

Evidence Synthesis for the Lancet Global Health Commission on Medical Oxygen Security

Background and context

The Lancet Global Health Commission on Medical Oxygen Security (hereinafter referred to as the Commission) was launched on September 1, 2022 to conduct a scientific review in response to the urgent, neglected, and understudied phenomena of inadequate access to medical oxygen and the often unsafe or inadequate provision of oxygen therapy that came to light globally during the COVID-19 pandemic. The COVID-19 pandemic exponentially increased the demand for medical oxygen in almost every country. Lack of access to medical oxygen in low- and middle-income countries (LMICs) contributed to excess deaths due to respiratory-related illness including COVID-19. Lack of medical oxygen across LMIC health systems has emerged as one of the defining inequities of the pandemic.

The Commission functions by engaging various stakeholders to generate and synthesize evidence, disseminate recommendations as they emerge, publish findings, and report on the afterlife of the Commission's work. The Commission's objectives are: 1) to identify and address the major evidence gaps related to hypoxemia burden, oxygen access, oxygen solutions, financing, and political economy and to identify priorities for future research; ii) mobilize a broad coalition to promote best practices in addressing the gaps in medical oxygen delivery systems and facilitate and conduct the relevant knowledge generation to inform implementation, and iii) accelerate investment efforts and impact towards stronger oxygen systems and reduced morbidity and mortality globally.

AT A GLANCE

- Period of Performance: February 15, 2023–June 30, 2024.
- A 20,000-word Commission report titled *Every breath counts: Reducing global inequities in medical oxygen access* has been submitted for review and publication.
- One manuscript has been published in a peer-reviewed journal titled "Improving effective coverage of medical oxygen services for neonates and children in health facilities in Uganda: A before-after interventional study."

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As secretariat of the Commission, Makerere University School of Public Health (MakSPH) coordinates the work package on oxygen solutions, people and products, this package is most closely aligned with EpiC's existing oxygen work and was therefore selected for a subgrant. The other secretariats include the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), Dhaka, Bangladesh leading the work to estimate the hypoxemia burden attributed to each disease condition; the University of Melbourne and the Murdoch Children's Research Institute, Melbourne, Australia leading the work to estimate effective coverage of medical oxygen services and definitions of related concepts; the Karolinska Institute in Sweden leading the work on political economy of medical oxygen systems; and the Every Breath Counts Coalition, U.S.A., providing overall coordination of these secretariats with the other governance structures of the Commission. The MakSPH secretariat began work in February 2023 under a subgrant with the USAID-funded Meeting Targets and Maintaining Epidemic Control (EpiC) project. While EpiC support has ended, MakSPH's work as Secretariat of the Commission continues with funding from UNITAID.

This brief summarizes work that was supported by the EpiC project from February 2023 to June 2024.

Objectives

SECONDARY RESEARCH

With EpiC support, MakSPH reviewed and synthesized evidence from studies conducted previously under separate funding. Additionally, MakSPH conducted a systematic review of published literature to synthesize evidence for the following objectives: 1) to evaluate the factors that influence implementation outcomes of pulse oximetry in health care settings in low- and middle-income countries; 2) to synthesize evidence on the impact of health workforce and work environment factors on the implementation of pulse oximetry and medical oxygen therapy; 3) to evaluate the effectiveness, feasibility, and scalability of existing interventions designed to improve the implementation of medical oxygen solutions; and 4) to develop evidence-based recommendations for stakeholders, aimed at enhancing strategies and policies for the effective implementation of pulse oximetry and medical oxygen therapy, particularly in resource-limited settings.

Generating evidence-based reports around these objectives aimed to identify barriers and enablers of medical oxygen access and identify areas for intervention. Catalyzed by the COVID-19 pandemic, the Commission viewed each objective through the lens of strengthening medical oxygen systems for pandemic preparedness.

PRIMARY RESEARCH

The EpiC project supported MakSPH to conduct two empirical case studies to generate evidence around supply chains and political economy, as the Commission identified research gaps in these areas. The first case study aimed to understand Uganda's medical oxygen supply chain system. The specific objectives included 1) to map the medical oxygen supply chain system, exploring the nodes and links from the medical oxygen sources to health facilities where it is needed; 2) to characterize inputs of the medical oxygen supply chain system and estimate their costs from the source to where it is consumed; 3) to examine the stakeholder positions, interests, and influences along the medical oxygen supply chain on access to medical oxygen at health facilities; and 4) to examine the coordination mechanisms at national, district, and at all health facility levels that facilitate the availability of medical oxygen at health facilities.

For the second case study, MakSPH also worked in collaboration with the Universidad Peruana Cateyano Heredia in Peru on a case study to understand stakeholder power, influence, roles, governance, and accountability, as well as regulation, safety, and financing in relation to medical oxygen in Peru. Lastly, MakSPH contributed to developing and validating a policy scorecard that countries can use to measure progress of their medical oxygen systems and medical oxygen access at the national level and inform priorities of their national medical oxygen road maps.

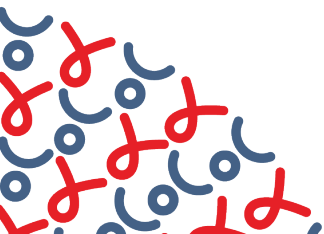
STAKEHOLDER ENGAGEMENT

As part of the EpiC grant, MakPSH also contributed to the coordination and mobilization of stakeholders to deliberate on key processes and products of the Commission as a means for co-design, quality control and consensus on priority evidence, best practices, and policies and interventions to support national and global development in medical oxygen. This included engagement with the Ministry of Health and national stakeholders in Uganda to spread awareness about emerging outputs of the Commission's work and ensure that the reports are not only academic outputs but can also be leveraged to influence practice and policy.

Research Questions

MakSPH addressed the following research questions:

1. What are the barriers and facilitators of medical oxygen access at the global and national levels by patient groups, level of care, and geographical distribution?
2. What are the factors that influence implementation outcomes of pulse oximetry interventions in LMICs?
3. What are the health worker and work environment factors that affect implementation outcomes of medical oxygen solutions?
4. To what extent have relevant standard treatment guidelines and health care packages incorporated and integrated pulse oximetry and oxygen therapy practices for routine implementation in health care settings?



Methods

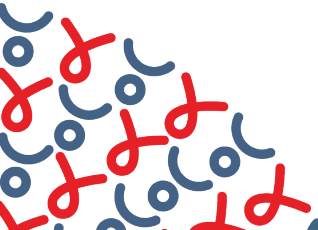
Research conducted adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines. MakSPH conducted a comprehensive literature search across the major biomedical databases, EMBASE, MEDLINE (PubMed), and CINAHL to ensure breadth of coverage. To mitigate potential publication bias, we performed searches in MedRXiv and BioRXiv, prominent repositories for preprints in the medical and biological sciences. All records retrieved from these database searches and additional sources were imported into EndNote v20 for record merging and deduplication. The consolidated bibliography was transferred to COVIDENCE software for screening and data extraction. Eligible studies included primary research articles — published in English, French, Spanish, Russian, Chinese, and Arabic between 2010 and 2023 — that reported on health workforce and work environment factors influencing the implementation of oxygen therapy and pulse oximetry. Two independent reviewers performed an initial screening based on each article’s title and abstract, followed by full-text review. Data from the final eligible articles were extracted using a pre-designed template in COVIDENCE by two independent reviewers. The risk of bias within individual studies was assessed using the appropriate Joanna Briggs Institute Critical Appraisal Tools corresponding to the study design.

Results

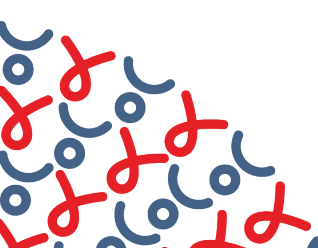
Based on the meta-analysis, five publications are in development that summarize the findings of this research. Key findings are summarized in the table below.

#	Manuscript	Key Findings
1	<u>Improving effective coverage of medical oxygen services for neonates and children in health facilities in Uganda: A before-after interventional study</u> ¹ has been published in the <i>Lancet Global Health</i> journal.	<p>Data were collected from 71,997 eligible newborns and children at 31 facilities. The use of pulse oximetry at admission increased from 23.7% (2,365 of 10,001) before the intervention to 87.7% (45,029 of 51,328) after the intervention. The analysis showed a much higher likelihood of using pulse oximetry after the intervention (odds ratio 40.10, 95% CI 37.38–42.93; p<0.0001). Improvements in hospital oxygen services are possible and can lead to better patient outcomes.</p> <p>The authors recommended that governments create national oxygen plans and invest in proven interventions like routine use of pulse oximetry and capacity building for clinical and biomedical staff.</p>

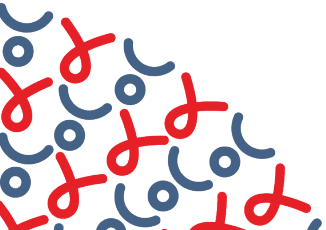
¹ Graham HR, Freddy Eric Kitutu, Yewande Kamuntu, Blasio Kunihiro, Engol S, Miller J, et al. Improving effective coverage of medical-oxygen services for neonates and children in health facilities in Uganda: a before–after intervention study. *The Lancet Global Health*. 2024 Aug 14;12(9):e1506–16.



2	Lessons from the field: barriers to access to medical oxygen.	<p>The Uganda medical oxygen system was in its infancy in early 2020 and most of the critical components were nonexistent. There was no patient record system to capture consumption of medical oxygen at the patient level to feed into quantification and forecasting of oxygen needs and procurement planning. Additionally, there was no established medical oxygen supply system. Medical oxygen delivery to the health facilities was erratic and ad hoc. The first steps in building a medical oxygen system in Uganda were to pilot initiatives to capture pulse oximetry readings, number of hypoxemic patients and oxygen use at the patient level. Additionally, a pilot medical oxygen supply system dependent on distribution of oxygen cylinders to augment existing functional oxygen concentrators was implemented. These initiatives led to stepwise design selecting the most urgent elements as described above to prioritize in the development and implementation of the Ugandan medical oxygen system.</p>
3	Pulse oximetry and oxygen therapy: Acceptability, appropriateness and feasibility in Ugandan health facilities.	<p>A total of 313 health workers were surveyed from 24 Level IV health centers and 7 hospitals, of which 41% were midwives. Most health workers accepted pulse oximetry (over 82%) and medical oxygen therapy (over 73%), found them appropriate, and thought their implementation was feasible at their health facilities. However, routine implementation faced barriers, such as lack of guidelines, insufficient knowledge, unreliable power supply, inadequate equipment, poor maintenance, and a lack of a learning culture among health workers. There were differences in the frequency of use of these tools, with higher usage and more pre-service training in regional referral and general hospitals compared to lower-level health facilities.</p>
4	Evaluation of health facility capacity against the National Advisory Committee on Medical Equipment guidelines.	<p>A total of 81 health facilities including 28 Level IV health centers, 32 general hospitals, 17 regional referral and 4 national referral hospitals in Uganda were assessed in this study. Less than half (43%) of the Level IV health centers and only one out of 17 regional referral hospitals met the minimum requirements set by the National Advisory Committee on Medical Equipment for their level of care. None of the general and national referral hospitals met the minimum requirements. Investment in medical equipment at health facilities in Uganda is still suboptimal and needs to be prioritized.</p>



<p>5 Barriers to implementation of medical oxygen therapy solutions and potential recommendations: a systematic review.</p>	<ul style="list-style-type: none"> ▪ Sources and availability of medical oxygen: Non-availability of medical oxygen in settings where it is needed is prevalent; even when available, the medical oxygen supply is inadequate and inconsistent. ▪ Availability and functionality of essential oxygen equipment and devices: Inadequate availability of essential oxygen equipment and non-availability in some instances; and oxygen concentrators and oximeter probes (when available) did not meet the usage needs for pediatric populations, including neonatal, infant, and under-age-five groups. ▪ Oxygen therapy treatment guidelines and job aids: Lack of up-to-date treatment guidelines and protocols is common. Where treatment guidelines are available, either health workers are not aware of them or they adhere to them poorly, likely due to inadequate equipment and resource limitations, low knowledge and skill gaps, and disagreement with the guidelines. ▪ Health worker capacity and perceptions: Health worker staff shortages are persistent in health systems — higher in public than private health facilities — which implies high staff workload, burnout, or stress that adversely affects implementation of oxygen therapy solutions. Additionally, there are inadequate numbers of specialized or trained staff cadres, such as anesthesiologists, surgeons, and obstetricians, which also contributes to inadequate supervision of junior clinicians and task-shifting to cadres less trained in oxygen therapy. There are inconsistent perceptions on roles and responsibilities of different health cadres in oxygen therapy, poor interprofessional communication, and lack of multidisciplinary collaborations. Health workers have poor knowledge, skills, limited work experience, and low confidence regarding medical oxygen therapy. There are poor perceptions and attitudes among health workers — varying by cadre — towards oxygen therapy benefits, pulse oximetry benefits, oxygen humidification, conservative oxygen therapy, use of oxygen delivery interfaces, effectiveness of oxygen blenders, and potential harm from oxygen therapy. ▪ Client or patient attitudes and beliefs: There are additional barriers from the patient perspective including perceived physical and emotional intrusion, concerns about becoming dependent on medical oxygen (especially in chronic disorders like COPD), and social stigma related to oxygen use. ▪ Financing medical oxygen systems: Several barriers were identified, including high costs of oxygen services, high transport costs, low funding, and oxygen funding disparities/inequities (including lack of funding for oxygen for rare conditions such as fibrotic interstitial lung disease), and perceived high costs of oxygen and oximetry in some cases.
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	<ul style="list-style-type: none"> ▪ Challenges of financing to procure equipment for the provision of oxygen (e.g., concentrators, CPAP, ventilators) and maintenance are known from anecdotal evidence but have not yet been widely included in research. Most of the research currently available focuses on health workers and patient-level points and overlooks systems-level issues such as financing. A lack of studies addressing systemic barriers is one considerable finding of the systematic review.
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REFLECTIONS FROM THE RESEARCH

- Globally, the need for medical oxygen is very high and remains unmet in many contexts.
- Available medical oxygen solutions are disproportionately distributed; people living in poverty in remote areas are often left out.
- The current work provides a fundamental platform on which future efforts to strengthen medical oxygen systems around the world can build using evidence.

Access to Medical Oxygen (ATMO₂S) Policy Scorecard

EpiC supported the Lancet Global Health Commission on Medical Oxygen Security to develop a draft “Access to Medical Oxygen Scorecard – ATMO₂S.” The scorecard contains performance indicators addressing all 20 items in the World Health Organization’s (WHO) [increasing access to medical oxygen resolution](#). This scorecard is intended to support Member States to monitor their implementation of the WHO resolution and to fulfill the bi-annual reporting requirements in 2026, 2028, and 2030. The scorecard has been translated into seven UN languages: English, Arabic, Chinese, French, Spanish, Russian, and Portuguese.

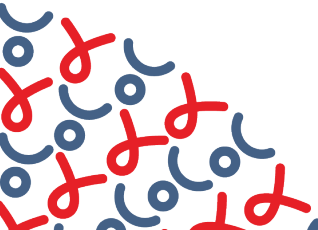
Commission Report

EpiC supported MakSPH’s participation in many coordination, consultation, and dissemination platforms at the national and global level to share the emerging findings, influence adoption of best practices, and build a broad coalition to promote best practices in strengthening medical oxygen delivery systems.

Dissemination

The secretariat, with support from EpiC has disseminated findings and best practices as follows:

- As part of the national medical oxygen taskforce in Uganda, MakSPH has recommended best practices for prioritization in the latest version of the *Uganda National Medical Oxygen Scale Up Implementation Plan*, the *Uganda Medical Oxygen Stock Management Guidelines*, and the *Uganda Clinical Guidelines 2023*. These are important policy documents that shape and guide the adoption and sustainability of interventions to increase access to medical oxygen.



- Additionally, research findings were disseminated at the 17th Joint Annual Scientific and Health Conference (JASHC 2023) organized by Makerere University College of Health Sciences and Uganda National Association of Community and Occupational Health (UNACOH) in Entebbe, Uganda September 20–22, 2023.
- Findings and recommendations are part of the Commission report titled “Every breath counts: Reducing global inequities in medical oxygen access” that will be published in January 2025.
- The MakSPH secretariat will finalize the draft manuscripts and submit them for publication in scientific peer reviewed journals. One article titled “[Improving effective coverage of medical-oxygen services for neonates and children in health facilities in Uganda: a before–after intervention study](#)” has been published in the *Lancet Global Health* journal. Additionally, reports addressing each of the research questions will be published.

NEXT STEPS

- The MakSPH secretariat will finalize the draft manuscripts and submit them to peer reviewed journals for publication and knowledge generation.
- The MakSPH secretariat will continue to share their expertise with the National Medical Oxygen Coordination Taskforce to guide the prioritization and implementation of core medical oxygen interventions in Uganda.
- The secretariat will continue to conduct implementation research to address unanswered questions including cost-effectiveness of medical oxygen intervention mixes and how to sustain gains. Throughout the course of this work, the secretariat identified that there is an appetite for modeling impact and cost effectiveness for morbidity and mortality, but there are challenges in mobilizing adequate resources to conduct modeling at the national level.
- MakSPH will participate in the dissemination activities as part of the launch of the report in early 2025. A representative will be attending the World Health Summit in Berlin in October 2024, where a session on the Lancet Global Health Commission on Medical Oxygen Security will be held.