Assessing Capacity and Access for Respiratory Care in Zambia

PATH

Oxygen Indicators Feasibility Assessment Report

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The work described within the report was carried out as part of the Strengthening Oxygen Utilization and Respiratory Care Ecosystem (SOURCE) project, which is an initiative led by PATH to improve equitable access to high-quality respiratory care services at all levels of the health care system and ultimately reduce maternal, child, and overall mortality from hypoxemia-related causes.

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Abbreviations

DHIS2	District Health Information Software 2
HMIS	health management information system
ICU	intensive care unit
M&E	monitoring and evaluation
MOH	Ministry of Health
PSA	pressure swing adsorption
TWG	Technical Working Group
WHO	World Health Organization
ZNMOSP	Zambia National Medical Oxygen Strategic Plan (2022 – 2026)

Executive summary

What is not measured cannot be managed. The low to nonexistent availability of quantitative data on hypoxemia, oxygen delivery, and respiratory care management is a critical barrier to improving access to oxygen. During the COVID-19 pandemic, Zambia's emergency response effort included the development of an oxygen dashboard to improve the management of oxygen supply and demand. However, as the pandemic waned, reporting rates from facilities have declined because the data collection is often viewed as burdensome on staff and the data collection tools are difficult to use. Yet, oxygen data remains critical for responding to a vast array of respiratory conditions. Thus, the Ministry of Health (MOH) and PATH began a plan to establish oxygen-related indicators for monitoring outcomes along the medical oxygen ecosystem.

The MOH, through the Access to Oxygen Technical Working Group (TWG), developed a list of proposed oxygen indicators for routine data collection in health facilities. The Access to Oxygen TWG created sub-committees to review and categorize the indicators into three domains: clinical indicators, respiratory care equipment indicators, and capacity-building indicators. After validation, these indicators were submitted to the MOH monitoring and evaluation (M&E) team for further review and feedback. The M&E team proposed a feasibility assessment to evaluate the ease of collecting data on the 21 oxygen indicators. The primary objective of the feasibility assessment is to evaluate the practicality of collecting data on oxygen indicators in selected health facilities. 76% of indicators were determined as feasible. However, ease of implementation is differentiated by availability of data collection tools, standard operating procedures, and resources such as data clerks at facilities.

Indicator Domain	Feasible	Not Feasible
Clinical	5	2
Staffing	3	0
RCE	9	2
% Feasible	76%	24%

This feasibility assessment revealed distinct recommendations for implementing indicators for routine monitoring:

- New standardized registers need to be created and distributed to facilities or amendments need to be made to the existing registers to aggregate data for reporting from facilities to MOH.
- Specific indicators should be re-evaluated for frequency of reporting to ensure that the data is collected at intervals that will demonstrate trends or change over time, but not too frequently as to be repetitive.
- Additionally, responsibility for reporting most indicators clearly falls within the purview of facilities, but it is recommended that definitions of indicators are revisited where it may be more appropriate for district or provincial levels of the health system to bear the responsibility for aggregation of data that requires monitoring an outcome within across facilities.

The routine monitoring of the medical oxygen ecosystem is essential for managing oxygen supply and providing the highest possible quality of care for respiratory conditions. Feasibility assessment findings should be responded to in preparation for a larger scale pilot of indicators with the ultimate goal of integration of oxygen indicators into health management information system (HMIS) and widespread reporting at all levels of the health system that are expected to provide oxygen therapy.

1. Introduction

Background

Access to oxygen is critical for the management of respiratory conditions, especially in low-resource settings like Zambia. The World Health Organization (WHO) emphasizes the importance of oxygen as an essential medicine. However, the availability and utilization of oxygen in health facilities across Zambia remain inconsistent. To address this gap, a comprehensive feasibility assessment of oxygen indicators is needed to guide policy and resource allocation.

Prior to the COVID-19 pandemic, there was no systematic data collection on oxygen availability and consumption, with oxygen primarily allocated for use in intensive care units (ICUs) and operating theatres. Currently, there is no tracking of hypoxemia prevalence in the country. The Ministry of Health (MOH) relies on the health management information system (HMIS) for data management. The HMIS aggregates disease data and service delivery information, allowing users to access statistics on various health conditions and services such as antenatal care, vaccination, and antiretroviral treatment. Data is collected by assigned personnel at each facility, who generate paper-based reports that are submitted to district health offices. These reports are then transferred into the HMIS by district health information officers, culminating in monthly reports that inform monitoring and decision-making at the MOH level.

To improve the management of oxygen supply, the MOH, through the Department of Clinical Care and Diagnostics Services and the office of the National Oxygen Coordinator, developed an oxygen dashboard in 2020. This online application aims to create an efficient, resilient, and safe oxygen delivery system by providing high-quality data and evidence. Utilizing the District Health Information Software 2 (DHIS2) platform, the oxygen dashboard collects data on oxygen demand and supply, particularly in response to the challenges posed by the COVID-19 pandemic. It was designed to facilitate regular data collection from health facilities and generate visualizations based on key oxygen indicators. Users of the dashboard include biomedical engineers, biomedical equipment technologists, and medical equipment officers.

The primary objectives of the dashboard included:

- Estimating oxygen demand at the facility level and monitoring cylinder usage.
- Tracking the supply of oxygen from cylinders, concentrators, and pressure swing adsorption (PSA) plants.
- Generating reports on oxygen demand, consumption, and supply availability for decision-makers at both facility and national levels.

The reports produced by the dashboard assisted biomedical engineers and facility-level decision-makers in predicting oxygen requirements, ensuring adequate procurement, improving patient referrals based on real-time oxygen availability, and identifying supply gaps. At the national level, data from the dashboard provided an evidence base for reallocating supplies to facilities with the greatest need.

Despite the implementation of the oxygen dashboard, reporting frequency has remained low. In response, the MOH and PATH have committed to exploring strategies to enhance data quality and increase reporting rates. This effort aligns with a key pillar of the Zambia National Medical Oxygen Strategic Plan (ZNMOSP 2022 – 2026) (Ministry of Health 2022), which seeks to establish a reliable, efficient, and safe oxygen delivery system through timely collection of high-quality data for informed decision-making.

To better understand the challenges faced by users of the oxygen dashboard, MOH and PATH conducted a survey (PATH 2022) to assess user challenges, understand the data culture, and investigate the reasons for low data quality and reporting frequency. The findings revealed several key issues:

- Respondents reported having numerous daily responsibilities beyond data reporting.
- Despite being familiar with the oxygen dashboard, 67% of respondents had never used it, citing reasons such as:
    - The time required to enter data.
    - The challenge of transitioning from a paper-based system to a digital one.
    - Lack of designated data collectors.

Based on these insights, several recommendations emerged:

- Integrate the oxygen dashboard into the HMIS to alleviate the data collection burden on biomedical engineers.
- Incorporate select oxygen indicators (e.g., patient data, oxygen equipment functionality, oxygen plant status, human capacity) into routine data collection at each facility.
- Provide practical training on the dashboard and review the initial training content.

Following these recommendations, the MOH, through the Access to Oxygen Technical Working Group (TWG), developed a list of proposed oxygen indicators for routine data collection in health facilities. The Access to Oxygen TWG created sub-committees to review and categorize the indicators into three domains: clinical indicators, equipment indicators, and capacity-building indicators. After validation, these indicators were submitted to the MOH monitoring and evaluation (M&E) team for further review and feedback. The M&E team proposed a feasibility assessment to evaluate the ease of collecting data on the developed oxygen indicators.

Objectives

The primary objective of the feasibility assessment is to evaluate the practicality of collecting data on oxygen indicators in selected health facilities. This includes to:

- Assess the availability of data elements that feed into the prioritized indicators.
- Identify the primary data sources for all available data elements.
- Identify the departments/units that will be reporting data elements for prioritized indicators.
- Assess data quality issues associated with available data elements.
- Assess the number of data collection tools, e.g., patient tool/s, equipment, etc. that will be required in a facility and their placement (most suitable units/departments to allocate tools).
- Define a data flow system for oxygen data collection reporting (frequency of data aggregation, responsible persons, data review and use, etc.).

2. Methodology

The feasibility assessment utilized a tool developed by the M&E team within the MOH. This standard tool evaluates the feasibility of proposed indicators for specific disease areas or health topics prior to their implementation in health facilities and the MOH's HMIS.

The assessment questions were designed based on indicators created by the Access to Oxygen TWG sub-committees and received approval from the MOH. Data collection involved physical visits to selected healthcare facilities to observe their data collection and reporting practices related to oxygen supply systems.

The assessment was conducted from 20 to 24 January 2025 by a team of PATH program officers, along with program and M&E officers from the MOH across seven health facilities. All Level 1, 2, and 3 hospitals in Zambia are expected to provide respiratory care and thus were surveyed on the feasibility of tracking oxygen indicators. These facilities included the UTH Adult Hospital, Kafue General Hospital, Chongwe District Hospital, Serenje District Hospital, Kabwe Central Hospital, and Kapiri Mposhi District Hospital as shown in Table 1.

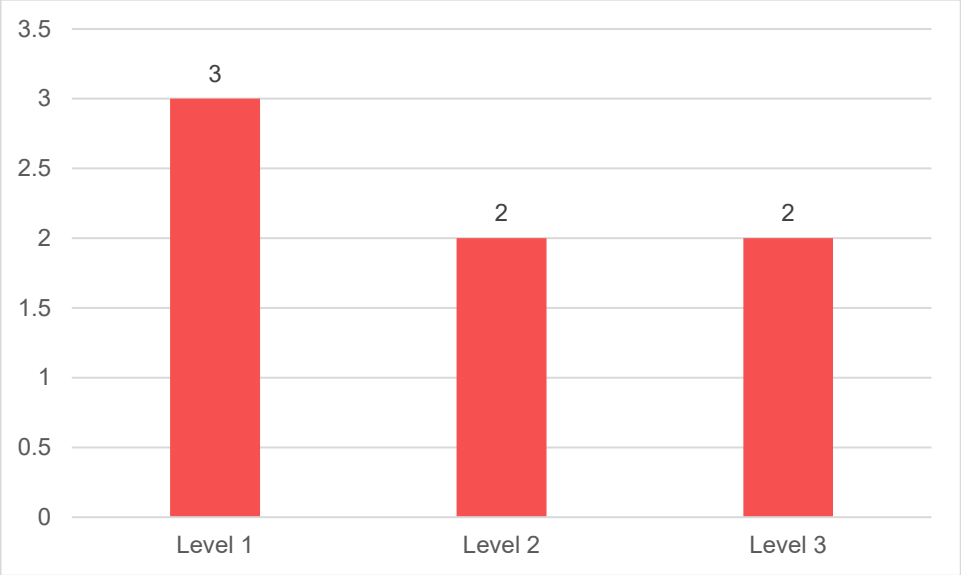
Table 1. Details of the facilities included in the feasibility assessment.

Province	Name of Facility	Level of Care	Geography	Oxygen provision
Lusaka	UTH Adult Hospital	Level 3	Urban	PSA plant is non-functional. The facility relies on oxygen cylinders bought from a private supplier.
Lusaka	UTH Children's Hospital	Level 3	Urban	The facility has a functional PSA plant and uses oxygen cylinders.
Lusaka	Kafue General Hospital	Level 2	Urban	The facility relies on oxygen cylinders bought from a private supplier.
Lusaka	Chongwe District Hospital	Level 1	Rural	The facility relies on oxygen cylinders bought from a private supplier.
Central	Kabwe Central Hospital	Level 2	Urban	The facility has a functional PSA plant and uses oxygen cylinders.
Central	Serenje District Hospital	Level 1	Rural	The facility relies on oxygen cylinders bought from a private supplier.
Central	Kapiri Mposhi District Hospital	Level 1	Urban	The facility relies on oxygen cylinders bought from a private supplier.

3. Results

The oxygen indicators feasibility assessment was conducted at seven hospitals in six districts of Lusaka province. Reponses are subjective, and respondents included biomedical engineers and technicians, critical care nurses, doctors, hospital administrators, monitoring and evaluation officers, and human resource officers. A summary of facility characteristics is described in Figure 1.

Figure 1. Number of surveyed facilities by facility level.

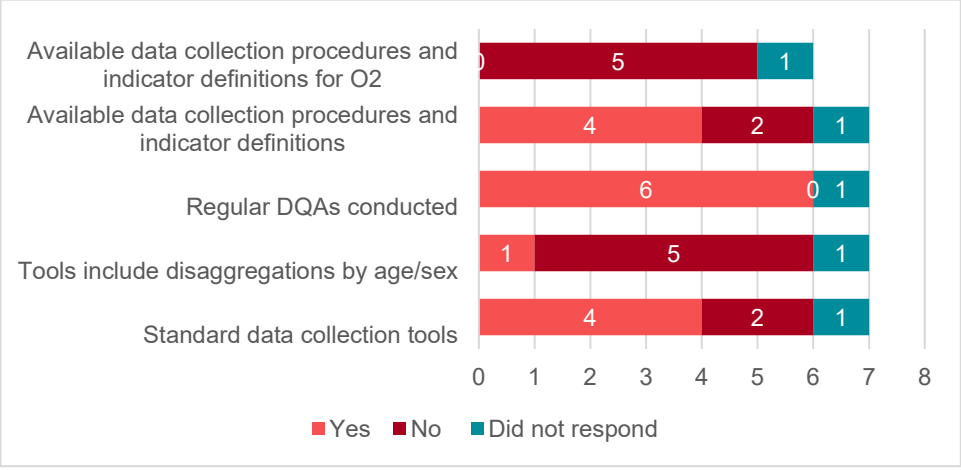


Monitoring and evaluation tools

This section of the feasibility assessment tool examined general monitoring and evaluation standards at the facility.

Six of the seven facilities responded to this section of the tool with one hospital choosing to abstain from responding. A summary of responses is described in Figure 2.

Figure 2. Responses to available M&E criteria at the surveyed facilities.



Reponses indicate that standard data collection tools, procedures and indicator definitions exist for many aspects of patient care including clinical registration, documenting vital signs, and other specific health areas such as malaria. However, existing tools and procedures do not capture oxygen.

The availability of data collection tools such as SmartCare Pro and DHIS2 is uneven across the facilities surveyed. Facilities generate reports monthly and quarterly through SmartCare Pro and DHIS2. Reports include high-level statistics for mortality, births, operations and admissions. The standard cadence of data quality assessments is quarterly.

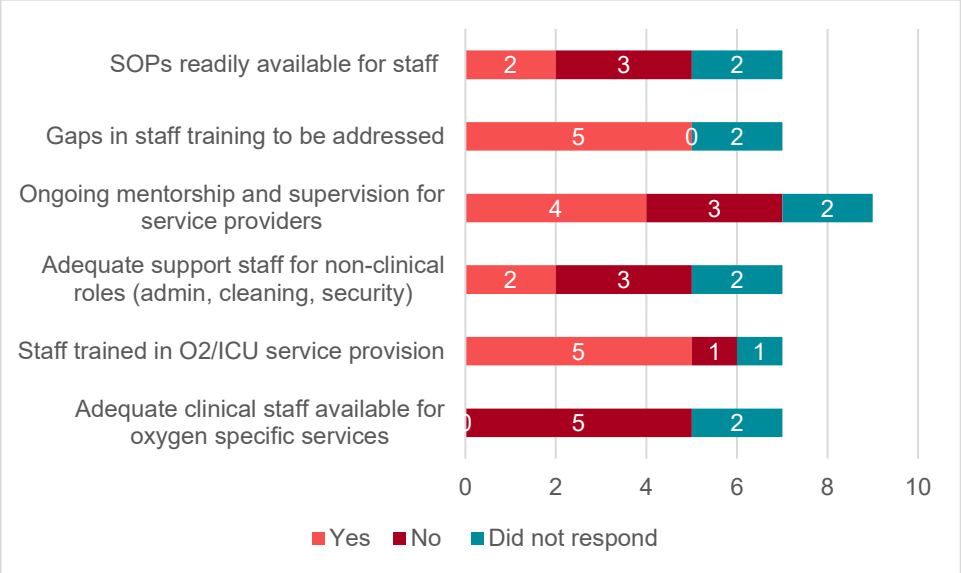
The largest facility, University Teaching Hospital (Adult and Children's), had biomedical engineers and technicians that regularly collect data on respiratory equipment, such as oxygen cylinders to track availability and distribution of oxygen resources, but this equipment data is not collected alongside any clinical data.

Staffing

This section of the feasibility assessment tool examined general monitoring and evaluation standards at the facility.

Data collection for new indicators is highly resource intensive. Therefore, a brief qualitative evaluation of available staffing for oxygen indicators was included in the feasibility assessment. A brief summary of findings is highlighted in Figure 3.

Figure 3. Available staff and resources for oxygen services at the surveyed facilities.



Some of the larger hospitals such as Chongwe District Hospital and UTH have dedicated monitoring and evaluation staff.

There are gaps in all categories of staffing: biomedical engineering, clinical/nursing, and support staff. Some facilities lacked any oxygen attendants or did not have attendants for all shifts. Most facilities identified understaffing in critical care nursing and anesthetists.

Less than half of facilities have standard operating procedures that staff can reference for their duties. Facilities that have standard operating procedures often noted gaps or outdated documentation that further exacerbate service quality issues due to high staff turnover. Mentorship and training are needed to continue to support available staffing across units. At UTH, staff requested that an assessment of training gaps and needs be completed.

Comments and recommendations

Recommendations from facility staffing include:

1. Revising the outpatient department (OPD) registers to include clinical oxygen indicators, including oxygen saturation at triage with other vital signs.
2. Continuing to track equipment data in equipment management systems rather than in clinical data system as they are collected by different staff and are aggregated separately for different audiences.

Indicators feasibility

Twenty-one indicators monitoring clinical, staffing, and equipment outcomes were evaluated for feasibility. Indicators were given a determination of Feasible or Not Feasible based on the following criteria:

1. Availability of data sources and/or whether registers could be easily edited or updated.
2. Relevancy of the indicator as determined by the availability of that service/equipment.
3. Importance of the indicator is based on whether the indicator is filling a data gap.

The determination of feasibility is subjective based on the perception of facility staff surveyed for this assessment and the available resources at each facility.

The twenty-one indicators assessed for feasibility are:

Clinical

- % of patients screened in critical entry points (OPD, accident, and emergency units) using a pulse oximeter
- % of patients with oxygen saturation levels < 90%.
- % of patients with oxygen saturation levels < 90% commenced on supplementary oxygen.
- % of patients commenced on supplementary oxygen with unknown or undocumented oxygen saturation levels.
- Average patient stay on supplementary oxygen (in days).
- Number of hospitalized patients receiving oxygen with SpO2 < 93% at 24 hours post-admission out of the total number of hospitalized patients receiving oxygen therapy.
- % of patients on supplementary oxygen who recovered/discharged.

Staffing

- % of clinical staff appointed in critical care units that received standardized oxygen therapy training.
- % of biomedical engineers and technicians that are trained to install, maintain and repair respiratory care equipment.
- % of oxygenated facilities that received at least one on-site biomedical engineer or technician providing technical support.

Respiratory care equipment

- % of oxygenated facilities with essential oxygen delivery devices.

- Number of facilities with at least one functional pulse oximeter in key entry points.
- Oxygen consumed within the facility (m^3) during the reporting period.
- % of oxygen cylinders in healthcare facilities that meet quality standards and safety requirements.
- % of oxygen concentrators in healthcare facilities that meet quality standards and safety requirements.
- Average number of cylinders consumed in a week.
- Number of empty oxygen cylinders.
- Number of filled oxygen cylinders.
- Number of oxygen cylinders taken for refill.
- % of healthcare facilities with planned preventative maintenance schedules for oxygen equipment (e.g. quarterly or annually).
- % of healthcare facilities with a documented equipment replacement plan.

A full list of indicators with detailed definitions disaggregation, data sources, and reporting periods is available in the Annex.

76% of indicators were determined as feasible (Table 2). However, ease of implementation is differentiated due to availability of data collection tools and resources such as data clerks.

Table 2. Breakdown of feasibility by indicator group.

Indicator Domain	Feasible	Not Feasible
Clinical	5	2
Staffing	3	0
Equipment	9	2
% Feasible	76%	24%

Clinical

A summary of the feasibility of clinical indicators is described below. Six of seven clinical indicators were determined as feasible.

Indicator: Percent (%) of patients screened in critical entry points (ODP, accident, and emergency units) using a pulse oximeter.

Determination: Feasible

Data is readily available in the patient files and reflects standard of care that all patients should be screened for hypoxemia using a pulse oximeter. Data would need to be collected from patient files and compiled into a new standardized register or existing OPD register. It should be noted that at least one hospital reported that not all patients are screened with a pulse oximeter at triage.

Indicator: Percent (%) of patients with oxygen saturation levels < 90%.

Determination: Feasible

Data is readily available in individual patient files, but the data would need to be collected from patient files and compiled into a new standardized register or existing OPD register. Data availability in patient files varies across facilities. At some hospitals, the saturation level is not documented, but rather there is a binary indicator of whether or not a patient is on oxygen. At other hospitals, saturation level is monitored for patients on oxygen, but that is in patient files documented in specific wards that provide respiratory care and there is no facility level register.

Indicator: Percent (%) of patients with oxygen saturation levels < 90% commenced on supplementary oxygen.

Determination: Feasible

Data is readily available in the patient files and reflects standard of care that all patients should be screened for hypoxemia using a pulse oximeter. Data would need to be collected from patient files and compiled into a new standardized register or existing OPD register.

Indicator: Percent (%) of patients commenced on supplementary oxygen with unknown or undocumented oxygen saturation levels.

Determination: Not feasible

Facility staff suggested to drop this indicator as it will be difficult to collect the data from various tools/sources to determine this indicator.

Indicator: Average patient stay on supplementary oxygen (in days).

Determination: Feasible

Data is currently recorded at some facilities in patient files, but not all facilities are documenting this data. This requires a new tool or updates to registers for data collection from patient wards. There is general agreement that this is a useful and important indicator for evaluating patient care.

Indicator: Number of hospitalized patients receiving oxygen with SpO2 < 93% at 24 hours post-admission out of the total number of hospitalized patients receiving oxygen therapy.

Determination: Not feasible

About half of facilities determined this indicator as feasible, while the other half determined this as not feasible. The definition of this indicator is very specific and does not have a practical application. The timeliness of the indicator will not align with clinical decision making. Some facilities indicated that it would be possible to collect this data in an ICU ward. Kafue General Hospital noted that while this indicator is feasible, that it should be documented in the hourly oxygen saturation chart which tracks time, date, oxygen saturation levels of patient, amount of oxygen given, and other important clinical factors. However, linking this data source to patients screened for hypoxemia using a pulse oximeter and with a SpO2 < 93% is overly complicated and many facilities noted that this makes the indicator not feasible for implementation.

Indicator: Percent (%) of patients on supplementary oxygen who recovered/discharged.

Determination: Feasible

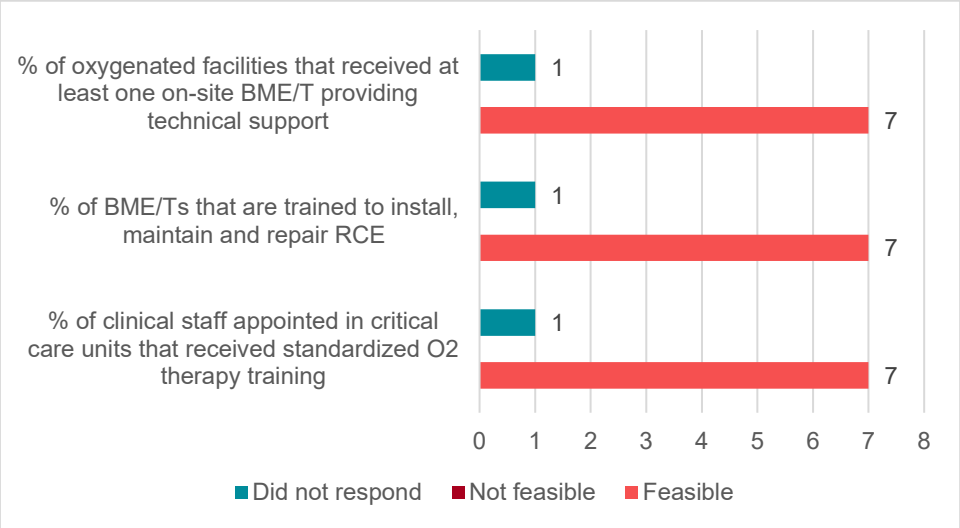
The data for this indicator is currently available in-patient files at most facilities. This indicator would need to be sourced from patient files, aggregated into a patient register, and calculated to obtain the percentage. All but one facility consider this a feasible indicator. Chongwe District Hospital did not

consider this to be a useful indicator. Kabwe Central Hospital suggested that patient death also be considered as an indicator; however, this was not chosen as an indicator as it may provide misleading information about cause of death.

Staffing

A summary of the feasibility of staffing indicators is described in Figure 4. All three staffing indicators were determined as feasible.

Figure 4. Feasibility of staffing indicators.



Indicator: Percent (%) of clinical staff appointed in critical care units that received standardized oxygen therapy training.

Determination: Feasible

The data for this indicator already exists in hospital training registers and is easily accessible.

Indicator: Percent (%) of biomedical engineers and technicians that are trained to install, maintain, and repair respiratory care equipment.

Determination: Feasible

Most facilities have a stationed biomedical engineer or technician. This data may be tracked in some training registers at facilities but is most likely available in human resource records. There are no standardized registers for this indicator, but it is easily collected.

Indicator: Percent (%) of oxygenated facilities that received at least one on-site biomedical engineer or technical providing technical support.

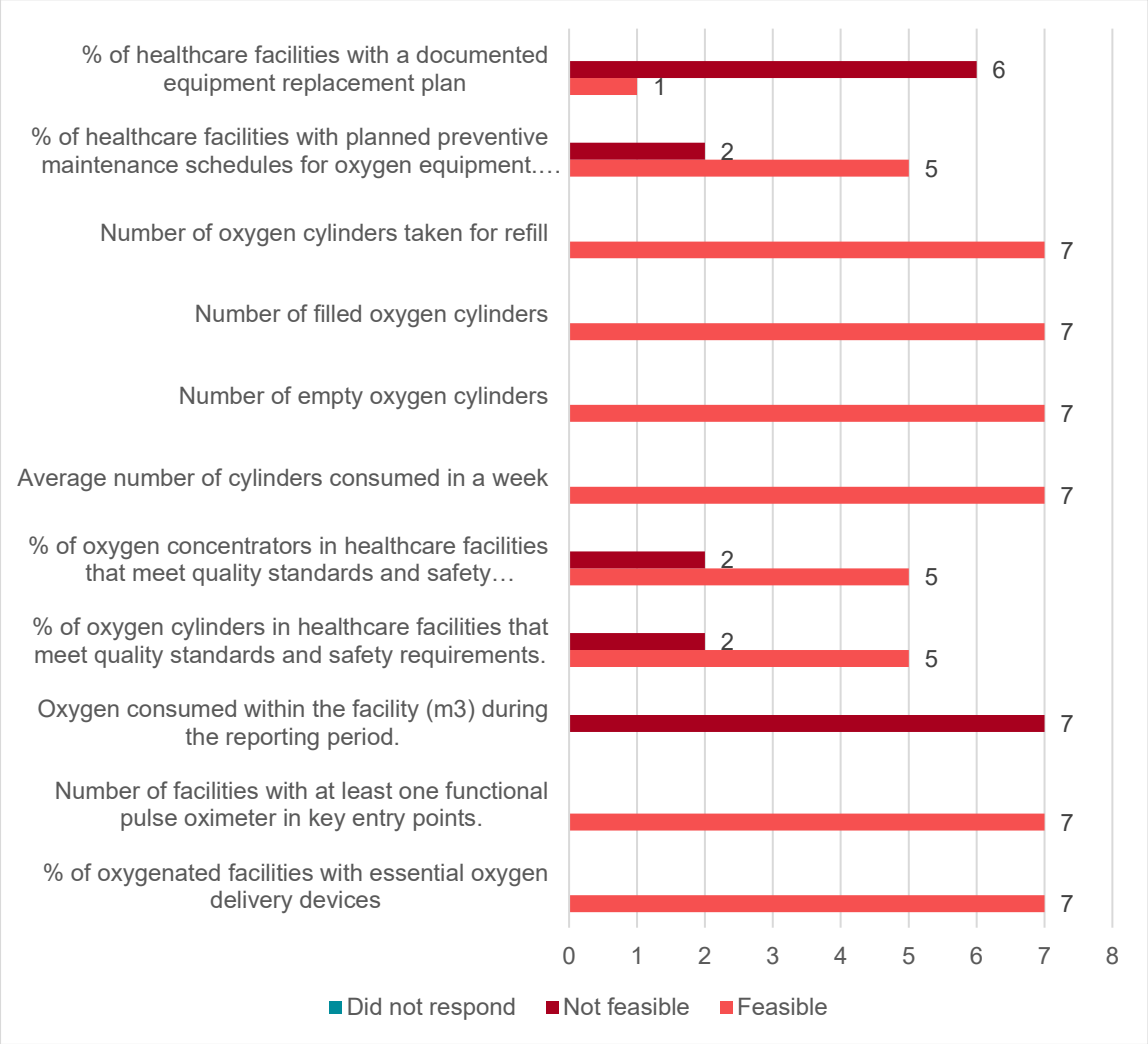
Determination: Feasible

While determined as feasible, the availability of this data at hospitals varies. Some facilities suggested that this would be better collected at a district level, rather than at a facility level indicator. Part of the difficulty in collecting this data is that while biomedical engineers or technicians are stationed at facilities, they are employed at the MOH. Some hospitals use maintenance record books available at the hospital, but this is not a universal practice.

Respiratory care equipment

A summary of the feasibility of respiratory care equipment indicators is described in Figure 5. While results were mixed across facilities, nine of eleven indicators were determined as feasible.

Figure 5. Feasibility of respiratory care equipment indicators.



Indicator: Percent (%) of oxygenated facilities with essential oxygen delivery devices.

Determination: Feasible

Data for this indicator is available; however, the ease of data collection varies significantly by device type and is complicated by the distribution of equipment across wards. Ventilators, cylinders, and concentrators are much more easily tracked than small equipment, such as flowmeters and oxygen regulators. Additionally, not all facilities have all equipment considered essential.

Indicator: Number of facilities with at least one functional pulse oximeter in key entry points.

Determination: Feasible

The data collection is feasible; however, it is well noted that the description of ‘number of facilities’ is confusing to collect at the facility level and that this indicator should be modified to read as ‘number of functional pulse oximeters at key entry points’. It is important to note that the appropriate number of pulse oximeters for a facility will vary by facility size and services provided.

Indicator: Oxygen consumed within the facility (m^3) during the reporting period.

Determination: Not feasible

Data is not readily available in the format of cubic meters as described in the indicator. Currently, the primary source of oxygen at most facilities is cylinders (either bedside or in a cylinder manifold). Facilities utilize data sources that record the number of cylinders distributed to wards. While some consumption data may be tracked in patient files, it is not easily available because it is located in individual patient records. This data may be available through prescribing pharmacies.

Indicator: Percent (%) of oxygen concentrators in healthcare facilities that meet quality standards and safety requirements.

Determination: Feasible

There is currently no documentation for oxygen concentrator standards and safety requirement. Typically, this is completed as a physical inspection with oxygen analyzers. Multiple facilities cited that written standards and standardized records would be helpful.

Indicator: Average number of cylinders consumed in a week.

Determination: Feasible

This data is available as recorded by biomedical engineers or technicians at the facility. Facilities without a PSA plant consume many more cylinders compared to those that have a PSA plant.

Indicator: Number of empty oxygen cylinders.

Determination: Feasible

This data is available as recorded by biomedical engineers or technicians at the facility because full cylinders can be procured only when empty cylinders are returned.

Indicator: Number of filled oxygen cylinders.

Determination: Feasible

This data is available as recorded by biomedical engineers or technicians at the facility because full cylinders can be procured only when empty cylinders are returned.

Indicator: Number of oxygen cylinders taken for refill.

Determination: Feasible

This data is available as recorded by biomedical engineers or technicians at the facility in the same cylinder management records as the previously mentioned cylinder indicators.

Indicator: Percent (%) of healthcare facilities with planned preventive maintenance schedules for oxygen equipment (e.g., quarterly or annually).

Determination: Feasible

The majority of facilities determined this indicator is feasible. Some hospitals are already collecting this data or felt that tracking this data could be easily implemented. Other facilities did not consider this feasible because maintenance schedules vary significantly by equipment type and manufacturer and that this would be difficult to track.

Indicator: Percent (%) of healthcare facilities with a documented equipment replacement plan.

Determination: Not feasible

The verbiage is confusing because it is framed as ‘% of healthcare facilities’ and should be rephrased to reflect implementation within facilities. While some facilities felt that this data was unnecessary to collect because there are no resources for actually replacing equipment and when equipment is bought, it is purchased centrally at district or provincial level by MOH.

3. Recommendations

Clinical

Most clinical indicators were determined as feasible because relevant data elements are being collected in patient files.

To implement these indicators for routine monitoring, new standardized registers need to be created and distributed to facilities or amendments can be made to the existing OPD registers to aggregate data.

Additionally, clinical staff are quite busy during their shifts and many of the smaller district hospitals do not have data clerks or dedicated M&E staffing. Indicators should be prioritized according to these resources. Standard operating procedures should be developed, tested, and established to ensure that data collection is manageable in a busy clinical setting and that data is complete and timely.

Staffing

Data is available but requires standardized registers. Some of this data is human resources data that is managed by MOH. It should be evaluated whether this data is reported by facilities or at the district or provincial level by MOH.

Respiratory care equipment

Many of the data elements for equipment indicators, in particular cylinder-related indicators are readily available and being actively tracked by biomedical engineers or technicians. Biomedical engineering staff note that these cylinder tracking methods are sufficient and while not directly aligned with the indicator definitions, there can be slight modifications made to the indicators to reflect current successful processes. Additionally, the indicator definitions should clearly define responsible reporting party. For examples, indicators phrased as '% of healthcare facilities' rely on aggregation at district or provincial level and thus should be reported by MOH. Processes for aggregating this data from facilities need to be well defined and implemented.

Several equipment indicators focused on quality and maintenance according to standards. However, facilities do not have standards and are looking for guidance from the MOH to guide maintenance schedules and quality standards. The MOH should identify and collaborate with the appropriate agency (Zambia Bureau of Standards & Zambia Medicines Regulatory Authority) to develop and document quality standards and safety requirements for respiratory care equipment. Implementing physical inspections and maintaining standardized records will improve the reliability of respiratory care equipment in healthcare facilities.

In reviewing the maintenance related indicators, the frequency of reporting should be explored. It is unlikely that equipment status requires quarterly reporting, and that more extensive and thorough quality checks might be able to be performed with equipment assessments annually or biannually as needed.

4. Conclusion

Routinely monitoring the medical oxygen ecosystem has a multitude of benefits important to managing the supply of oxygen to ensure it is sufficient to meet demand for critical respiratory care. The facility staff who participated in this assessment were in favor of implementing routine oxygen indicators. Successfully implementing indicators requires a variety of stakeholders (healthcare workers, ministry administrators, biomedical engineers, etc.) to agree on the purpose and use of indicator data, and investment in the health information systems, standard operating procedures, and trainings that support indicator collection, review, and usage.

76% of indicators evaluated through this small-scale assessment of seven facilities were determined as feasible. Indicators that were not feasible were determined as such because the definitions were confusing, the data was too resource intensive to collect, and/or there are existing methods of data collection for the same data that are preferred.

Feasible indicators still require clear actions for implementation and scale up including:

- Standardized registers (digital or paper-based) for data collection that aggregate data elements for monthly, quarterly, and/or annual reporting.
- Standard operating procedures to assist responsible staff with the data collection and aggregation process. Roles and responsibilities for indicator implementation should be well defined and integrated into job descriptions.

This feasibility assessment has been a necessary step in solidifying the necessity of routine indicators for the medical oxygen ecosystem. Next steps include finalizing oxygen indicators based on the feedback in this assessment and preparing for an indicator pilot as well as evaluating available resources for indicator scale-up.

5. Annex

Proposed Indicator	Indicator Definition	Disaggregation	Reporting Period	Source of Data
Clinical Indicators				
% of patients screened in critical entry points (OPD, accident, and emergency units) using a pulse oximeter.	***Definition of indicator –*** This indicator measures the percentage of clients whose oxygen saturation levels are checked / assessed using a pulse oximeter when they present at key entry points, specifically OPD, accident and emergency units. ***Calculation of indicator –*** **Numerator:** Number of OPD, accidents and emergency clients with documented oxygen saturation levels measured/assessed using a pulse oximeter at entry point. **Denominator:** Total OPD attendance, accidents and emergency clients during the reporting period.	Age, Sex, Pregnancy Status	Monthly	OPD, accident, and emergency records.
% of patients with oxygen saturation levels < 90%.	***Definition of indicator*** – This indicator measures the percentage of patients screened that have a documented oxygen saturation levels below 90% as measured by a pulse oximeter. ***Calculation of indicator*** – **Numerator**: Number of OPD, accidents and emergency clients with oxygen saturation levels < 90%. **Denominator:** Total number of OPD, accidents and emergency clients whose saturation levels were checked/ measured using a pulse oximeter during the reporting period.	Age, Sex, Pregnancy Status	Monthly	OPD, accident, and emergency records.
% of patients with oxygen saturation levels < 90% commenced on supplementary oxygen	***Definition of indicator –*** This indicator measures the percentage of patients who had low oxygen saturation levels, determined by the pulse oximeter, and were commenced on supplementary oxygen. ***Calculation of Indicator –*** **Numerator:** Total number of clients from OPD, accidents and emergency units with oxygen saturation levels < 90% commenced on supplementary oxygen. **Denominator:** Total number of OPD, accidents and emergency clients with oxygen saturation levels < 90%.	Age, Sex, Pregnancy Status	Monthly	
% of patients commenced on supplementary oxygen with unknown or undocumented oxygen saturation levels.	***Definition of indicator*** – This indicator measures the percentage of patients who were started on supplemental	Age, Sex, Pregnancy Status	Monthly	

Proposed Indicator	Indicator Definition	Disaggregation	Reporting Period	Source of Data
	oxygen therapy (via nasal cannula, mask, etc.) but did not have baseline oxygen saturation (SpO2) levels documented. ***Calculation of indicator*** – **Numerator:** Number of patients on supplementary oxygen with unknown and or undocumented oxygen saturation levels. **Denominator:** Number of patients commenced on supplementary oxygen during the reporting period.			
Average patient stay on supplementary oxygen (in days).	***Definition of indicator*** – This indicator measures the average number of days that patients spent receiving supplementary oxygen therapy during their stay in a hospital, within a given reporting month. ***Calculation of indicator*** – **Numerator**: Total number of days patients are on supplementary oxygen (SUM of all patients on supplementary oxygen during the reporting period). **Denominator**: Total number of patients on supplementary oxygen during the reporting period.	Age, Sex, Pregnancy Status	Monthly	
Number of hospitalized patients receiving oxygen with SpO2 < 93% at 24 hours post-admission out of the total number of hospitalized patients receiving oxygen therapy.	***Definition of indicator*** – This indicator measures the number of hospitalized patients who are receiving supplementary oxygen therapy and have an oxygen saturation (SpO2) level less than 93% at 24 hours after their admission to the healthcare facility, expressed as a proportion of the total number of hospitalized patients receiving oxygen therapy. ***Calculation of indicator*** – **Numerator:** Total number of patients whose SpO2 is less than 93% when measured 24 hours after hospital admission. **Denominator:** Total number of patients receiving supplementary oxygen who have been hospitalized > 24 hours.	Age, Sex, Pregnancy Status	Monthly	
% of patients on supplementary oxygen who recovered/were discharged.	***Definition of indicator –*** Measures patients that were commenced on supplementary oxygen and had favorable outcomes. These patients should have progressed well and have either been discharged or are off oxygen. ***Calculation of indicator –*** **Numerator:** Number of patients commenced on supplementary oxygen and had favorable outcomes/no longer on oxygen. **Denominator:** Total number of patients commenced on supplementary oxygen during the reporting period.	Age, Sex, Pregnancy Status	Monthly	

Proposed Indicator	Indicator Definition	Disaggregation	Reporting Period	Source of Data
Capacity building indicators				
% of clinical staff appointed in critical care units that received standardized oxygen therapy training.	***Definition of indicator –*** this indicator refers to the proportion of healthcare workers in designated critical care units who have been trained on the appropriate use and management of oxygen therapy. i) Definition of critical care units - (Areas where oxygen therapy is utilized) High Dependency Unit, ICU, Maternity ward, Neonatal ICU, Emergency ward (The team discussed that these units can be defined as a specialized units where patients with respiratory conditions or any conditions which may lead to respiration challenges requiring intensive care and advanced oxygen therapy to maintain their oxygen levels; and they also discussed that these should be collected per ward to ensure an accurate understanding of the percentage for this indicator). ii) Definition of clinical staff - nurses, doctors, anesthesiologists, clinical officers* iii) List of standardized oxygen therapy training - MOH does not have a standardized training package for oxygen therapy. This will need to be formulated. There is a basic critical care training that has been running from central level that was tailored towards COVID-19 with the component of oxygen escalation. The target audience for this training was critical care nurses, but it has been changing over time and including more cadres. Therefore, the training has changed and is not a basic training anymore. ***Calculation of indicator – Numerator:*** total clinical staff with training in standardized oxygen therapy in critical care units. ***Denominator:*** total clinical staff attached to critical care units * 100.		Quarterly	Training registers and staff allocation registers.
% of BME/Ts that are trained to install, maintain and repair RCE equipment.	***Definition of indicator –*** refers to the proportion of specialized healthcare technicians who have the necessary skills and knowledge to work with respiratory care equipment. ii) Definition of biomedical engineers/technicians – biomedical engineers can be covered as biomedical engineering professionals.		Quarterly	Training registers and staff allocation registers.

Proposed Indicator	Indicator Definition	Disaggregation	Reporting Period	Source of Data
	Calculation of indicator – Numerator: number of biomedical engineers trained. ***Denominator:*** number of biomedical engineers employed *100.			
% of oxygenated facilities that received at least one on-site BME/T providing technical support.	***Definition of indicator –*** refers to the proportion of healthcare facilities that have access to a dedicated biomedical engineer/technician who can provide on-site maintenance, repair, and troubleshooting services for the respiratory care equipment used in the facility. i) Definition of on-site support - (facilities that do not have a resident biomedical engineers/technicians). ***Calculation of indicator – Numerator:*** number of oxygenated facilities that received at least one biomedical engineer/technician on site providing technical support. ***Denominator:*** number of facilities that does not have a biomedical engineer/technician*100.		Quarterly	Visitors book and maintenance record.
Equipment indicators				
% of oxygenated facilities with essential oxygen delivery devices	***Definition of indicator*** – refers to the percentage of health facilities that have the basic medical equipment necessary to administer oxygen therapy to patients in need. i) Definition of oxygenated facilities - facilities that utilize oxygen (i.e. generated or received). ii) ii) Essential oxygen delivery devices - oxygen concentrators, oxygen cylinders, oxygen regulators and flow meters, nasal cannulas or oxygen masks, tubingm and connectors. ***Calculation of indicator*** – ***Numerator:*** number of oxygenated facilities with essential oxygen delivery devices. ***Denominator:*** total number of facilities*100.		Monthly	Inventory list from the facility.
Number of facilities with at least one functional pulse oximeter in key entry points.	***Definition of indicator –*** refers to the count of healthcare facilities that have at least one working pulse oximeter device available at critical access points within the facility. i) Definition of entry points - The first point of access. These entry points are the Emergency unit, Pediatric unit, Maternity unit, High Dependency Unit, Theatre and ICU.		Monthly	Inventory list from the facility.

Proposed Indicator	Indicator Definition	Disaggregation	Reporting Period	Source of Data
	ii) Definition of functionality - passes a calibration test or shows accuracy.			
Oxygen consumed within the facility (m^3) during the reporting period.	***Definition of indicator –*** refers to the total volume of oxygen gas, measured in cubic meters (m^3), that was utilized within a healthcare facility during a specific reporting period. ***Calculation of indicator –*** Consumption = liquid oxygen delivered (measured in tons) + cylinders utilized + PSA filled cylinders.		Monthly	Electronic consumption logs downloaded with telemetry for PSA plants and invoices from bulk tank suppliers for liquid oxygen.
% of oxygen cylinders in healthcare facilities that meet quality standards and safety requirements.	***Definition of indicator –*** refers to the proportion of oxygen cylinders used in healthcare facilities that comply with established standards and regulations for the safe storage, handling, and use of medical oxygen. i) Definition of quality standards and safety requirements – Zambia Bureau of Standards has standards. MOH will review these standards. ***Calculation of indicator*** – ***Numerator:*** number of cylinders meeting quality standards and safety requirements. ***Denominator:*** number of cylinders present at a facility owned by MOH*100.		Quarterly	Inventory list from the facility.
% of oxygen concentrators in healthcare facilities that meet quality standards and safety requirements.	***Definition of indicator –*** refers to the proportion of oxygen concentrators used in healthcare facilities that comply with established standards and regulations for the safe storage, handling and use of medical oxygen. i) Definition of quality standards and safety requirements - 83% and above of oxygen produced, clinically safe, connected to an electric analyzer. ***Calculation of indicator – Numerator:*** total number of oxygen concentrators meeting quality standards and safety requirements. ***Denominator:*** total number of functional oxygen concentrators present at a facility*100.		Monthly	Inventory list from the facility.
Average number of cylinders consumed in a week	***Definition of indicator –*** refers to the average quantity of oxygen cylinders used by a healthcare facility or set of facilities over the course of a one-week period.		Weekly	

Proposed Indicator	Indicator Definition	Disaggregation	Reporting Period	Source of Data
	Calculation of indicator – Numerator: Total number of oxygen cylinders consumed during the week. ***Denominator:*** 7 days.			
Number of empty oxygen cylinders.	***Definition of indicator –*** refers to the total count of oxygen cylinders that have been depleted of their oxygen content and are awaiting refilling or replacement at a healthcare facility.		Weekly	
Number of filled oxygen cylinders.	***Definition of indicator –*** refers to the total count of oxygen cylinders that are currently filled with oxygen and available for use within a healthcare facility.		Weekly	
Number of oxygen cylinders taken for refill.	***Definition of indicator –*** refers to the total count of individual oxygen cylinders that are removed from the facility or distribution point and sent to be refilled with medical oxygen.			
% of healthcare facilities with planned preventive maintenance schedules for oxygen equipment. (e.g., quarterly or annually).	***Definition of indicator –*** refers to the proportion of healthcare facilities that have established and implemented regular maintenance schedules for their oxygen-related equipment and infrastructure. i) Definition of preventive maintenance - the act of performing regularly scheduled maintenance activities to help prevent unexpected failures in the future. ii) Definition of oxygen equipment - oxygen generating and delivery equipment. Systems that are designed to provide supplemental oxygen to patients who require it due to medical conditions. These are various and include equipment such as oxygen tanks/cylinders, oxygen concentrators, oxygen masks, nasal cannulas, oxygen regulators, oxygen humidifiers, various accessories such as tubing, connectors, and carrying cases that facilitate the use of oxygen equipment and ensure comfort and convenience for the user. ***Calculation of indicator – Numerator:*** Total number of health facilities with a preventive maintenance schedule. ***Denominator:*** total number of health facilities *100.		Quarterly	

Proposed Indicator	Indicator Definition	Disaggregation	Reporting Period	Source of Data
% of healthcare facilities with a documented equipment replacement plan.	***Definition of indicator –*** refers to the proportion of healthcare facilities that have established and documented a comprehensive plan for the systematic replacement of their medical equipment, including oxygen-related equipment. i) Definition of documented equipment replacement plan - document stipulating when and how equipment should be replaced. ***Calculation of indicator – Numerator:*** Number of facilities with a documented equipment plan. ***Denominator:*** total number of health facilities *100.		Annually	Equipment replacement plan.

6. References

Ministry of Health . 2022. *Zambia National Medical Oxygen Strategic Plan (2022-2026)*. Lusaka: Minsitry of Health Zambia.

PATH. 2022. *Strengthening Oxygen Data Management Systems: Zambia Oxygen Data Dashboard Survey Report.* Seattle: PATH.