



REPUBLIC OF ZAMBIA
MINISTRY OF HEALTH

2022–2026

Zambia National Medical Oxygen Strategic Plan

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Statement by the Honourable Minister of Health



The Government of the Republic of Zambia is committed to securing modern health equipment, infrastructure maintenance, and equitable access to high-quality health care services to all Zambians.

Zambia faces immense challenges in the provision of safe and reliable access to medical oxygen, which has been exacerbated by the COVID-19 pandemic. This presents a pivotal opportunity for the country to prioritise investments in medical oxygen systems through the development and implementation of the National Medical Oxygen Strategic Plan (NMOSP) 2022–2026.

The NMOSP 2022–2026 describes the Zambian health system's current state and ability to provide safe and reliable access to medical oxygen. The NMOSP will strengthen oxygen delivery systems, increase the overall availability of medical oxygen and oxygen delivery accessory options to patients, and decrease morbidity and mortality related to hypoxemia. Prioritised interventions within this strategy cover the following components of oxygen systems: medical oxygen production capacity, equipment and supplies availability, medical oxygen distribution and delivery, industry landscape, medical oxygen purity, clinical use of medical oxygen, and human resource capacity.

Our hope is that implementation of the NMOSP will build on existing medical oxygen systems in the public and private sectors, support the optimisation of medical oxygen investments, and guide future investments from the government, multilateral and bilateral partners in the health care space, and private-sector actors. To accomplish this, Zambia shall engage a diverse group of stakeholders to increase awareness of medical oxygen as an essential medicine, strengthen the country's technical expertise, and identify and pursue financing opportunities for medical oxygen even beyond the COVID-19 pandemic.

A handwritten signature in black ink, appearing to read 'Sylvia T. Masebo'.

Hon. Sylvia T. Masebo, MP
Minister of Health

Foreword



Oxygen is an essential medicine used to manage a wide range of conditions across the spectrum of diseases that includes but not limited to: prehospital and acute care, maternal and child health and inpatient medical care, and treatment of infectious respiratory diseases such as COVID-19. In 2020 the global pandemic further underscored the critical role of oxygen as a lifesaving therapy. The Biomedical Equipment Survey 2020, conducted in COVID-19 treatment facilities in Zambia, revealed gaps in medical oxygen production capacity, equipment, supplies, infrastructure, and human resources. The systems to supply and distribute medical oxygen have been further strained, resulting in even less availability of this critical commodity. This has demonstrated the need for robust systems to support medical oxygen access in Zambia. To bridge the highlighted gaps and challenges, there is a need to increase medical oxygen-generation capacity by optimising placement of production sources and strengthening oxygen delivery and supply systems.

Improving access to medical oxygen requires comprehensive investment in medical oxygen systems, including but not limited to the following:

- Increasing medical oxygen-generation capacity.
- Making distribution of medical oxygen more widespread and reliable.
- Procuring medical devices and associated technologies to facilitate safe oxygen administration to patients.
- Building capacity of clinicians and engineers to use medical devices to administer medical oxygen and to maintain devices.
- Establishing standards, guidelines, protocols, and job aids for medical oxygen-generation equipment and medical oxygen administration.
- Monitoring the effect of interventions for medical oxygen.

The Ministry of Health's vision is that the National Medical Oxygen Strategic Plan 2022–2026 will build on existing medical oxygen systems in the public and private sectors. This will further optimise medical oxygen investments, as well as motivate future investments from other oxygen stakeholders. The Ministry of Health will endeavour to engage key stakeholders to ensure that resilient medical oxygen systems are developed and accessible to all Zambians. I therefore urge all key stakeholders to actively participate in the implementation of this strategic plan.

A handwritten signature in black ink, appearing to read 'Jackson Kasonka', written over a faint circular watermark.

Prof. Jackson Kasonka
Permanent Secretary–Technical Services
Minister of Health

Acknowledgements



The development of the National Medical Oxygen Strategic Plan (NMOSP) 2022–2026 was made possible through an inclusive and consultative process with a diverse group of stakeholders, including government officials, clinicians, technical experts, international organisations, and donors. These efforts have resulted in a comprehensive document. Special gratitude is extended to the consortium of partners (Global Fund, US Agency for International Development, World Health Organization, PATH, and Clinton Health

Access Initiative) for technical support towards the development of this document.

On behalf of the Ministry of Health, I also wish to acknowledge and give special thanks to PATH for the financial and technical support and for coordinating in the formulation of the document. The direction and valuable support of our cooperating partners made it possible for the plan to be successfully completed.

Special thanks also go to all the members of staff of the Ministry of Health, provincial health offices, district health offices, and hospitals, as well as representatives of statutory boards, for their participation in, contributions to, and support for the process of formulating this NMOSP.

It is my hope that the NMOSP 2022–2026 successfully addresses the medical oxygen–related issues currently found in our health institutions.

A handwritten signature in black ink, consisting of a stylized 'A' followed by a series of loops and a long horizontal stroke.

Dr. Alex Makupe

Director of Clinical Care and Diagnostic Services
Minister of Health

Abbreviations

ASU	air separation unit
COVID-19	coronavirus disease 2019
CP	coordinating partner
DHO	district health office
eLMIS	electronic logistics management information system
EU	emergency unit
HCC	head of clinical care
HDU	high-dependency unit
HIV/AIDS	human immunodeficiency virus / acquired immunodeficiency syndrome
HMIS	health management information system
ICU	intensive care unit
LOX	liquid oxygen
M&E	monitoring and evaluation
MOH	ministry of health
NDP	National Development Plan
NMOSP	National Medical Oxygen Strategic Plan
NOC	national oxygen coordinator
OPD	outpatient department
PSA	pressure swing adsorption
SOP	standard operating procedure
SWOT	strengths, weaknesses, opportunities, and threats
WHO	World Health Organization
ZAMMSA	Zambia Medicines and Medical Supplies Agency
ZAMRA	Zambia Medicines Regulatory Authority

Executive Summary

Medical oxygen therapy plays a central role in the management of hypoxemia (low oxygen level in the blood). In Zambia, illnesses such as pneumonia result in high hypoxemia prevalence and unmet need for medical oxygen. Overall, the current demand for medical oxygen outstrips supply, restricting access to oxygen. This results in high morbidity and mortality from a variety of illnesses and conditions that require medical oxygen therapy. Additionally, surges in medical oxygen demand due to COVID-19 have revealed shortfalls in medical oxygen production capacity, as well as shortages of equipment and supplies, and Zambia also faces technical challenges in quantifying oxygen needs and determining appropriate allocation of resources across health facilities.

In 2020, a Biomedical Equipment Survey was conducted to assess respiratory care services in eight government-owned health facilities that were designated COVID-19 treatment centres by the Zambia National Public Health Institute.¹ The assessment quantified their treatment capacity for providing respiratory care, including supplies and equipment, human resources, and oxygen production capacity. The assessment revealed that all assessed institutions urgently needed to procure medical equipment for medical oxygen delivery, monitoring devices to support safe medical oxygen administration to patients, and the accompanying consumables. It also found that all facilities had inadequate staff trained to manage COVID-19 patients who required respiratory care, especially medical oxygen therapy.

Investments in reliable and comprehensive oxygen system infrastructure, production, and delivery should be prioritised. Therefore, the focus of the *Zambian National Medical Oxygen Strategic Plan (NMOSP) 2022–2026* will be on the following eight strategic objectives:

1. Strengthen medical oxygen supply systems in 60 percent of public hospitals in Zambia.
2. Improve the rational use of medical oxygen at all levels of health care services.
3. Increase the proportion of health facilities receiving high-quality medical oxygen.
4. Increase the number of staff involved in oxygen management from 44 to 3,614.ⁱ
5. Ensure an efficient, resilient, and safe oxygen delivery system by systematically collecting high-quality data in a timely manner to provide information for decision-making
6. Strengthen research in key medical oxygen system priority areas and scale up research activity to all level 1 facilities
7. Promote a coordinated approach to leadership, governance, and accountability.
8. Mobilise adequate financial resources to sustain the provision of medical oxygen services.

ⁱ Table 18. NMOSP Strategic Objective Framework, 2022 to 2026 – strategic objective no. 7.

The total cost to implement the NMOSP 2022–2026 is estimated at US\$1,627,243,928.

The main source of data for monitoring of the NMOSP will be administrative and programme reports. At the Ministry of Health level, these reports will be generated using the District Health Information System 2 and an electronic health management information system.

The evaluation plan for this NMOSP consists of three phases: gathering of baseline data, conducting of a midterm evaluation midway through the implementation period, and conducting of an end-line evaluation at the end of the strategy implementation period.

This strategy is intended to serve as a core reference document for oxygen policy implementation from 2022 to 2026.

1. Background

1.1 Introduction

The Zambian National Medical Oxygen Strategic Plan (NMOSP) 2022–2026 provides strategic direction for ensuring the supply of safe medical oxygen needed to manage clients with respiratory conditions, including COVID-19. The NMOSP first provides context for and background on the country of Zambia, including an overview of the population size, key national policies, progress towards achieving established health and development goals, and the structure of the health care system. These are all important factors to consider when making recommendations for improved medical oxygen services.

In the situational analysis, it describes Zambia’s existing oxygen services and highlights the findings of the Biomedical Equipment Survey that the Ministry of Health (MOH) and PATH conducted in 2020 across Zambia’s health facilities. The findings describe the current state of infrastructure and human resources for supporting oxygen services, equipment and supplies availability, and medical oxygen–generation capacity in the public and private sectors. Additionally, the findings were used to arrive at an estimate for oxygen supply and equipment (pulse oximetry) needs and make recommendations for financing and resource mobilisation for oxygen.

Overall, the NMOSP provides strategies to tackle medical oxygen production, supply, and distribution, as well as overall support for the country in meeting its oxygen needs. A total cost estimate for enacting the NMOSP is provided, as well as recommendations for monitoring and evaluation (M&E) of the NMOSP.

1.2 Country Profile

The Republic of Zambia is located in the southern part of sub-Saharan Africa. It covers approximately 752,612 km² and is land-linked to eight other countries—namely, Tanzania, the Democratic Republic of the Congo, Malawi, Mozambique, Zimbabwe, Botswana, Namibia, and Angola.

The country has ten provinces comprising 116 districts. Zambia’s total population was projected to be 18,400,343 in 2021.² Lusaka is the most populated of the ten provinces, accounting for 18.9 percent of the total population. Copperbelt Province was second with 14.9 percent, and Southern Province was third with 11.9 percent. Table 1 presents population data for 2021, by province.

Table 1: Zambian Population, by Province

Province	Population (2021)		
	Rural	Urban	Total
Central	1,328,910	452,536	1,781,446
Copperbelt	427,511	2,308,039	2,735,550
Eastern	1,847,401	271,930	2,119,331
Luapula	1,001,471	306,579	1,308,050
Lusaka	479,059	3,005,335	3,484,394
Muchinga	804,713	334,564	1,139,277
North-Western	654,012	321,547	975,559
Northern	1,263,065	303,304	1,566,369
Southern	1,601,167	594,249	2,195,416
Western	965,870	129,081	1,094,951
All provinces	10,373,179	8,027,164	18,400,343

Source: Population and Demographic Projections, 2011– 2035 July 2013. 2010 Census of population and housing, Zambia Statistics Agency.

Since 2006, Zambia has implemented the Vision 2030 strategy, which aims to transform the country into a prosperous middle-income nation by 2030.³ The country attained lower-middle-income status in 2011, although the economic performance has stalled in recent years. Zambia has worked to attain Vision 2030 through implementation of a series of successive five-year National Development Plans (NDPs), which outline the country’s overall socioeconomic development agenda. Most recently, the country implemented the seventh NDP, which expired in December 2021.

The attainment of Zambia’s goal of being a prosperous middle-income country by 2030 depends upon having a healthy and productive population.^{4,5} Through Vision 2030 and the NDPs, Zambia intends to provide equitable access to high-quality health care for all by 2030. The country has prioritised health and is committed to the attainment of “equity of access to cost-effective quality health services, as close to the family as possible.”⁶ In this regard, the health care sector’s focus is on provision of a continuum of care, with particular emphasis on promotional, preventive, curative, rehabilitative, and palliative services. This provision is challenged by the burden of diseases in Zambia, which is very high and characterised by a high prevalence of communicable diseases; emerging and re-emerging infectious diseases,⁷ including COVID-19; and an emerging burden of non-communicable diseases. This burden has had a significant impact on morbidity and mortality levels across the country.⁶

Table 2 shows the top ten causes of mortality from 2015 to 2019, with respiratory infection (pneumonia) in the second position, and Table 3 shows the top ten causes of morbidity in health facilities from 2015 to 2019, with respiratory infection (pneumonia) in the first position.

Table 2: Top Ten Causes of Mortality, 2015–2019

Disease	Deaths per Year					
	2015	2016	2017	2018	2019	Average
Malaria	2,538	1,796	1,344	1,160	1,275	1,586.6
Respiratory infection (pneumonia)	1,741	1,231	955	1,041	875	1,168.6
Tuberculosis	1,576	1,134	954	923	810	1,079.4
Anaemia	1,493	1,299	975	825	960	1,110.4
Diarrhoea (non-bloody)	1,281	839	583	463	516	736.4
Cardiovascular diseases	1,268	1,014	755	790	767	918.8
Other disease	1,057	941	345*	588	663	649.8
Severe malnutrition	792	553	431	391	454	542.2
Hypertension	739	542	517	792	675	653.0
Digestive system (not infectious)	640	504	372	364	488†	376.0

Source: DHIS2 Zambia Health Management Information System website. <http://dhis2.moh.gov.zm/hmis>.

*Pregnancy complications (abortions) were excluded in the analysis of the average.

†Mental health (psychosis) was excluded in the analysis of the average.

Table 3: Top Ten Causes of Morbidity, 2015–2019

Disease Position	2015	2016	2017	2018	2019
1	Respiratory infection (non-pneumonia) 6,190,069	Respiratory infection (non-pneumonia) 6,489,505	Respiratory infection (non-pneumonia) 7,215,899	Respiratory infection (non-pneumonia) 7,261,622	Respiratory infection (non-pneumonia) 6,486,961
2	Malaria 4,127,288	Malaria 6,000,688	Malaria 6,056,296	Malaria 5,193,173	Malaria 5,279,014
3	Diarrhoea (non-bloody) 1,563,569	Diarrhoea (non-bloody) 1,645,841	Diarrhoea (non-bloody) 1,702,923	Diarrhoea (non-bloody) 1,679,603	Diarrhoea (non-bloody) 1,558,367
4	Muscular skeletal and connective tissue (not trauma) 1,078,920	Muscular skeletal and connective tissue (not trauma) 1,169,010	Muscular skeletal and connective tissue (not trauma) 1,314,817	Muscular skeletal and connective tissue (not trauma) 1,378,156	Muscular skeletal and connective tissue (not trauma) 1,325,816
5	Digestive system (not infectious) 737,522	Digestive system (not infectious) 848,969	Digestive system (not infectious) 939,615	Digestive system (not infectious) 945,442	Digestive system (not infectious) 920,496
6	Trauma (other injuries, wounds) 415,361	Skin diseases (not infectious) 430,854	Skin diseases (not infectious) 471,318	Skin diseases (not infectious) 428,093	Trauma (other injuries, wounds) 458,542
7	Respiratory infection (pneumonia) 401,998	Dental carries 401,793	Dental carries 412,359	Dental carries 398,272	Skin diseases (not infectious) 412,449
8	Dental carries 392,097	Respiratory infection (pneumonia) 382,973	Throat diseases 406,415	Throat diseases 391,877	Dental carries 372,948
9	Skin diseases (not infectious) 388,212	Throat diseases 378,934	Respiratory infection: pneumonia 389,311	Respiratory infection: pneumonia 361,848	Respiratory infection: pneumonia 333,119
10	Throat diseases 345,407	Trauma (other injuries, wounds) 375,612	Trauma (other injuries, wounds) 339,988	Trauma (other injuries, wounds) 310,754	Throat diseases 324,789

Source: DHIS2 Zambia Health Management Information System website. <http://dhis2.moh.gov.zm/hmis>.

Table 4 presents a summary of select demographic and socioeconomic indicators, showing a poverty level of 58.7 percent and urban population of 46.4 percent. Table 5 presents health indicators, showing an adult mortality rate of 5.11 deaths per 1,000 people.

Table 4: Demographic and Socioeconomic Indicators for Zambia

Indicator	Status	Source
Population	18.4 million	World Bank 2020*
Sex ratio (male to female)	1:1	World Bank 2020*
Average annual population growth rate	2.8%	World Bank 2021†
Life expectancy at birth	63.5 years	World Bank 2020*
Population under the age of 15 years	26.2%	World Bank 2014‡
Urban population	46.4%	ZDHS 2013-2014‡
Poverty level	58.7%	World Bank 2020*
Gross domestic product per capita	US\$1055.90	World Bank 2020*

Sources:

*The World Bank. Macro Poverty Outlook for Zambia. Washington, DC: World Bank Group; 2017. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/873591507018703264/macro-poverty-outlook-for-zambia>.

†The World Bank website. The World Bank in Zambia overview page. <https://www.worldbank.org/en/country/zambia/overview>.

‡World Bank website. Demographic and Health Survey 2013-2014, Zambia 2013-2014 page. <https://microdata.worldbank.org/index.php/catalog/2246>.

Abbreviation: ZDHS, Zambia Demographic and Health Survey.

Table 5: Health Indicators for Zambia.

Indicator	Status
Adult mortality rate	5.11 deaths / 1,000 people
Maternal mortality rate	252 deaths / 100,000 live births
Infant mortality	42 deaths / 1,000 live births
Mortality rate for children under 5 years old	61 deaths / 1,000 people
HIV prevalence	11.1%

Source: Zambia Statistics Agency, Zambia Ministry of Health (MOH), ICF. *Zambia Demographic and Health Survey 2018*. Lusaka and Rockville, MD: Zambia Statistics Agency, MOH, and ICF; 2020. <https://dhsprogram.com/publications/publication-fr361-dhs-final-reports.cfm>.

1.3 Justification for the NMOSP

Zambia's capacity to produce medical oxygen in public health facilities is inadequate due to the small number and low production capacity of pressure swing adsorption (PSA) plants; insufficiently maintained plants and other associated infrastructure, such as manifolds and medical oxygen reticulation; and inadequate supply of oxygen cylinders.

In addition, limited private-sector participation results in few options for sourcing medical oxygen, yet health care facilities are extremely dependent on the private sector to supply oxygen cylinders due to low production from government-owned oxygen plants. It would be ideal to have multiple oxygen supply sources to avoid reliance on any one supply source, which could result in complete unavailability in an adverse event (e.g., power outage, device failure) or unreliable stock of medical oxygen supply, accessories, consumables, or spare parts.

Furthermore, there is a shortage of medical devices, such as oxygen concentrators, ventilators, and pulse oximeters. Respiratory care units, including COVID-19 treatment centres, urgently need to procure medical devices, accessories, and consumables for safe administration of high-quality oxygen.

To address the inadequacies evidenced in the oxygen space as a result of the COVID-19 pandemic and foster a multi-stakeholder response for oxygen, the MOH co-hosted a virtual Zambia Oxygen Summit from 20 to 23 October 2020, in collaboration with the Zambia National Public Health Institute and PATH, as part of its work to prioritise and increase oxygen access amidst the COVID-19 pandemic and beyond.⁸ The summit focused on fulfilling medical oxygen demand for the management of critically and severely ill COVID-19 patients within the designated pandemic treatment centres and around the country. Essential actions to take according to the resolutions of the summit include but are not limited to the following:

- Develop a national strategy for oxygen that would outline immediate solutions for scaling up production, distribution, and supply of medical oxygen.
- Divide the country into zones and set up provincial hubs for oxygen production, distribution, and supply.
- Review and monitor oxygen distribution and consumption systems.
- Install bulk liquid oxygen tanks at Level 3 hospitals.
- Develop guidelines and standards for certification of oxygen purity and safety from production to patient use under the leadership of the Zambia Medicines Regulatory Authority (ZAMRA).
- Upgrade the skills of clinicians in respiratory care management and ensure that specialist care is available at all levels of the health care system.

Addressing these insufficiencies will ensure uninterrupted supply of high-quality and safe medical oxygen to patients through adequate infrastructure to support oxygen supply systems, oxygen delivery equipment and supplies, monitoring equipment for safe oxygen administration, and oxygen production equipment and supply.

1.4 Health Care System Structure

1.4.1 Overview

The Zambian health care system includes the public health sector, faith-based health sector, and private sector. Both for-profit and not-for-profit health services exist within these sectors, as well as traditional and alternative health services.⁹ Table 6 presents a breakdown of the number of health facilities in Zambia, by managing authority.

Table 6: Distribution of Health Facilities, by Managing Authority

Managing Authority	2022 list of Zambia Health Facilities Number (%)
Government	2,822 (82.8%)
Government (military)	57 (01.7%)
Government (police)	8 (00.2%)
Mission	91 (03.8%)
Non-governmental organisation	19 (00.6%)
Private sector	393 (11.0%)
Total	3,409 (100.0%)

The number of health facilities varies by province, as seen in Table 7.

Table 7: Number of Health Facilities, by Province

Province	No. of Health Facilities (%)
Central	321 (9.4%)
Copperbelt	384 (11.3%)
Eastern	362 (10.6%)
Luapula	285 (08.4%)
Lusaka	481 (14.1%)
Muchinga	202 (05.9%)
Northern	298 (08.7%)
North-Western	331 (09.7%)
Southern	425 (12.5%)
Western	320 (09.4%)
All provinces	3,409 (100.0%)

Core health service delivery facilities are categorised into eight levels: community health service (at the community level), health posts (at the community level), health centres (at the community level), mini hospitals (at the community level), level 1 hospitals (at the district level), level 2 hospitals (at the provincial level), level 3 hospitals (at the central level), and level 4 hospitals (also called specialised hospitals at the central level). The patient referral system follows the same hierarchy. Additionally, mobile health services provide a significant amount of surgical care, equivalent to level 2 hospitals. Table 8 presents a breakdown of the number of health facilities in Zambia, by level of care.

The National Health Strategic Plan 2017–2021 defines the framework within which both public and private health service delivery is organised, based on the Zambia Basic Health Care Package.¹⁰ This package is delivered through a system that comprises the eight levels of health care, as outlined below.⁹

1.4.2 Community Health Services

Community-based volunteers provide essential health care to individuals and families. Key elements of community health service include health promotion; use of rapid diagnostic tests for malaria; home-based care, including for HIV, diabetes, and kidney disease; growth monitoring and immunisation of children; screening for cancer, diabetes, and hypertension; and hospice care. The community-based volunteers are responsible for follow-up and monitoring of adherence to treatment for chronic ailments.

1.4.3 Health Posts

Health posts are located within a community and are staffed by midwives, general nurses, environmental health officers, public health nurses, and community health assistants. Health post catchment areas cover 500 households (3,500 people) in rural areas and 1,000 households (7,000 people) in urban areas. Health posts are the first level of patient contact with health care providers and offer promotive and preventive services; limited diagnostic tests, like microscopy and haemoglobin tests; and rehabilitative services. Curative services include treatment of uncomplicated malaria, acute diarrhoeal diseases, upper respiratory tract infections, and provision of first aid.

1.4.4 Rural and Urban Health Centres

There are two types of health centres in Zambia—namely, rural health centres that are intended to serve a population of up to 10,000 people and urban health centres that are intended to serve a catchment population of 30,000 to 50,000 people. Each rural health centre is staffed by a midwife, general nurse, environmental health personnel, clinical officer, and public health nurse, whilst each urban health centre is staffed by the same plus a medical doctor; medical licentiate; and pharmacy, laboratory, physiotherapy, dental, and nutrition personnel.

The main activities at the health centre level are predominantly health promotion and disease prevention. However, some limited curative services are provided, too, with complicated cases being referred to the next level of care.

Primary health care services offered include the following: antenatal, postnatal, and neonatal care; family planning; routine Expanded Programme on Immunisation activities; growth monitoring; management of childhood diseases; treatment of malaria and tuberculosis, including Directly Observed Treatment, Short-Course; antiretroviral therapy and volunteer counselling and testing; surveillance and screening for communicable and non-communicable diseases, environmental health, water and sanitation, school health and nutrition, and epidemic preparedness; treatment of minor injuries; surgery; infant incubation; and ultrasound scans.

1.4.5 Mini Hospitals

Mini hospitals serve a catchment population of between 50,000 to 80,000 and are each staffed by a medical doctor, medical licentiate, clinical officer, midwife, general nurse, public health nurse, and pharmacy, laboratory, physiotherapy, environmental health, dental, and nutrition personnel. They provide minor surgical, obstetrics and gynaecological, and diagnostic services, as well as HIV/AIDs and outpatient services. Complicated cases are referred to the next level of care.

1.4.6 Level 1 Hospitals

Level 1 referral hospitals are found in most districts, are intended to serve a catchment population of between 80,000 and 200,000, and are each staffed by a medical doctor, medical licentiate, clinical officer, midwife, nurse, specialist nurses, and pharmacy, laboratory, physiotherapy, environmental health, dental, radiology, and nutrition personnel. Services offered include primary health care services and medical, surgical, obstetric, and diagnostic services with a high-dependency unit. The clinical services provided at level 1 support mini hospital and health centre referrals. This level is also the entry point for curative and rehabilitative services provided at the secondary and tertiary levels of care.

1.4.7 Level 2 Hospitals

Level 2 (general) hospitals are intended to serve catchment areas ranging from 200,000 to 800,000 people and are each staffed by specialist doctors, a medical doctor, medical licentiate, clinical officer, midwife, nurse, specialist nurses, and pharmacy, laboratory, physiotherapy, environmental health, dental, radiology, and nutrition personnel. Services provided include the following: internal medicine, general surgery, paediatrics, obstetrics and gynaecology, dental, psychiatry, and intensive care units (ICUs). They also act as referral centres for Level 1 hospitals, including the provision of technical support to referring facilities. Most of the general hospitals have training institutions on-site, most frequently nursing institutions, and serve as training centres during student clinical attachments.

1.4.8 Level 3 Hospitals

Level 3 facilities, or central hospitals, are designed to serve a catchment population of 800,000 and above and are each staffed by a medical doctor, medical licentiate, clinical officer, midwife, nurse, specialist nurses, and pharmacy, laboratory, physiotherapy, environmental health, dental, radiology, and nutrition personnel. Services provided include the following: internal medicine, general surgery, paediatrics, obstetrics and gynaecology, dental, psychiatry, and ICUs. Level 3 hospital has one MRI scanner and provide technical support to level 2 hospitals.

1.4.9 Specialised Hospitals

Specialised hospitals provide specialised health care services, training, and research. They are each staffed by specialist doctors, a medical doctor, specialised and general nurses, and pharmacy, physiotherapy, radiology, laboratory, environmental health, and nutrition personnel.

Currently, there are eight facilities offering specialised services: Cancer Diseases Hospital, Chainama Hills Hospital, Arthur Davison Hospital, Kitwe Eye Hospital, University Teaching Hospital – Eye, University Teaching Hospital – Women and Newborn, University Teaching Hospital – Children’s Hospital, and National Heart Hospital.

Level 4 (specialised) facilities are also the country’s major training centres, with affiliation to university schools of medicine. The specialised hospitals provide clinical attachment and mentorship for different health care workers. Level 4 facilities are expected to be centres of excellence in provision of health care services.

Table 8: Distribution of Health Facilities by Level of Care for the Year 2022

Facility Type	No. of Health Facilities (%)
Health post	1436 (42.2)
Rural health centre	1,124 (33.0)
Urban health centre	580 (17.0)
Mini-Hospital	89 (02.6)
Level 1 hospital	126 (03.7)
Level 2 hospital	38 (01.1)
Level 3 hospital	8 (00.2)
Level 4 hospital	8 (00.2)
Total	3,409 (100.0)

Source: Ministry of Health (MOH), Government of the Republic of Zambia. List of health facilities by district and level of care ,2022.

Since 1991, Zambia’s approach to health sector organisation has focused on decentralisation of planning, management, and resources to the district level (i.e., level 1). This approach has inevitably called for broader participation by all key stakeholders, particularly the communities, in the governance of the health sector. The Zambia Basic Health Care Package describes the appropriate services to provide at each level of care, which includes respiratory care at all level 1 hospitals.¹⁰ For this reason, enabling level 1 hospitals to provide respiratory care is paramount. This is in addition to strengthening comprehensive, complex, and demand-driven respiratory

services in level 2 and 3 hospitals. To do so, we must have appropriate and adequate human resources, equipment, and supplies, as well as supporting infrastructure.

1.5 Health Disciplines That Administer Oxygen

All levels of the health system require medical oxygen supply to provide patient care in several wards and various health services. Many of these wards and service areas lack or have inadequate medical oxygen supply.^{11,12} The wards/units where respiratory care services are required at each facility level are as follows:

- Community and level 1 (health posts, health centres, district hospitals):
 - General ward
 - Labour unit
 - Neonatal resuscitation corner
 - Emergency triage
 - Transport to referral
- Level 2 (general hospitals):
 - Emergency triage
 - Labour and delivery room
 - Neonatal care
 - Paediatric and/or adult ward
 - ICU
 - Operating theatre
- Level 3 (tertiary, specialised hospitals, specialised outpatient clinics):
 - Emergency triage
 - Labour and delivery room
 - ICU (neonatal, paediatric, adult)
 - Paediatric and adult wards
 - Surgery and recovery wards
 - Cardiopulmonary ward
 - Emergency ward

2. Situation Analysis

2.1 Health Status of the Population

Medical oxygen is used in critical care for a wide range of diseases and conditions. Amongst the country's priorities is to reduce mortalities related to pregnancy, children's ill health, and COVID-19. Zambia has made progress in reducing acute respiratory infections (pneumonia) from 1,741 in 2015 to 875 in 2019.¹³ Despite the improvements recorded in acute respiratory infection outcomes, there remains a lot to be done to reduce pneumonia-related morbidity and mortality. Around 2,248 people die every year from respiratory infection–related causes in Zambia, which include both pneumonia and non-pneumonia (tuberculosis) causes.¹³ Zambia recorded 401,998 respiratory infections–related morbidities in 2015 and 333,119 in 2019. This illustrates that significant progress was being made, but this changed when COVID-19 hit. In 2021 alone, Zambia recorded around 3,243 deaths and a morbidity rate of about 186,218 due to COVID-19 and associated conditions.^{14,15}

The World Health Organization (WHO) declared COVID-19 outbreak a Public Health Emergency of International Concern in January 2020. On 11 March 2020, WHO declared COVID-19 a global pandemic. Since 18 March 2020, Zambia has seen a rise in COVID-19 cases, and these have spread from the initial imported cases to community-transmitted cases.

In Zambia, this pandemic has manifested in three waves. The first wave surged around June/July 2020; the second wave surged from December 2020 to May 2021; and the third wave surged from June 2021 to November 2021, when this strategy was being developed. The cumulative number of COVID-19 cases increased with each wave of the pandemic—from 5,195 in the first wave, to 24,297 in the second wave, and then to 91,133 in the third wave.¹⁵ From the start of the pandemic to 27 October 2021, a cumulative total of 209,657 cases and 3,660 deaths were recorded.¹⁵ In the third wave, the number of patients on oxygen averaged 1,100 patients per day for two to three weeks, with a peak of 1,300 patients per day. An average of 200 critical patients were recorded when the pandemic was at its peak in the third wave, with each consuming 60 to 70 litres of oxygen per minute.

2.2 Oxygen Production Equipment and Supply

2.2.1 Overview

There is a paucity of data on oxygen supply for both public and private hospitals in Zambia; on oxygen production equipment, including oxygen concentrators, PSA plants, and cryogenic oxygen plants that can purify atmospheric oxygen for medical use; and on oxygen cylinders for medical oxygen storage and cylinder manifolds. The 2020 Biomedical Equipment Survey revealed that there is inadequate functional equipment, supplies, equipment servicing or repair, spare parts, consumables, and accessories. Additionally, sourcing oxygen from private suppliers still

remains a challenge. The data in Tables 9 to 11 were collected primarily from the survey report, *Biomedical Equipment for COVID-19 Case Management: Zambia COVID-19 Treatment Facility Survey Report*, supplemented by additional data collected over the past year.

As shown in Table 9 on availability of cylinder manifolds, six manual switch manifolds and three automatic switch manifolds currently are available in public health facilities.

Table 9: Cylinder Manifolds Across All Health Care Facilities

Cylinder Capacity (No. of Cylinders a Manifold Can Fit)	Total Number Per Switching Type		Total
	Manual Switch	Automatic Switch	
2	1	0	1
3	3	0	3
4	0	0	0
5	2	1	3
6	0	0	0
7	0	0	0
8	0	2	2
Grand total			9

Source: PATH.¹

The country has ten existing PSA plants, but only nine are functional. The PSA plants are located in five provinces; however, 50 percent are situated in Lusaka. The PSA plants based at the Lewanika General Hospital and Mansa General Hospital are functioning, but suboptimally.ⁱⁱ Table 10 shows both the functional and nonfunctional PSA plants that are available in public facilities.

ⁱⁱ Frequent breakdowns and lack of adequate service and maintenance.

Table 10: Public Pressure Swing Adsorption Oxygen Facilities

Facility Name	Location	Operational Hours	Status	Filling	Plant Capacity	Cylinders/ 24 Hours	Cylinder Fill Time
Lewanika General Hospital	Mongu	24 hours	Functional	Yes	Unknown	8	2.3 hours
Mansa General Hospital	Luapula	24 hours	Functional	Yes	Unknown	8	2.3 hours
Chinsali General Hospital	Muchinga	24 hours	Functional	No	30 m ³ /hour	Unknown	Unknown
Kalindawalo General Hospital	Chipata, Petauke	24 hours	Functional	No	30 m ³ /hour	Unknown	Unknown
University Teaching Hospital–Adult Hospital	Lusaka	24 hours	Nonfunctional	Yes	60 m ³ /hour	70–85	12 minutes
University Teaching Hospitals–Children’s Hospital	Lusaka	Unknown	Functional	Yes	30 m ³ /hour	25	Unknown
National Heart Hospital	Lusaka	Unknown	Functional	Unknown	10 m ³ /hour	Unknown	Unknown
Levy Mwanawasa University Teaching Hospital	Lusaka	24 hours	Functional	Yes	120 m ³ /hour	Unknown	Unknown
Maina Soko Medical Centre	Lusaka	24 hours	Functional	Unknown	30 m ³ /hour	Unknown	Unknown
St. Francis’ Hospital	Katete	24 hours	Functional	Yes	12 m ³ /hour	Unknown	Unknown

Source: PATH.¹

In the private sector, there are 16 industrial oxygen production plants; however, only 6 of these facilities provide medical oxygen gas. Table 11 presents privately owned air separation units and PSA plants that provide oxygen for medical and industrial uses in the country.

Table 11: Private Oxygen Facilities

Facility Name	Location	Primary Use	Unit Type	Status	Plant Capacity (ton per day)
Kansanshi Copper Mine (First Quantum Minerals)	Solwezi	Industrial	ASU	Functional	750
Chambishi Metals	Chambishi	Industrial	ASU	Out of service	100
Mopani Copper Mines	Kitwe	Industrial	ASU	Functional	60
Scaw Metals*	Kitwe	Industrial	ASU	Functional	3
Kansanshi Copper Mine (First Quantum Minerals)	Kitwe	Industrial	ASU	Functional	650
Mopani Copper Mines	Mufulira	Industrial	ASU	Functional	850
Afrox Zambia*	Ndola	Industrial	ASU	Functional	17
Mine Gases*	Kitwe	Industrial	ASU	Functional	2
Kansanshi Copper Mine (First Quantum Minerals)	Nkana	Industrial	ASU	Functional	60
Konkola Copper Mines*	Nchanga	Industrial	ASU	Functional	750
Zambia Air Force (ZAF)	Lusaka	Industrial	PSA	Functional	3
Chingases*	Lusaka	Industrial	PSA	Functional	6
Nitrogen Chemicals of Zambia	Lusaka	Industrial	ASU	Functional	350
Kafue Steel (UMCIL)*	Lusaka	Industrial	ASU	Functional	6
Oxyzam	Lusaka	Industrial	PSA	Functional	3

Source: PATH.¹

Abbreviations: ASU, air separation unit; PSA, pressure swing adsorption.

*Provides medical oxygen.

2.2.2 Oxygen Delivery Equipment

The 2020 Biomedical Equipment Survey revealed that the surveyed health facilities did not have sufficient functional oxygen delivery equipment of various device types. These types include ventilators, suction devices, resuscitation devices, and related consumables. The eight surveyed facilities reported having 104 functional ventilators for a total of 77 ICU beds. There were a total of 876 functional suction devices and 145 functional resuscitation devices for a combined bed capacity of 3,820.

2.2.3 Monitoring Equipment

All the surveyed facilities reported that the monitoring equipment was inadequate for safe oxygen administration. This equipment included pulse oximeters and patient monitors. The surveyed facilities reported having 52 functional pulse oximeters and 75 functional patient monitors for a combined bed capacity of 3,820. This suggests that many patients go without safely delivered oxygen and/or the lack of oxygen monitoring equipment constrains the number of patients who can receive oxygen therapy.

2.3 Human Resources for Medical Oxygen Administration

Human resources are a cardinal driver of oxygen delivery systems. Using facilities' bed capacity to estimate the required human resources and oxygen to support respiratory care indicates that the country has a chronic shortage of human resources for medical oxygen administration, with 44 biomedical staff for a total of over 3,003 health facilities countrywide. These include surgeons, anaesthetists, obstetricians, and nurses who are associated with the surgical and respiratory care system. The combined density of respiratory care personnel in Zambia is 1.1 per 100,000 people.¹⁶ International standards set in 2015 recommended a minimum of 20 respiratory care personnel per 100,000 people.¹⁷ The gap is partially addressed in Zambia by task sharing and the broader scopes of practice of many health care providers; however, the remaining gap is still temporary, non-national workers, resulting in frequent fluctuation of the size of Zambia's skilled health workforce. For proper case management, clinical officer anaesthetists, critical care nurses, medical officers, critical care specialists, and anaesthetists require continuous professional development and formal training.¹⁸ However, this does not occur in most facilities, as evident from the 2020 Biomedical Equipment Survey.

In addition, durable medical equipment, including oxygen equipment, requires biomedical engineers and/or trained health facility staff to perform regular preventative and corrective maintenance. However, due to the lack of available biomedical engineers and technologists, health facilities can expect to have equipment that is rarely serviced, and therefore many devices may become nonfunctional long before they can be repaired. The number of biomedical staff that should be employed at a specified health facility follows a structure set by MOH policy, yet current employment drastically falls short of this standard. For instance, Central Province only has three biomedical equipment technologists to service oxygen equipment at 205 health facilities. In total, the country has 6 biomedical engineers, 36 biomedical equipment technologists, 1 chief medical equipment officer, and 1 chief medical equipment technician. The distribution of these personnel, by province, is shown in Table 12.

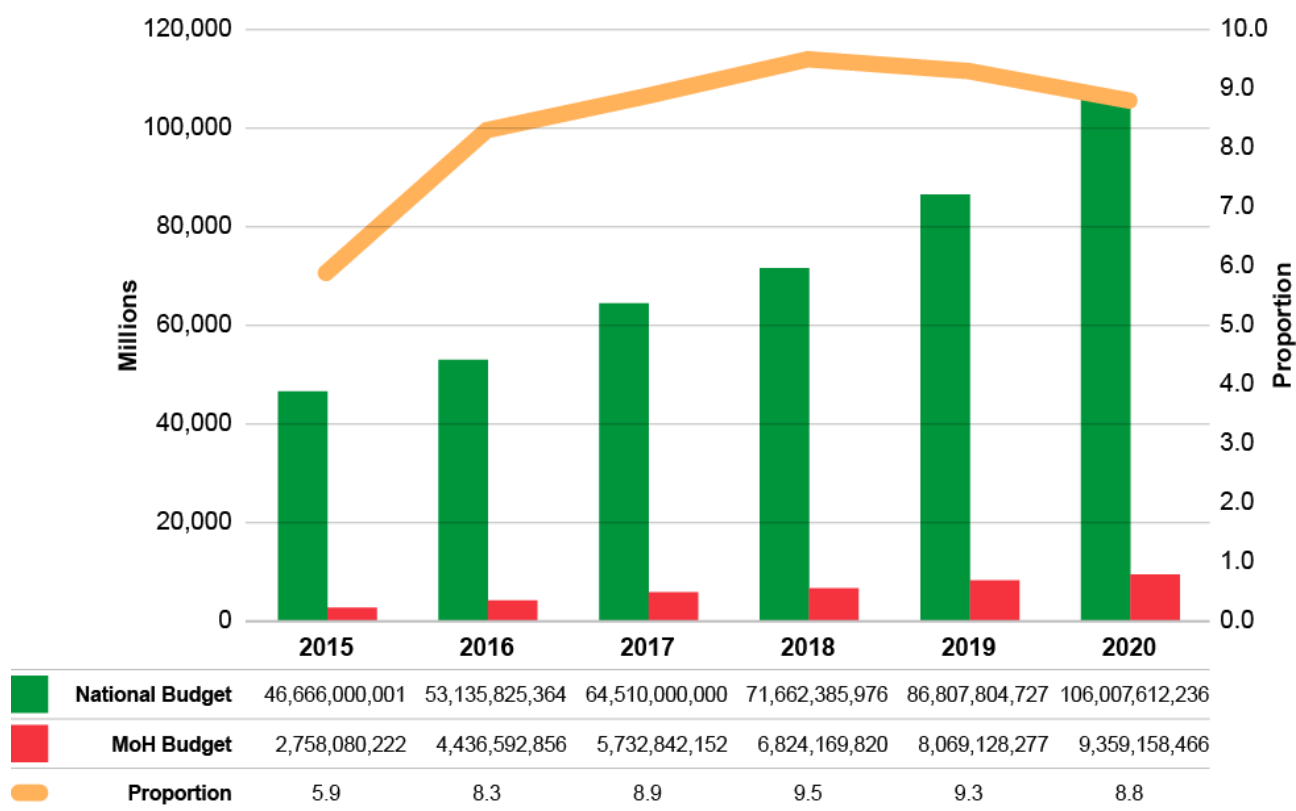
Table 12: Current Number of Government-Employed Biomedical Staff, by Province

Province	Biomedical Engineer	Biomedical Equipment Technologist	Chief Medical Equipment Officer	Chief Medical Equipment Technician	Total
Central	0	3	0	0	3
Copperbelt	1	6	0	0	7
Eastern	1	2	0	0	3
Luapula	1	4	0	0	5
Lusaka	2	5	1	1	9
Muchinga	0	3	0	0	3
North-Western	0	3	0	0	3
Northern	0	4	0	0	4
Southern	1	4	0	0	5
Western	0	2	0	0	2
All provinces	6	36	1	1	44

2.4 Finance and Resource Mobilisation for Medical Oxygen

The cost of medical oxygen as a drug is borne by public (government), private (households and employers), and external (cooperating partners, CPs), sources. Despite nominal improvements in allocations to the health budget, as shown in Figure 1, public funds are not sufficient to meet the need for the optimum package of health care or adequately cover the rising respiratory care needs of the Zambian population. This results in more people paying out of pocket for respiratory care, which is expensive, and the population having inequitable access to health care. In response to this, the government of Zambia, through the MOH, introduced the National Health Insurance Scheme. This system was built to ensure that all Zambian citizens and established residents have equitable access to high-quality essential health services, regardless of their socioeconomic status.

Figure 1: Health-Sector Budgetary Allocation in Zambia, 2016–2020.



Abbreviation: MoH, ministry of health.

Currently, funds are allocated for respiratory care through a monthly operations grant that is directly disbursed to level 2 hospitals, level 3 hospitals, and district health offices (DHOs) for level 1 hospitals, health centres, and health posts. At present, all COVID-19-related medical oxygen needs are wholly funded by the government and cooperating partners.

2.5 Key Challenges in Oxygen Production and Supply in Zambia

Medical oxygen production capacity is inadequate in Zambia due to limited PSA plants, insufficiently maintained plants and other associated infrastructure, inadequate availability of oxygen cylinders, and shortage of medical devices, such as oxygen concentrators, ventilators, and pulse oximeters. Respiratory care units in Zambia, including COVID-19 treatment centres, urgently need to procure medical devices, accessories, and consumables for safe administration of high-quality oxygen.

In addition, health facilities appear to be extremely dependent on the private sector for their supply of oxygen cylinders. Very few oxygen concentrators are available in facilities. Overall, it would be ideal to have multiple oxygen supply sources to avoid sole reliance on any one supply source, which could result in complete unavailability of medical oxygen during an adverse event, such as a power outage or device failure, or unreliable restock of supply of accessories, consumables, or spare parts.

2.6 Legal and Regulatory Framework

The regulation of the local manufacturing of medicines and allied substances in Zambia is the mandate of ZAMRA. ZAMRA was established under an act of parliament (the Medicines and Allied Substances Act No. 3 of 2013 of the Laws of Zambia) to regulate and control the manufacture, importation, storage distribution, supply, sale, and use of medicines and allied substances. ZAMRA's main objective is to ensure that all medicines and allied substances that are made available to the Zambian people consistently meet the set standards of quality, safety, and efficacy.

WHO classifies medical oxygen as an essential medicine, one that is well established as a therapeutic agent for the management of hypoxemia, a common complication of several serious illnesses and conditions, including COVID-19.¹⁹

The Medicines and Allied Substances Act No. 3 of 2013 requires local pharmaceutical manufacturers of medicines and allied substances to apply for a pharmaceutical licence and their products to receive marketing authorisation before placement on the Zambian market. Although the act has these provisions, it must be noted that there is not a specific guideline that addresses the standards that apply to both manufacturing and marketing authorisation of medical oxygen. ZAMRA has been developing current Good Manufacturing Practice guidelines for local manufacturers of medical oxygen. The completed guidelines are expected later in 2022.

The lack of regulation of medical oxygen supplies has compromised its quality and availability, thereby endangering the lives of patients. Unreliable supply of oxygen at the facility level has been as a result of poor maintenance of equipment and inadequately qualified technicians involved in the production of medical oxygen. Furthermore, excessive demand and overuse of equipment puts pressure on PSA plants and other devices, which, coupled with poor maintenance practices, results in diminished quality of the medical oxygen produced.

2.7 Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis

This section presents a SWOT analysis of key oxygen investment areas, including production, distribution, supply, storage, and human resources in the Zambia health system. However, this analysis assesses the performance, industry landscape, risks, and potential of the country's oxygen delivery systems. It further helps to analyse what has been done best and devise a successful strategy for the future. The elements of a SWOT analysis are defined as follows:

- **Strengths:** Aspects of the oxygen delivery system that the country's health system operates effectively. These might be the motivation of staff or sufficient oxygen production capacity.
- **Weaknesses:** Identified instances where either insufficient or substandard human resources, financial resources, production, distribution, supply, and storage impact the feasibility of implementing a given intervention.
- **Opportunities:** Favourable external factors that could give the country's health systems better prospects for oxygen access and delivery. These include change in government policy (for instance, cuts in tariffs for oxygen-related imports), political will, cooperating partner support, and developments in the market or in the technology used.
- **Threats:** Factors that have the potential to harm the oxygen delivery systems of the country's health care system. These include rising costs for oxygen-related materials or equipment, increasing private-sector ownership of bulk oxygen production, and tight labour supply.

Tables 13, 14, and 15 provide a SWOT analysis, by investment area, for medical oxygen production, supply/distribution/storage, and human resources, respectively.

Table 13: SWOT Analysis of Medical Oxygen Production

Investment Area	Strengths	Weaknesses	Opportunities	Threats
Liquid oxygen (LOX)	<ul style="list-style-type: none"> Strong private-sector participation. 	<ul style="list-style-type: none"> Lack of personnel in health system with expertise in LOX. 	<ul style="list-style-type: none"> Political will from the government. Goodwill from cooperating partners. 	<ul style="list-style-type: none"> A notable rise in the cost of LOX technology.
Pressure swing adsorption (PSA) plants	<ul style="list-style-type: none"> Availability of ten PSA plants in the country's health system, five of which have high-pressure filling compressors. 	<ul style="list-style-type: none"> Limited technical know-how to service and maintain plants. 	<ul style="list-style-type: none"> Framework contracts for maintenance. Presence of purity meters on the market. Political will from the government. Goodwill from cooperating partners. Availability of semi-skilled workforce. 	<ul style="list-style-type: none"> Production by PSA plants of poor oxygen purity recordings when availability of service and maintenance parts is constrained. Inability of available PSA plants to produce the desired quantities of oxygen due to the plants' size.
Concentrators	<ul style="list-style-type: none"> Adequate personnel capable of operating the equipment in health facilities if they received required training. 	<ul style="list-style-type: none"> Lack of maintenance plans. Inadequate oxygen delivery devices, such as regulators, flow meters, and humidifiers. 	<ul style="list-style-type: none"> Political will from the government. Goodwill from cooperating partners. 	<ul style="list-style-type: none"> Lack of skilled staff to operate devices. Limited flow rate. Unavailability of spare parts for repair and servicing of equipment.
Cylinders	<ul style="list-style-type: none"> Adequate refilling capacity of private suppliers. 	<ul style="list-style-type: none"> Lack of maintenance plans. Unavailable storage space for cylinders. Lack of valve guards for cylinders. Unsecured cylinders in the wards. 	<ul style="list-style-type: none"> Political will from the government. Goodwill from cooperating partners to support manifold systems installation. Adequate space to construct storage facilities for cylinders. 	<ul style="list-style-type: none"> Oxygen cylinders provided by vendors that do not conform to standards.

Abbreviation: SWOT, strengths, weaknesses, opportunities, and threats

Table 14: SWOT Analysis of Supply/Distribution/Storage

Investment Area	Strengths	Weaknesses	Opportunities	Threats
Liquid oxygen (LOX)	<ul style="list-style-type: none"> • Strong private sector for supplying LOX. 	<ul style="list-style-type: none"> • Insufficient capacity of public sector to distribute LOX. 	<ul style="list-style-type: none"> • Goodwill from cooperating partners to support LOX. 	<ul style="list-style-type: none"> • Rising cost of distribution tanks.
Infrastructure	<ul style="list-style-type: none"> • Presence of cylinder manifold systems in a few facilities. • Adequate space in health facilities to construct cylinder storage shelters. 	<ul style="list-style-type: none"> • Lack of standardisation of oxygen cylinder manifolds. 	<ul style="list-style-type: none"> • Political will from the government. 	<ul style="list-style-type: none"> • High costs of construction and human resources to staff storage facilities.
Transport and logistics management information system for oxygen	<ul style="list-style-type: none"> • Availability of ZAMMSA for capacitation. 	<ul style="list-style-type: none"> • Lack of dedicated transport vehicles to transport oxygen cylinders in an upright position. 	<ul style="list-style-type: none"> • Political will from the government. 	<ul style="list-style-type: none"> • High costs of designer transport vehicles for distribution of cylinders.
Health and safety standards	<ul style="list-style-type: none"> • Available standards for health facilities to adopt. 	<ul style="list-style-type: none"> • Lack of local adoption of standards and/or revision of standards to fit Zambia's context. 	<ul style="list-style-type: none"> • Political will from the government and goodwill from cooperating partners to build capacity. 	<ul style="list-style-type: none"> • Lack of experts to strengthen health and safety in public facilities.

Abbreviations: SWOT, strengths, weaknesses, opportunities, and threats; ZAMMSA, Zambia Medicines and Medical Supplies Agency.

Table 15: SWOT Analysis of Human Resources

Investment Area	Strengths	Weaknesses	Opportunities	Threats
Nurses	<ul style="list-style-type: none"> • Availability of training institutions and programmes that provide nursing trainings. 	<ul style="list-style-type: none"> • Lack of sub-specialisation and task-sharing courses. 	<ul style="list-style-type: none"> • Availability of training institutions and programmes with specialised training abroad. 	<ul style="list-style-type: none"> • Inadequate content on oxygen in training programmes.
Anaesthetists	<ul style="list-style-type: none"> • Adequately trained anaesthetists in respiratory care and oxygen management. 	<ul style="list-style-type: none"> • Inadequate staffing levels. 	<ul style="list-style-type: none"> • Rich content in respiratory care and oxygen management in training institutions' curricula. 	<ul style="list-style-type: none"> • Staff attrition.
Biomedical engineering personnel	<ul style="list-style-type: none"> • Adequate training institutions. 	<ul style="list-style-type: none"> • Lack of sub-specialised training. • Lack of medical oxygen standards and guidelines. • Lack of adherence to maintenance schedules. • Lack of capacity-building for oxygen usage. • Lack of annual cylinder inspections to ascertain safety of these storage devices. 	<ul style="list-style-type: none"> • Room for advanced specialised training. 	<ul style="list-style-type: none"> • Limited positions in institutions.
Oxygen attendants	<ul style="list-style-type: none"> • Minimum entry requirements. 	<ul style="list-style-type: none"> • Lack of formal training. 	<ul style="list-style-type: none"> • Introduction of short-term courses. 	<ul style="list-style-type: none"> • Lack of technical know-how.

Abbreviation: SWOT, strengths, weaknesses, opportunities, and threats.

2.8 Key Priorities

After the SWOT analysis, the MOH identified high-priority investment areas for the NMOSP, presented in Table 16. Prioritisation of investment areas was based on the specific objectives of the strategy, as well as the SWOT analysis. Table 16 broadly describes the current state of these investment areas in the country's health system, what actions should be taken, and the target for each investment area.

Table 16: High-Priority Investment Areas

Prioritisation	Investment Area	Action to Be Taken	Current Estimated Baseline in 2022	Target
1	LOX and PSA plants	<ul style="list-style-type: none"> • Increase bulk LOX supply in all level 3 hospitals. • Install PSA plants in level 2 and 3 hospitals. 	<ul style="list-style-type: none"> • Lack of available LOX supply at public health facilities. • Inadequate number of PSA plants, with public facilities having a total of ten. 	<ul style="list-style-type: none"> • Ensure bulk supply of medical oxygen in 15 facilities.
2	Installation of manifolds and pipeline systems	<ul style="list-style-type: none"> • Increase reticulation in level 2 and 3 hospitals. 	<ul style="list-style-type: none"> • Manifold systems in only nine facilities. 	<ul style="list-style-type: none"> • Install manifolds and pipeline systems in 30 facilities.
3	Adequate medical oxygen delivery and monitoring devices	<ul style="list-style-type: none"> • Increase availability of medical oxygen delivery and monitoring devices. 	<ul style="list-style-type: none"> • One device to 30 beds. 	<ul style="list-style-type: none"> • Ensure devices are adequate to meet patient needs in OPDs, EUs, HDUs, and ICUs.
4	Adequate skilled human resources	<ul style="list-style-type: none"> • Increase skilled workforce for medical oxygen. 	<ul style="list-style-type: none"> • 44 biomedical engineering personnel countrywide. 	<ul style="list-style-type: none"> • Ensure that all levels of health care have biomedical engineering personnel.
5	Strong leadership and governance system	<ul style="list-style-type: none"> • Strengthen leadership and governance systems at national and subnational levels. 	<ul style="list-style-type: none"> • One national oxygen coordinator for the country. 	<ul style="list-style-type: none"> • Ensure that the subnational level has strong leadership to drive oxygen delivery systems.
6	Private-sector engagement	<ul style="list-style-type: none"> • Increase private-sector engagement and participation. 	<ul style="list-style-type: none"> • Private suppliers, some manufacturing companies, and some mining houses that support medical oxygen work. 	<ul style="list-style-type: none"> • Increase the overall percentage of private production capacity that is supplied to public health facilities at a safe medical oxygen standard.
7	Adequate financing	<ul style="list-style-type: none"> • Increase financing for medical oxygen delivery systems. 	<ul style="list-style-type: none"> • Financing by government and cooperating partners for the purchase of medical oxygen. 	<ul style="list-style-type: none"> • Ensure sustainable financing for medical oxygen systems.

Abbreviations: EU, emergency unit; HDU, high-dependency unit; ICU, intensive care unit; LOX, liquid oxygen; OPD, outpatient department; PSA, pressure swing adsorption.

2.9 Stakeholder Analysis

This subsection presents qualitative information that determines whose interests should be considered when implementing the NMOSP. It is intended to help policymakers and managers interact more effectively with key stakeholders, increase support, detect potential misunderstandings and/or opposition during implementation, and act to prevent these misunderstandings and opposition. This information was systematically gathered and analysed by a multidisciplinary team of experts, including international cooperating partners, national legislators, public officials (MOH, Ministry of Finance, and other government agencies), labour representatives (unions, societies, associations), commercial/private for-profit staff, non-profit organisation and foundation staff, civil society organisation members, traditional leaders, and users/consumers.

Table 17 describes the role of each stakeholder, including each stakeholder’s interest areas (anticipated foremost concerns), level of interest, ability to influence the situation to produce a positive change, and anticipated level of criticality to solve problems.

Table 17: Summary of NMOSP Stakeholders and their Roles and Interests

Stakeholder	Role of Stakeholder	Interest Areas	Interest Level	Influence	Level of Criticality
General population and communities	<ul style="list-style-type: none"> • Be informed on oxygen care—what it is, its presentation, how it is stored. • Seek screening, use oxygen care only if prescribed, and go for early treatment. • Share information on oxygen care. • Engage in open dialogue to demystify oxygen use and reduce stigma. 	<ul style="list-style-type: none"> • Inadequate availability of information on oxygen care. • Lack of policy regarding family use of oxygen. 	High	High	Supportive
Cabinet	<ul style="list-style-type: none"> • Provide overall policy direction on provision of oxygen care services and ensure implementation of policy. • Ensure adequate resource allocation and mobilisation for oxygen care. • Ensure the health and productivity of the population. 	<ul style="list-style-type: none"> • Lack of a national oxygen strategic plan. • Inadequate funding and structured support from partners. 	High	High	Supportive

Stakeholder	Role of Stakeholder	Interest Areas	Interest Level	Influence	Level of Criticality
Ministry of Health (MOH)	<ul style="list-style-type: none"> Provide information and services for safe use of oxygen care to the Zambian population. Provide infrastructure and equipment for production, storage, and distribution of oxygen. Create framework contracts for procurement of oxygen, equipment, and oxygen accessories and maintenance of oxygen plants. 	<ul style="list-style-type: none"> Identifiable need to prioritise oxygen care and make efforts to provide these services. 	High	High	Supportive
Other government line ministries, statutory bodies, and departments	<ul style="list-style-type: none"> Include information in training curricula on oxygen use and risks of storage at the health facility level. Determine hospital accreditation and oxygen care licensing and monitor professionals' ethical conduct and training institutions' quality of training (Health Professions Council of Zambia). Support staff licensing of all nursing practitioners (General Nursing & Midwifery Council). Work to enforce specific legislation and regulations relevant to oxygen care (ZAMRA). Support the improvement of compliance with household storage standards (ZAMRA). 	<ul style="list-style-type: none"> Lack of interministerial communication that assists policy approval. 	High	High	Supportive
Professional societies	<ul style="list-style-type: none"> Provide a community and mentorship network for health care providers. Allow members to play integral roles in policy development, training, research, and health system decision-making. 	<ul style="list-style-type: none"> Engagement of societies at various levels of oxygen strategic plan development. 	Low	High	Supportive

Stakeholder	Role of Stakeholder	Interest Areas	Interest Level	Influence	Level of Criticality
Non-governmental and civil society organisations	<ul style="list-style-type: none"> Continue a health sector-wide approach for civil society and non-governmental organisation coordination and optimisation, which has worked well to identify key health care issues facing Zambia. As oxygen care initiatives develop, be apprised of opportunities to collaborate that could make a meaningful impact on the oxygen care system (civil society organisations). Promote delivery of high-quality and equitable oxygen care services to communities. Mobilise community participation in health and safety measures. Mobilise resources for oxygen care. Ensure government and private-sector provision of medical oxygen. 	<ul style="list-style-type: none"> Lack of equitable distribution of organisations throughout Zambia. Low focus on funding for oxygen care. 	Low	High	Supportive
Faith-based organisations	<ul style="list-style-type: none"> Provide safe and affordable oxygen care services to the general public. 	<ul style="list-style-type: none"> The significant role that the Churches Health Association of Zambia plays in providing oxygen care in Zambia. Involvement in appropriate referral of patients to the next level. Availability of telemedicine mentoring services in only a few facilities. 	High	High	Supportive
Private health care companies	<ul style="list-style-type: none"> Foster relationship between private and public health care providers. Consider methods of involving private-sector leaders in public initiatives, when appropriate. Continue to provide oxygen care, for those companies that have hospitals that provide such care. 	<ul style="list-style-type: none"> Lack of formal coordination mechanisms on oxygen care. 	High	Low	Supportive

Stakeholder	Role of Stakeholder	Interest Areas	Interest Level	Influence	Level of Criticality
Health care workers	<ul style="list-style-type: none"> Have appropriate training, exposure, and support in the prevention, early detection, and management of hypoxic conditions for different cadres at all levels of care. Have a community health worker package that includes education regarding early detection and referral systems for patients. Provide prompt referral of patients to higher levels of care for appropriate treatment and follow-up. 	<ul style="list-style-type: none"> Inadequate knowledge of oxygen care amongst health care workers. Inadequate number of health care workers with formal training in oxygen care. 	High	High	Integral
Suppliers of goods and services	<ul style="list-style-type: none"> Supply—in a fair, efficient, consistent, and transparent manner—the MOH with high-quality goods and services for the control and management of oxygen care. 	<ul style="list-style-type: none"> Procurement procedure that is laborious and bureaucratic. Lack of local manufacturers for most equipment. Suppliers that do not adhere to contracts. Government suppliers that are only registered by the Zambia Public Procurement Authority. Lack of understanding of the Public Procurement Act and terms of the contracts by some suppliers.* Challenges in obtaining higher purities from oxygen companies. 	High	Low	Supportive
International community	<ul style="list-style-type: none"> Provide financial and technical support to the health care sector within the established policy, strategic framework, and priorities. 	<ul style="list-style-type: none"> Provision by some in the international community of technical and/or financial support. 	High	High	Supportive
Traditional / community leaders	<ul style="list-style-type: none"> Disseminate res care information to increase awareness and enforcement at community level. 	<ul style="list-style-type: none"> Lack of information on oxygen care and services available, leading to disempowerment. 	High	High	Supportive

Abbreviations: NMOSP, National Medical Oxygen Strategic Plan; ZAMRA, Zambia Medicines Regulatory Authority.

*National Assembly of Zambia website. The Public Procurement Act, 2020 page. <https://www.parliament.gov.zm/node/8634#:~:text=An%20Act%20to%20revise%20the,fairness%20and%20public%20confidence%20in>. Accessed 27 January 2022.

3. NMOSP Framework

3.1 Strategic Mission and Vision

The NMOSP builds on existing strategies and programmes, such as the National Health Strategic Plan and COVID-19 National Multi-Sectoral Contingency Preparedness and Response Plan, as well as on efforts being undertaken by the MOH within national health policies, programmes, interventions, and strategies. The NMOSP framework details the vision, mission, goal, objectives, and key principles.

3.1.1 Vision

The vision of the NMOSP is for Zambia to be a nation of healthy and productive people.

3.1.2 Mission

The mission of the plan is to provide safe, affordable, and timely respiratory care services to all Zambians.

3.1.3 Goal

The goal is to ensure sustainable availability and access to medical oxygen, strengthen Zambia's response to the COVID-19 pandemic, and improve respiratory care services by the year 2026.

3.2 Key Principles

Instituting oxygen delivery systems that ensure safe administration of medical oxygen at the patient level calls for a multi-sectoral and multidisciplinary approach. Following are guiding principles that the MOH has decided are important for oxygen delivery systems and should therefore guide partner actions:

- **Safe:** To ensure safety in the production, distribution, delivery, and use of medical oxygen.
- **Cost-effective:** To ensure rational use of medical oxygen and scale-up of pulse oximeters.
- **Affordable:** To ensure all patients requiring medical oxygen are not hindered by financial challenges.
- **Essential:** To regard medical oxygen as an essential drug at all levels of health care.
- **Timely:** To ensure oxygen is available to meet demand by installing PSA plants at strategic facilities, increasing cylinder refilling capacity, and enforcing reliable cylinder delivery from suppliers.
- **Equitable:** To ensure that medical oxygen services are accessible to everyone in the same manner at all levels of care and across the country.

- **Effective:** To provide medical oxygen services promptly and affordably.
- **Efficient:** To avoid waste, including malfunction of oxygen production equipment, supplies, and energy.

4. Strategic Objectives

This section lists the strategic objectives that the Zambian government has agreed would improve respiratory care services by 2026:

1. Strengthen medical oxygen supply systems in 60 percent of public hospitals in Zambia.
2. Improve the rational use of medical oxygen at all levels of health care services.
3. Increase the proportion of health facilities receiving high-quality medical oxygen.
4. Increase the number of staff involved in oxygen management from 44 to 3,614.ⁱⁱⁱ
5. Ensure an efficient, resilient, and safe oxygen delivery system by systematically collecting high-quality data in a timely manner to provide information for decision-making
6. Strengthen research in key medical oxygen system priority areas and scale up research activity to all level 1 facilities
7. Promote a coordinated approach to leadership, governance, and accountability.
8. Mobilise adequate financial resources to sustain the provision of medical oxygen services.

For each of these strategic objectives, strategies/interventions and activities have been identified. These have been organised in the framework in Table 18.

ⁱⁱⁱ Table 18. NMOSP Strategic Objective Framework, 2022 to 2026 – strategic objective no. 7.

Table 18: NMOSP Strategic Objective Framework, 2022–2026

No.	Strategic Objectives for 2022 to 2026	No.	Specific Strategies/ Interventions	No.	Activities
Medical Oxygen Service Delivery					
1	Strengthen medical oxygen supply systems in 60% of public hospitals in Zambia	1.1	Increase and strengthen oxygen production and refilling capacity in hospitals	1.1.1	Conduct feasibility studies on oxygen production and filling capacity in all 10 provinces, including on sizing and filling capacity of the proposed PSA installation sites in provincial hubs
				1.1.2	Conduct feasibility studies on oxygen production and filling capacity of all health centres, mini hospitals, and level 1 and 2 hospitals in all provinces
				1.1.3	Procure and install 10 duplex PSA systems with filling capacity for provincial hubs
				1.1.4	Engage private oxygen suppliers to set up 3 cryogenic tanks with accessories, including bulk tanks, in the 3 tertiary hospitals (Levy Mwanawasa, University Teaching Hospital-Adult Hospital, and Ndola Teaching Hospital) in 2022
		1.2	Strengthen medical oxygen reticulation in all hospitals in Zambia	1.2.1	Procure and install oxygen manifolds and reticulation for all level 1, 2, and 3 hospitals
				1.2.2	Conduct monitoring visits to ensure availability of functional, portable pulse oximeters
				1.2.3	Conduct 14-day assessment of the 120 facilities proposed for central pipeline and manifold installation
				1.2.4	Install central pipeline in 8 level 3 hospitals and in 18 level 2 hospitals and install manifolds in 89 level 1 hospitals.*
				1.2.5	Maintain and service central pipeline and manifolds in the 10 health facilities where they exist

No.	Strategic Objectives for 2022 to 2026	No.	Specific Strategies/ Interventions	No.	Activities
		1.3	Advocate for long-term medical supply contracts for all hospitals that depend on private suppliers	1.3.1	Conduct a workshop with all private oxygen suppliers to discuss production and distribution of oxygen and the existing challenges
				1.3.3	Map private oxygen suppliers
				1.3.5	Conduct review meetings with private suppliers who have existing oxygen supply contracts with the government
				1.3.7	Create biannual platforms with private oxygen suppliers to discuss oxygen supply issues
		1.4	Strengthen service contracts management for existing PSA plants installation	1.4.1	Collect data on performance of previous service contracts in all 3 hospitals (University Teaching Hospitals, Lewanika General Hospital, Mansa General Hospital, Levy Mwanawasa) in Zambia.
				1.4.3	Conduct 3 after-service inspections per year in each hospital where PSA plants exist
2	Improve the rational use of medical oxygen at all levels of health care services	2.1	Scale up the accessibility, availability, and acceptance of pulse oximeters, delivery devices, and other accessories across all levels of health care service delivery	2.1.1	Procure 5,000 pulse oximeters by 2026
				2.1.2	Conduct 10 provincial advocacy meetings on the role of pulse oximetry in the management of oxygen therapy
				2.1.3	Conduct 2 provincial trainings per province in a year on pulse oximetry use from the health centre level to level 3 hospitals
				2.1.4	Conduct 10 provincial quantification meetings for oxygen delivery devices
				2.1.5	Procure and distribute oxygen delivery devices
Infrastructure, Equipment, and Supply					
3	Increase the proportion of health facilities receiving high-quality medical oxygen	3.1	Establish storage sheds for medical oxygen cylinders at all provincial hubs, ZAMMSA headquarters, and all health care facilities	3.1.1	Construct 26 oxygen cylinder storage sheds at level 2 and 3 hospitals, 10 provincial hubs, and ZAMMSA headquarters

No.	Strategic Objectives for 2022 to 2026	No.	Specific Strategies/ Interventions	No.	Activities
		3.2	Ensure all medical oxygen cylinders in use are tested with a hydrostatic test and rambling every 5 years	3.2.1	Procure 2 oxygen cylinder hydrostatic pressure testing machines and equipment
				3.2.2	Train 10 biomedical engineering staff in medical oxygen cylinder standard testing
		3.3	Ensure procurement of appropriate oxygen delivery devices for each level of care	3.3.1	Procure 270 oxygen monitoring devices for quality control
		3.4	Strengthen transportation systems for oxygen cylinders	3.4.1	Procure 12 fifteen-ton trucks with appropriate loading bins, cylinder racks, and tailgate lifters for carrying medical oxygen cylinders
				3.4.2	Procure 20 twenty-four-cylinder carts with hydraulic lifters, appropriate loading bins, and tailgate lifters for carrying medical oxygen cylinders
				3.4.3	Procure 20 two-cylinder carts with hydraulic lifters for handling oxygen cylinders at low-volume sites
Human Resources for Medical Oxygen					
4	Increase the number of staff involved in oxygen management from 44 to 3,614	4.1	Scale up the recruitment of biomedical staff for management of medical oxygen services	4.1.1	Identify 26 biomedical engineers to manage medical oxygen services
				4.1.2	Employ 800 biomedical technologists to manage and maintain oxygen equipment
				4.1.3	Employ 1,302 oxygen plant operators
				4.1.4	Employ 1,222 oxygen plant attendants
				4.1.5	Employ 115 oxygen plant managers
				4.1.6	Employ 149 oxygen plant technicians

No.	Strategic Objectives for 2022 to 2026	No.	Specific Strategies/ Interventions	No.	Activities
		4.2	Build the capacity of a team of biomedical engineers in areas of specialisation in oxygen plant management	4.2.1	Train 10 biomedical staff members, through programmes abroad, on maintenance and servicing of oxygen plants
				4.2.2	Conduct annual capacity-building training in oxygen management for biomedical staff
				4.2.3	Train warehouse staff and drivers in all 10 provinces on safe handling of combustible gases (i.e., medical oxygen)
				4.2.4	Train ZAMMSA staff in the management of medical oxygen orders on the eLMIS
		4.3	Build the capacity of personnel in oxygen production, supply, and administration	4.3.1	Conduct 10 provincial trainings per year in basic critical care, including oxygen administration and escalation across all levels of care
				4.3.2	Create a database of all health workers trained in oxygen administration
				4.3.3	Hold consultative meetings with all health training institutions to strengthen curricula in basic critical care and oxygen administration and escalation
				4.3.4	Print and disseminate to all districts 5,000 SOPs and guidelines on oxygen escalation strategy and triage using pulse oximeters
Logistics Management Information System					
5	Ensure an efficient, resilient, and safe oxygen delivery system by systematically collecting high-quality data in a timely manner to provide information for decision-making	5.1	Incorporate medical oxygen technologies and supplies into medical equipment standard list	5.1.1	Review, print, and disseminate to government stakeholders and health facilities 6,000 copies of guidelines/SOPs for the essential commodities and equipment standard list
		5.2	Strengthen supply chain strategy for medical oxygen	5.2.1	Conduct 3 meetings for the design of the supply chain strategy
				5.2.2	Conduct 2 meetings to develop the guidelines and SOPs

No.	Strategic Objectives for 2022 to 2026	No.	Specific Strategies/ Interventions	No.	Activities
				5.2.3	Orient and train provincial health office staff and clinical staff on the guidelines and SOPs
		5.3	Expand the eLMIS to include medical oxygen management systems for all levels of care	5.3.1	Train professionals to enter data on various indicators on the eLMIS
				5.3.2	Hold requirements-gathering meetings for inclusion of oxygen on the eLMIS
				5.3.3	Conduct user-acceptance testing for medical oxygen inclusion on the eLMIS
		5.4	Strengthen medical oxygen indicators in the monthly eLMIS and HMIS reports	5.4.1	Train 50 biomedical engineers, 50 pharmacists, and 50 monitoring and evaluation officers in data analysis in order to use information from these indicators
Medical Oxygen Systems Research					
6	Strengthen research in key medical oxygen system priority areas and scale up research activity to all level 1 facilities	6.1	Strengthen research capacity and a research culture through training programmes	6.1.1	Support 30 research activities/projects
		6.2	Focus efforts on obtaining funding opportunities for research	6.2.1	Hold stakeholder meetings to share concept notes and research proposal on medical oxygen systems
		6.3	Develop research proposals or methodologies for measuring or collecting data to assess key priority areas	6.3.1	Conduct meetings on research proposal or methodology development on key priority areas of medical oxygen
		6.4	Encourage research to be published in a peer-reviewed journal and/or presented at conferences for knowledge dissemination (focusing on local opportunities first)	6.4.1	Hold conferences to disseminate research findings on medical oxygen systems
				6.4.2	Publish articles in peer-reviewed journals

No.	Strategic Objectives for 2022 to 2026	No.	Specific Strategies/ Interventions	No.	Activities
Data and Quality Management					
		6.5	Establish a data management system for medical oxygen	6.5.1	Conduct meetings for development of guidelines and SOPs
				6.5.2	Conduct meetings for development of data elements and registers
				6.5.3	Print a combined 6,000 SOPs, guidelines, and registers.
				6.5.4	Conduct 4 meetings to harmonise the oxygen data into the HIMS
		6.6	Strengthen high-quality management processes to improve their effectiveness and efficiency	6.6.1	Conduct meetings to identify and review systems performance indicators for quality improvement projects
				6.6.2	Conduct meetings to standardise devices for systematic planning and easy maintenance and repair
				6.6.3	Conduct health facility assessments to increase availability, functionality, and accessibility of medical oxygen delivery systems
Leadership and Governance					
7	Promote a coordinated approach to leadership, governance, and accountability	7.1	Strengthen leadership at the MOH, provincial, and district levels to coordinate the implementation of medical oxygen services	7.1.1	Conduct 12 technical supportive supervision and mentorship visits at the provincial, district, and facility levels
				7.1.2	Hold provincial- and district-level review meetings on oxygen management quarterly and monthly respectively
		7.2	Strengthen stakeholder coordination mechanisms	7.2.1	Hold annual meetings to review terms of references for the National Medical Oxygen Committee
				7.2.2	Include biomedical engineering personnel in the medicines therapeutic committee
				7.2.3	Conduct quarterly stakeholder meetings to ensure effective oxygen service delivery and system harmonisation
				7.2.4	Hold monthly technical working group meetings on access to oxygen service delivery

No.	Strategic Objectives for 2022 to 2026	No.	Specific Strategies/ Interventions	No.	Activities
		7.3	Strengthen legal and regulatory framework for provision of medical oxygen services	7.3.1	Develop current Good Manufacturing Practice guidelines on medical oxygen
				7.3.2	Conduct training for current Good Manufacturing Practice inspections of medical oxygen manufacturers
				7.3.3	Conduct capacity-building training on high-quality analysis of medical oxygen
				7.3.4	Develop guidelines on marketing authorisation for medical oxygen
				7.3.5	Develop a sampling plan for medical oxygen
Finance and Resource Mobilisation					
8	Mobilise adequate financial resources to sustain the provision of medical oxygen services	8.1	Promote private-sector participation through public-private partnerships	8.1.1	Hold 30 stakeholder meetings to engage key medical oxygen players
		8.2	Lobby for external funding through direct sector budget support and strengthen partnerships with CPs and civil society organisations	8.2.1	Hold 30 stakeholder meetings to engage CPs and civil society organisations
				8.2.2	Promote and strengthen the memorandum of understanding with CPs and civil society organisations
				8.2.3	Update and refine evidence-based resource allocation formula at the district level to include medical oxygen systems and to take into account epidemiological, geographic, demographic, socioeconomic, and intra-district factors
				8.2.4	Update and implement evidence-based resource allocation formulas for level 2 and 3 facilities to include medical oxygen services
				8.2.5	Track financial resources and their allocation

Abbreviations: CP, cooperating partner; eLMIS, electronic logistics management information system; HMIS, health management information system; NMOSP, National Medical Oxygen Strategic Plan; PSA, pressure swing adsorption; SOP, standard operating procedure; ZAMMSA, Zambia Medicines and Medical Supplies Agency.

*PATH.¹

5. Implementation Arrangements

5.1 Leadership and Management

5.1.1 National Level

Implementation of the NMOSP at the national level will be led by the Department of Clinical Care and Diagnostic Services, with support from the Department of Physical Planning and Medical Technologies. The MOH will provide policy direction and hold dissemination workshops for the strategy, as well as monitor its performance through the health sector's quarterly performance review meetings and midterm reviews. The MOH also will be responsible for annual resource allocation for the medical oxygen needs in the country.

5.1.2 Provincial Level

Provincial health offices will be responsible for the operationalisation of the NMOSP and will be linked to lower-level structures, which include DHOs, hospitals, and training institutions. Provincial health offices also will provide technical support supervision and mentorships for the institutions under its jurisdiction.

5.1.3 District and Facility Levels

DHOs and hospital management structures will be responsible for implementation of the NMOSP at their respective levels. Specifically, DHOs will ensure that the NMOSP is implemented at health posts, health centres, mini hospitals, and level 1 hospitals, while implementation at level 2 and 3 hospitals and specialised hospitals will be ensured by the respective hospital services.

5.1.4 Training Institutions

Training institutions will be responsible for capacity development of biomedical engineering personnel to support enhancement of the production, supply, and administration of medical oxygen.

5.2 Coordination Mechanisms of the NMOSP

The National Medical Oxygen Committee will be the overall coordinating mechanism for this plan. It will be supported by subnational committees, including the Provincial Medical Oxygen Committee, Level 3 Hospital Medical Oxygen Committee, Level 2 Hospital Medical Oxygen Committee, District Medical Oxygen Committee, and Level 1 Hospital Medical Oxygen Committee. The various technical working groups or subcommittees that are aligned with the Medical Oxygen Programme will coordinate the specific technical work to be carried out under each thematic area in the programme.

5.3 Policy, Legal, and Regulatory Framework

Successful implementation of the NMOSP relies on contributions from both the public and private sectors and is contingent on each stakeholder group having a clear understanding of its role. The following is a brief description of the main contributions that government stakeholders will make to successfully scale up medical oxygen services in Zambia.

5.3.1 Ministry of Health (MOH)

The MOH will perform the following functions:

- Disseminate the essential medicines list, essential equipment list, national standard treatment guidelines, regulations, and NMOSP to relevant stakeholders for implementation.
- Work with regulatory agencies (ZAMRA / Zambia Bureau of Standards) to update regulations to clarify registration and importation requirements for oxygen supply equipment and diagnostics and ensure they meet international standards (e.g., WHO, International Organisation for Standardisation, and Institute of Electrical and Electronics Engineers Standards Association specifications).
- Establish an oxygen desk and assign an officer to lead the national multi-stakeholder coordinating mechanism on medical oxygen services.
- Lead fundraising efforts for the strategy and galvanise funding commitments from other MOH and cooperating partners, including public insurance scheme authorities, such as National Health Insurance Scheme and private insurance authorities.
- Lead national coordinating mechanism meetings and plan for the annual reviews.
- Enforce standards for high-quality clinical practice.
- With partners, update national policies, clinical guidelines, regulations, and other standards and disseminate them to other stakeholders.
- Implement guidelines and policies, conduct training, and provide resources for medical oxygen services.

5.3.2 Zambia Medicines and Medical Supplies Agency (ZAMMSA)

The following functions will be carried out by ZAMMSA:

- Procure and distribute commodities and medical oxygen from the point of manufacturing at proposed designated hospital production facilities to the point of use at hospitals that do not have production capacity.
- Invest in dedicated storage facilities at both production sites and existing ZAMMSA storage facilities.
- Support procurement of appropriately equipped vehicles for the purpose of cylinder transportation.

5.3.3 ZAMRA

ZAMRA will carry out the following the functions:

- Develop the regulatory framework for oxygen, including legal guidelines and standards.
- Work with various institutions to ensure that medical oxygen meets the three regulatory pillars of quality, safety, and efficacy for pharmaceutical products.
- Work with stakeholders to draft guidelines for the current Good Manufacturing Practices and marketing authorisation of medical oxygen. These guidelines will:
 - Guide industry on matters of personnel, premises, equipment, and other areas of Good Manufacturing Practices pertinent to the manufacture of medical oxygen that consistently meet the required standards of quality, safety, and efficacy.
 - Provide the applicable pharmacopeia standards for medical oxygen.
 - Monitor oxygen manufacturing for compliance. Though public health manufacturing is deemed extemporaneous as it is done on-site, health facilities will be required to comply with the minimum requirements of current Good Manufacturing Practices.

5.4 Governance Framework

Implementation of the NMOSP will follow the existing governance frameworks used in the MOH. The MOH will collaborate with development partners; the private sector; non- governmental, faith-based, and civil society organisations; and others in implementing the NMOSP 2022–2026. The MOH, through its coordination mechanism, will ensure that all players support the same priorities and interventions relating to the NMOSP.

The MOH and relevant stakeholders will be accountable for the successes and failures in implementation of the NMOSP and will ensure that operationalisation of the plan will be done in accordance with the financial management and procurement guidelines and procedures.

5.5 Partnership Framework

The MOH will use the principles of partnership and collaboration incorporated into the sector-wide approach. This approach is an important platform in the mobilisation and utilisation of financial resources from cooperating partners and the government.

The private sector will be responsible for the production of medical oxygen and will collaborate with the MOH in effectively delivering health services. The private sector also will be involved in the review and implementation of the medical oxygen guidelines and will adhere to the regulations and quality assurance standards.

The cooperating partners will be responsible for financial and technical support in the implementation of the NMOSP. They also will conduct joint monitoring with the MOH to ensure that the set targets in the plan are met. As stakeholders they are key in actualising the principles inherent in the mechanisms of the sector-wide approach.

6. Costing of the NMOSP

6.1 Costing Overview and Assumptions

This section presents estimations of costs to implement the NMOSP from 2022 to 2026. The aim is to support strategic planning and evidence-based decision-making, as well as domestic and donor resource mobilisation. The estimations of resource needs will also support the MOH in being transparent and accountable in operationalisation of the NMOSP.

The costing methodology that was used to estimate the resources needed to implement the NMOSP was activity-based budgeting. This entailed the identification of activities, inputs required to carry out these activities, unit costs of inputs, and associated quantities. The total cost was derived by summing the price of all inputs that will be used to undertake all activities. An ingredients-based approach was used to identify the specific inputs needed to carry out each intervention and the targets set in consultation with the thematic areas' focal point persons.

The costing framework used was the model used by the MOH to detail inputs and cost plans under the Medium-Term Expenditure Framework and annual action planning and budgeting processes. This alignment to existing planning and budgeting approaches was considered necessary to avoid multiplicity of methods/approaches and to make implementation easier.

The budget was developed by key stakeholders, including programme managers and technical experts from the MOH and cooperating partners. The process also benefited from technical and financial support from PATH.

The budget covers a duration of five years, from 2022 to 2026. This is intended to realign the NMOSP to the National Health Strategic Plan, which also is in force from 2022 to 2026. The baseline unit costs were the prevailing market prices of goods and services for the year 2021; other costs were based on the standard prices set by the government of the Republic of Zambia (e.g., allowances). The baseline unit prices were compounded to reflect future values at the rate of 8.5 percent as the cost of capital (interest rate). The prices were converted into US dollars at the exchange rate of 19.70 Zambian kwacha per US\$1.00.²⁰

6.2 Costs to Implement the NMOSP

The total cost to implement the NMOSP for its five-year duration is estimated at \$1,627,243,928. Table 19 shows the distribution of the estimated costs by thematic area: medical oxygen service delivery; infrastructure, equipment, and supply; human resources for medical oxygen; logistics management information system; medical oxygen systems research; data and quality management; leadership and governance; and finance and resource mobilisation. Medical oxygen service delivery accounts for the highest share, amounting to \$1,524,849,503. Finance and resource mobilisation accounts for the lowest share, amounting to \$2,295,557.

Table 19: Distribution of Estimated Costs to Implement the NMOSP, by Thematic Area and Year.

Thematic Area	Cost (US\$)					Total (US\$)
	2022	2023	2024	2025	2026	
Medical oxygen service delivery	257,342,373	279,216,475	302,949,875	328,700,614	356,640,166	1,524,849,503
Infrastructure, equipment, and supply	1,261,947	1,369,213	1,485,596	1,611,872	1,748,880	7,477,506
Human resources for medical oxygen	11,849,309	12,856,502	13,949,305	15,134,995	16,421,469	70,211,580
Logistics management information system	1,559,735	1,690,430	1,797,352	1,950,127	2,115,887	9,113,531
Medical oxygen systems research	403,076	437,338	474,511	514,845	558,606	2,388,376
Data and quality management	476,827	517,358	561,333	609,046	660,815	2,825,379
Leadership and governance	1,361,215	1,480,617	1,606,469	1,743,019	1,891,176	8,082,496
Finance and resource mobilisation	387,411	420,342	456,070	494,836	536,897	2,295,557
TOTAL	274,641,893	297,988,275	323,280,511	350,759,354	380,573,896	1,627,243,928

Abbreviation: NMOSP, National Medical Oxygen Strategic Plan.

This budget will be implemented through the established Medium-Term Expenditure Framework and annual action planning and budgeting frameworks. These frameworks involve health-sector partners, who participate in the planning, budgeting, prioritisation, and identification of areas to support.

6.3 Projected Available Financing and Financing Gap

It is assumed that the budget will be funded from a combination of sources, including the national budget through annual budgetary allocations; established/active cooperating partners who are currently supporting programmes related to the thematic areas listed in Table 19; and new partners and funding initiatives who will advocate for the programme activities and solicit support.

During the annual planning cycle, leadership of each thematic programme will determine financing gaps based on the government's estimations in this budget and the available funding and pledges received from cooperating partners.^{iv}

7. M&E Plan

7.1 Overview

M&E of the NMOSP is key to tracking the progress of its implementation and assessing the effectiveness and impact of its various interventions. This M&E plan seeks to achieve the following:

- Enable timely and efficient gathering of relevant information.
- Enable the tracking of actual performance against the set targets to ensure that interventions are carried out to the required standards and guidelines.
- Enable the effective gathering of baseline and follow-up data for evaluation.
- Enable the timely preparation and use of reports for managing the strategy implementation.
- Ensure data quality in terms of accuracy, reliability, completeness, precision, integrity, timeliness, and confidentiality.
- Outline the roles and responsibilities of the different actors involved in M&E of the strategy.

The main performance indicators are listed in Table 20, which details the annual targets from 2022 to 2026, data sources, and reporting timelines. The indicators in Table 20 are grouped under the same eight thematic areas from Table 19. More detailed information, including responsibilities and major assumptions, are provided in Appendix 2.

^{iv} The MOH does annual planning and budgeting for activities. The NMOSP, running from 2022 to 2026, will have four annual plans for how the MOH will fund its activities.

Table 20: NMOSP Indicator Matrix

Indicator	Baseline	Target 2022	Target 2023	Target 2024	Target 2025	Target 2026	Data Source	Reporting Timelines
Medical Oxygen Service Delivery								
Number of health facilities with production plants therapy	9	11	15	19	23	27	<ul style="list-style-type: none"> • MOH surveys • HMIS HCCs 	Annual
Number of hospitals with oxygen production plants with refilling capacity	4	15	17	19	22	24	<ul style="list-style-type: none"> • MOH surveys • HCCs • HAdmin 	Annual
Number of facilities installed with bulk liquid oxygen tanks	0	2	6	10	14	15	<ul style="list-style-type: none"> • MOH reports • MOH surveys 	Annual
Number of oxygen manifolds procured and installed for level 1, 2, and 3 hospitals	6	26	36	46	56	66	<ul style="list-style-type: none"> • MOH reports • MOH surveys 	Annual
Infrastructure, Equipment, and Supply								
Number of medical oxygen cylinder storage sheds constructed at provincial hubs, ZAMMSA headquarters, and health care facilities	0	7	14	21	28	35	<ul style="list-style-type: none"> • ZAMMSA reports 	Annual
Percentage of medical oxygen cylinders tested (hydrostatic) and indexed	0	-	-	-	90	95	<ul style="list-style-type: none"> • Hub-level reports 	Annual
Percentage of facilities with oxygen monitoring devices procured for quality control (e.g., oxygen analysers, purity meters)	0	40	70	90	95	100	<ul style="list-style-type: none"> • MOH reports • MOH surveys 	Annual
Human Resources for Medical Oxygen								
Number of biomedical staff currently employed and trained to manage medical oxygen services	44	300	600	900	1,000	1,200	<ul style="list-style-type: none"> • MOH reports • MOH surveys 	Annual
Number of biomedical technologists employed to manage and maintain oxygen equipment	0	30	60	90	120	150	<ul style="list-style-type: none"> • MOH reports • MOH surveys 	Annual

Indicator	Baseline	Target 2022	Target 2023	Target 2024	Target 2025	Target 2026	Data Source	Reporting Timelines
Number of biomedical engineers trained to subspecialise in oxygen plant management	0	10	20	30	40	50	<ul style="list-style-type: none"> MOH reports MOH surveys 	Annual
Number of annual in-house trainings conducted to strengthen knowledge and skills in oxygen management systems amongst medical oxygen plant operators and attendants	0	100	200	300	400	500	<ul style="list-style-type: none"> Facility reports 	Annual
Logistics Management Information System								
Number of SOPs/guidelines printed and disseminated	0	1,000	2,000	3,000	4,000	6,000	<ul style="list-style-type: none"> MOH reports MOH surveys 	Annual
Medical Oxygen Systems Research								
Number of research activities/projects conducted	0	5	10	15	20	30	<ul style="list-style-type: none"> MOH reports MOH surveys 	Annual
Data and Quality Management								
Number of facilities using data-capturing tools (e.g., tracking tools, commodity control cards, forms, SOPs, and worksheets)	0	20	40	60	80	100	<ul style="list-style-type: none"> HMIS Facility reports 	Annual
Number of trainings conducted on oxygen data-capturing tools	1	10	20	30	40	50	<ul style="list-style-type: none"> HMIS Facility reports 	Annual
Leadership and Governance								
Number of technical supportive supervision and mentorship visits done to provincial hubs countrywide	0	10	20	30	40	50	<ul style="list-style-type: none"> Provincial health office reports NOC 	Annual
Number of meetings held to review oxygen supply chain system	0	2	4	6	8	10		Biannual
Finance and Resource Mobilisation								
Number of public-private partnership stakeholder engagement meetings held	0	5	8	8	8	8	<ul style="list-style-type: none"> MOH reports MOH surveys 	Annual

Indicator	Baseline	Target 2022	Target 2023	Target 2024	Target 2025	Target 2026	Data Source	Reporting Timelines
Number of districts with updated resource allocation formula that includes medical oxygen systems	0	16	40	70	90	116	<ul style="list-style-type: none"> • MOH reports • MOH surveys 	Annual

Abbreviations: HAdmin, Hospital Administrator; HCC, head of clinical care; HMIS, health management information system; MOH, ministry of health; NOC, national oxygen coordinator; SOP, standard operating procedure; ZAMMSA, Zambia Medicines and Medical Supplies Agency.

7.2 Performance Review Process

7.2.1 M&E

The main source of data for monitoring purposes will be administrative and programme reports. At the MOH level, these reports will be from the District Health Information System 2 and a web-based health management information system (HMIS) database. Reporting lines, timelines, and frequency of reporting are already well established for these systems. When feasible/possible, opportunities for integrating additional indicators into the HMIS will be explored, along with the need to revise existing data collection forms and registers to collect these additional indicators.

In general, data are collected at the facility level on an ongoing basis and compiled monthly for submission first to the district level and then to the provincial and national levels. From the district level to the national level, the data are compiled and transmitted electronically. The frequency of data collection is adequate; however, the timeliness of analysis and reporting at the national level needs to be strengthened to meet the needs of this strategy, as the information needs to be made available to the relevant programmes consistently and without undue delays to inform decision-making. The use of data at all levels of the health system—particularly at the health facility level—for performance assessment, management, and decision-making also needs to be strengthened.

The evaluation plan for the NMOSP consists of three phases: gathering of baseline data, conducting of a midterm evaluation midway through the implementation period, and conducting of an endline evaluation at the end of the strategy implementation period. Baseline data will be obtained from the HMIS, as well as from surveys already conducted, such as the Health Facility Census and the Demographic and Health Survey for 2018. Routinely collected administrative data will be used as part of the evaluation to check for trends over time, as well as general performance. However, the evaluation will depend largely on special studies and data from routine surveys, such as Multiple Indicator Cluster Surveys and Demographic and Health Surveys, to assess the outcomes and impact of the implemented interventions.

7.2.1.1 Annual Performance Review

The MOH, with technical support from partners, will carry out an annual performance review. This review will be a collaborative process that will look at the status of strategy implementation every year. Findings will be used to make important and timely decisions regarding the way forward year by year. An annual review format will be developed that will help to enable consistency across the five years of NMOSP implementation.

7.2.1.2 Midterm Review

The midterm review will be designed to follow up on baseline indicators, as well as to assess other aspects of implementation. It will be conducted using a mixed-methods approach (qualitative and quantitative). Part of its aim will be to assess implementation enablers and

challenges at all levels. It will also incorporate any timely survey data available at the time of the review.

7.2.1.3 Endline Review

Like the midterm review, the endline review will employ a mixed-methods approach and incorporate any timely survey data available at the time of the review. In planning for the evaluation, the MOH will seek opportunities to include questions related to NMOSP indicators in ongoing surveys, such as the Demographic and Health Surveys, Malaria Indicator Surveys, Public Expenditure Tracking Surveys, and Reproductive Health Commodity Security survey, amongst others. Relevant linkages with the agencies that are responsible for these studies will thus have to be strengthened to ensure that the issues in this strategy are addressed adequately.

7.2.2 Special Studies

Some special studies may have to be commissioned to answer specific questions that may not be answered adequately using administrative data or existing survey methodologies. In this regard, it is important to engage with academia as a rich and available source of expertise and time dedicated to such studies. In implementing a complex strategy with multiple stakeholders, such as this one, it is important to assess the overall impact of the different interventions from different actors. Special studies are required for this. Fortunately, many such studies are already conducted regularly and can be used to gather the required information to assess the outcomes and impact of the NMOSP, as well as to gauge its overall contribution to these achievements. These existing sources of data include district health surveys, household surveys, health facility surveys, Demographic and Health Surveys, performance surveys, Public Expenditure Tracking Surveys / quality of delivery surveys, Malaria Indicator Surveys, and financial records. The information obtained will, whenever possible, be disaggregated along equity stratifications, such as gender, age group, education attainment, income/wealth quintile, level of the health system, and geographical location (rural and urban).

7.2.3 Feedback Mechanisms

Often, vital information remains at the national level and is not shared with lower levels on a timely basis for decision-making, planning, and management purposes. To remedy this, feedback mechanisms will be established to disseminate the findings of the annual reviews to the provincial, district, community, and facility levels. Such feedback will include the findings of the midterm and endline evaluations. This feedback will be critical in allowing all stakeholders to adjust course during implementation and to know what is working well and what is not working so well. As with the dissemination of the strategy itself, feedback will be coordinated through the provincial and district structures.

8. Appendices

Appendix 1: Costs to Implement the National Medical Oxygen Strategic Plan 2022–2026, by Strategy

Tables 21 through 28 present a breakdown of strategic objectives and strategies/interventions for each thematic area, including the total costs for each strategy, per year, for the five-year period from 2022 to 2026.

Table 21: Strategic Objectives and Interventions for Medical Oxygen Service Delivery

Strategic Objectives for 2022 to 2026	Specific Strategies / Interventions	Cost (US\$)					Total
		2022	2023	2024	2025	2026	
1 Strengthen medical oxygen supply systems in 60% of public hospitals in Zambia	1.1 Increase and strengthen oxygen production and refilling capacity in hospitals	99,011,744	107,427,742	116,559,100	126,466,624	137,216,287	586,681,497
	1.2 Strengthen medical oxygen reticulation in all hospitals in Zambia	24,862,537	26,975,853	29,268,800	31,756,648	34,455,963	147,319,801
	1.3 Advocate for long-term medical oxygen supply contracts for all hospitals that depend on private suppliers	199,384	216,331	234,719	254,671	276,317	1,181,422
	1.4 Strengthen service contracts for existing PSA plants installations	20,601	22,352	24,252	26,314	28,551	122,071
Subtotal		124,094,266	134,642,279	146,086,872	158,504,256	171,977,118	735,304,791

Strategic Objectives for 2022 to 2026	Specific Strategies / Interventions	Cost (US\$)					Total
		2022	2023	2024	2025	2026	
2 Improve the rational use of medical oxygen at all levels of health care services	2.1 Scale up the accessibility, availability, and acceptance of pulse oximeters, delivery devices, and other accessories across all levels of health care service delivery	133,248,107	144,574,196	156,863,003	170,196,359	184,663,048	789,544,712
Subtotal		133,248,107	144,574,196	156,863,003	170,196,359	184,663,048	789,544,712
TOTAL: Medical Oxygen Service Delivery		257,342,373	279,216,475	302,949,875	328,700,614	356,640,166	1,524,849,503

Abbreviations: MOH, ministry of health; PSA, pressure swing adsorption.

Table 22: Objectives and Interventions for Infrastructure, Equipment and Supply

Strategic Objective for 2022 to 2026	Specific Strategies/ Interventions	Cost (US\$)					Total
		2022	2023	2024	2025	2026	
3 Increase the proportion of health facilities receiving high-quality medical oxygen	3.1 Establish storage sheds for medical oxygen cylinders at all provincial hubs, ZAMMSA headquarters, and all health care facilities	531,650	576,840	625,872	679,071	736,792	3,150,224
	3.2 Ensure all medical oxygen cylinders in use are tested with a hydrostatic test and rambling every 5 years	26,507	28,760	31,204	33,857	36,734	157,061
	3.3 Ensure procurement of appropriate oxygen delivery devices for each level of care	439,425	476,776	517,302	561,273	608,981	2,603,757
	3.4 Strengthen transportation systems for oxygen cylinders	264,365	286,837	311,218	337,671	366,373	1,566,464
Subtotal		1,261,947	1,369,213	1,485,596	1,611,872	1,748,880	7,477,506
TOTAL: Infrastructure, Equipment, and Supply		1,261,947	1,369,213	1,485,596	1,611,872	1,748,880	7,477,506

Abbreviation: ZAMMSA, Zambia Medicines and Medical Supplies Agency.

Table 23: Objectives and Interventions for Human Resources for Medical Oxygen

Strategic Objectives for 2022 to 2026	Specific Strategies / Interventions	Cost (US\$)					Total
		2022	2023	2024	2025	2026	
4 Increase the number of staff involved in oxygen management from 44 to 3,580	4.1 Scale up the recruitment of biomedical staff for management of medical oxygen services	11,184,643	12,135,337	13,166,841	14,286,022	15,500,334	66,273,178
	4.2 Build the capacity of a team of biomedical engineers in areas of specialisation in oxygen plant management	67,110	72,815	79,004	85,719	93,005	397,654
	4.3 Build the capacity of personnel in oxygen production, supply, and administration	298,778	324,175	351,730	381,627	414,065	1,770,374
Subtotal		298,778	324,175	351,730	381,627	414,065	1,770,374
TOTAL: Human Resources for Medical Oxygen		11,849,309	12,856,502	13,949,305	15,134,995	16,421,469	70,211,580

Table 24: Objectives and Interventions for the Logistics Management Information System

Strategic Objective for 2022 to 2026	Specific Strategies / Interventions	Cost (US\$)					Total
		2022	2023	2024	2025	2026	
5 Ensure an efficient, resilient, and safe oxygen delivery system by systematically collecting high-quality data in a timely manner to provide information for decision-making	5.1 Incorporate medical oxygen technologies and supplies into medical equipment standard list	146,292	158,727	172,219	186,857	202,740	866,836
	5.2 Strengthen supply chain strategy for medical oxygen	1,169,437	1,268,839	1,376,691	1,493,709	1,620,675	6,929,352
	5.3 Expand eLMIS to include medical oxygen management systems for all levels of care	83,089	88,269	59,007	64,022	69,464	363,851
	5.4 Strengthen medical oxygen indicators in the monthly eLMIS and HIMS reports	160,917	174,595	189,436	205,538	223,008	953,494
Subtotal		1,559,735	1,690,430	1,797,352	1,950,127	2,115,887	9,113,531
TOTAL: Logistics Management Information System		1,559,735	1,690,430	1,797,352	1,950,127	2,115,887	9,113,531

Abbreviations: eLMIS, electronic logistics management information system; HIMS, health management information system.

Table 25: Objectives and Interventions for Medical Oxygen Systems Research

Strategic Objective for 2022 to 2026	Specific Strategies / Interventions	Cost (US\$)					Total
		2022	2023	2024	2025	2026	
6 Strengthen research in key medical oxygen system priority areas and scale up research activity to all level 1 facilities	6.1 Build research capacity and a research culture through research training programmes	271,910	295,022	320,099	347,307	376,828	1,611,166
	6.2 Focus efforts on obtaining funding opportunities for research	38,676	41,964	45,531	49,401	53,600	229,172
	6.3 Develop research proposals or methodologies for measuring or collecting data to assess key priority areas	52,968	57,470	62,355	67,655	73,406	313,854
	6.4 Encourage research to be published in a peer-reviewed journal and/or presented at conferences for knowledge dissemination (focusing on local opportunities first)	39,522	42,881	46,526	50,481	54,772	234,183
Subtotal		403,076	437,338	474,511	514,845	558,606	2,388,376
TOTAL: Medical Oxygen Systems Research		403,076	437,338	474,511	514,845	558,606	2,388,376

Table 26: Objectives and Interventions for Data and Quality Management

Strategic Objective for 2022 to 2026	Specific Strategies / Interventions	Cost (US\$)					Total
		2022	2023	2024	2025	2026	
	6.5 Establish a data management system for medical oxygen	228,995	248,460	269,579	292,493	317,355	1,356,881
	6.6 Strengthen high-quality management processes to improve their effectiveness and efficiency	247,832	268,898	291,754	316,553	343,460	1,468,498
Subtotal		476,827	517,358	561,333	609,046	660,815	2,825,379
TOTAL: Data and Quality Management		476,827	517,358	561,333	609,046	660,815	2,825,379

Table 27: Objectives and Interventions for Leadership and Governance

Strategic Objective for 2022 to 2026	Specific Strategies / Interventions	Cost (US\$)					Total
		2022	2023	2024	2025	2026	
7 Promote a coordinated approach to leadership, governance, and accountability	7.1 Strengthen leadership at the MOH, provincial, and district levels to coordinate the implementation of medical oxygen delivery services	502,447	545,155	591,493	641,770	696,321	2,977,186
	7.2 Strengthen stakeholder coordination mechanisms	791,215	862,167	935,451	19,994,803	1,101,237	4,705,035
	7.3 Strengthen legal and regulatory framework for provision of medical oxygen services	67,553	73,295	79,525	86,284	93,618	400,275
Subtotal		1,361,215	1,480,617	1,606,469	1,743,019	1,891,176	8,082,496
TOTAL: Leadership and Governance		1,361,215	1,480,617	1,606,469	1,743,019	1,891,176	8,082,496

Abbreviations: MOH, ministry of health; NMOSP, National Medical Oxygen Strategic Plan.

Table 28: Objectives and Interventions for Finance and Resource Mobilisation

Strategic Objective for 2022 to 2026	Specific Strategies/Interventions	Cost (US\$)					Total
		2022	2023	2024	2025	2026	
13 Increase financial resources and ensure effectiveness, efficiency, and equity in resource allocation and use at all levels of health care	13.2 Promote private-sector participation in public-private partnerships	22,242	24,133	26,184	28,409	30,824	131,792
	13.3 Lobby for external funding through direct sector budget support and strengthen partnerships with CPs and civil society organisations	365,169	396,209	429,886	466,427	506,073	2,163,765
Subtotal		387,411	420,342	456,070	494,836	536,897	2,295,557
TOTAL: Finance and Resource Mobilisation		387,411	420,342	456,070	494,836	536,897	2,295,557

Appendix 2: Logical Framework for the National Medical Oxygen Strategic Plan 2022–2026

Table 29 summarises the achievement indicators and assumptions for each of the eight thematic areas.

Table 29. Achievement Indicators and Assumptions for the NMOSP, per Thematic Area

Indicator to Verify Achievement	Means of Verification	Responsible Person	Key Assumptions
Medical Oxygen Service Delivery			
Number of health facilities providing uninterrupted oxygen therapy	MOH surveys HMIS HCCs	NOC	<ul style="list-style-type: none"> Essential health services, including respiratory care, that are packaged for each level of care (through the National Health Services Act) and translated into services charter Sustained funding by cooperating partners for medical oxygen and respiratory care services
Number of hospitals with oxygen production and refilling capacity	MOH surveys HCCs HAdmin	NOC	
Number of health workers trained in oxygen administration and basic critical care services	MOH surveys HCCs	NOC	
Number of trainings conducted in oxygen administration and basic critical care services	NOC Nccmc	NOC	
Number of functional oxygen manifolds procured and installed for Level 1, 2, and 3 hospitals	MOH reports MOH surveys	NOC	
Infrastructure, Equipment, and Supply			
Number of Level 1, 2, and 3 health facilities installed with central pipeline and manifolds	MOH reports MOH surveys	NOC	<ul style="list-style-type: none"> Medical oxygen infrastructure and essential respiratory care supplies that are funded according to plan Consistent release of funding from treasury Sustained funding by cooperating partners for medical oxygen and respiratory care services
Number of medical oxygen cylinder storage sheds constructed at provincial hubs, ZAMMSA facilities, or health facilities	ZAMMSA reports	NOC	
Number of biomedical staff trained in medical oxygen cylinder standard testing	Facility-level reports	NOC	
Percentage of medical oxygen cylinders tested (hydrostatic) and indexed	Hub-level reports	NOC	
Percentage of facilities with oxygen monitoring devices procured for quality control (e.g., oxygen analysers, purity meters)	MOH reports MOH surveys	NOC	

Indicator to Verify Achievement	Means of Verification	Responsible Person	Key Assumptions
Number of 15-ton trucks procured with appropriate loading bins, cylinder racks, and tailgate lifters for carrying medical oxygen cylinders		NOC	
Number of cylinder carts procured with hydraulic lifters, appropriate loading bins, and tailgate lifters for carrying medical oxygen cylinders	MOH reports MOH surveys	NOC	
Human Resources for Medical Oxygen			
Number of biomedical staff currently employed and trained to manage medical oxygen services	MOH reports MOH surveys	NOC	<ul style="list-style-type: none"> • No disruptions to academic calendars of training institutions • Treasury authority that is granted and open for all positions within the health facility establishment • Consistent release of funding from treasury • Lack of drastic changes in the existing governance structures before the end of 2026 • Sustained funding by cooperating partners for medical oxygen and respiratory care services
Number of biomedical technologists employed to manage and maintain oxygen equipment	Facility reports	NOC	
Number of biomedical engineers trained to subspecialise in oxygen plant management	MOH reports MOH surveys	NOC	
Number of annual in-house trainings conducted to strengthen knowledge and skills in oxygen management systems amongst medical oxygen plant operators and attendants	MOH reports MOH surveys	NOC	
Logistics Management Information System			
Number of meetings held to develop the guidelines and SOPs	MOH reports MOH surveys	NOC	<ul style="list-style-type: none"> • Medical oxygen infrastructure and eLMIS will be funded according to plan
Number of SOPs/guidelines distributed on essential commodities and equipment	MOH reports MOH surveys	NOC	
Medical Oxygen Systems Research			
Number of research activities/projects conducted	HMIS Facility reports	NOC	<ul style="list-style-type: none"> • Additional funding outside the national budget • Sustained funding by cooperating partners for
Number of research proposals developed	HMIS facility reports	NOC	

Indicator to Verify Achievement	Means of Verification	Responsible Person	Key Assumptions
Number of conferences/research dissemination meetings held	HMIS Facility reports	NOC	medical oxygen and respiratory care services
Number of research articles published in peer-reviewed journals	HMIS Facility reports	NOC	
Data and Quality Management			
Number of facilities using data-capturing tools (e.g., tracking tools, commodity control cards, forms, SOPs, and worksheets)	HMIS Facility reports	NOC	<ul style="list-style-type: none"> Financing by the treasury for all key positions needed for data management at all levels Expansion of internet penetration for rural districts to improve data completeness and timeliness
Quality improvement chair established at each facility who can champion improvement and be primarily responsible for oversight of all facility-specific data and subsequent reports to other levels	HMIS Facility reports	NOC	
Number of trainings conducted on oxygen data-capturing tools	MOH reports MOH surveys	NOC	
Policy, Legal, and Regulatory Framework			
Number of technical supportive supervision and mentorship visits done to provincial hubs countrywide	MOH surveys HMIS HCCs	NOC	<ul style="list-style-type: none"> Stable MOH leadership to oversee implementation of the Zambian NMOSP No drastic changes in the existing governance structures before the end of 2026 Increase in government funding and contribution to health services, relative to other sources of funding Sustained funding by cooperating partners for medical oxygen and respiratory care services
Number of monthly provincial- and district-level review meetings held on oxygen management	MOH surveys HCCs HAdmin	NOC	
Number of monthly trainings conducted on data capturing to strengthen monitoring of oxygen consumption	MOH surveys HCC's	NOC	
Number of meetings held to develop terms of references for the National Medical Oxygen Committee	NOC Nccmc	NOC	
Number of meetings held to develop an oxygen supply chain system	MOH reports MOH surveys	NOC	
Number of national, provincial, district, and facility committees appointed	MOH reports MOH surveys	NOC	
Number of monthly technical working group meetings held on access to oxygen service delivery	MOH reports MOH surveys	NOC	

Indicator to Verify Achievement	Means of Verification	Responsible Person	Key Assumptions
Good Manufacturing Practice guidelines on medical oxygen developed	ZAMMSA reports	NOC	
Training for current Good Manufacturing Practice inspections of medical oxygen manufacturers conducted	Facility-level reports	NOC	
Guidelines of marketing authorisation for medical oxygen developed	Hub-level reports	NOC	
Capacity-building on quality analysis of medical oxygen conducted	MOH reports MOH surveys	NOC	
Finance and Resource Mobilisation			
Number of public-private partnership stakeholder engagement meetings held	MOH reports MOH surveys	NOC	<ul style="list-style-type: none"> Stable MOH leadership to oversee implementation of the National Health Insurance Scheme Sustained funding by cooperating partners for respiratory care service programmes
Number of districts with updated resource allocation formula that includes medical oxygen systems	MOH reports MOH surveys	NOC	

Abbreviations: eLMIS, electronic logistics management information system; HAdmin, Hospital Administrator; HCC, head of clinical care; HMIS, health management information system; MOH, ministry of health; NCCMC, national COVID-19 clinical management coordinator; NOC, national oxygen coordinator; SOP, standard operating procedure; ZAMMSA, Zambia Medicines and Medical Supplies Agency.

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9. References

1. PATH. *Biomedical Equipment for COVID-19 Case Management: Zambia COVID-19 Treatment Facility Survey Report*. Seattle: PATH; 2021. <https://www.path.org/resources/biomedical-equipment-covid-19-case-management-zambia-covid-19-treatment-facility-survey-report/>.
2. Central Statistical Office (CSO). *2010 Census of Population and Housing: Population and Demographic Projections 2011–2035*. Lusaka: CSO; 2013. <https://www.zamstats.gov.zm/phocadownload/Zambia%20Census%20Projection%202011%20-%202035.pdf>.
3. Government of the Republic of Zambia. *Vision 2030: “A Prosperous Middle-Income Nation by 2030.”* Lusaka: GRZ; 2006. https://www.zambiaembassy.org/sites/default/files/documents/Vision_2030.pdf.
4. Republic of Zambia Ministry of Health (MOH). *National Health in All Policies Strategic Framework 2017–2021*. Lusaka: MOH; 2018. <https://www.afro.who.int/sites/default/files/2019-05/NATIONAL%20HEALTH%20IN%20ALL%20POLICIES%20%20STRATEGIC%20FRAMEWORK%20%20%283%29.pdf>.
5. Government of the Republic of Zambia (GRZ). *National Health Policy. ‘A Nation of Healthy and Productive People’*. Lusaka: GRZ; 2012. <https://bettercarenetwork.org/sites/default/files/Zambia%20National%20Health%20Policy.pdf>.
6. Republic of Zambia Ministry of Health (MOH) website. About us page. https://www.moh.gov.zm/?page_id=5811. Accessed 27 January 2022.
7. World Health Organization (WHO) Secretariat. *Revision of the International Health Regulations: Severe Acute Respiratory Syndrome (SARS)*. Geneva: WHO; 2003. Fifty-sixth World Health Assembly, Provisional Agenda Item 14.16 (A56/48). https://apps.who.int/gb/archive/pdf_files/WHA56/ea5648.pdf.
8. PATH, Republic of Zambia Ministry of Health (MOH). *Zambia Oxygen Summit Report*. Seattle, Lusaka: PATH, MOH; 2021. <https://www.path.org/resources/zambia-oxygen-summit/>.
9. Republic of Zambia Ministry of Health (MOH). *The 2012 List of Health Facilities in Zambia: Preliminary Report (Version No. 15)*. Lusaka: MOH; 2013. <https://library.adhl.africa/handle/123456789/11647?locale-attribute=en>.
10. Republic of Zambia Ministry of Health (MOH). *Zambia National Health Strategic Plan 2017–2021*. Lusaka: MOH; 2017. https://extranet.who.int/countryplanningcycles/sites/default/files/planning_cycle_repository/zambia/zambianhsp.pdf.

11. World Health Organization website. Medical use of oxygen page. <https://www.who.int/teams/health-product-policy-and-standards/assistive-and-medical-technology/medical-devices/oxygen>. Accessed 26 January 2022.
12. World Health Organization (WHO), United Nations Children's Fund (UNICEF). *WHO-UNICEF Technical Specifications and Guidance for Oxygen Therapy Devices*. Geneva: WHO, UNICEF; 2019. WHO Medical Device Technical Series. <https://apps.who.int/iris/handle/10665/329874>.
13. DHIS2 Zambian Health Management Information System website. <http://dhis2.moh.gov.zm/hmis>. Accessed 2 April 2020.
14. Republic of Zambia Ministry of Health (MOH), Zambia National Public Health Institute (ZNPHI), World Health Organization. *Zambia Situation Report No. 103*. Lusaka: ZNPHI; 2021. https://mcc-covid.crc.pitt.edu/COVID19_official_websites/Zambia/nih_sitreps/Zambia_COVID-Situational-Report-No-103_7January2021_Final.pdf.
15. Republic of Zambia Ministry of Health (MOH), Zambia National Public Health Institute (ZNPHI), World Health Organization. *Zambia COVID-19 Situation Report No. 338 – EPI Week 45*. Lusaka: ZNPHI; 2021. http://znphi.co.zm/news/wp-content/uploads/2021/06/Zambia_COVID-Situational-Report.
16. Republic of Zambia Ministry of Health (MOH). *National Surgical, Obstetric, and Anaesthesia Strategic Plan (NSOAP): Year 2017–2021*. Lusaka: MOH; 2017. https://docs.wix-static.com/ugd/d9a674_70f6813fe4e74c4d99eb028336a38745.pdf.
17. World Health Organization (WHO). *Health Workforce Requirements for Universal Health Coverage and the Sustainable Development Goals*. Geneva: WHO; 2016. Human Resources for Health Observer Series, No. 17. <https://apps.who.int/iris/bitstream/handle/10665/250330/9789241511407-eng.pdf?sequence=1&isAllowed=y>.
18. Ministry of Health (MOH), Government of the Republic of Zambia; PATH. *Zambia Oxygen Summit: Summit Report*. Lusaka, Seattle: MOH, PATH; 2021. https://media.path.org/documents/2021.02.10_Zambia_Oxygen_Summit_Report_Final.pdf.
19. The life-saving power of medical oxygen [newsroom story]. World Health Organization website. 25 February 2021. <https://www.who.int/news-room/feature-stories/detail/the-life-saving-power-of-medical-oxygen>.
20. Budget Office, Zambian Ministry of Finance and National Planning. 2022–2024 Budget Call Circular. Lusaka: Government of the Republic of Zambia; 2021. <https://www.course-hero.com/file/130465613/FINAL-2022-BUDGET-CALL-CIRCULARpdf/>.

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