THE LANCET Global Health

COMMISSION ON MEDICAL OXYGEN SECURITY

Reducing global inequities in medical oxygen access: *The Lancet Global Health* Commission on Medical Oxygen Security

OFFICIAL LONG FORM DECK

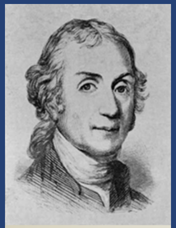
Oxygen therapy is life-saving for people with acute illness, life-sustaining for people undergoing anaesthesia and surgical care, and life-enhancing for people with chronic respiratory failure. Oxygen is an essential medicine and an essential service, and requires a systems approach.

A short history of oxygen and other medical milestones

Oxygen is a life-saving therapy that is more than 100 years old, yet is not available for most people…

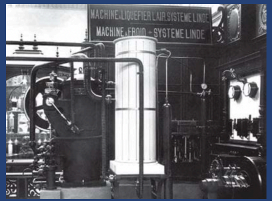
Carl Wilhelm Scheele (1742-1786)

1771
"Fire air" (oxygen) discovered by Scheele



Joseph Priestley (1733–1804)

1774
"Dephlogisticated air" (oxygen) discovered by Priestley



1796
Vaccination (smallpox) discovered by Jenner

1838
Ventilator developed by Dalziel and Jones

1885
Liquid oxygen developed by von Linde

Young pneumonia patient treated with oxygen by Holtzapple

1895
X-rays discovered by Röntgen

1907
Nasal catheters developed by Lane

1928
Penicillin invented by Fleming

1941
Retinopathy of Prematurity (ROP) discovered

1955
Long-term oxygen therapy developed by Petty

1957
Blood gas analyzers invented by Severinghaus

1960
PSA plant technology developed by Skarstrom

1974
Pulse oximeters and home oxygen concentrators invented

1980
CPAP invented by Sullivan

2020
M-COG invented at NASA by Graf

THE *LANCET GLOBAL HEALTH* COMMISSION
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COVID-19 wake up call

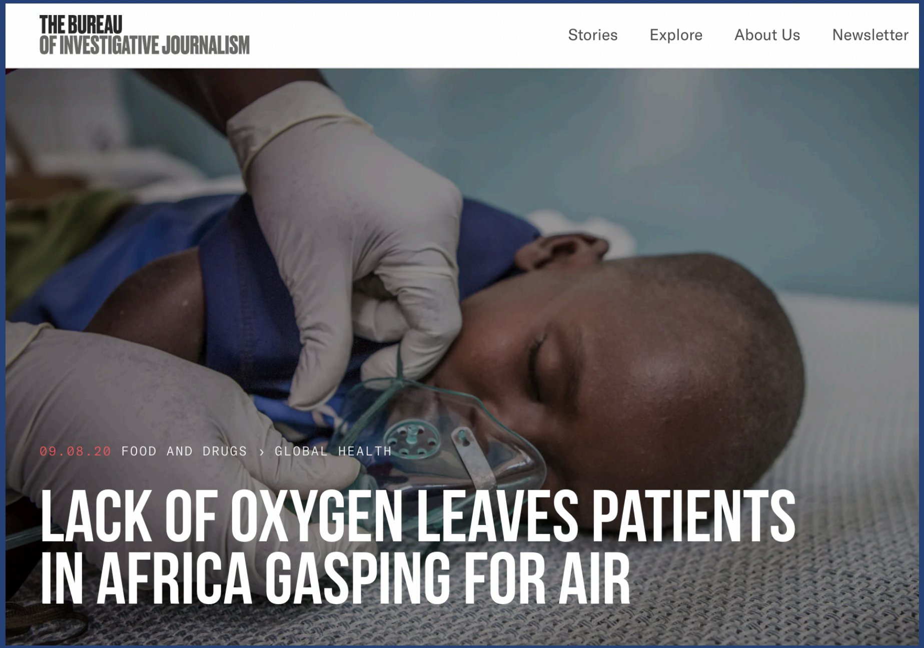
Pandemic thrust oxygen into the global spotlight

Catastrophe years in the making

- Global health blind spot → chronic systems failure → acute crisis

Even though I am a doctor, I never thought in my life that oxygen security is the mainstay of everything. It should be available every time, everywhere, in every hospital, small or large… COVID taught me that oxygen is a big issue. ***Without oxygen, no one can survive.***

Doctor, Bangladesh



COVID-19 wake up call

Pandemic emergency oxygen response was slow but grew

ACT-A Oxygen Emergency Taskforce

- Over US$1 billion mobilized
- Emergency response large but challenging

It is unlikely that oxygen would have been neglected if low- and middle-income country representatives were included in ACT-A.

External Evaluation of ACT-A, October 2022

Post-pandemic opportunity to sustain and build on pandemic investments

- New coordination body → Global Oxygen Alliance (GO_2AL)
- New global resolution → WHO resolution (WHA76.3)
- New actors and innovation in practice and policy

A Lancet Commission

Sep 2022

A scientific review, inquiry, and response to an urgent, and perhaps neglected or understudied, health predicament

- Science-led
- International collaboration
- Multidisciplinary
- Aims for (transformational) change
- Focused on policy and/or political action
- Report of no more than 20,000 words and 250 references
- Published in regular journal and printed as a stand-alone booklet
- Around two years in the making

Comment

Announcing the *Lancet Global Health* Commission on medical oxygen security

Published Online September 23, 2022 https://doi.org/10.1016/S2214-109X(22)00407-7

Medical oxygen is an essential health treatment for both acute and chronic conditions across all age groups. Strong medical oxygen systems save lives. Therefore, adequate access to safe, affordable, and appropriate medical oxygen services is crucial for improving population health and meeting the Sustainable Development Goal targets. However, severely limited or unreliable oxygen services have been a persistent issue in many low-income and middle-income countries (LMICs), particularly among small health facilities serving poor, rural, and otherwise marginalised populations.

Medical oxygen insecurity has been a defining inequity of the COVID-19 pandemic, with LMICs bearing the worst of oxygen-related disruptions and excess mortality. Millions of health-care workers and families have experienced the desperation of trying to find oxygen for severely unwell patients and family members. We might never know how many COVID-19 deaths resulted from a lack of access to oxygen during the pandemic, but the limited data available suggest that it is substantial. For example, a study of COVID-19 deaths in 64 intensive care units across ten African countries showed that one in two patients died without receiving medical oxygen,[1] with the situation likely to be worse in smaller, less-resourced hospitals.

Although COVID-19 exposed and exacerbated a massive underlying gap in access to medical oxygen across LMICs, it also resulted in unprecedented attention to, and investment in, oxygen systems that can benefit many patients. Severe COVID-19 is just one indication for medical oxygen therapy. Other notable indications include neonates in respiratory distress; infections including pneumonia, malaria, sepsis, and tuberculosis; chronic illnesses including chronic obstructive pulmonary disease, heart disease, and asthma; and surgery and trauma care. Data suggest that this cumulative need is massive and largely underserved.[2,3] For example, an estimated 7 million children with hypoxaemic pneumonia alone needing medical oxygen therapy are admitted to LMIC hospitals each year,[4] yet in many contexts only one in five actually receives it.[5]

Health-care personnel and patients in many LMICs have experienced the medical oxygen crisis as a painful reality for many years, frustrating efforts to provide quality care, forcing choices about who to prioritise, and burdening patients with treatment costs. But it has taken a global respiratory disease pandemic to draw the attention of the global community. With support from the Access to COVID-19 Tools Accelerator Oxygen Emergency Task Force, and other donors, many LMICs have received new oxygen technologies (eg, liquid, pressure swing adsorption plants, mobile concentrators, pulse oximeters, continuous positive airway pressure devices, ventilators, etc) to treat patients with COVID-19. However, radical improvements in underlying support structures, processes, and personnel are needed if these are to be sustainably integrated into health systems, alongside surge capacity, to achieve a long-lasting effect on lives.

Figure: Four key research themes and pillars

Kitutu, F. E., et al. (2022). "Announcing the Lancet Global Health Commission on medical oxygen security." The Lancet Global Health.

The team

Sep 2022 — Feb 2025

Commissioners
18 academic experts

Consultations
- Industry
- Health ministries
- Patients and caregivers

Executive
5 institutions

icddr,b · Makerere University · murdoch children's research institute · Karolinska Institutet · Every Breath Counts

Advisors
40 stakeholders from diverse sectors

Oxygen Access Collaborators
100+ global network

Photo: Lancet Global Health

Photo: Lancet Global Health

Key findings

OXYGEN NEED

OXYGEN COVERAGE

OXYGEN COST

OXYGEN SOLUTIONS

RECOMMENDATIONS

Oxygen need

Each year, 374 million people need medical oxygen: 306 million (82%) live in low- and middle-income countries (LMICs). During emergencies, the need for oxygen can rise exponentially, putting enormous pressure on health systems.

Global medical oxygen need

Who needs oxygen?

374 million people

- 1·2 billion cubic meters (Nm3) for acute medical and surgical (on map)
- 3.2 billion Nm3 for COPD (not on map)

306 million (82%) live in LMICs

- 30% (93 million) in South Asia
- 29% (88 million) in East Asia & Pacific
- 24% (72 million) in Sub-Saharan Africa
- 8% (24 million) in Latin America & Caribbean
- 5% (17 million) in Middle East & North Africa
- 4% (12 million) in Europe & Central Asia

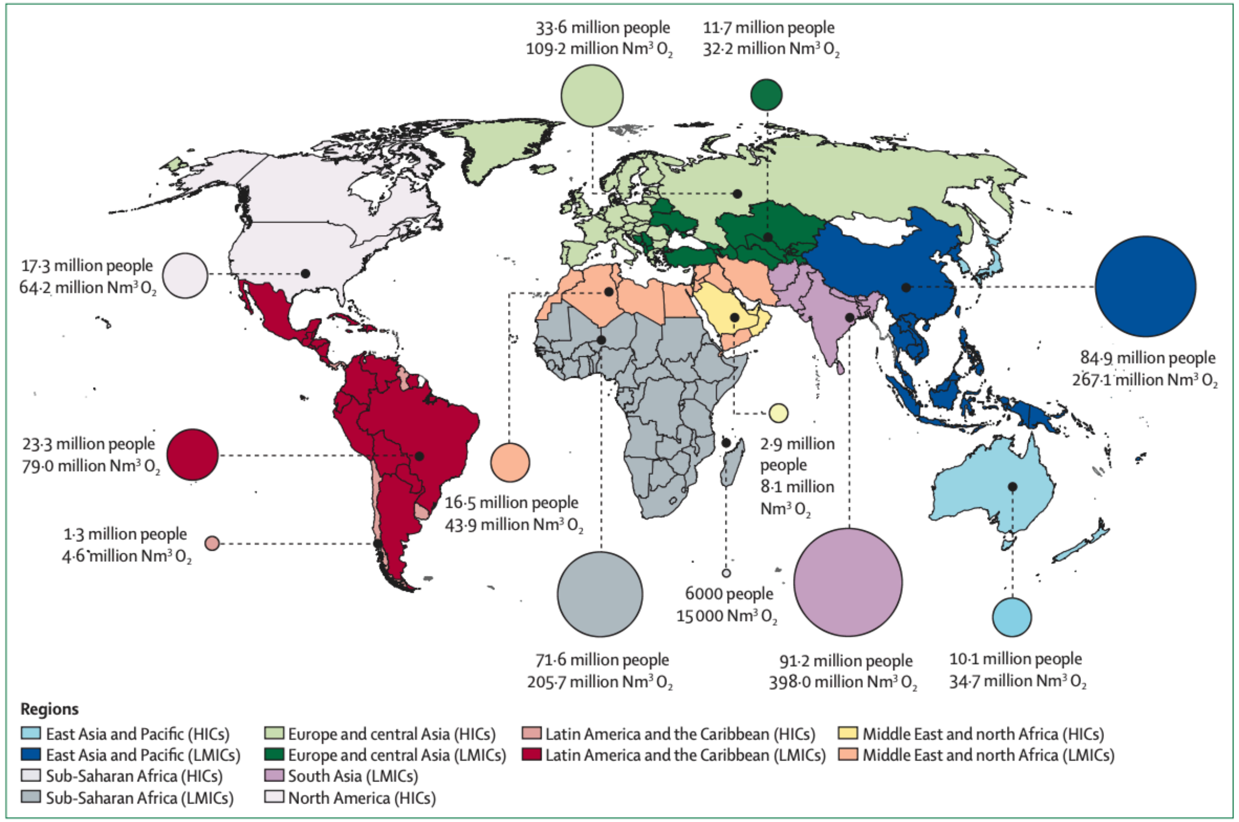


***Figure 1:* Location of people with acute medical and surgical oxygen needs in 2021, and minimum volume of oxygen required to meet need, by World Bank region**
Note that this figure excludes oxygen requirements related to COVID-19. Oxygen need is represented by the circles, the sizes of which are proportional to the number of people in that region who need medical oxygen therapy. Minimum volume of oxygen required to meet need was calculated using data for recommended and usual flow rates and duration for various conditions and assumes no inefficiencies in oxygen use and no wastage or inefficiencies in upstream oxygen production, supply, and distribution. HICs=high-income countries. LMICs=low-income and middle-income countries. Nm³=normal cubic metres.

Pp. 8-10 in the Commission report
Section 2.1.1, 2.1.2, 2.2.1 and 4.1 in Appendix 1

Global medical oxygen need

Who needs oxygen?

People of all ages and across many conditions

- respiratory infections, trauma, prematurity, sepsis, peri-operative, chronic respiratory failure, and more…

I remember when I got to the emergency room my saturation was 80%. I had a blackout in front of my eyes. I thought I would die. I was sweating. I felt like there was no life in my hands or feet. I felt much better when I got on oxygen and my symptoms got better and I thought I would come out of it. It gave me hope.

Young patient in respiratory failure, Pakistan

Respiratory tract infection (pneumonia, bronchiolitis)

Traumatic injury (road trauma, violence, other)

Neonates (preterm, sepsis)

Surgical procedures (sedative)

Chronic obstructive pulmonary disease (COPD)

Pp. 8-10 in the Commission report
Section 2.1.1, 2.1.2, 2.2.1 and 4.1 in Appendix 1

Global medical oxygen need

Who needs oxygen?

Increasing need

- Extra 33 million patients (9%) with acute medical and surgical need since 2010
- Extra 2.3 million patients (33%) needing long-term oxygen therapy for chronic obstructive pulmonary disease (COPD)

Prevention of need is important

- Increasing immunization, road safety, healthy diets
- Reducing smoking, malnutrition, drug and alcohol use, injuries, air pollution…

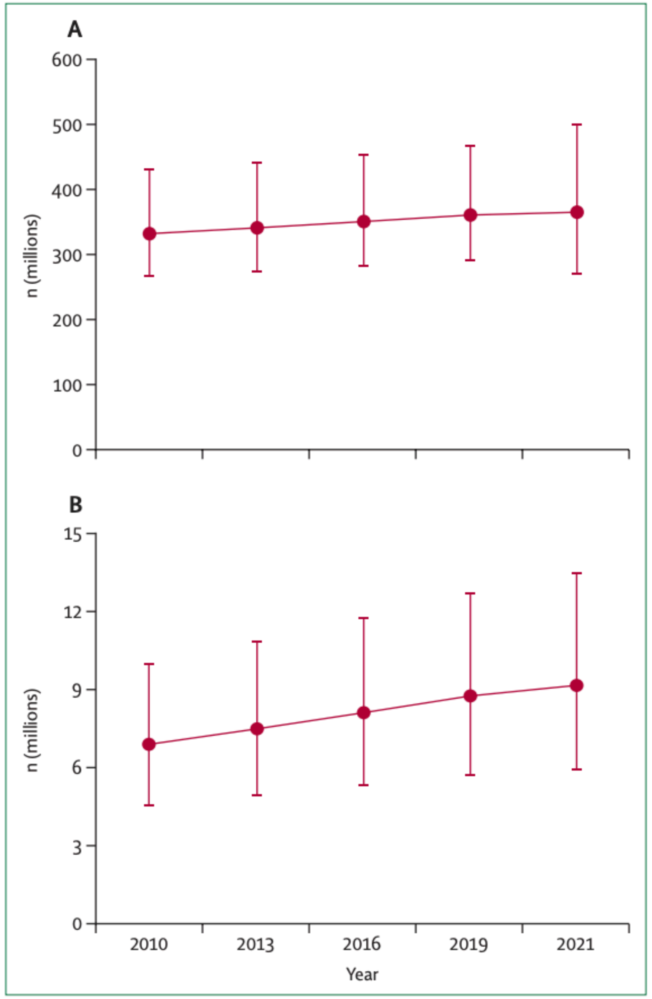


Figure 2: **Trends in estimated global oxygen need (2010–21) for acute medical and surgical oxygen therapy (A) and long-term oxygen therapy (B)**
Data are from the Global Burden of Disease.[63] Oxygen need related to COVID-19 is excluded. Error bars represent uncertainty intervals.

Pp. 8-11 in the Commission report
Section 2.1.1, 2.1.2, 2.2.1 and 4.1 in Appendix 1

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MEDICAL OXYGEN SECURITY

Global medical oxygen need

Who needs oxygen?

Humanitarian emergencies

- Rapidly increase oxygen need (e.g., respiratory pandemics, mass trauma)
- Destroy health facility and oxygen infrastructure (e.g., conflict)
- Restrict access (e.g., natural disasters)

In 2021, 52 million people with COVID-19 needed oxygen

When we arrived, there were a lot of patients - it was very crowded - but they took us in and gave [my husband] an oxygen mask and big green cylinder. Five to six patients were sharing one cylinder.

Wife of elderly man with COVID-19, Philippines

Photo: Global Fund

Pp. 9-10 in the Commission report
Section 2.1.1, 2.1.2, 2.2.1 and 4.1 in Appendix 1

Oxygen coverage

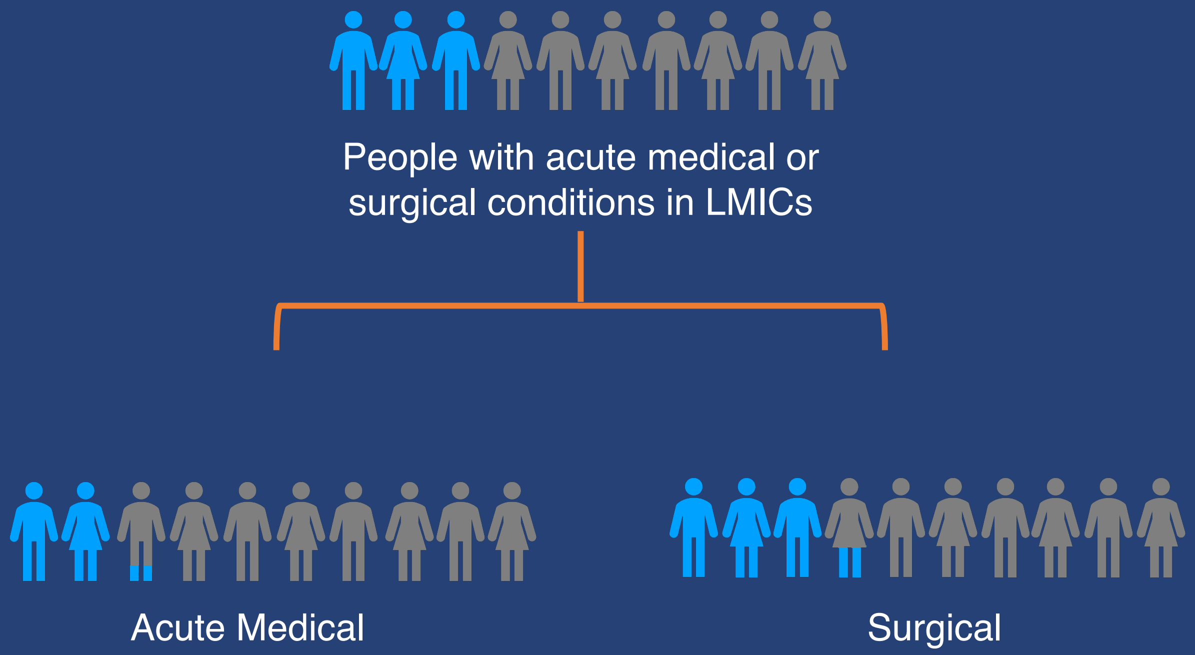
Less than 1 in 3 people who need oxygen for acute medical or surgical conditions receives it. This 70% coverage gap far exceeds treatment gaps for HIV/AIDS (23%) and tuberculosis (25%).

Oxygen coverage gaps

Who receives oxygen in LMICs?

In LMICs, less than 1 in 3 people who need oxygen receive it

- 30% coverage for people with acute medical and surgical conditions (89 of 299 million)
- 22% coverage for people with acute medical conditions (20 of 87 million)
- 33% coverage for people with surgical conditions (70 of 212 million)
- Long-term oxygen therapy not included



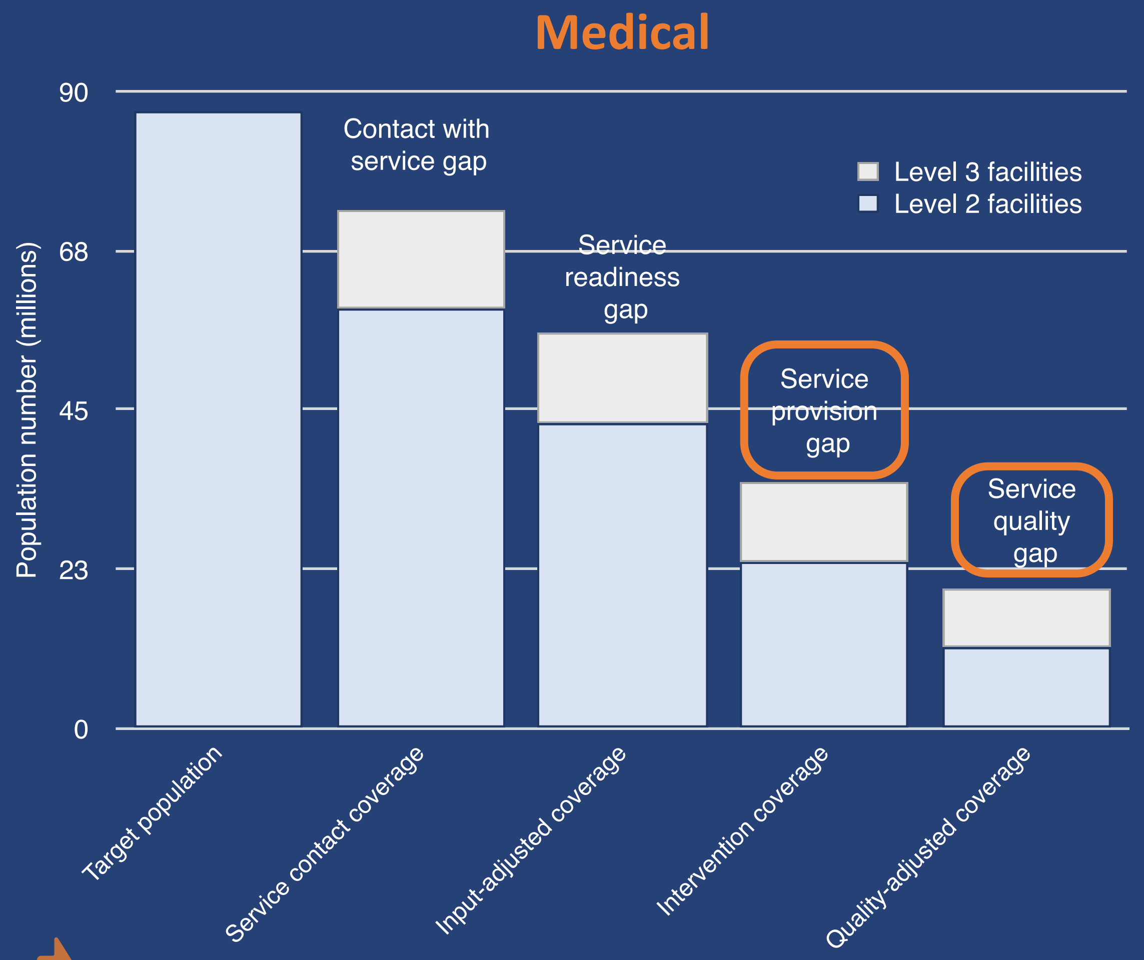
In LMICs, more than 3 in 4 people with HIV/ AIDS or TB get treated

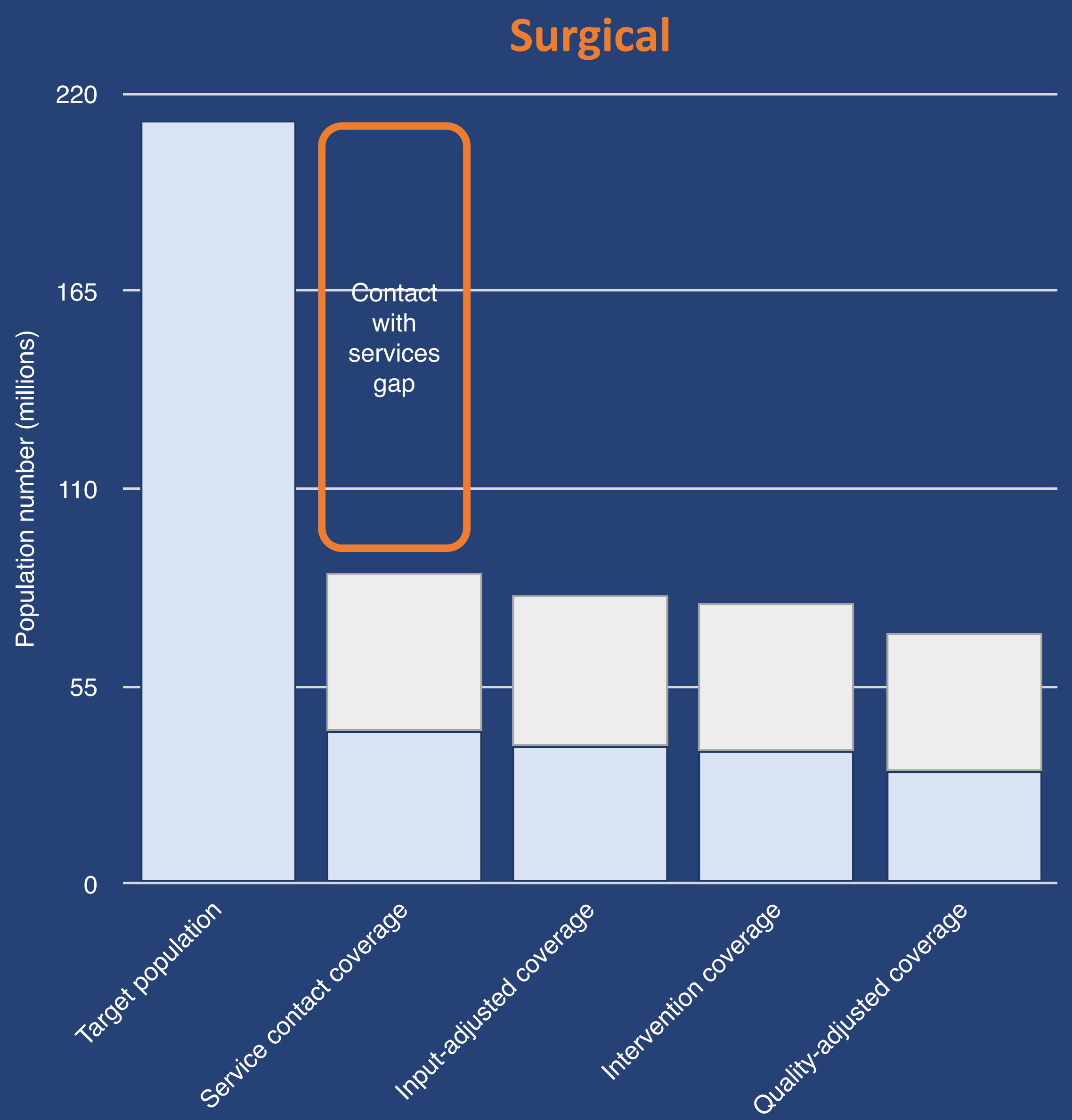
- 75% coverage of TB medicines (1)
- 77% coverage of AIDS medicines (2)

Pp. 10-12 in the Commission report
Section 2.1.3, 2.2.2 and 4.2 in Appendix 1
1) Global tuberculosis report 2024, WHO 2024; 2) AIDS at a crossroads: 2024 global AIDS update, UNAIDS 2024.

Oxygen coverage gaps

Why the coverage gap in LMICs?





Pp. 10-12 in the Commission report
Section 2.1.3, 2.2.2 and 4.2 in Appendix 1

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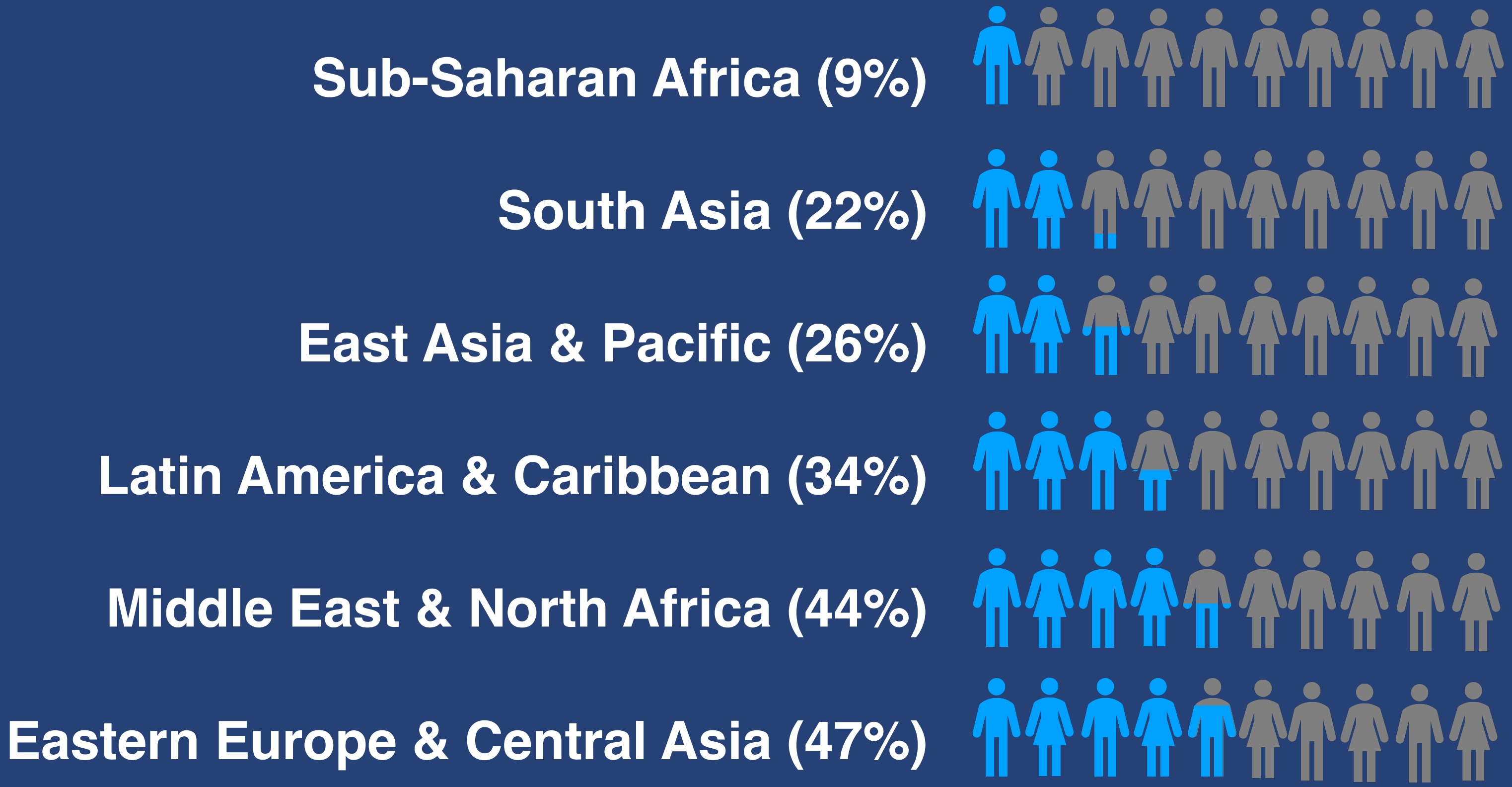
MEDICAL OXYGEN SECURITY

Oxygen coverage gaps

Regional differences in medical oxygen coverage

- Deep regional inequities in oxygen coverage for patients with acute medical conditions
- Less than half of all patients needing medical oxygen for acute conditions are getting it across six regions
- Coverage ranges from just 9% of patients in Sub-Saharan Africa to 47% in Eastern Europe & Central Asia
- Inadequate data to do regional breakdown for surgical or chronic oxygen needs

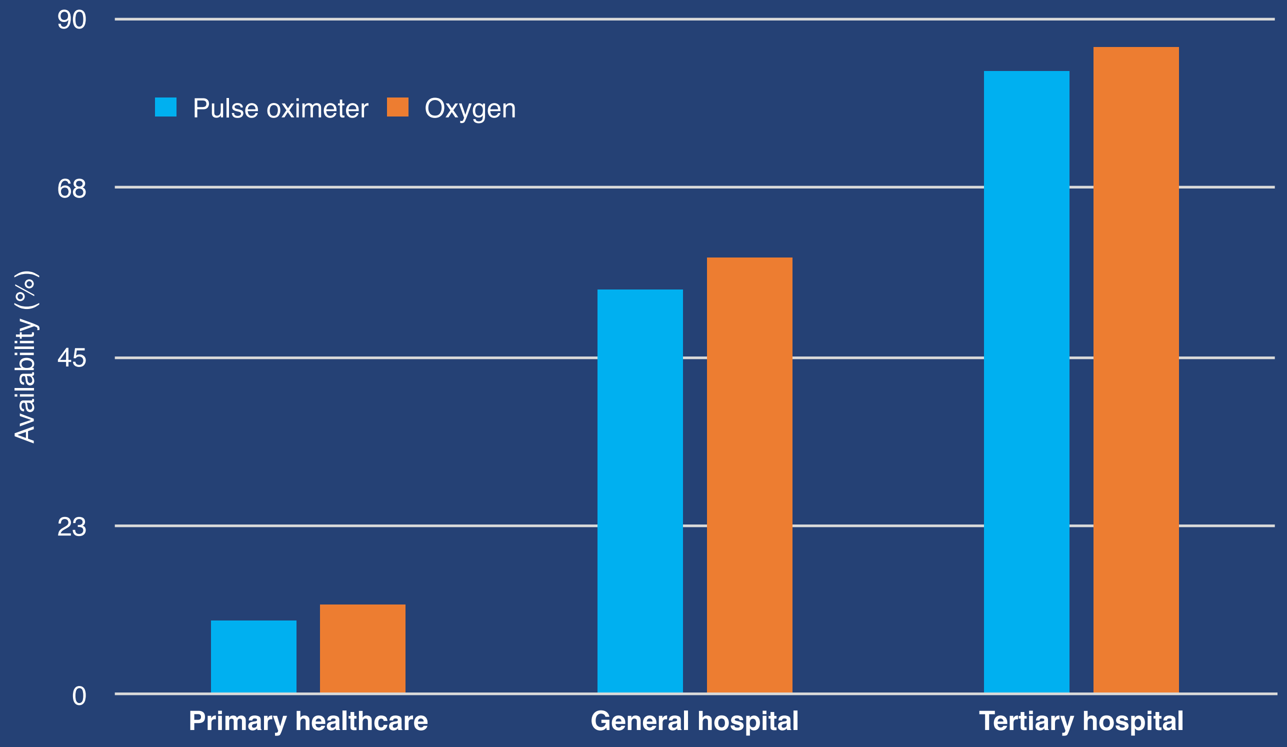


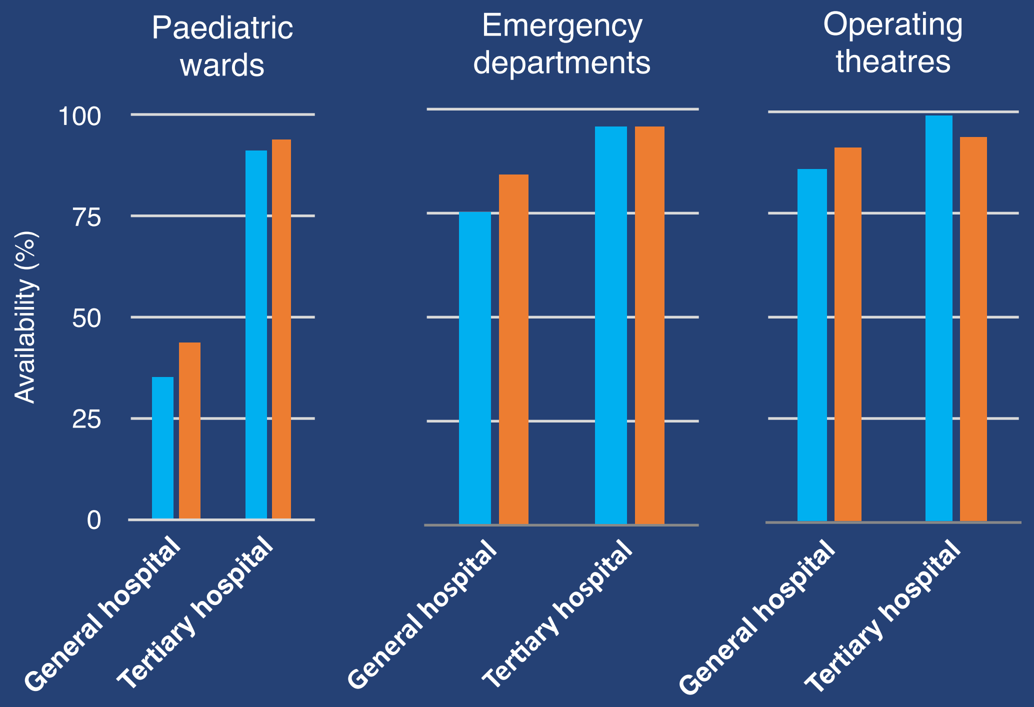
Pp. 10-12 in the Commission report
Section 2.1.3, 2.2.2 and 4.2 in Appendix 1

Oxygen coverage gaps

Inequities in pulse oximeter and oxygen availability

Proportion of wards in LMIC health facilities with pulse oximeters and oxygen





- Rural - Urban inequity (3x lower)
- Public - Private inequity (3x lower)

Pp. 14-18 in the Commission report
Section 2.1.3, 2.2.2 and 4.2 in Appendix 1

Oxygen coverage gaps

What do patients think?

Community perceptions can influence acceptance and adherence to oxygen

- Fears of oxygen are can delay seeking care
- Seeing oxygen working can improve attitudes

High costs are a barrier to oxygen access

At that time [2021], oxygen cylinders cost about 20 000 taka [US$180] each and you had to refill every 2–3 hours. It is almost impossible for patients who are not highly paid to afford medical oxygen.

Family of a patient with COVID-19, Bangladesh

Photo: ALIMA

Pp. 18-19 in the Commission report

Oxygen cost

There should be no question as to whether investment in oxygen-system strengthening is value for money. Rather, the focus should be on how much funding is needed and how this money would be most effectively spent.

Costing the oxygen coverage gap

How much will it cost?

US$6.8 billion a year is needed to close the coverage gap —US$34 billion to 2030

- South Asia: US$2·6 billion
- East Asia & Pacific: US$1·8 billion
- Sub-Saharan Africa: US$1·7 billion
- Latin America & Caribbean: US$436 million
- Middle East & North Africa: US$212 million
- Europe & Central Asia: US$148 million

A COVID patient used about four cylinders per day so we ran out quickly and asked the health ministry to send more, but they didn't have enough money.

Doctor, Sierra Leone

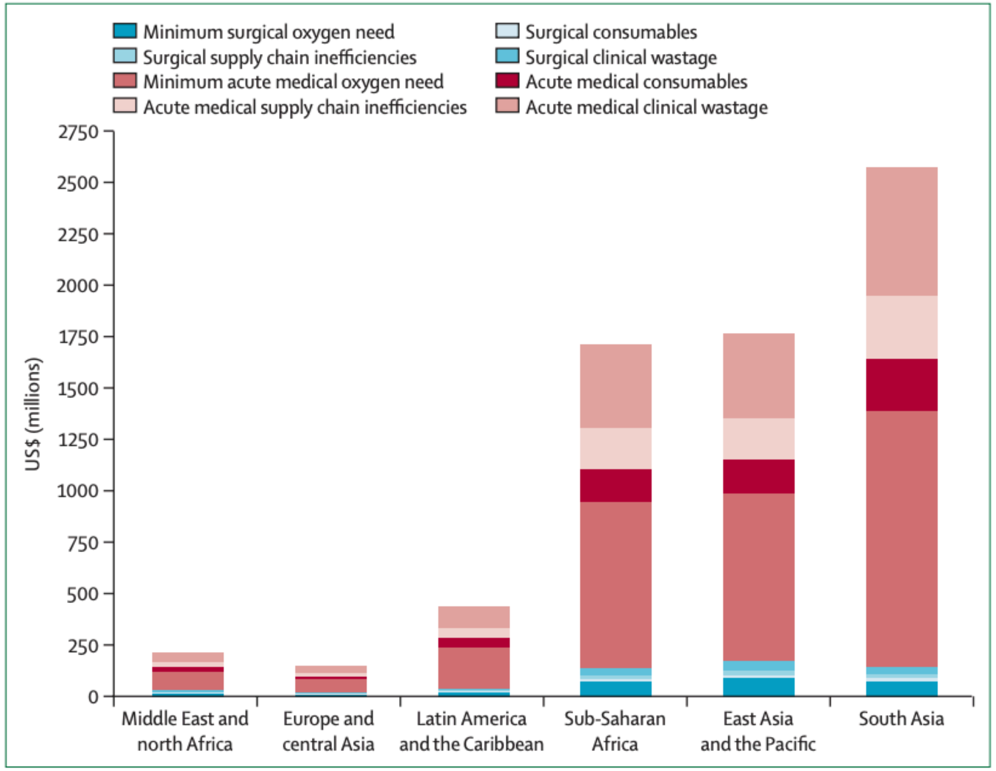


Figure 4: **Annual cost to close the acute medical and surgical oxygen gaps in low-income and middle-income countries**

The minimum cost of the medical and surgical oxygen need is the cost to fill the oxygen coverage gap, based on recommended treatment. We inflated this cost to reflect actual practice and included inefficiencies in the system, clinical wastage, and additional consumables in our estimates (appendix 1 p 78). Supply chain inefficiencies refer to leakages in oxygen delivery systems and losses during production, distribution, and storage. Clinical wastage is the use of higher flow rates for longer periods than recommended, and treatment of patients without a clinical need for oxygen. Consumables includes the cost of pulse oximetry, nasal cannulas, masks, and staff time.

92% of cost gap is acute medical

Pp. 11-13 in the Commission report
Section 2.1.3, 2.2.2 and 4.2 in Appendix 1

Costing the oxygen coverage gap

How much will it cost?

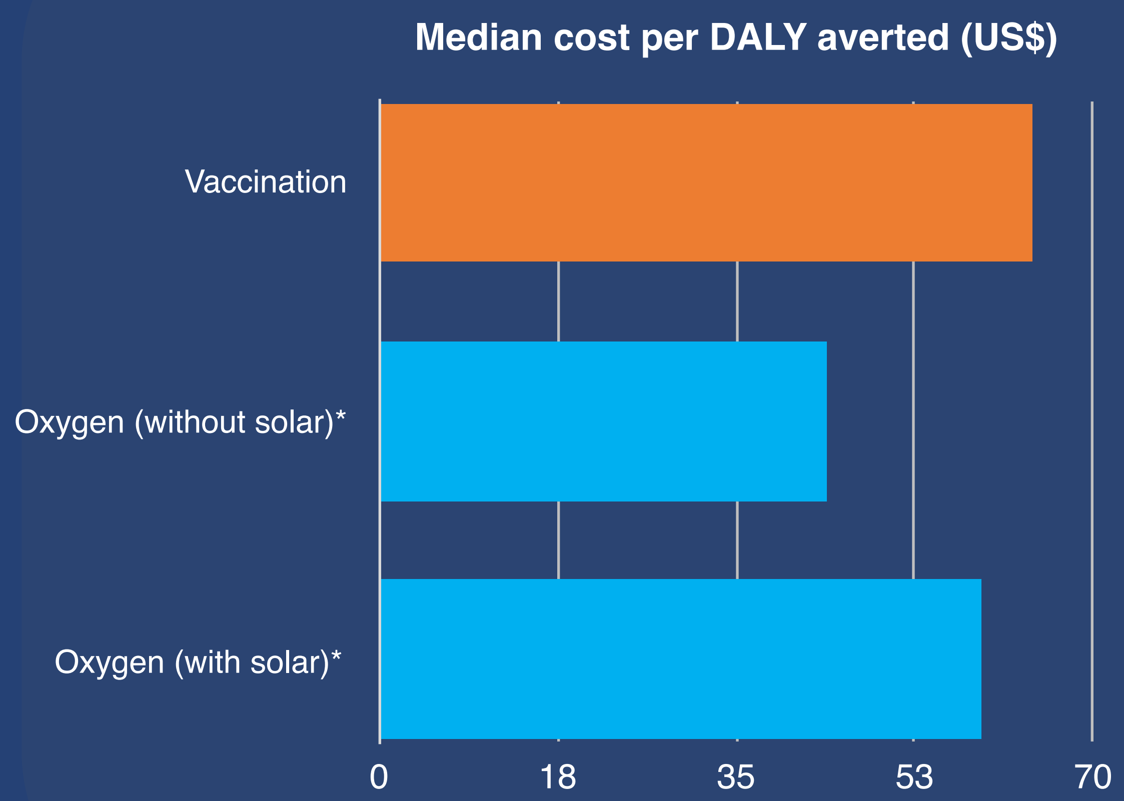
COVID-19 required an additional US$6.8 billion to meet the increased oxygen need

The cost to meet the long-term oxygen therapy need for COPD is US$3-US$10 billion a year

- Limited data on long-term oxygen costs from LMICs
- Portable concentrators are a more cost-effective solution
- Home power supplies will exacerbate inequities in access – 675 million people did not have access to power at home in 2021

Prevention of long-term oxygen need in LMICs should be an urgent public health priority

Oxygen is a cost-effective investment



*Estimated from studies focussed on paediatric pneumonia

Pp. 11-13 in the Commission report
Section 2.1.5 and 2.2.3 in Appendix 1

Oxygen solutions

The Commission’s solutions address five areas: pulse oximetry at all levels of care; resilient oxygen production, storage, distribution, and delivery systems; coordination of the management of national oxygen systems; strengthening of medical oxygen markets, regulations, and standards; and robust monitoring and evaluation

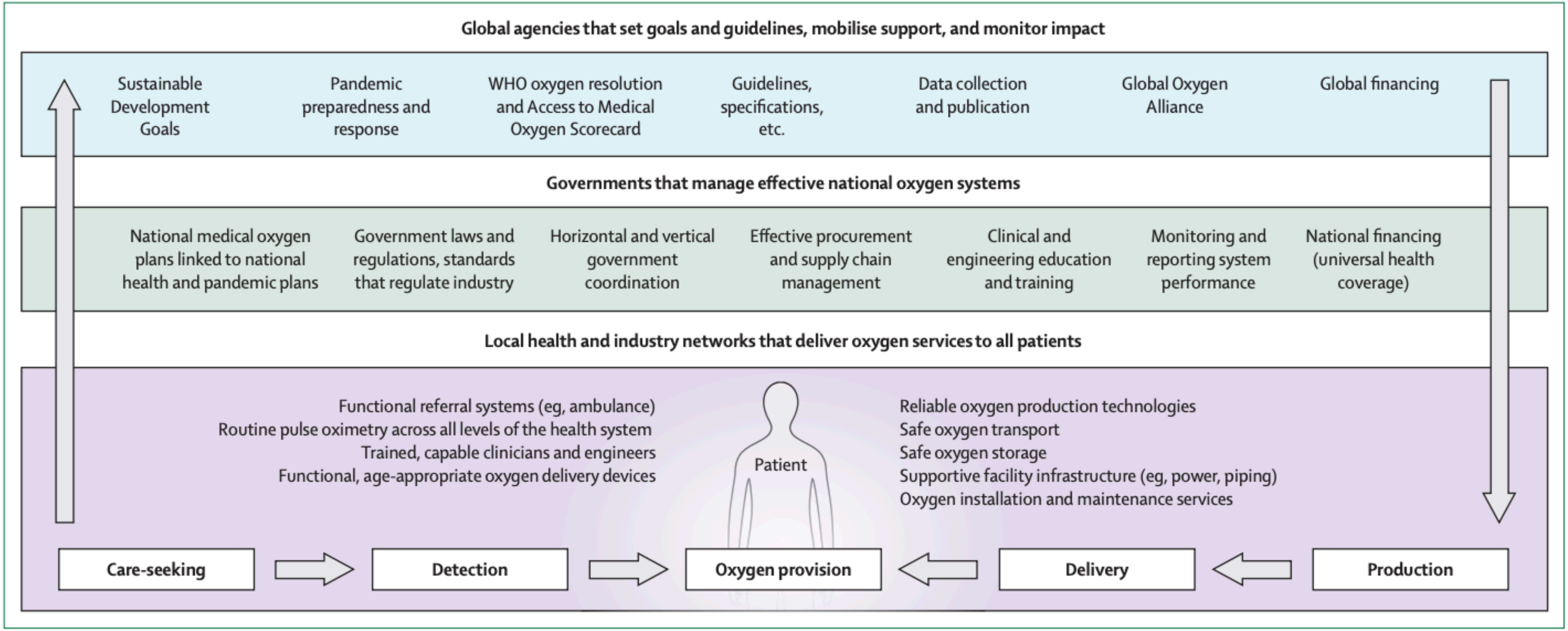


***Figure 8:* Key features of a resilient national medical oxygen system**

The arrows depict inter-related efforts and the direction of patient and medical oxygen flows required to provide treatment to a patient in hospital.

Oxygen solutions

Linking patients to care: pulse oximetry at every health facility

Use quality, age-appropriate pulse oximeters at every level of care, so patients in need of oxygen are identified and linked to services

Build resilient medical oxygen supply systems

Establishing resilient oxygen production, storage, distribution and delivery systems, that ensure quality, safe and affordable oxygen is accessible to patients in need

Coordinate management of national medical oxygen systems

Coordinating management of oxygen systems at the national and sub-national level, with national oxygen plans and integration into emergency preparedness and response

Strengthen medical oxygen regulation and markets

Strengthening medical oxygen markets, regulations, and standards for pulse oximeters, oxygen and related technologies, to promote equitable access globally

Monitor for impact

Monitoring progress towards universal oxygen coverage using core oxygen coverage indicators and the ATMO_2S policy scorecard

Pp. 19-20 in the Commission Report
Section 4.3 in Appendix 1

Oxygen solutions: linking patients to care

SpO2 is a vital sign

Integrate pulse oximetry into all relevant clinical guidelines

- Pulse oximetry and oxygen missing from key guidelines, e.g., malaria, HIV/AID, TB
- Largely absent from primary care guidelines

Workforce capability needs to be addressed at pre-service and in-service levels simultaneously

- Practice-based, spaced and supported with job aides
- Supervision and mentorship are critical
- Motivation is lost when healthcare workers cannot treat hypoxaemic patients with oxygen therapy

Right now, even after COVID, half of the clinical workforce doesn't feel comfortable working with oxygen.

Doctor, Sierra Leone

Photo: Unitaid

Oxygen solutions: linking patients to care

Pulse oximetry is the gateway to safe and appropriate use of medical oxygen

Implementation of pulse oximetry in primary care settings is feasible

- Hypoxaemia is an important danger sign
- Low SpO_2 should prompt re-assessment, referral or follow-up
- Introduction needs to consider wider service provision capacities
- Implementation needs to be supported by a functional referral system

Pulse oximetry is key to maximising the cost-efficiency of oxygen systems

Our modelling suggests that introduction of routine pulse oximetry across the health system could quintuple the net health benefit of oxygen implementation scenarios.

Thanzi la Onse Model

Pp. 21-24 in the Commission Report
Section 2.5 in Appendix 1

Oxygen solutions: building resilient oxygen systems

Oxygen systems are not a one-size-fits all solution

Systems need to fit the context - including essential infrastructure and biomedical support

- Mixed sources of oxygen should be embraced
- Back-up oxygen sources are essential

Affordable, uninterrupted and clean power

- Local energy environment needs to be planned for
- Equip devices with surge and voltage fluctuation protection
- Solar solutions should consider the needs of the whole facility
- New technologies should prioritize energy efficiency

When the power went off, patients on the concentrators had to wait for the generator to kick in. Sometimes it took five minutes, and we had patients who died in that gap of time.

Doctor, Sierra Leone

Photo: The Global Fund

Pp. 25-30 in the Commission Report
Section 2.1.7 in Appendix 1

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MEDICAL OXYGEN SECURITY

Oxygen solutions: building resilient oxygen systems

Oxygen system design must consider the total cost of ownership

Operational costs account for 50-90% of the total cost of ownership

- Distribution costs most important for cylinders
- Energy costs most important for PSA and concentrators
- Low-cost pulse oximeters can have higher total cost of ownership if they require frequent replacement

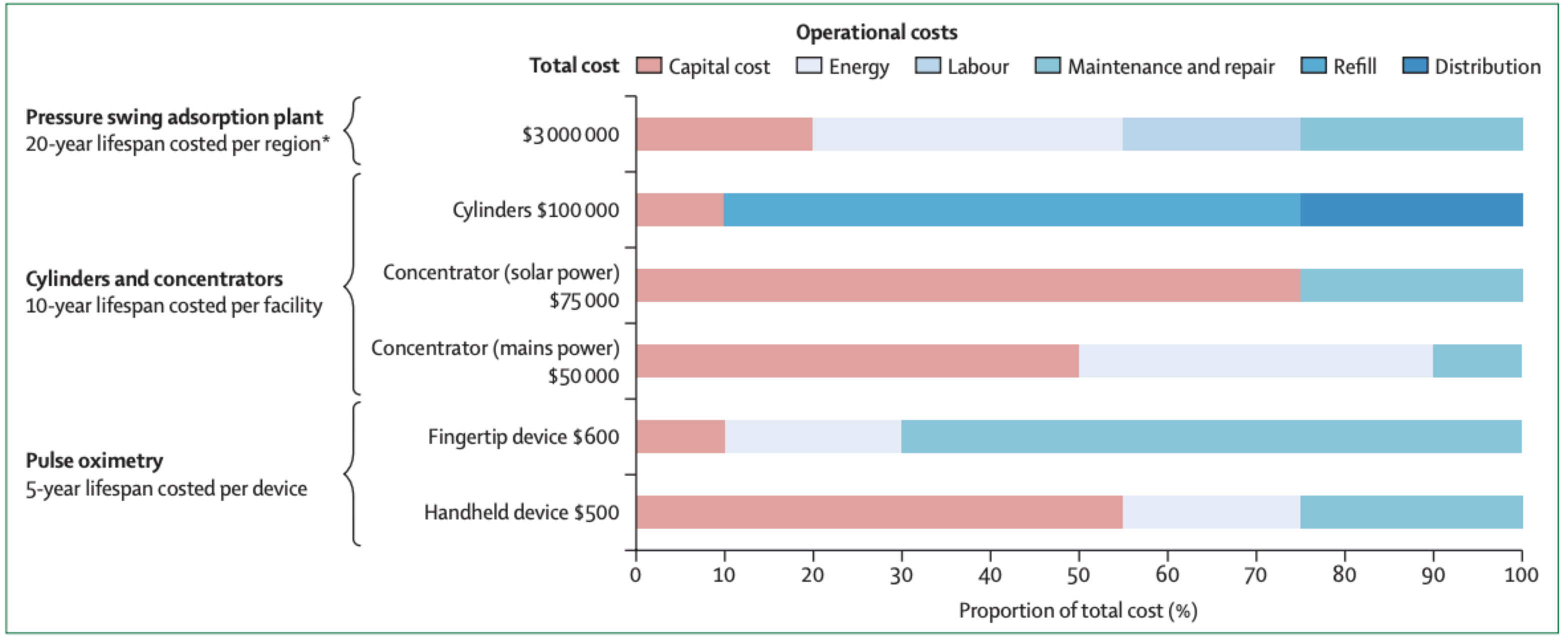

***Figure 10:* Capital and operation costs of different oxygen system components**

Costs are an estimated total cost of ownership. The breakdown of cost categories (in US$) is based on data from publications[83,230–232] and Open Oximetry related to projects in six countries (Nigeria, Papua New Guinea, The Gambia, Kenya, Rwanda, and Ethiopia), and is intended to support budget planning. The balance between categories will vary by setting, and this figure should not be used as a cost-comparison tool. *Based on regional hub-and-spoke models.

Pp. 25-30 in the Commission Report
Section 2.1.5 in Appendix 1

Oxygen solutions: building resilient oxygen systems

Biomedical engineers are key members of the health workforce

Strategic investment is needed to strengthen biomedical engineering capacity

- Skills and density need to align with the complexity of the health system
- Must be included in oxygen system planning
- Data on biomedical engineers should be reported in the Global Health Workforce database

Biomedical engineers are a source of innovation

We prayed that this one concentrator that we all bandaged up by plaster - we basically Macgyvered it - would keep two patients alive. Human ingenuity during challenging times is amazing and both patients lasted the whole weekend.

Doctor, Ethiopia

≥ 0.4 biomedical engineers per 10,000 (~1 per 100 hospital beds)

Photo: Build Health International

Pp. 25-30 in the Commission Report
Section 3.2.2 in Appendix 1

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MEDICAL OXYGEN SECURITY

Oxygen solutions: coordinated management

Coordination and planning across multiple stakeholders is needed

National oxygen plans are powerful tools for coordination, advocacy, and fundraising

- Only 27 countries have published a plan
- Oxygen is largely missing from pandemic preparedness and emergency planning
- M&E is the weakest domain in existing plans

Coordination must connect stakeholder groups horizontally, with a clear point of contact

- Multiple government ministries are involved in the management of oxygen systems
- Oxygen Desks are an example of Federal and State coordination

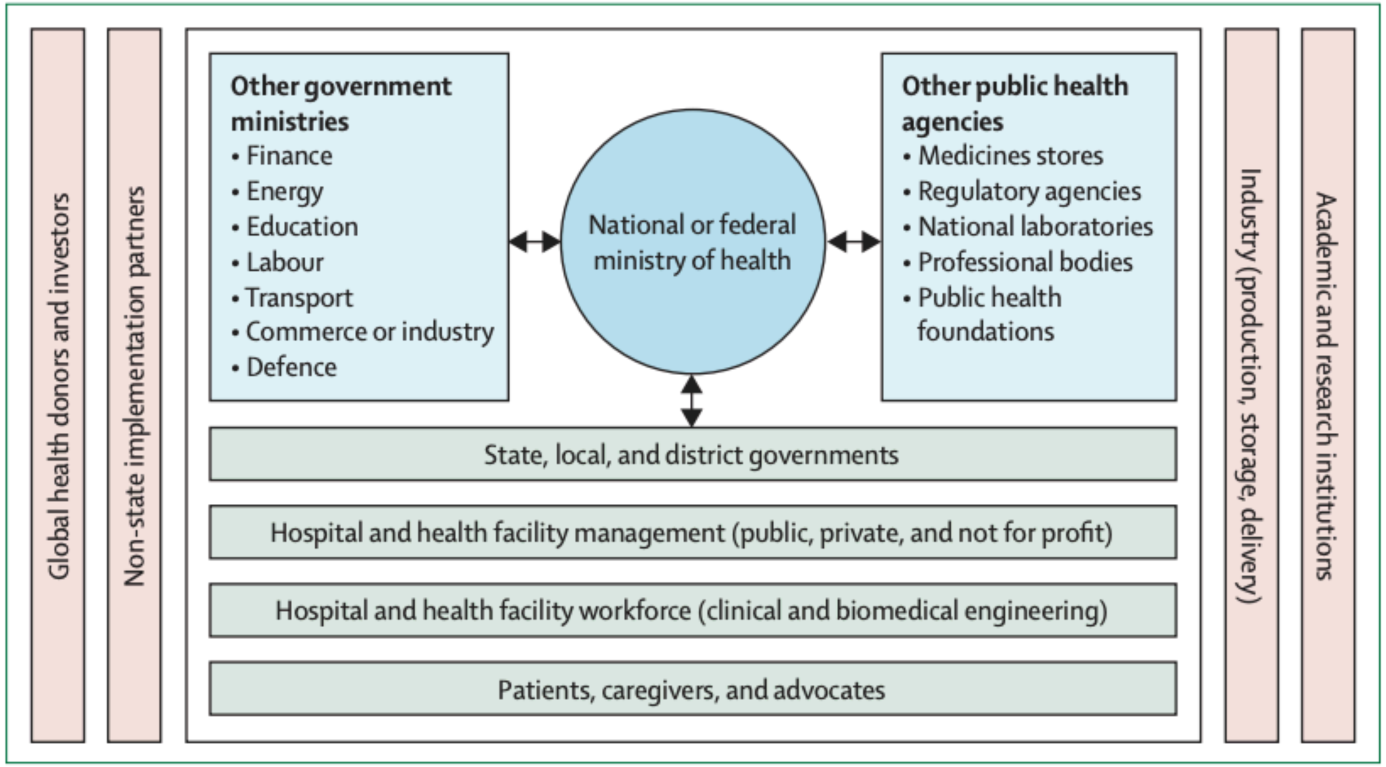


Figure 11: **Key stakeholders in a national medical oxygen system**
Adapted from Mirza et al (2023).[266]

Pp. 30-34 in the Commission Report

Oxygen solutions: coordinated management

Oxygen funding must align with needs, gaps, and capacity to implement

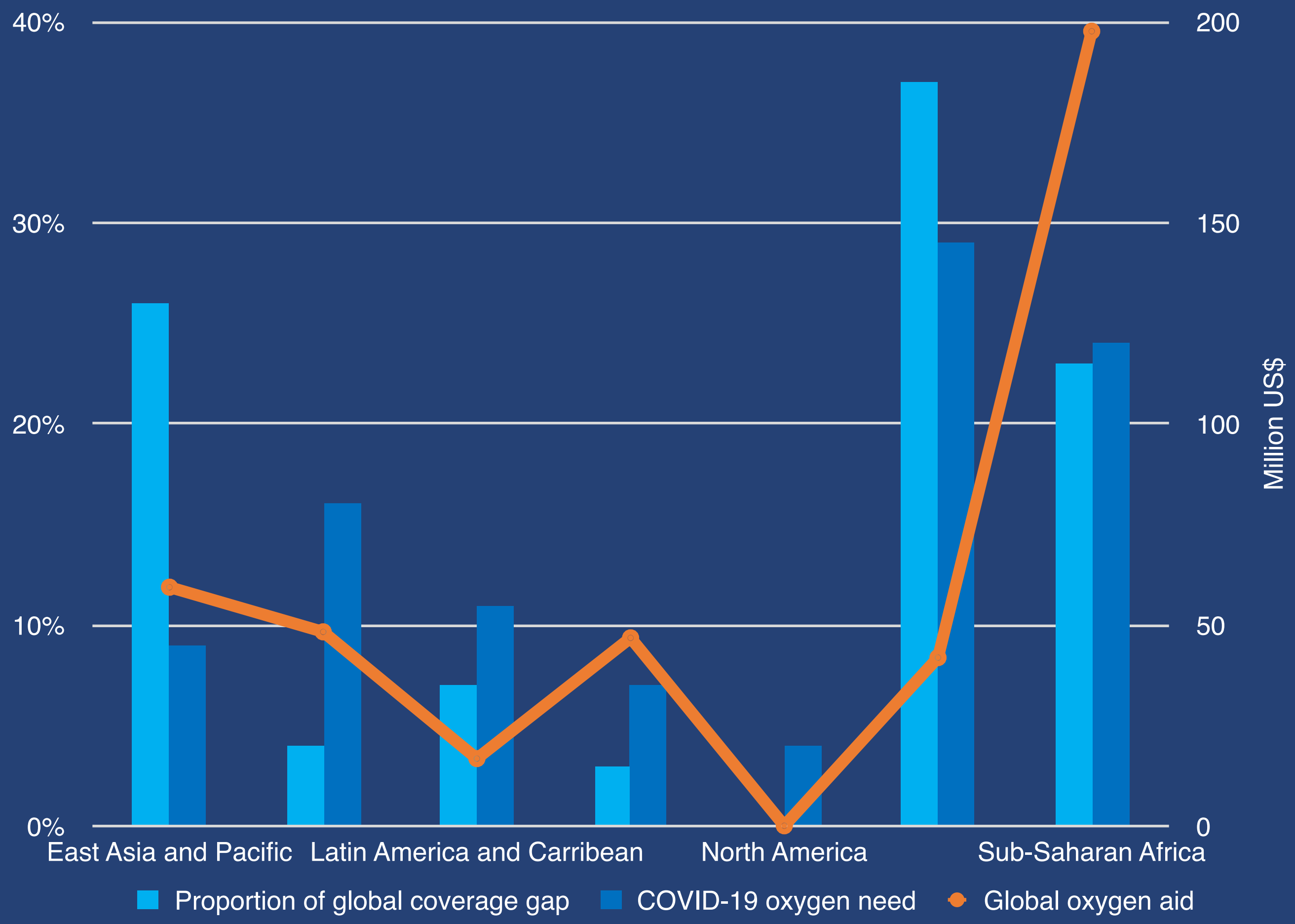
Over $1 billion was donated during COVID-19, and <1% was spent on operational costs

- National spending guided by need estimates
- External support coordinated to maximize efficiencies
- Donors share responsibility to ensure financing is directed towards national priorities
- During emergencies, investments should be balanced between pre-existing health system gaps and the acute event

While setting up PSA plants, the Ministry of Health did not include maintenance budgets for these plants. When the plants break down, hospitals incur the cost of bringing in a maintenance engineer but there is often no budget line.

Ministry of Health Official, Uganda

Pp. 30-34 in the Commission Report



Oxygen solutions: regulations and markets

Medical oxygen industry, like the pharmaceutical industry, is a critical player in global public health

Governments need to foster fair market conditions to ensure competition and market entry

Open tenders are critical to address current oligopolies and high prices

We have very few companies that make oxygen and most hospitals do not have the capacity to manufacture their own, so we have to rely on company monopolies, and this created the situation that we found ourselves in.

Son of deceased COVID-19 patient, Kenya

Photo: One Health Trust

Pp. 30-34 in the Commission Report

Oxygen solutions: regulations and markets

National medical oxygen definitions should mirror the International Pharmacopoeia and define both cryogenically-distilled liquid oxygen (oxygen 99.5%) and PSA/VSA-generated oxygen (oxygen 93%), as safe for patient use

- This will enable competition between the suppliers of liquid oxygen and on-site PSA/VSA plants

> *It was a political and economic issue because, by raising the level of oxygen purity it was directed to two companies that were the only ones [that would] meet that requirement… it was like giving the way only to the two of them*
>
> Peru Case Study

Working document QAS/20.867/Rev6
May 2022
For publication in the 11th Edition of Ph.Int.

World Health Organization

[Note from the Secretariat. The monograph on Medicinal Oxygen was adopted at the 56th meeting of the WHO Expert Committee on Specifications for Pharmaceutical Preparations for publication in the 11th Edition of The International Pharmacopoeia. *In the interim, the monograph is made available on the WHO website. The text may be subject to appropriate editorial modifications and will replace the monograph on Oxygen.]*

MEDICINAL OXYGEN

(OXYGENIUM MEDICINALIS)

Molecular formula. O_2

Relative molecular mass. 32.00

Chemical name. Oxygen; CAS Reg. No. 7782-44-7.

Description. A colourless gas.

Category. Gas for inhalation.

Additional information. Oxygen is mentioned in the current *WHO Model list of essential medicines* (EML) and in the *EML for Children*.

Depending on the clinical medicinal necessity and in accordance with clinical guidelines, Medicinal Oxygen is used either (1) in the undiluted form, (2) as mixtures of Oxygen 93%, Oxygen 99.5% or other oxygen products, or (3) in the undiluted form or as mixtures in combination with ambient or compressed air of a suitable quality or other medicines.

WHO International Pharmacopoeia

Pp. 30-34 in the Commission Report

Oxygen solutions: regulations and markets

Regulatory bodies must ensure fit for purpose oxygen equipment and governance, including

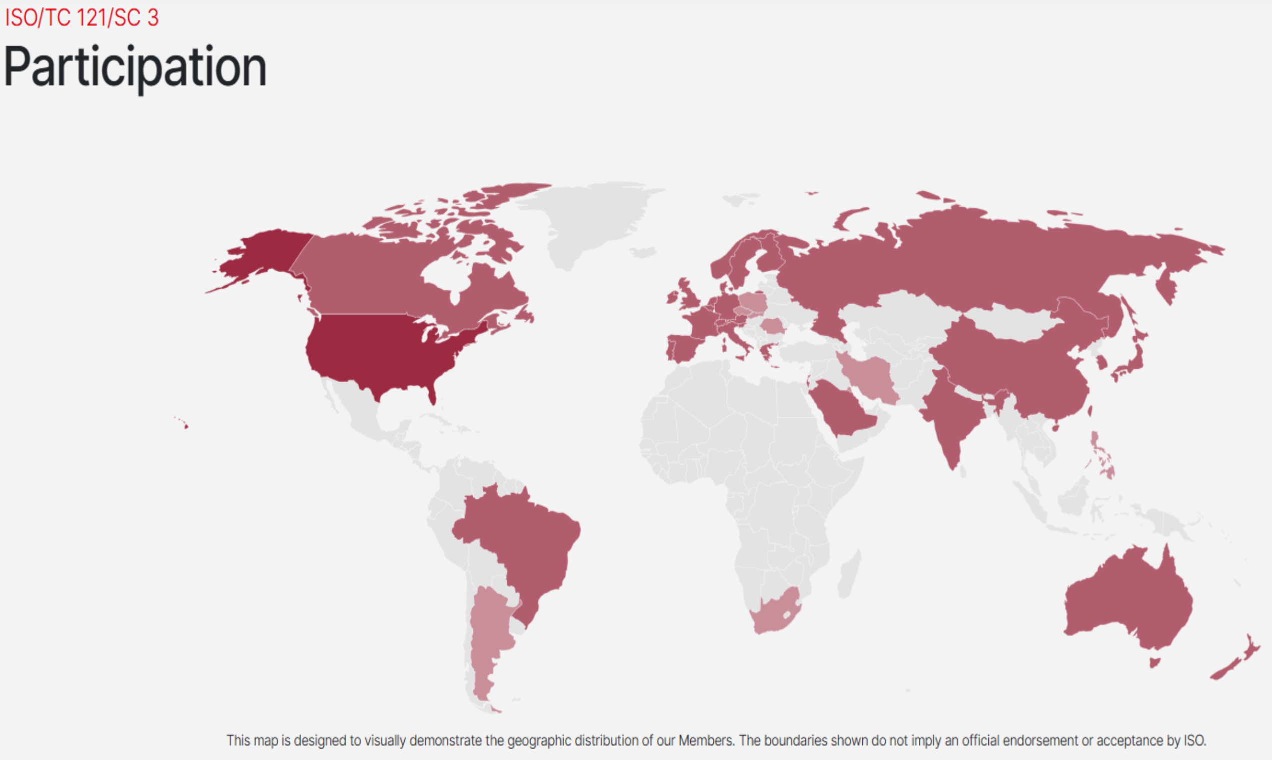
High-quality pulse oximeters with quality performance across skin tones

Harmonized standards for oxygen cylinder connections

- Increase interoperability
- Reduce ''lock-in" to specific providers
- Prevent equipment graveyards

Include LMICs in standards bodies

- Just 6 of 31 representatives on ISO Anaesthetic and Respiratory Equipment and Supplies Technical Committee 121 are from LMICS
- Standards are not sensitive to LMIC contexts



ISO Technical Committee 121 representation

Pp. 30-34 in the Commission Report

Oxygen solutions: data for impact

Accurate and timely data is essential for effective evidence-informed decision making

Current indicators for measuring medical oxygen coverage are inadequate

- Rely too heavily on equipment availability
- Inadequately assess patient-level access, affordability or quality

Commission proposes two new tools

- 10 Oxygen Coverage Indicators
- Access to Medical Oxygen Scorecard ($ATMO_2S$)

	Definition	Target
Pulse oximetry coverage*	Proportion of patients presenting to hospital with acute illness or undergoing surgery whose SpO_2 is documented at triage or admission (or during non-emergency surgery)	>80%
Oxygen production and storage capacity*	Mean (and maximum) monthly production volume (in Nm^3) of medical oxygen, and storage capacity, of each production facility (air separation units for cryogenic production of liquid oxygen or pressure-swing or vacuum-swing adsorption oxygen plants)	Individualised country targets
Pulse oximeter and oxygen availability*	Number and proportion of acute ward areas in health facilities with a functional pulse oximeter and an oxygen supply sufficient to meet patient need in the past month	100%
Pulse oximetry and oxygen service accessibility	Proportion of the population who can access, within 2 h, a health facility that provides low-flow oxygen services, including pulse oximetry measurement and monitoring	100%
Hypoxaemia prevalence	Proportion of patients attending a health facility who have hypoxaemia (ie, SpO_2 <90%) at triage or admission	None (reflects magnitude of oxygen need)
Oxygen coverage	Proportion of patients with hypoxaemia (ie, SpO_2<90%) at triage or admission to a health facility who receive oxygen therapy within 1 h	>80%
Hypoxaemia-related mortality	Proportion of patients attending a health facility who have hypoxaemia (ie, SpO_2<90%) and die before discharge or within 30 days	Individualised country targets
Clinical workforce	Number of doctors, nurses, and midwives per 10 000 population	≥44·5 clinicians per 10 000 population[249]
Biomedical engineering workforce	Number of biomedical engineers (defined broadly as per WHO[244]) per 10 000 population	≥0·4 biomedical engineers per 10 000 population†
Protection against catastrophic health expenditure	Proportion of patients receiving medical oxygen whose out-of-pocket expenditure on oxygen services is greater than 1% of their total annual household expenditure or income	<5% of patients experience catastrophic health expenditure

These indicators are most useful when used and interpreted collectively, because no one indicator in isolation provides an adequate representation of oxygen-related service provision. All targets should be adapted to the local context and given a timeline. SpO_2=oxygen concentrations in peripheral blood. Nm^3=normal cubic metres. *Highest priority and most feasible indicators. †In the absence of accepted global targets for biomedical engineering workforce, we propose a new target (appendix 1 p 102).

***Table 7*: Core indicators for monitoring universal access to safe, affordable, high-quality pulse oximetry and medical oxygen services**

Pp. 40-45 in the Commission report
Section 2.1.3, 2.4, 3.1, 3.2, 3.3 and 4.2 in Appendix 1

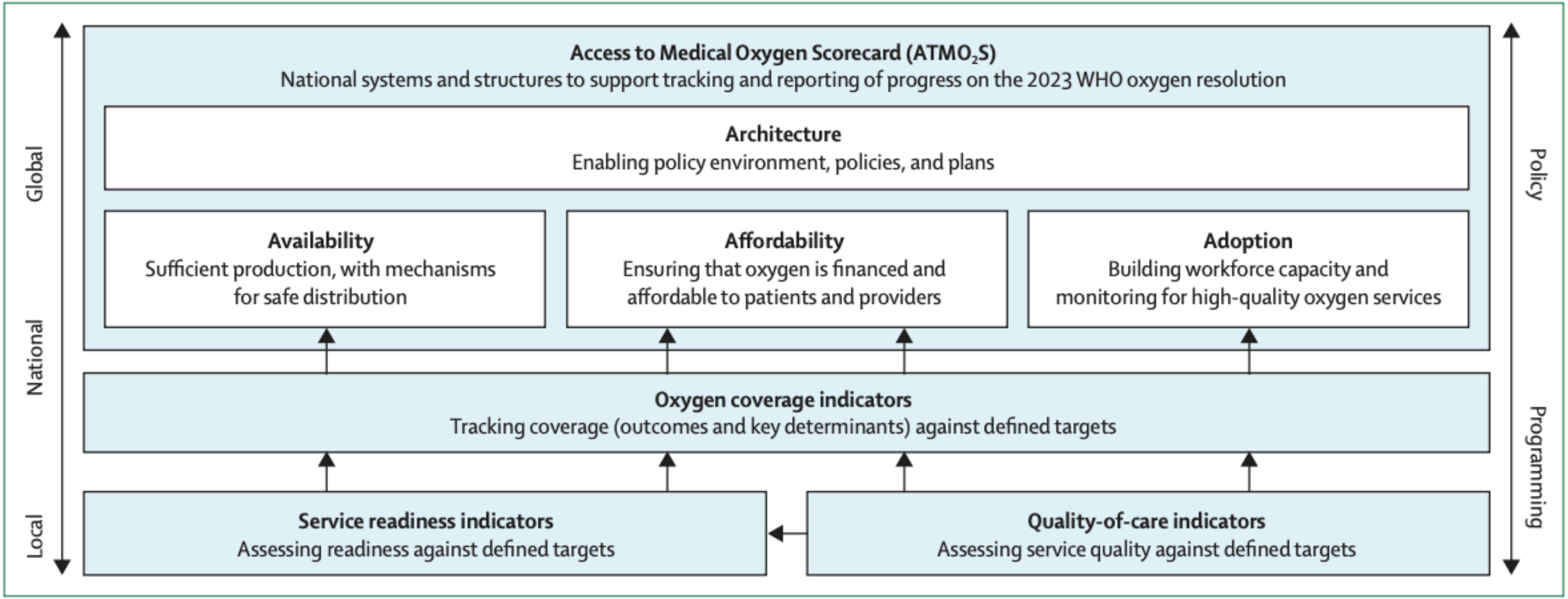


***Figure 13*: Proposed approach and indicators for a national medical oxygen monitoring framework**

Pp. 40-45 in the Commission report
Section 2.1.3, 2.4, 3.1, 3.2, 3.3 and 4.2 in Appendix 1

THE ***LANCET GLOBAL HEALTH*** COMMISSION
MEDICAL OXYGEN SECURITY

Oxygen solutions: innovations

20 priority areas for investment in oxygen innovations are highlighted

- Many originated in LMICs

Recommends national governments, global health agencies, and donors increase investment in high-impact innovations with the greatest likelihood of cost-effectively sustaining medical oxygen access over time

- Supports calls for greater "localization" in the way global health agencies and donors invest in oxygen innovations
- Need for greater investment in innovators - individuals and institutions - that emerge from low-resource settings

	Examples
Pulse oximetry and oxygen use	
Improve accuracy of pulse oximeters	Open Oximetry: a free online platform that reports pulse oximetry performance based on independent studies
Improve clinical and biomedical oxygen-related training	The Oxygen Series: an extensive series of free, online training videos and resources in multiple languages for clinicians in LMICs from Stanford Medicine, Assist International, and Lifebox
Develop better, more affordable oxygen delivery devices	Polite CPAP: low-cost neonatal CPAP device designed and built in Nigeria to replace the commonly used improvised CPAP devices[254]*
Strengthen professional associations	African Women in Biomedical Engineering Alliance: the first professional association for women working as biomedical engineers and technicians across Africa, with the aim of strengthening skills, networks, and opportunities for leadership, and closing the wide gender gaps in the profession*
Oxygen supply systems	
Develop more robust oxygen concentrators	PulmO2: a 10 L per min oxygen concentrator designed to the specifications of UNICEFs target product profile
Reduce graveyards of broken equipment	OpenO2: an organisation of mobile biomedical engineers who repair broken oxygen concentrators and related devices for a fraction of the cost of purchasing new equipment*
Improve oxygen service management models	Airbank: a social business delivering oxygen directly to hospitals in Nigeria and Kenya as part of the Oxygen Hub (which provides entrepreneurs in Kenya, Ethiopia, and Nigeria with financing, equipment leasing, and management support)*
Develop more affordable methods of oxygen generation	Medical ceramic oxygen generator: a new technology for generating medical oxygen in harsh operating environments based on ceramic ion transport membrane technology
Improve access to spare parts	Centralised procurement mechanism for oxygen compressor spare parts: a mechanism that provides fast access to affordable spare parts for oxygen plants designed by PATH and partners
Introduce power-outage-proof oxygen technologies	FREO2 low-pressure oxygen system: this system includes a reserve that holds excess oxygen from a concentrator; if the power cuts out, this oxygen is automatically released, providing a supply that lasts 8–10 h
Reduce energy costs of oxygen plants	Africa Infrastructure Relief and Support: an initiative providing installation and maintenance of solar-powered oxygen plants and biomedical engineering training at three sites in west Africa
Coordination	
Strengthen national government leadership	National medical oxygen plans: government plans outlining how a country will ensure access to pulse oximetry and medical oxygen*
Improve oxygen data generation and management	India's national medical oxygen grid: an online platform for hospitals to manage medical oxygen supplies and for governments to minimise stockouts at local, regional, and national levels*
Raise awareness about oxygen as an essential medicine	World Oxygen Day: a global effort to rally the world to advocate for access to medical oxygen held annually on Oct 2
Connect public and private oxygen sectors	Oxygen Alliance: a collaboration of public and private sector stakeholders for the repair and maintenance of biomedical devices to ensure the delivery of high-quality health care*
Better coordinate management of national oxygen systems	Oxygen desks, Nigeria: dedicated officers, based in federal and state ministries of health, who coordinate medical oxygen activities horizontally across national stakeholders and vertically with subnational stakeholders*
Better coordinate global oxygen support to LMICs	Global Oxygen Alliance: an alliance of 20 global health agencies and donors providing oxygen support to LMICs
Oxygen markets and regulation	
Reduce anti-competition practices in the oxygen industry	*WHO Pharmacopoeia*: This standard defines both 99% and 93% oxygen as safe for medical use and enables the mixing of oxygen from both sources, reducing the risk that health facilities will be locked in to one supplier
Increase manufacturing and supply chain management in LMICs	Hewatele's east Africa liquid oxygen plant: the first fully African-owned liquid oxygen facility with finance from donor governments, development finance institutions, and philanthropists*
Increase corporate oxygen access responsibility	Aire Liquide Access Oxygen: a corporate programme that involves company oxygen access targets, regular reporting, and flagship programmes in several LMICs to increase access to medical oxygen

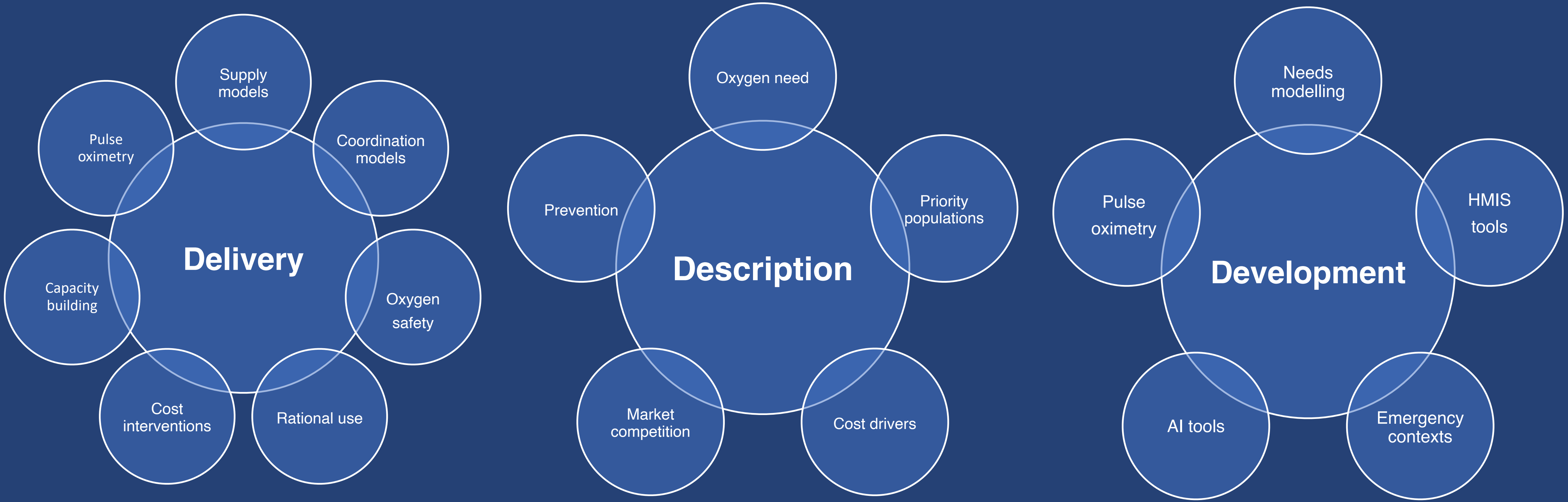
The use of brand names or any mention of specific commercial products or services is solely for educational purposes and does not imply endorsement by the *Lancet Global Health* Commission on medical oxygen security. LMICs=low-income and middle-income countries. CPAP=continuous positive airway pressure. *LMIC innovation.

Table 4: **Priority areas for medical oxygen-related innovation**

Pp. 40-45 in the Commission report

Oxygen solutions: research priorities

Big opportunities to address the current knowledge gaps and build a learning health system that can continually generate and translate new learning into policy and practice



Pp. 40-45 in the Commission report

Recommendations

The Commission makes 52 recommendations for governments, industry, global health actors, academics, and professional bodies to work towards by 2030 and recommend that an independent body assess progress in 2027, with the results made publicly available.

Recommendations

Pp. 46-48 in the Commission report

Recommendations

Government

- Develop and implement a costed national medical oxygen plan
- Increase domestic spending for national medical oxygen systems, with a line item for oxygen in government health budgets that separates capital and operating costs.
- Update all clinical guidelines, essential medicines and medical device lists, and related health policies to include pulse oximetry and medical oxygen,
- Integrate core oxygen service coverage indicators into routine health and logistic information systems, especially the District Health Information System.
- Negotiate contracts with private medical oxygen-related companies that deliver affordable oxygen with service contracts with multi-year warranties

Civil society & patients

- Engage with governments about the development and implementation of national oxygen plans and other relevant oxygen policies and programmes.
- Establish patient advocacy groups to ensure that the voices of patients who need oxygen for acute medical and surgical procedures and for long-term oxygen therapy (and their caregivers) are heard by all
- Mobilise civil society organisations and patient advocacy groups globally to increase the impact of World Oxygen Day.

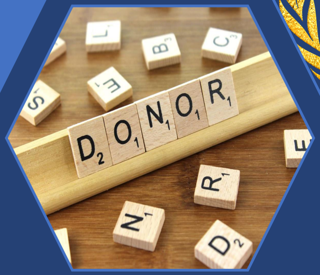
Pp. 46-48 in the Commission report

Recommendations

- Increase investments in medical oxygen, contributing to GO2AL's US$4 billion resource mobilisation target for 2025–30.
- Support the inclusion of medical oxygen in the 8th replenishment of The Global Fund.
- Announce a specific pandemic fund call to strengthen pandemic preparedness
- Increase financing from development finance institutions to private sector oxygen providers, including small and medium enterprises in LMICs
- Require grantees to apply best practices in the procurement of pulse oximeters and medical oxygen
- Increase funding for the repair and recommissioning of broken oxygen equipment— stop perpetuating a throw-away culture by only funding and donating new equipment.

Global health agencies

Global health donors



- Ensure health surveys, facility assessment tools, and related data tools appropriately include pulse oximetry and medical oxygen (e.g. DHS SPA and SARA)
- Champion the use of the Commission's core oxygen coverage and related indicators.
- Increase support to national governments to develop national oxygen plans
- Coordinate global oxygen-related activities within and across agencies, engaging with GO2AL
- Ensure at least 50% of future global oxygen investments are dedicated to supporting the operational costs
- Ensure that procurement processes for oxygen supplies align with national medical oxygen plans, assess prices based on total cost of ownership

Pp. 46-48 in the Commission report

Recommendations

Industry

Professional organisations

- Adopt specific access to medical oxygen targets and implement flagship oxygen access programmes.
- Commit to greater price transparency
- Accelerate investments in innovations that improve the cost-effectiveness of pulse oximetry and medical oxygen (e.g. reducing energy costs)
- Design products to meet the needs of patients and health facilities in low-resource settings
- Contribute to increased manufacturing of key components of medical oxygen systems in LMICs,
- Formalise national biomedical engineering professional associations

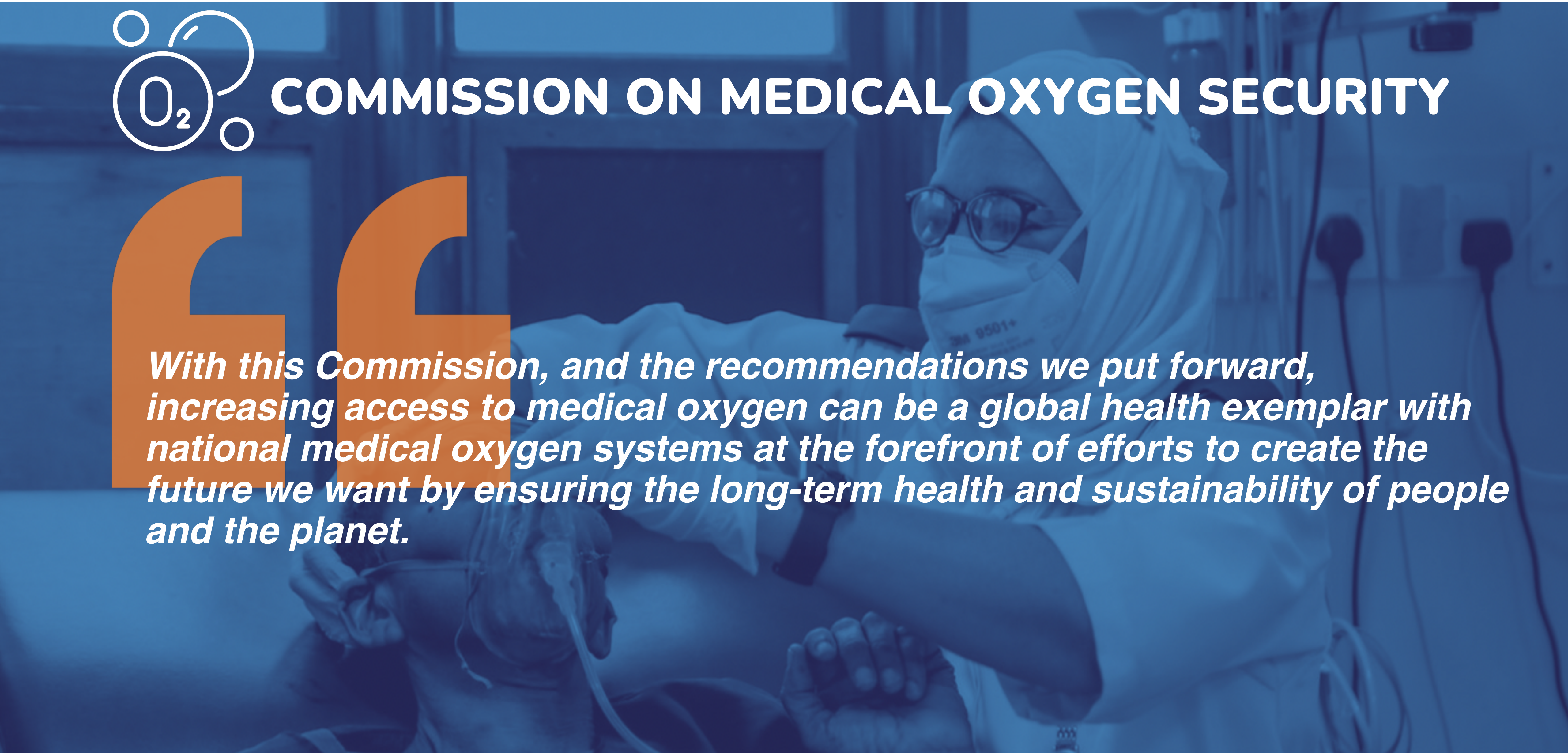
Academic & research

International standards

- Increase oxygen-related research, with emphasis on implementation science, health systems, and health economics research.
- Embed theoretical and practical content on pulse oximetry and medical oxygen into curriculums for clinical and biomedical professionals
- Ensure that at least 50% of participating members of the Anaesthesia and Respiratory Equipment Committee (ISO/TC 121) are representatives from the national standards bodies of LMICs.

Pp. 46-48 in the Commission report

THE LANCET Global Health



COMMISSION ON MEDICAL OXYGEN SECURITY

With this Commission, and the recommendations we put forward, increasing access to medical oxygen can be a global health exemplar with national medical oxygen systems at the forefront of efforts to create the future we want by ensuring the long-term health and sustainability of people and the planet.