technical considerations inform the planning process for scale-up:
- Short-term successes
- Enable sustainable, longer term operations
The project cycle, however, requires a multidisciplinary approach to enable successful and sustainable outcomes

Holistic approach used to scale oxygen sources to best respond to the COVID-19 surge

<table>
<thead>
<tr>
<th>Strategic planning</th>
<th>Procurement</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantification of demand and assessment of medical oxygen needs at facility, sub- or national level.</td>
<td>Feasibility analysis and selection of oxygen sources to surge: 1. Rapid concentrator deployment 2. Local or regional supply landscape 3. Absorptive capacity for at-scale sources 4. Consider innovations</td>
<td>Depending on the process:  • Vendor solicitation  • Technical assessment  • Establishment of requirements for long-term agreements</td>
</tr>
<tr>
<td>Support with infrastructure compatibility and additional needs:  • Infrastructure/design  • Reliable energy  • Ensure compatibility and quality of ancillary devices  • Clinical perspective</td>
<td></td>
<td>• Oxygen distribution systems  • Oxygen delivery and monitoring devices  • Health work force  • Technical and clinical trainings  • Installation guidance and support for service level agreements  • Ensure ancillary services are present, e.g. continuous and reliable energy, transport  • Engineering support</td>
</tr>
</tbody>
</table>

World Health Organization

HEALTH EMERGENCIES programme
High-level quantification of demand and needs assessment: one approach to forecasting oxygen needs for strategic planning and advocacy

1. **Quantification of demand:**
   - Assessment of demand at level under study (can be facility, subnational or national levels)
   - Example of tools to do so: WHO’s COVID-19 ESFT for national or aggregated demand

2. **Baseline assumptions:**
   - Considering no clear indication of availability and accessibility at country level: not enough baseline data about the existing capacity for oxygen production in countries
   - Considerations could be given to country by income level, health facility type (i.e. typical requirements)

3. **Determine the need gap:**
   - Quantifying
   
   \[
   \text{Need} = \text{demand} - \text{baseline supply capacity}
   \]

Solution needs to be customized to local setting.

Non COVID-19 hypoxaemia demand (including seasonal) is not calculated in ESFT.
Quantification of demand, with focus on LMICs, using the WHO Essential Supplies Forecasting Tool (ESFT) for COVID-19

**Calculation pathway**

1. **Define parameters**  
   - Patient severity  
   - Health workforce  
   - Bed capacity  
   - Testing capacity  
   - Oxygen utilization

2. **Define equipment usage**  
   - PPE  
   - Hygiene  
   - Biomedical  
   - Medicines and consumables

3. **Estimate # of cases**  
   - Weekly estimates  
   - Three modelling options: SIR, SEIR, or manual entry

4. **Model specific scenarios**  
   - Forecast period (4, 8, 12 weeks)  
   - Testing strategy

- **Estimated O₂ demand, in m³/day** (output shown as greatest demand-day by week)
- **Biomedical equipment quantities** for severe and critical patients receiving inpatient care
- Imperial College “SEIR” epidemiological model: SEIR = Susceptible, Exposed, Infected, Recovered
All hospitalized patients require supplemental oxygen

*All hospitalized patients require supplemental oxygen*

ESFT clinical inputs

- **75% “Severe”**
  - Average flow: 10 L/min
  - Non-invasive ventilation

- **25% “Critical”**
  - Average flow: 30 L/min
  - Invasive mechanical ventilation

- **20%**
  - Require URGENT hospitalization
  - Isolate & recover

- **40% “Moderate”**
  - Isolate & recover

- **40% “Mild”**
  - Isolate & recover

Broad estimates have indicated severe patients hospitalized 7 days, critical hospitalized 14 days. Duration of stay will change, and O₂ flows will be titrated over course of treatment. This is not indicative of any one case, but best estimates to cover all incidence and use of O₂ therapy for COVID-19.
SEIR projection model has been selected. This model forecasts the number of COVID-19 infections according to three scenarios based on where a specific country is in their current epidemic.

COVID-19 itself remains unpredictable, and country-level strategy and/or interventions change. The following examples are illustrative of using the latest ESFT with the SEIR projection model.

**Input:** latest reported cases per country on day of run  
**Calibration:** reported number of deaths, details of implemented interventions  
**Output:** three forward-facing scenarios as follows:
1. **50% reduction** (decrease in cases): projection if country implements measures from the day of data run  
2. **Status quo:** assumes country will continue the same trajectory  
3. **50% relaxation** (increase in cases): projection if a country experiences an increase greater than from day of data run

Country on a downward trajectory (Congo, Rep.*):  
Country on an upward trajectory (Burkina Faso*)

<table>
<thead>
<tr>
<th>O₂ demand estimate, m³ (max. day)</th>
<th>Strengthened</th>
<th>Status quo</th>
<th>Relaxed</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-weeks</td>
<td>4 068 772</td>
<td>4 884 188</td>
<td>10 130 207</td>
</tr>
<tr>
<td>8-weeks</td>
<td>5 985 774</td>
<td>7 656 029</td>
<td>34 880 669</td>
</tr>
<tr>
<td>12-weeks</td>
<td>5 985 774</td>
<td>8 133 104</td>
<td>44 111 535</td>
</tr>
</tbody>
</table>

**WHO Using ESFT to estimate daily O₂ requirements for 138 LMICs**

**Current as of 2020/10/13**

**PATH & EBC O₂ requirement estimate:**  
2-9 Sept. / 123 countries: 8,719,301 m³/day

PATH/EBC: Estimating the cost of oxygen need in LMICs: Oxygen cost calculations to meet the daily increase in COVID-19 cases, 22 September 2020.

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Assumptions on existing capacity by country income

Considerations:
- Focus geographies on all WB classified low- and middle-income countries
- Patients in these countries do not have guaranteed access to oxygen
- Existing oxygen production capacity is fully utilized

<table>
<thead>
<tr>
<th>Existing capacity</th>
<th>GSCC</th>
<th>WHO / ACT-A</th>
<th>PATH/ EBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIC</td>
<td>5–10%*</td>
<td>0%</td>
<td>20%</td>
</tr>
<tr>
<td>LMIC</td>
<td>25%</td>
<td>20%</td>
<td>40%</td>
</tr>
<tr>
<td>UMIC</td>
<td>50–75%*</td>
<td>40%</td>
<td>60%</td>
</tr>
</tbody>
</table>

- GSCC: Global Supply Chain Consortium
- WHO / ACT-A exercise
- PATH/EBC: Estimating the cost of oxygen need in LMICs: Oxygen cost calculations to meet the daily increase in COVID-19 cases, 22 September 2020.
Assumptions on oxygen supply mix solutions

<table>
<thead>
<tr>
<th>Oxygen Source</th>
<th>PSA Oxygen Plant</th>
<th>Oxygen conc., 10 LPM (0.6 m³/hr)</th>
<th>Oxygen Cylinder, 7 m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO / ACT-A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary hospitals</td>
<td>70% (3 sizes)</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>District hospitals</td>
<td>60%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Health center</td>
<td>0</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>PATH/EBC</td>
<td>Global supply mix</td>
<td>40% (1 size)</td>
<td>20%</td>
</tr>
</tbody>
</table>
### Questions to steer workshop/discussions

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the oxygen demand calculated from the COVID-19 Essential Supplies Forecasting Tool (EFST) sufficient to estimate the oxygen needs for countries to act?</td>
</tr>
<tr>
<td>Which baseline assumptions that have been presented about oxygen availability and accessibility at country level should be used to make a need-gap analysis?</td>
</tr>
<tr>
<td>Which baseline assumptions on oxygen supply mix should be used to inform cost forecasting?</td>
</tr>
<tr>
<td>Are there any other assumptions that we should be considering?</td>
</tr>
</tbody>
</table>
Thank you!

As noted in the **milestones** in the **introduction**, many of the achievements to date have been the development and publication of **global goods**. Some that have been particularly useful for this exercise:

**ACTION!**

Entities are encouraged to think what could be achieved not only through these consultation sessions, but beyond.

➢ What other guidance is needed?
Important information

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