Zambia Oxygen Summit

October 20–23, 2020
Lusaka, Zambia

Summit report

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PATH

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Published February 2021

Acknowledgments

On behalf of the Zambia Ministry of Health, Zambia National Public Health Institute, and PATH, we wish to acknowledge all partners and members who contributed to hosting the 2020 virtual Zambia Oxygen Summit.

The summit was organized as part of the COVID-19 Respiratory Care Response Coordination project, an initiative led by PATH and a coalition of partners to support low- and middle-income countries in the development and execution of a comprehensive respiratory care plan to respond to COVID-19.

We would like to commend our implementing partners and funders for their participation and insightful contribution to the summit, which resulted in policy recommendations and strengthening of collaborative efforts toward safe and reliable provision of medical oxygen to the people of Zambia:

- Zambia Association of Obstetricians and Gynaecologists
- US Centers for Disease Control and Prevention
- Chingases Company Limited
- Zambia Paediatric Association
- Pharmaceutical Society of Zambia
- Society of Anaesthetists of Zambia
- United Nations Children's Fund
- US Agency for International Development
- World Health Organization
- Zambia Chamber of Commerce and Industry
- Zambia College of Physicians
- Zambia Medicines Regulatory Authority

We acknowledge that without the invaluable contributions from the stakeholders and partners, the summit would not have been possible. The Ministry of Health looks forward to continued partnership in implementing its mission to provide access to safe oxygen, as well as collaboration in hosting similar events in future.

Dr. Kennedy Malama
Permanent Secretary for Technical Services
Ministry of Health, Zambia

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Abbreviations

CDC	Centers for Disease Control and Prevention
COVID-19	coronavirus disease 2019
ICU	intensive care unit
MGPS	medical gas pipeline system
MOH	Ministry of Health
PSA	pressure swing adsorption
SPRINT	Scaling Pneumonia Response INnovaTions
UNICEF	United Nations Children's Fund
USAID	US Agency for International Development
UTH	University Teaching Hospital
WHO	World Health Organization
ZABS	Zambia Bureau of Standards
ZACCI	Zambia Chamber of Commerce and Industry
ZAMRA	Zambia Medicines Regulatory Authority
ZNPHI	Zambia National Public Health Institute

Executive summary

Critical care services use oxygen as a primary commodity required for the management of moderate and severe COVID-19 patients, particularly in accident and emergency departments and intensive care units (ICUs). Similarly, general and specialist anesthesia services all rely on oxygen support through noninvasive[a] and invasive[b] mechanical ventilation.

To this end, the Zambia Ministry of Health (MOH), in collaboration with its Zambia National Public Health Institute (ZNPHI) and PATH, cohosted a virtual Zambia Oxygen Summit from October 20 to 23, 2020. The summit aimed at addressing demand for national medical grade oxygen, or medical oxygen, in the management of critically or severely ill COVID-19 patients within the designated pandemic treatment centers and around the country.

Zambia Oxygen Summit resolutions

The summit's primary goal was to obtain stakeholder input and recommendations to improve the government's oxygen escalation plan for acute respiratory care among COVID-19 patients. Going forward from the summit, key expected outcomes for participants are to (1) develop a country action plan that outlines each stakeholder's support to strengthen the oxygen supply chain and (2) formulate a road map for implementation of the oxygen escalation strategy.

After four days of deliberations, participants developed the following resolutions:

1. Develop a national strategy for critical and respiratory care that outlines an oxygen escalation plan (e.g., divide the country into zones and set up and utilize existing provincial hubs for oxygen production, distribution, and supply; review and monitor oxygen distribution and consumption systems; install cryogenic oxygen distribution and storage facilities for tertiary hospitals), including a road map for implementation.
2. Contribute to the development of legislation, guidelines, and standards that will regulate the production, distribution, and quality of supply of medical grade oxygen, as well as the use of oxygen as a medical product at the point of use. This will be under the leadership of the Zambia Medicines Regulatory Authority.
3. Establish a multisectoral technical working group for respiratory care at the national level to coordinate the steps outlined in the first two points above.
4. Conduct/complete the rapid assessment of biomedical equipment, including oxygen availability and use around the country.
5. As an immediate measure, support the MOH to ensure that pulse oximeters are available at the lowest level of care as a basic standard of diagnosis and referral of critically ill patients.
6. Upgrade the skills of clinicians in respiratory care management and ensure that specialist care[c] is available at all levels of the health system.
7. Upgrade the skills of biomedical technologists in biomedical equipment management.

This report shares highlights from the discussions held during the summit around strategies and approaches to improving access to medical oxygen. It illustrates the current national status of oxygen scale-up, challenges, and lessons learned, as well as mitigation strategies in the production and

a. Noninvasive ventilation refers to the provision of ventilatory support through the patient's upper airway using a mask or similar device.
b. Mechanical ventilation is termed "invasive" if it involves any instrument inside the trachea through the mouth, such as an endotracheal tube, or the skin, such as a tracheostomy tube.
c. The specialist care refers to health care providers that are trained to provide oxygen therapy and respiratory care safely in hospitals.

supply of medical oxygen. The report also presents a set of proposed recommendations to improve access to safe oxygen in Zambia.

Introduction

Medical grade oxygen, or medical oxygen, is an essential medicine used to manage a wide range of conditions across newborn, child, and adult populations. In the last year, the global COVID-19 pandemic has emphasized the role of oxygen as a lifesaving therapy for patients struggling to breathe, as well as the need for timely and robust planning for reliable oxygen delivery to protect and save lives from the current COVID-19 crisis and beyond. To determine the extent of respiratory care need in Zambia, it is important to assess the availability of different sources of oxygen, as well as the delivery and supply systems. Since April 4, 2020, the global supply chain has been disrupted due to the COVID-19 pandemic. Consequently, all health ministries across the globe were encouraged to leverage existing supplies and resources where possible to enable an immediate response This assessment aims to help prioritize and allocate the commodity based on the identified need.

Elements of the Zambia Oxygen Summit

Focus and objectives

As part of its work to prioritize and increase oxygen access, the Zambia Ministry of Health (MOH), in collaboration with its Zambia National Public Health Institute (ZNPHI) and PATH, cohosted a virtual Zambia Oxygen Summit from October 20 to 23, 2020. The summit focused on fulfilling medical oxygen demand for the management of critically and severely ill COVID-19 patients within the designated pandemic treatment centers and around the country. The objectives of the summit were to:

- Outline the current state of, successes with, and challenges with oxygen production, procurement, distribution, and use for COVID-19 and other respiratory illnesses.
- Enhance coordination among stakeholders in their activities to strengthen oxygen supply chain and use.
- Share the government's oxygen escalation plan for COVID-19 acute respiratory care with local and international stakeholders.
- Advocate for prioritization of oxygen therapy and maximization of resources.
- Recognize oxygen therapy guidelines for different levels of health care.

Participants

The summit brought together close to 60 participants representing MOH departments, medical regulatory bodies, cooperating partners, implementing partners, professional bodies, and the private sector (see Appendix B).

Format and approach

The virtual summit used Zoom video conferencing to connect participants remotely. Prework was set for presenters to maximize the use of time. Facilitators prepared and shared their presentations ahead of the summit. All presentations were followed by a question-and-answer session. The summit meeting was recorded for reference purposes, and a wide range of experts and stakeholders were invited to share their oxygen-related views and experiences, as well as provide recommendations for next steps. Sessions were composed of plenary presentations, panel discussions, talk show–style interviews, and instant polling for input toward recommendations.

Highlights and structure

The summit began on October 20, 2020, and was officiated by a representative from the MOH's Office of the Permanent Secretary. PATH's chief of the Africa region, Dr. Nanthalile Mugala, delivered a message of goodwill, followed by Ms. Noala Skinner from the United Nations Children's Fund (UNICEF). Dr. Paul Psychas of the United States Agency for International Development (USAID), representing the US Centers for Disease Control and Prevention (CDC), gave opening remarks. On the final day of the summit, the closing remarks were delivered by the summit convener, the MOH's national coordinator of Anesthesia and Critical Care Services, Dr. Christopher Chanda, as well as the cohost, Dr. Earnest Muyunda, PATH's Zambia country director. This report is divided according to each session of the summit:

- Session 1: Background and current situation of critical or respiratory care in Zambia during the COVID-19 era.
- Session 2: Government strategy for escalating respiratory care during the COVID-19 pandemic.
- Session 3: Industry support toward meeting the medical oxygen needs of the country.
- Session 4: Mobilizing stakeholder support toward the government's response to critical/respiratory care during the COVID-19 era and beyond.
- Session 5: Standards and guidelines for ensuring uninterrupted supply of oxygen for health facilities.

The summit identified the following areas of concern:

- There is a significant medical oxygen and oxygen delivery equipment gap, which has been amplified by the COVID-19 pandemic. Filling this gap will require effective planning, procurement, and distribution of additional equipment.
- There is an urgent need to develop a strategy and road map for critical or respiratory care that includes an oxygen escalation plan. This plan should cover training for both biomedical engineers and health care staff, which would play an essential role in sustained access and utilization of oxygen and respiratory care equipment.
- It is of crucial importance to match oxygen delivery sources to treatment use cases. This is an essential part of supply planning.
- There is a need for legislation governing the registration, production, distribution, storage, and use of medical oxygen. These laws will outline the qualifications and training for the users and the standards around the production of oxygen.

Opening ceremony

The summit began on October 20, 2020, with remarks from PATH, the MOH, the CDC, and UNICEF. The opening remarks identified the crisis of gaps in oxygen access and set the stage for stakeholders to grapple with the challenges to increasing access to respiratory care.

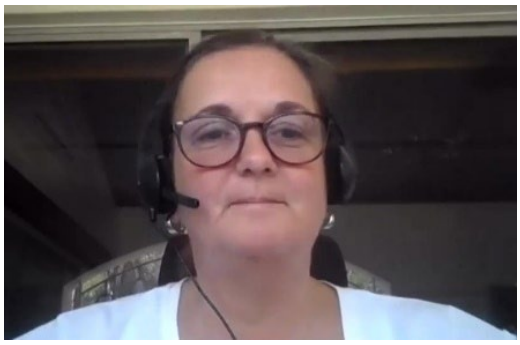
Dr. Earnest Muyunda, PATH's country director, welcomed participants to the summit and summarized the meeting agenda (see Appendix A). Further, he outlined the ground rules for the virtual meeting and invited the convener from the MOH, Dr. Christopher Chanda, to deliver his welcome speech. Dr. Chanda, the national coordinator of Anesthesia and Critical Care Services, welcomed the participants and informed them that the summit was a platform for stakeholders to brainstorm and critically review the challenges encountered in medical oxygen production, distribution, and use. He was hopeful that the summit would engage all stakeholders in meaningful discussions around context-sensitive solutions speaking to the local environment.

Message of goodwill from PATH

Dr. Nanthalile Mugala, PATH's chief of the Africa region. Photo: PATH.

Dr. Nanthalile Mugala, PATH's chief of the Africa region, highlighted the role of PATH in supporting ministries of health across the continent and around the world. This encompasses 70 countries in which PATH operates. She encouraged the pursuit of health equity by bringing public institutions, social enterprises, businesses, and investors together to address some of the world's most pressing challenges, such as medical oxygen, which was being discussed during the summit. She also highlighted PATH's leadership in the COVID-19 Respiratory Care Response Coordination project[d], which aims to support the decision-making and execution of the respiratory care escalation plan by the government.

Remarks by UNICEF



Ms. Noala Skinner, country representative for UNICEF. Photo: PATH.

Speaking on behalf of multilateral partners, Ms. Noala Skinner, UNICEF's country representative, noted that oxygen is a key ingredient to a resilient health system and that securing sustainable oxygen supply is both a cost-effective and strategic health investment. She elaborated on UNICEF's COVID-19 response in Zambia—notably, the rehabilitation, installation, and reconditioning of oxygen plants at several health facilities with support from the Swedish and German governments. Ms. Skinner commended the MOH for identifying medical oxygen as a key area for strategic investment and for organizing the summit, in collaboration with PATH. She pledged UNICEF's continued support to the government's priorities in medical oxygen services.

Remarks by the CDC

Dr. Paul Psychas, resident advisor for the Presidential Malaria Initiative, USAID. Photo: PATH.

Dr. Paul Psychas, on behalf of Dr. Megan Itoh of the CDC, began his remarks by paying tribute to the COVID-19 frontline health workers and applauded the various directorates of the MOH, such as the ZNPHI, who continued to lead COVID-19 response efforts. Also, he commended the Incident Management Clinical Structure Group for coordinating stakeholders working in the oxygen space. He urged all stakeholders to recognize the existing gaps in oxygen access and hoped the summit would help bridge the gap between supply and demand of medical oxygen in Zambia. He noted that the summit would be essential in systematically providing a feasible landscape in which cooperating partners can work.

d. The COVID-19 Respiratory Care Response Coordination project is a partnership between PATH, the Clinton Health Access Initiative, and Every Breath Counts coalition to support country decision-makers in development and execution of a comprehensive respiratory care plan to meet the demands of COVID-19. The project is also pursuing strategies to help prioritize and improve access to oxygen therapy and other essential equipment involved in respiratory care as an integral part of health systems strengthening, beyond the pandemic response. More information: oxygen@path.org.

Summit objectives and expected outcomes

Dr. Daniel Makawa, assistant director of Clinical Care & Diagnostic Services for the MOH, introduced the meeting objectives and expected outcomes (refer to “Background” section above). Participants were also allowed to contribute to expectations via an instant poll.

Keynote address

Dr. Alex Makupe, director of Clinical Care & Diagnostic Services, MOH. Photo: PATH.

In the keynote address, Dr. Alex Makupe, who is the director of Clinical Care & Diagnostic Services and who represented the Office of the Permanent Secretary of the Zambia MOH, welcomed summit participants. He gave an overview of the COVID-19 situation in Zambia, in which he stated that 15,897 COVID-19 cases had been confirmed (as of October 19, 2020). This included 346 deaths and 15,031 recoveries, with a total of 212,699 tests conducted. He added that during the winter, when the pandemic was at its peak, 10 to 15 percent of the COVID-19 patients had severe respiratory disease and required oxygen and assisted ventilation support. Of those, 5 percent were admitted to an intensive care unit (ICU) and required oxygen and invasive mechanical support. These patients were monitored in isolation facilities in Lusaka, Muchinga, Copperbelt, Southern, and Northwestern provinces. Dr. Makupe noted that the COVID-19 pandemic emphasized the vital role oxygen therapy plays in critical and respiratory care. He also thanked partners for the rehabilitation of the oxygen plant and procurement of oxygen concentrators to supplement the supply of the commodity to the isolation centers.

In closing his address, Dr. Makupe said there was a need to build a resilient health system based on the World Health Organization (WHO) health system building blocks[e,1] to respond to the oxygen demands with minimal disruption of routine health services. He emphasized the need for collaboration among stakeholders to address problems related to oxygen supply and delivery. Additionally, he recommended strategy and policy development to guide production, storage, and distribution of medical oxygen. Lastly, he thanked partners participating in the summit—UNICEF, WHO, USAID, and PATH, among others—for their support during the COVID-19 pandemic and said that he looked forward to continued partnership.

e. The WHO framework describes health systems in terms of six core components, or “**building blocks**”: (i) leadership and governance; (ii) service delivery; (iii) health system financing; (iv) health workforce; (iv) medical products, vaccines, and technologies; and (vi) health information systems.

Session 1: Background and current situation of critical or respiratory care in Zambia during the COVID-19 era

The first day of the summit was focused on the critical care and respiratory care situation in Zambia during the COVID-19 pandemic. The session included the following:

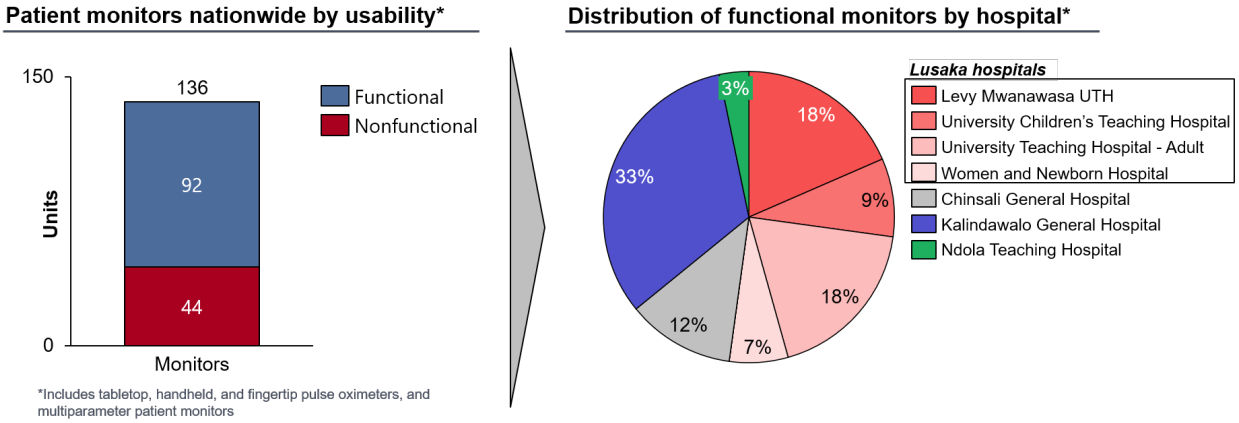
- Overview of critical or respiratory care in Zambia and an assessment of COVID-19 treatment centers.
- Overview of the oxygen situation in Zambia.
- Panel discussion on experiences of oxygen availability in practice.
- Panel discussion on the management of medical oxygen as a commodity in Zambia.

Overview of critical or respiratory care in Zambia and an assessment of COVID-19 treatment centers

In providing an overview of the state of current critical and respiratory care in Zambia, Dr. Chanda noted that COVID-19 was an emerging crisis and shared results from a rapid assessment of COVID-19 treatment centers in Zambia. This assessment was conducted to determine facility preparedness for respiratory care. The instrument used was adopted from the WHO Biomedical Equipment Survey. The main objective was to quantify treatment capacity; available and functional oxygen delivery equipment and oxygen generation equipment, including pressure swing adsorption (PSA) plants; and availability of human resources at the facility level. The findings of the assessment revealed the following:

- Functional availability of respiratory care was found to be lacking at many of Zambia's most well-equipped health care facilities (Figure 1 on the following page). For instance, it was found that a significant proportion of available equipment is nonfunctional (i.e., approximately 30 percent of patient monitors and 21 percent of ventilators). Thus, it reflected the insufficient and inequitable distribution of oxygen equipment and consumables in COVID-19 treatment centers, a situation which results in diminished capacity to provide respiratory and critical care.
- Only Levy Mwanawasa and Chinsali General Hospitals possess functional on-site PSA plants, a significant piece of equipment for oxygen generation.
- ICUs have a total of 64 beds across the whole country: Chinsali, 11; Chipata, 4; Kalindawalo, 11; Livingstone, 6; Lusaka, 22; Mongu, 3; and Ndola, 7. Out of 3,820 inpatient beds, only 61 (1.6 percent) are ICU beds. Table 1 breaks these findings down further.
- There is a limited number of critical care staff in health facilities. It was found that only 156 critical care nurses are registered countrywide, as shown in Table 2. Of health facilities surveyed, Levy Mwanawasa and Ndola Teaching Hospital have larger numbers of critical care staff than others.

Figure 1. Distribution of functional and nonfunctional patient monitors in assessed health facilities in Zambia.



Abbreviation: UTH, University Teaching Hospital.

Table 1. Total inpatient and ICU beds, by facility.

Facility name	Location	Total # inpatient beds	# ICU beds
Cancer Diseases Hospital	Lusaka	252	0
Chinsali General Hospital	Chinsali District	220	11
Kalindawalo General Hospital	Petauke District	220	11
Levy Mwanawasa University Teaching Hospital	Lusaka	730	12
Ndola Teaching Hospital	Ndola	851	12
University Teaching Hospital – Children's	Lusaka	365	8
University Teaching Hospital – Adult	Lusaka	850	14
Women and Newborn Hospital	Lusaka	332	2
Grand total		**3,820**	**61**

Table 2. Human resources capacity, by facility.

Facility name	Location	# clinical officer anesthetists	# critical care nurses	# critical care specialists	# anesthesiologists
Cancer Diseases Hospital	Lusaka	1	2	1	1
Chinsali General Hospital – new	Chinsali	-	-	-	-
Kalindawalo General Hospital	Petauke	-	-	-	-
Levy Mwanawasa University Teaching Hospital – new	Lusaka	0	0	0	0
Ndola Teaching Hospital	Ndola	4	11	2	2
University Teaching Hospital – Children's	Lusaka	0	3	0	0

Facility name	Location	# clinical officer anesthetists	# critical care nurses	# critical care specialists	# anesthesiologists
University Teaching Hospital – Adult	Lusaka	0	17	30	30
Women and Newborn Hospital	Lusaka	0	0	0	0
Grand total		**5**	**33**	**33**	**33**

Dr. Chanda concluded his presentation with a set of recommendations to address the issues outlined above, which included the need to undertake a landscape analysis for equitable distribution of equipment and the development of guidelines for handling of medical equipment, the transport and supply of oxygen, and training of noncritical care workers to meet the demand for critical care in the context of COVID-19.

During the discussion that followed, speakers commented on the alarmingly low levels of trained personnel for respiratory care. It was also noted that, while a good attempt had been made to conduct a rapid assessment of treatment centers, it would have been better to have a comprehensive sample of facilities, particularly at the peripheral level, to represent the needs of the health system broadly. In response, the presenter stated that, as a solution to critical care staffing levels, the MOH has introduced a Bachelor of Science degree program focusing on critical care at the Levy Mwanawasa University. The program has converted the Higher National Diploma and training of registered nurses into qualifying programs for anesthetists and critical care specialists, while ensuring that quality of training is maintained. However, there should be a deliberate policy to train a higher number of specialists. The president of the Society of Anaesthetists of Zambia, Dr. Hazel Sonkwe, concurred with Dr. Chanda on the need to train more medical cadre in critical care and appealed to the partners to support the training program.

Overview of the oxygen situation in Zambia

Mr. Emmanuel Mwale, a biomedical engineer at the University Teaching Hospital (UTH), presented on the oxygen situation in Zambia, highlighting oxygen availability in relation to the populations' need. He apprised summit participants of national oxygen production capacity, as well as the projected patient oxygen demand over a period of time. Mr. Mwale stated that there are challenges in the delivery of medical oxygen in the country. These include the absence of regulations governing the production and use of medical grade oxygen, limited number of biomedical engineers responsible for management of biomedical equipment, and the insufficient supply of medical grade oxygen.

To address the prevailing issues, the following recommendations were proposed:

- Engage the private sector in oxygen production through public-private partnerships.
- Repair nonfunctional oxygen concentrators.
- Increase the filling capacity of existing and new PSA oxygen plants, as well as consider procurement of skid-mounted PSA plants or trucks to ensure equitable distribution of oxygen to all parts of the country.
- Review the technical specifications of pulse oximeters before procurement and make them available in all health facilities.
- Increase skill and capacity-building among biomedical and health care personnel.

During the discussion that followed the presentations, it was observed that standards and guidelines for regulating the production and distribution of oxygen across the industry have not been developed. The MOH's Medical Equipment Management Guidelines[2] document includes standard lists of equipment;[3,4] however, the lists of equipment for 2nd and 3rd level hospitals currently do not include ICU needs. Critical care is amplifying the introduction of High Dependency Units care. MOH and partners need to come together as soon as possible to revise the standard equipment list regarding standards and guidelines since, often when equipment is procured, the maintenance aspect is overlooked. Instead, new equipment should be backed up by spare parts, personnel should be trained to investigate problems and perform repairs, and equipment should maintain an uptime of at least 97 percent.

Mr. Mwale advised scaling up the number of cylinders—and doing so in proportion to the appropriate cylinder gauges since the current situation shows that one gauge will be switched between two cylinders, which may be life-threatening to patients requiring critical care. A clarification was sought on the number of cryogenic air separation units in the country since most seen are PSA. Medical oxygen is an essential drug. Therefore, it should be regulated from a pharmaceutical perspective. This being the case, the Zambia Medicines Regulatory Authority (ZAMRA) is expected to provide guidelines related to oxygen production with an emphasis on purity, marketing, transportation, and plant maintenance. About medical supplies, the meeting learned that issues of oxygen supply are critical and that cylinders should be discussed in the context of primary, secondary, and tertiary supply while maintaining safety procedures and ensuring 24/7 availability. The government and UNICEF are currently working together to ensure that more oxygen plants are rehabilitated or that new ones are installed in other parts of the country.

Key lessons that can be drawn from the presentation include the following:

- *In the absence of oxygen, merely increasing the number of ventilators does not address the oxygen crisis because respiratory care devices such as ventilators depend on supplied oxygen.*
- *Matching oxygen sources to treatment of cases is an essential part of oxygen supply planning.*
- *When analyzing available oxygen capacity, it is crucial to consider the oxygen required for routine medical health services.*

Panel discussion on experiences of oxygen availability in practice

The team of panelists was comprised of clinicians working in hospitals. This team included representatives from the Society of Anesthetists of Zambia, the Zambia College of Physicians, and the Pharmaceutical Society of Zambia. Panelists shared their experiences on the availability of oxygen and challenges they encountered. They all demonstrated that it is necessary to avoid misuse of medical equipment and there is a shortage of human capital. Consequently, they gave recommendations and strategies on improving oxygen therapy during the COVID-19 era and beyond.

Dr. Hazel Sonkwe, president of the Society of Anaesthetists of Zambia, emphasized the need for practical plans to avoid oxygen wastage and infection prevention. She explained that oxygen supplies are not in tandem with different facility-level requirements. Dr. Sonkwe also cited the shortage of human capital as a major challenge, which

"There is less than one anesthetist for every 100,000 hospital patients instead of the recommended five for every 100,000. As a result, access to safe surgeries and anesthesia is limited."

Dr. Hazel Sonkwe

is more evident during the COVID-19 pandemic and with the prevalence of other diseases. Therefore, oxygen and critical care staff must be diverted to COVID-19 patient care due to a surge in demand. Dr. Sonkwe additionally emphasized the critical workforce shortage. She further noted that equipment for critical care is often nonfunctional and that, even when functional, staff lack adequate maintenance skills. Lastly, Dr. Sonkwe noted that oxygen purity quality is compromised to less than 50 percent.

The following were Dr. Sonkwe's recommendations to ensure oxygen availability:

- Ensure that the government invests in training health personnel in efficient use of oxygen.
- Have anesthetists and biomedical engineers work together to match oxygen requirements at every level of care.
- Develop strategy on how, where, and when to escalate oxygen therapy.
- Ensure that standards and guidelines for oxygen requirements and equipment maintenance are observed at each health care level.
- Ensure that all regions in the country have their own oxygen plants so that there is no shortage of the commodity.

Dr. Edna Chikoye, representing the Zambia College of Physicians, made the following observations on oxygen availability in practice:

- Patients with long-term oxygen therapy (e.g., chronic pulmonary conditions) are not included during the procurement of oxygen.
- Pulse oximeters were only considered key vital sign devices during the COVID-19 pandemic, in comparison to thermometers and blood pressure monitors.
- There is an alarming proportion of nonfunctional equipment (34 percent).

She advocated for pulse oximeters to be readily available in all health facilities as a vital sign device. She argued for noncritical care staff to be trained in the efficient and effective use of oxygen. She also expressed the need to develop protocols, such as on how much oxygen to use and when to use it, which would help decrease the number of nonfunctional equipment in health facilities. Dr. Chikoye further encouraged teamwork between biomedical technicians and health care workers to promote effective communication, reduce inefficient use of resources, and ensure timely repair of the equipment.

"These challenges border on a waste of medical oxygen as a commodity."

Dr. Edna Chikoye

In the question-and-answer session that followed, clarification was sought on how the anesthetists were addressing oxygen quality with the increased demand of the commodity during the COVID-19 pandemic and what the proposed next steps would be. In response, Dr. Sonkwe confirmed that at the peak of the pandemic, medical oxygen was an issue because the oxygen suppliers were overwhelmed by the demand, resulting in some areas of the country having oxygen purity of less than 50 percent. As a way forward, she suggested embedding appropriate sources of oxygen where required. She cited the example of Ndola Teaching Hospital, whose source of oxygen was in Lusaka. This meant sourcing from private suppliers, which is very expensive. Dr. Sonkwe urged hospitals to have oxygen PSA plants to supply regional hospitals and liquid oxygen. She also mentioned the need to improve the filling of oxygen in cylinders in these plants, which would help reduce substandard or impure oxygen. It would be prudent to also have oxygen on standby that is free from impurities.

COVID-19 is a unique problem, and health systems need to plan for patient care in this category. Physicians were asked which options or recommendations would be preferable. In response, Dr. Chikoye noted that there is a category of patients who need long-term therapy (home-based care oxygen therapy), which would need to be factored in when procuring oxygen. It was also noted that cylinders have high running costs. Among these are the regular (but erratic) supply of concentrators. Additionally, there is a need for an assessment to inform the decisions that we make. She expressed the need for data on the magnitude of the problem and development of a plan for the provision of home-based care oxygen therapy. These data would help assess the best delivery methods for those at home and provide a base to assess what ways could be used to support these patients. Dr. Chikoye encouraged participants to think about ways to support people within the community, not only post-COVID-19 cases, but all who need oxygen therapy at home.

Panel discussion on the management of oxygen as a medical commodity in Zambia

In this segment, three key topics consistently permeated the discussion: (1) adoption of legal guidelines and standards for oxygen, (2) effective enforcement of medical oxygen regulations, and (3) the need for effective monitoring equipment. The discussants demonstrated the need for more technical and financial support, interventions, and investments for the implementation of these guidelines.

ZAMRA intends to work with various institutions to ensure that medical oxygen meets the three regulatory pillars of quality, safety, and efficacy, as all medicines should. ZAMRA has commenced the drafting of local guidelines and will involve stakeholders.

Adoption of legal guidelines and standards for oxygen

Mr. Frank Laban of ZAMRA presented on the guidelines and standards for the production, distribution, and use of oxygen. He spoke on the legislation and legal aspects of medical oxygen and therapy in the country. Mr. Laban informed the summit participants that ZAMRA:

- Recognizes medical oxygen as an essential medication.
- Has been in collaboration with the Zambia Bureau of Standards (ZABS) to develop guidelines on marketing authorization standards.
- Ensures that ZABS Pharmacopeia standards are used to measure medical oxygen.
- Has advised manufacturers to comply with United States Pharmacopeia standards or specifications.

Effective enforcement of medical oxygen regulations

Mr. Laban also encouraged adherence to the International Pharmacopoeia specifications or European Pharmacopoeia specifications, which uphold an oxygen purity of 99.0 or 99.5 percent.[f] He also noted that manufacturing of medical oxygen undertaken by the various public health faculties in Zambia is extemporaneous since it is done on-site while still needing to comply with a lot of International Organization Standards for Good Manufacturing Practices and quality procedures that must be in place to ensure that the final product is of the required standard. The summit participants were

f. The International Pharmacopoeia standards for oxygen purity are currently being reviewed and revised. Proposed revisions will lower the oxygen purity requirement to “Oxygen contains not less than 90.0% v/v of O2”, which may encourage new market entrants and potentially lower costs for oxygen. (https://www.who.int/docs/default-source/medicines/norms-and-standards/current-projects/qas20_867_oxygen.pdf).

informed that most of the regulators in the Southern African Development Community region were not regulating oxygen as a medical product. This is because it falls under the jurisdiction of the standards bodies. He referred to the WHO-UNICEF Technical Specifications and Guidance for Oxygen Therapy Devices[5] as a helpful tool to be considered for adaptation at the country level. Key recommendations from Mr. Laban were as follows:

- Manufacturers and suppliers of medical oxygen should comply with national and international standards.
- There should be an adaptation of WHO standards and guidelines.

The need for effective monitoring equipment

The next discussion noted that fingertip pulse oximeters were procured for patient monitoring. Yet, some patients have escalating oxygen needs that require constant monitoring of blood oxygen saturation, in which case there is a need for tabletop pulse oximeters. These would enable nurses to check a pulse the way they check a temperature, and for up to four hours[9]. The number of cases of patients with severe COVID-19 is quite high, and they tend to escalate over a short period of time. Dr. Masuzyo Zyambo, UTH appealed to the government and its partners to consider purchasing tabletop pulse oximeters that would continuously monitor the patient.

Mr. Marlon Banda, president of the Pharmaceutical Society of Zambia, noted that COVID-19 is a wake-up call that exposed the pharmaceutical sector as being neglected. He observed that ZAMRA has provided guidelines that direct the sector in marketing authorization of medicines in a general way, which could be applied to the supply of oxygen as a medicine. This meant that all activities concerning procurement, storage, and supply are controlled by ZAMRA. However, there is no specific provision for medical oxygen as it pertains to production, storage facilities, distribution, and use in patients. He added that, in essence, there is virtually no regulation compared to the regulation currently provided in other countries. Zambia has a lot of work to do to ensure that standards are met in the delivery of pure medical oxygen and that measures that guide the production, storage, and use of oxygen are put in place. Mr. Banda also observed that there is no regulation on who is responsible for the production, distribution, storage, and supply of oxygen to patients. He went on to recommend that both biomedical and critical care personnel should be trained in various aspects of medical oxygen management from a standard and regulatory perspective.

In the subsequent discussion, Dr. Paul Psychas explained that USAID donated equipment and supplies to the MOH. He empathized with the desire to clarify the requirements and communicate with stakeholders who may have some resources to contribute to the cause. He highlighted the issue around distribution by explaining that pandemic responses are always challenging because government and partners must be proactive. He informed summit participants that the COVID-19 incidence-management structure is undergoing a review process. This is spearheaded by the MOH and WHO. So far, lessons learned have been particularly focused on distribution of medical oxygen. Dr. Psychas added that many supplies went to UTH stores but that the autonomous government agency Medical Stores Limited was not involved. This raised questions about whether the supplies reached the targeted populations. He advocated for the need to streamline procurement, storage, and distribution processes in the future, especially during a pandemic. This also calls for regular and effective communication among the stakeholders.

[9] Pulse oximetry is recommended by the World Health Organization as an important tool to improve health outcomes and should be used as a critical part of an integrated approach to detecting severe illness and patient monitoring for safe oxygen administration. As resurfaced by the recent research data, greater awareness among health care workers is needed around discrepancies in pulse oximetry readings based on skin pigmentation. Country-specific guidance on their use and clinical thresholds for screening within a given population would be a helpful step in ensuring equitable access to health care. Likewise, further data validation and data sharing is needed to help build evidence around the performance and accuracy of these devices in all variations of skin color.

In response, Dr. Makawa assured summit participants that the MOH would consider the recommendations immediately since the feedback has been provided. He added that these concerns also came from the various clinical settings and meetings. He acknowledged some of the issues around the ideal type of pulse oximeters. He noted the various types available at Medical Stores Limited but did not have the full details of what was being procured except for the basic description (e.g., a pulse oximeter). Dr. Makawa recognized the need to go back to the drawing board and categorize what is available. He hoped the documents shared by UNICEF would serve as a guide. As a next step, there was a proposal to develop specifications relating to procurement of medical oxygen. This would be supplemented with a guiding document. He noted that there was need to heed regular maintenance of equipment for assured access to high-grade medical oxygen purity. He alluded to the fact that COVID-19 taught the nation some hard lessons, but most importantly the resolve to build resilience.

Session 2: Government strategy for escalating respiratory care during the COVID-19 pandemic

This second day of the summit focused on addressing the government's escalation plan for respiratory care during the COVID-19 pandemic. This session covered the following topics: (1) the medical gas pipeline system (MGPS) in Zambia, (2) guidelines to medical oxygen and determination of supply sources for health facilities, and (3) the government's plan for acute respiratory care during the COVID-19 pandemic.

MGPS in Zambia

The government strategy in escalating respiratory care during the COVID-19 pandemic session began with a presentation from Dr. Christopher Chanda, consultant pediatric anesthetist and national coordinator of Anesthesia and Critical Care Services. His presentation covered the medical gas supply situation in Zambia. Dr. Chanda laid out the challenges faced in supplying medical gas to large institutions. He noted that the choice of oxygen supply systems and size is affected by hospital dynamics such as the bed capacity, case load, and biomedical engineer capacity. The possible sources of oxygen to consider would be the PSA plant, liquid oxygen tank, and manifold system. Dr. Chanda advocated for the development of medical legalities governing the supply of oxygen in health facilities. His presentation also covered a brief overview of the MGPS. This system would cater to the primary and secondary supply of oxygen needed in the hospitals. It would also provide bulk storage and a bulk supply of oxygen. Dr. Chanda concluded his presentation by urging the pharmacists to track the quality of oxygen in the health facilities.

Guidelines to medical oxygen and determination of supply sources for health facilities

The next presentation was led by Mr. Emmanuel Mwale, a biomedical engineer from the UTH in Zambia. Mr. Mwale highlighted that the absence of regulations and guidelines, as well as fragmented supply and distribution for oxygen systems, aggravates problems with accessing oxygen for patients. He noted that "in the absence of regulations and guidelines, we have an issue with the supply of oxygen and how safe it can be for patients." His presentation covered the different components considered for the estimation of oxygen supply per facility (e.g., the number of critical care beds, the number of general beds requiring oxygen, and the number of health facilities to be supplied).

Government's plan for acute respiratory care during the COVID-19 pandemic

This session was framed as an open microphone "talk show" for participants to have an opportunity to learn more about the government's plan for acute respiratory care during the COVID-19 pandemic. It was led by Dr. Joseph Kayaya, project product development lead at PATH, and featured Dr. Christopher Chanda. The discussion focused on medical oxygen generation, supply, and consumption; the government's strategy for tracking medical oxygen in Zambia; mechanisms for quality assurance; and epidemic/pandemic preparedness in relation to medical oxygen, among others.

Refer to the recording for more information:
https://path.box.com/s/pitmizxkkxvpmv3nyld6aptj3cuyjezd.

Session 3: Industry support toward meeting the medical oxygen needs of the country

The third session of the summit addressed private-sector support toward meeting medical grade oxygen needs in Zambia. This session included an open discussion with a representative from Chingases Company Limited, which was proceeded by a presentation delivered by PATH.

Private-sector support toward medical oxygen

During the open discussion on private-sector support toward meeting the medical oxygen needs in Zambia, which was led by Mr. Laurian Haangala, Zambia Chamber of Commerce and Industry vice president, the discussant, Mr. Dickson Liu, managing director of Chingases, shared experiences from industry and explored ideas on how best to obtain the participation of the private sector in filling commodity gaps as required by the health sector. He also discussed the capacity of the private sector to bridge the existing gap as well as provide technical support. The session looked at the opportunities for collaboration between the industry and the MOH through public-private partnerships. Mr. Liu stressed the need to strike a balance between product provision and profits or breaking even due to operational costs incurred.

Mr. Dickson Liu, managing director of Chingases Company Limited. Photo: PATH.

During the COVID-19 pandemic, companies such as Chingases have encountered challenges, particularly during the lockdown. It was difficult to get the supplies into the country since the borders were closed. Furthermore, the company had to deal with myths and misconceptions about COVID-19 by educating the employees and ensuring they followed safety guidelines. Concerning the meeting of required standards for medical oxygen, Mr. Liu clarified that each country should have some quality assurance or quality control mechanisms that manufacturers should comply with.

"We are using foreign legislation, and the ideal situation would be to domesticate them."

Dr. Christopher Chanda

In the discussion that followed, there was a question around how the government can help the private sector understand the standards and policies under which the commodity should be manufactured and distributed. Dr. Chanda advised that there is a need to conduct a desk review to determine the legislation that governs medical oxygen manufacturing. Furthermore, it was noted that pharmacists are not involved in the development of regulations governing medical oxygen supply, which should not be left to the critical care personnel alone.

The summit provided a platform for the MOH, cooperating partners, and the private sector to sit with other industry players to ensure that regulatory guidelines are developed together. Mr. Liu expressed concern over the delayed payments by the government for medical oxygen. He advocated for payments to be made promptly. In response, Dr. Chanda assured the private sector that government would consider signing memoranda of understanding with suppliers so that there is a continuous supply of oxygen.

Costing and filling in of Zambia’s respiratory care–equipment gaps

Mr. Zachary Clemence, Market Dynamics program officer, PATH. Photo: PATH.

The next segment of the session was a presentation on costing and filling in of Zambia’s respiratory care–equipment gaps by Zachary Clemence, Marketing Dynamics program officer, PATH. Mr. Clemence began his presentation by sharing results from a Biomedical Equipment Survey that was conducted in the country. The results of the survey highlighted the significant oxygen and equipment gap that exists irrespective of the severity of the COVID-19 outbreak. He urged that filling the gap would require effective procurement of additional equipment, as well as the appropriate distribution of equipment. Lastly, Mr. Clemence noted that the survey was limited due to the small sample size used. Therefore, for more robust estimations, additional facilities should be surveyed, and current supply values reconfirmed.

Session 4: Mobilizing stakeholder support toward the government's response to critical/respiratory care during the COVID-19 era and beyond

This session focused on the stakeholder support toward government efforts in improving the availability of oxygen for respiratory and critical care during the COVID-19 pandemic. The presentations were delivered by the following partners: PATH, the CDC, UNICEF, and USAID.

PATH support

Alex Rothkopf, Supply Chain and Data Science advisor, summarized PATH's work on the COVID-19 Respiratory Care Response Coordination project to support country decision-makers in the development and execution of a comprehensive respiratory care plan to meet the demands of COVID-19. The project is also pursuing strategies to help prioritize and improve access to oxygen therapy and other essential equipment involved in respiratory care as an integral part of health systems strengthening, beyond the pandemic response. The project focuses on the following four areas:

- Rapid facility assessment at individual facilities across regions and focus at the national level on global respiratory care coordination: Respiratory care for COVID-19 is more complex than just supplying oxygen and other respiratory equipment. Supplies of this essential equipment are limited. To ensure equitable access, the current availability of equipment within countries is gathered and compared to the forecasted need for equipment. The gap between current availability and estimated need informs procurement and distribution of equipment. The activities in this area include:
    - Biomedical equipment survey.
    - Rapid demand quantification.
- Supplier landscaping and outreach and country-specific decision-making. This includes outreach to suppliers to understand existing inventory, available manufacturing capacity, and how current pricing can facilitate effective supply and demand matching. The project works with manufacturers and other global partners to pool available intelligence on capacity and lead times for equipment that is essential to respiratory care in the COVID-19 response. This is done in collaboration with the key global coordinating bodies and procurers to assist with rapid supplier engagement and market landscaping, analytics, and other related support. Immediate activities include:
    - Supplier landscaping and outreach to firms, particularly those with available capacity to supply equipment.
    - Centralized procurement and distribution support.
    - Tracking respiratory care innovations.
- Quantification of total needed biomedical equipment for respiratory care in health facilities. Currently, the Zambia MOH, through the Department of Clinical Care and Diagnostic Services, and working in partnership with the Anesthesia and Critical Care Unit and PATH, is conducting a nationwide rapid assessment of respiratory care equipment in health facilities. This followed an earlier rapid assessment that was conducted in July 2020. The purpose of this assessment was to understand current COVID-19 treatment capacity, the potential scenarios around COVID-19

related patient surges and increased demand, and the estimated gaps that need to be filled with either additional training, procurement of medical equipment, or relocation of existing equipment.

PATH has developed many resources to help government planners and other stakeholders concerned with oxygen access to develop strategy for scale-up, deployment, and general management of oxygen systems.

Resources for oxygen: https://www.path.org/programs/market-dynamics/increasing-access-safe-oxygen/.

CDC support

Dr. Paul Psychas, a partner of the MOH in Zambia, presented on the CDC's support of COVID-19 related interventions.[h] The CDC's main involvement in the COVID-19 response in Zambia has been in scaling up laboratory capacity for COVID-19 testing, providing technical assistance for surveillance, and performing case contact tracing. Further work has been in providing technical and financial support for prevalence surveys, technical assistance for COVID-19 clinical and public health guidelines, and training and procurement of medications and oxygen supplies.

The CDC focused on meeting the immediate clinical needs of COVID-19 centers to maximize impact on morbidity and mortality. In collaboration with other stakeholders in the clinical Incident Management System pillar, they conducted a gap analysis of oxygen supplies based on collaborating partners' abilities to mobilize resources such as equipment, consumables, and other medical supplies for intubation. Some funds from the President's Emergency Plan for AIDS Relief were redirected to the refurbishment of the oxygen machine at UTH – Children's Hospital. Challenges cited included lack of clarity on responsibility for the distribution of supplies. This is because it was being done separately from the normal Medical Stores Limited distribution system. The distribution process outside Lusaka was slow, and oxygen supplies were not necessarily distributed to prioritized facilities. Dr. Psychas expressed that the impact and needs remain unclear.

"Since the distribution of procured oxygen supplies remains unclear, we have not been able to determine the impact of our response."

Dr. Paul Psychas

Consequently, it was difficult to target future support in this area. Dr. Psychas recommended clinical and logistics coordination to conduct an oxygen needs assessment.[i] He also urged the need for a transparent and rapid distribution plan, especially outside of Lusaka. He concluded by encouraging integration and coordination with the Medical Stores Limited distribution system to respond to facility-level needs.

UNICEF support

Dr. Rodgers Mwale shared that UNICEF's main entry point for health-sector support in Zambia was through sustaining essential health services. This came through advocacy; partner coordination on essential medicines; and investment in medical oxygen production, delivery, and administration. Summit participants heard that the organization, in collaboration with the Swedish International Development Cooperation Agency, rehabilitated oxygen plants at the UTH – Children's Hospital, as well as Lewanika and Mansa General Hospitals, and procured 316 oxygen concentrators in Ndola

h. Strategic focus areas of CDC support typically include HIV prevention, care, and treatment; integration of HIV and tuberculosis management; malaria prevention and care; public health workforce/ZNPHI capacity strengthening and development through the CDC's Field Epidemiology Training Program; and support to health systems strengthening through surveillance, laboratory, and health information systems.
i. A needs assessment is currently underway by the MOH, with support from PATH.

with additional support from KfW promotional bank in Germany and USAID. UNICEF also procured 310 oxygen cylinders with attendant flowmeter regulators. Regarding operational support for essential health services, the organization distributed medical oxygen to low-performing districts and diagnostics for COVID-19 with support from KfW. Challenges cited included lack of a clearing house for accessing information to inform decisions and for balancing quick action with financial due diligence and the delayed procurement due to constrained global supply chains. UNICEF's recommendations for government and partners were focused on the need to conduct a strategic assessment of the medical oxygen situation to define a way forward and develop the necessary guidelines, such as a national strategy, standard operating procedures, and a monitoring framework.

USAID support

Dr. George Sinyangwe, USAID's chief medical officer, shared the main areas of support rendered to the health sector in Zambia. These include HIV, tuberculosis, malaria, family planning, and maternal and child health support. Also, he stated that further support is given toward emerging medical emergencies, such as Ebola and COVID-19. Furthermore, Dr. Sinyangwe stated that channeling of resources is largely through local and international implementing partners, as well as through direct granting to the government. However, he emphasized that USAID has considered local partners lately. Additionally, USAID supports technical assistance to government agencies and procurement of equipment supplies. Regarding oxygen support, Dr. Sinyangwe mentioned that USAID does not typically support oxygen supplies to Zambia. However, in response to the COVID-19 pandemic, USAID procured 1,300 oxygen concentrators on behalf of the MOH. He added that the organization would be willing to support critical care equipment in the future, but this would be contingent on funding. Dr. Sinyangwe urged cooperating partners to coordinate efforts as they support the government in providing access to safe oxygen.

Session 5: Standards and guidelines for ensuring uninterrupted supply of oxygen for health facilities

This session focused on the standards and guidelines for ensuring the uninterruptible supply of oxygen to health facilities and discussed how government and stakeholders can ensure the continuous supply of oxygen as a commodity to facilities offering critical and respiratory care during the pandemic and beyond.

Legal requirements for medical oxygen production, distribution, and supply to hospitals

Mr. Frank Laban, ZAMRA's principal registration officer, gave a presentation that looked at existing legislation on medical oxygen production, distribution, and supply. He began his presentation by providing ZAMRA's mandate to "regulate and control the manufacture, importation, storage distribution, supply, sale, and use of medicines and allied substances under the Medicines and Allied Substances Act No. 3 of 2013."[6] The main objective of ZAMRA is to ensure that all medicines and allied substances being made available consistently meet the set standards of quality, safety, and efficacy. He went on to elaborate that ZAMRA has established procedures for granting registration of medicines and allied substances. He noted that there are no guidelines for the registration of medical oxygen. The process for the regulation of medical oxygen will commence in 2021. Currently, medical oxygen would need to satisfy the following guidelines:

- ZABS Zambia Standard 825 on medical oxygen.
- The International Pharmacopoeia, 9th ed. (2019), on medical oxygen.
- The United States Pharmacopeia 29 monographs on medical oxygen.

Standards and guidelines for medical oxygen devices and their operations and maintenance

Ms. Bev Bradley, a biomedical engineer, and a technical specialist at UNICEF, led the next presentation on standards and guidelines for medical oxygen devices and their operations and maintenance. She informed summit participants that UNICEF has been involved in the COVID-19 response in the areas of infection prevention and control, personal protective equipment, diagnostics, oxygen therapy devices, and support for oxygen scale-up efforts globally. Before the pandemic, UNICEF had embarked on an interagency collaboration with WHO in oxygen supply systems within the broader context of clinical need and access. Together, they developed the WHO Technical Series for Medical Devices guide. This provided detailed product categories with merits and demerits for each device so that rational procurement decisions can be made. She cited an example of three types of pulse oximeters: tabletop, fingertip, and handheld.

She cautioned participants that the guide was not meant to give step-by-step instructions but rather provide equipment planners with an idea of the level of expertise required to install the devices and the types and frequency of maintenance interventions required. She emphasized that the guidelines aim to help decision-makers, planners, and procurement staff gauge the availability of necessary skills and resources. This would then help design a plan for capacity-building, if necessary.

Ms. Bradley also informed summit participants that during the COVID-19 pandemic, WHO published interim specifications for plants with a focus on clinical use; technical characteristics; utility

requirements; accessories; consumables; spare parts; training; installation and utilization; warranty and maintenance; as well as standards and regulations. These were developed to provide direction on the minimum specifications and requirements that should be considered before the purchase or donation of medical devices. The summit participants learned that oxygen projects should be driven by country stakeholders who understand the local context to be able to define the requirements and solutions that will work best for them and that will be sustainable in the long term.

In 2018, UNICEF launched the Innovations to Scale Initiative for investing in proven lifesaving interventions. One such innovation was the Scaling Pneumonia Response INnovaTions (SPRINT),[7] a project aimed at scaling proven interventions for the treatment of pneumonia. Ms. Bradley stated that in light of COVID-19, the global ramp-up of oxygen equipment would dramatically increase the need for models such as SPRINT to support oxygen programming in countries. Additionally, as part of UNICEF/WHO's Oxygen Therapy Project,[8] in April 2020 UNICEF developed the Oxygen System Planning Tool,[9] an Excel-based tool to help stakeholders at the national, subnational, or health facility level to plan for their oxygen supply system, from the oxygen source to the patient delivery device.

Conclusion

Dr. Christopher Chanda thanked all individuals and organizations who made the summit a success. He said the way forward for access to safe oxygen in Zambia lay in collaboration between government and stakeholders.

Recommendations for next steps in promoting wider access to medical grade oxygen

Essential actions to take:

1. Develop a national strategy for oxygen that will outline immediate solutions for scaling up production, distribution, and supply of medical oxygen.
2. Establish a multisectoral technical working group at national, provincial, and district levels to coordinate the development, implementation, and monitoring of the comprehensive oxygen escalation plan for respiratory care.
3. Conduct an immediate assessment of oxygen plants for capacity and functionality.
4. Divide the country into zones and set up provincial hubs for oxygen production, distribution, and supply.
5. Review and monitor oxygen distribution and consumption systems.
6. Install cryogenic oxygen plants for tertiary hospitals.
7. Ensure that oxygen devices such as pulse oximeters are available at the lowest levels of care.
8. Develop guidelines and standards for certification of oxygen from production to patient use under the leadership of the Zambia Medicines Regulatory Authority.
9. Upgrade the skills of clinicians and biomedical technologists in respiratory care management and ensure that specialist care is available at all levels of the health system.

To access presentations from the summit, please visit: https://path.box.com/s/pitmizxkkxvpmv3nyld6aptj3cuyjezd.

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Appendix A. Virtual Zambia Oxygen Summit 2020 agenda

Session 1: Tuesday, October 20, 2020 Moderator: Dr. Francis Mupeta, case management lead, Zambia National Public Health Institute Topic: Background and the current situation around critical or respiratory care in Zambia in the COVID-19 era (Dr. Christopher Chanda).		
Time	**Topic**	**Speaker/discussant/presenter**
08:30–08:35	Welcome remarks.	**Dr. Christopher Chanda** National anesthetic coordinator, MOH Summit host
08:30–09:30	Official opening ceremony.	**Guest of Honor** Dr. Kennedy Malama Permanent Secretary Technical Services, MOH
09:30–10:00	Overview of critical/respiratory care in Zambia. Assessment of COVID-19 treatment centers in Zambia.	**Dr. Christopher Chanda** National anesthesia coordinator, MOH Conference host
10:00–10:30	Energizer/health/tea break.	
10:30–11:30	The oxygen situation in Zambia. Highlighting oxygen availability versus population needs, capacities for production, projected oxygen demand to meet a patient surge, public-sector involvement production, private-sector players, capacities for optimal use of oxygen in the public sector.	**Mr. Emmanuel Mwale** Biomedical engineer University Teaching Hospital MOH

Time	Topic	Speaker/discussant/presenter
11:30–12:00	**Panel discussion 1** Experiences around oxygen availability in practice, challenges encountered, recommendations and strategies to improve oxygen therapy during the COVID-19 era and beyond.	Discussants: **Dr. Hazel Sonkwe** President, Society of Anaesthetists of Zambia **Dr. Musaku Mwenechanya** president, Zambia Paediatric Association **Dr. Swebby Macha** President, Association of Obstetricians and Gynecologists in Zambia **Dr. Edna Chikoye** President, Zambia College of Physicians
12:00–12:30	**Panel discussion 2** Management of oxygen as a medical commodity in Zambia: • Guidelines and standards for the use of oxygen in health facilities. • Legal aspects of oxygen use/therapy in Zambia.	Discussant: **Mr. Marlon Banda** President, Pharmaceutical Society of Zambia
12:30–13:00	Question and answers around oxygen availability and use in the country in plenary, next steps, and way forward; close for the day.	Session moderator

Session 2: Wednesday, October 21, 2020

Moderator: Mr. Wisdom Chelu, chief anesthetic officer, Zambia MOH, and summit cohost

Topic: Government strategy for escalating respiratory care during the COVID-19 pandemic.

Time	Topic	Speaker/discussant/presenter
08:30–08:45	Review of day 1 (using Mentimeter).	Rapporteurs
08:45–09:30	**A moment with Dr. Christopher Chanda**, consultant pediatric anesthetist and national coordinator for Anesthesia and Critical Care Services, MOH. Highlighting the government's plan for the escalation of oxygen therapy and critical care teams' setup in the country.	Show host: **Dr. Joseph Kayaya** Team leader, Living Labs Project at PATH
09:30–10:00	**A moment with the Infrastructure and Planning Department in the MOH** Progress toward actualizing the government's strategy toward improving the current oxygen situation. Highlighting local public-sector oxygen production, distribution, and supply in major provincial and tertiary facilities in Zambia.	Discussant: **Mr. Mwanza** Director, Infrastructure & Planning, MOH Show host: **Dr. Joseph Kayaya** Team leader, Living Labs Project at PATH
10:00–10:30	Energizer/health/tea break	

Session 3: Wednesday, October 21, 2020

Moderator: Mr. Laurian Haangala, vice president of Industry & Manufacturing, Zambia Chamber of Commerce and Industry, and summit cohost

Topic: Industry (private-sector) support toward meeting the medical oxygen needs of the country.

Time	Topic	Speaker/discussant/presenter
10:30–11:30	**Panel discussion** • Participation of industry in filling commodity gaps as required by the health sector. • Private-sector capacity to meet the existing medical oxygen gap. • A view from industry—oxygen utilization by the health sector. • Technical support and opportunities for collaboration between industries and MOH.	Discussants: Representative – Afrox (African Oxygen Ltd.), Zambia Representative – Chingases Representative – Trojan Representative – Delta Gas
11:30–12:30	Costing and filling of Zambia's respiratory care–equipment gap.	**Mr. Zach Clemence** Market Dynamics program officer, PATH
12:30–13:00	**Plenary discussion** • Critical care and the need for oxygen at different levels of care. • Community-based respiratory care strategies as part of the COVID-19 response.	Discussant: **Dr. Christopher Chanda:** National anesthetic coordinator Summit host
13:00	Summary, next steps, and close for the day.	Session moderator

Session 4: Thursday, October 22, 2020

Moderator: Dr. Rodgers Mwale, UNICEF

Topic: Mobilizing stakeholder support toward the government's response to critical/respiratory care during the COVID-19 era and beyond.

Time	Topic	Speaker/discussant/presenter
08:30–08:45	Review of day 2 – using Mentimeter.	Rapporteurs
08:30–10:00	**Plenary presentations** (4–5 slides per stakeholder group). Partner support toward the government's response to critical care in the COVID-19 era. Highlighting available stakeholder support for respiratory/critical care to government efforts toward improving oxygen availability during the COVID-19 era and beyond.	Discussants: Representative – USAID/Zambia Representative – UNICEF Representative – WHO Representative – PATH Representative – CDC Zambia
10:00–10:30	Energizer/health/tea break.	

Time	Topic	Speaker/discussant/presenter
10:30–11:00	**Plenary discussion** Questions and answers around partner support toward the government's response to critical care in the COVID-19 era. (Questions via instant polling using Mentimeter.)	Session moderator
11:00–11:30	**Plenary discussion** A look into the future and living with the new "normal"; re-purposing hospitals and health centers to manage COVID-19.	Discussant: **Dr. C. Chanda**
11:30–12:00	Next steps and close for the day.	

Session 5: Friday, October 23, 2020

Moderator: Dr. Laston Chitembo, national professional officer HIV/tuberculosis, WHO Zambia Country Office

Topic: Standards and guidelines for ensuring uninterrupted supply of oxygen for health facilities. Session 5 will discuss how the government and partners can ensure a continuous supply of oxygen as a commodity to facilities offering critical/respiratory care during the pandemic and beyond.

Time	Topic	Speaker/discussant/presenter
08:30–09:00	**Rapporteur session** Rapporteurs present a summary of takeaway points from day 3.	Rapporteur team
09:00–09:30	Legal requirements for medical oxygen production, distribution, and supply to hospitals (existing legislation or steps toward legislation).	**Mr. Lyoko Nyambe** Assistant director, Marketing Authorizations; Acting director, Medicines Control, Zambia Medicines Regulatory Authority
09:30–10:00	Current regulation and guidelines on donated medical equipment, including oxygen delivery equipment (equipment used at point of use).	**Mr. Wisdom Cheulu** Chief anesthetic officer MOH
10:00–10:30	Oxygen therapy guideline for health facilities.	**Dr. John Masina** Emergency physician, Levy Mwanawasa University Teaching Hospital / Case Management member, ZNPHI
10:30–11:30	Medical oxygen device standards and guidelines and their operations and maintenance.	**Dr. Monjur Hossain** Chief of Health and HIV / AIDS, UNICEF
11:30–12:30	Summary, way forward, and next steps (instant polling using Mentimeter).	Session moderator
12:30	Closing remarks, health break, close of meeting.	**Dr. C. Chanda** Summit host

Abbreviations: CDC, Centers for Disease Control and Prevention; MOH, Ministry of Health; UNICEF, United Nations Children's Fund; USAID, US Agency for International Development; WHO, World Health Organization; ZNPHI, Zambia National Public Health Institute.

Appendix B. List of participants

Name	Organization	Email
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Abbreviations: CDC, Centers for Disease Control and Prevention; UNICEF, United Nations Children's Fund; USAID, US Agency for International Development; WHO, World Health Organization; ZACCI, Zambia Chamber of Commerce and Industry; ZNPHI, Zambia National Public Health Institute.

Appendix C. Participant expectations from the Zambia Oxygen Summit

At the opening ceremony, participants were asked to share their expectations of the virtual Zambia Oxygen Summit. Participants responded that they expect to learn:

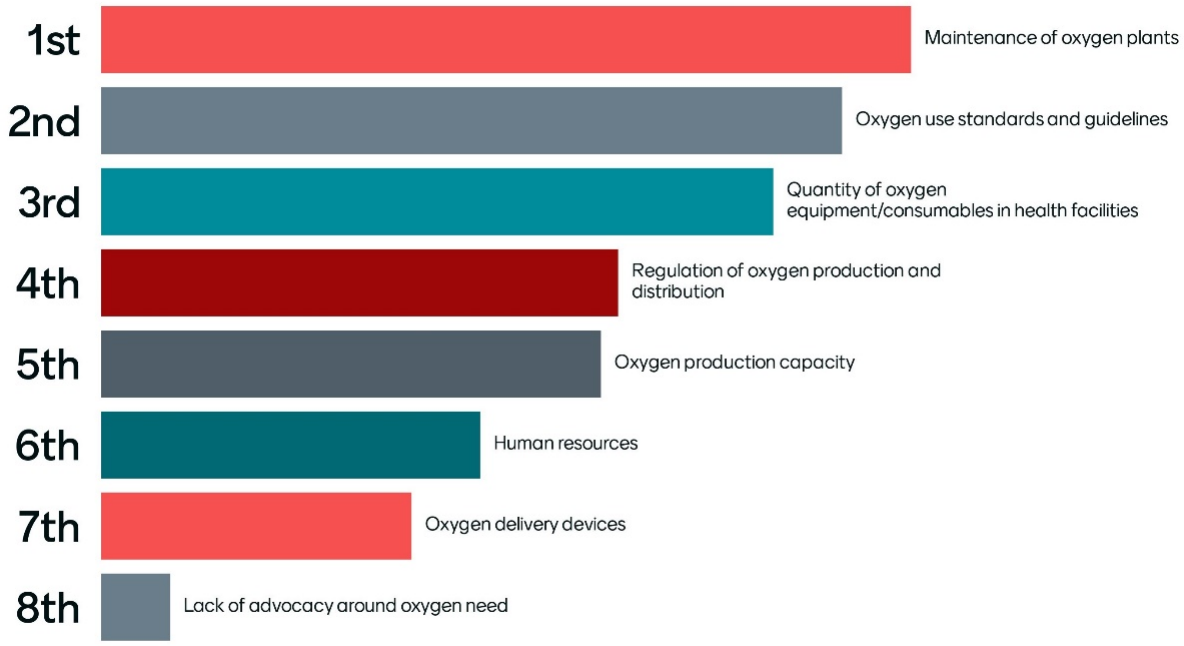
- What partners are doing to support the government in filling the gap of medical grade oxygen in hospitals.
- What the government's position is on increasing access to the commodity (oxygen) and what its plan is for supplying it.
- What the way forward is for a harmonized, sustainable medical oxygen supply system.
- What the national standards and operational guidelines are on operations and maintenance of oxygen devices.

Appendix D. Meeting evaluation

The participants were given the opportunity to provide feedback on their experience at the virtual Zambia Oxygen Summit using an instant poll on the Mentimeter app. The feedback poll also served as a mechanism to determine areas of interest for future iterations of the learning network. The evaluation questionnaire was built around feedback on the meeting objectives, technical content, key lessons learned, importance of the lessons, and possible improvements in action plans. Summaries of the responses to the following questions are highlighted below:

- What did attendees think the most pressing issues are related to oxygen that Zambia is facing?
- What are some additional issues attendees feel are pressing related to oxygen that Zambia is facing?
- What did the attendees say about the summit?

Figure 2. Participant feedback on most pressing oxygen issues.



Additional pressing issues that need to be addressed/improved:

- Involvement of private health facilities in these discussions.
- Oxygen governance, coordination, and regulatory mechanisms.
- Maintenance skill development and standardized equipment.
- Need for oxygen to be a priority, with pressure swing adsorption (PSA) as second in line.
- Need for Zambia to update its Essential Medicines List to include oxygen to be in line with the World Health Organization.
- Need for cryogenic oxygen to stand as a priority, with PSA as second in line.
- Need to consider investments in PSA plants and liquid ox tanks, as well as ensure that locations are picked smartly so that oxygen access will be available to as many people as possible in the long run, particularly considering the logistics issues and operational costs.

General feedback:

- This is wonderful work.
- Oxygen has been neglected but now we are happy that we are here.
- Like Emmanuel said in a presentation, COVID-19 is a blessing because it has exposed our bottlenecks.

Figure 3. Participant descriptors for the summit.