



African Population and
Health Research Center



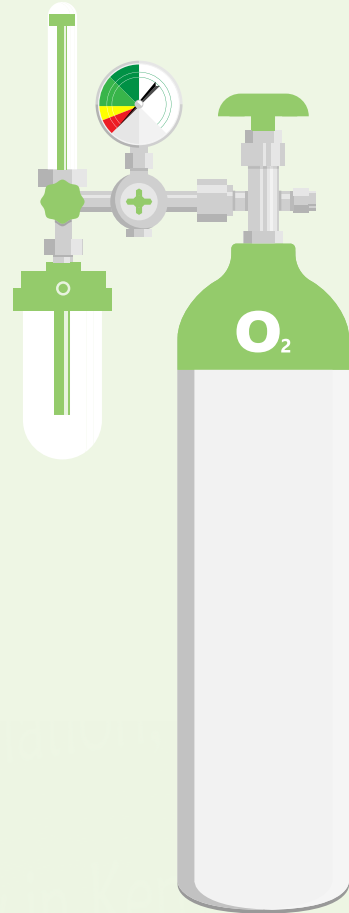
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SCALING ACCESS TO MEDICAL OXYGEN IN KENYA

Assessment of Policy
Constraints, Institutional
Barriers, and Public
Budgeting Challenges

TECHNICAL REPORT
AUGUST 2024







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1 Introduction

1.1 Background

A sufficient supply of medical oxygen is instrumental to an effectively functioning health system. Oxygen helps save lives, and its provision is a critical component of emergency respiratory resuscitation worldwide; it consequently features on the World Health Organization's (WHO) list of essential medicines. According to the WHO, Oxygen is crucial in managing pneumonia and other lung diseases. In addition, it is essential for treating various non-respiratory conditions. It is equally necessary for surgical care, emergencies, and anesthesia. The outbreak of the COVID-19 pandemic highlighted the critical importance of medical oxygen as an essential commodity for managing severe COVID-19 cases requiring respiratory support. This emphasized the need for enhanced access to medical oxygen in health facilities. In 2017, the World Health Organization

(WHO) listed oxygen as an essential medicine, which Kenya ratified in 2019. Including oxygen on the Kenya Essential Medicines List (KEML) elevated it to a priority medication, increasing demand for its procurement, distribution, and prescription. This prioritization necessitates corresponding investment in budgeting, financing, procurement, and distribution mechanisms.

Despite these advancements, oxygen availability remains low in Kenyan health facilities. The Health Sector Report by the Ministry of Health for 2022/23-2024/25 highlights that while Kenya has approximately 70 Pressure Swing Adsorption (PSA) plants, 89 percent are not operating at optimal capacity. Contributing factors include obsolete technology, inadequate maintenance capabilities, failure to account for population growth in planning, and a historical lack of prioritization for oxygen as an essential medicine.





Moreover, affordability remains a significant barrier, despite the government's move to exempt medical oxygen from VAT, effective July 1, 2022, as per the Finance Act of 2022.

The African Population and Health Research Center (APHRC) undertook an extensive nationwide stakeholder consultation process through its "Scaling access to medical oxygen in Kenya" project with funding from the Rockefeller Foundation. APHRC conducted an assessment in nine select counties involving stakeholders at different levels. The study aimed to understand Kenya's policy and institutional frameworks governing medical oxygen regulation, access, and affordability. Specific objectives included identifying the gaps and constraints to access and utilization within public health facilities, mapping the key stakeholders, and assessing the institutional arrangements governing stakeholder behavior, values, incentives, and interests. Additionally, the study sought to deepen understanding of how these arrangements impact the availability, accessibility, and affordability and to deepen understanding of the policy gaps or constraints that hinder investments in and the supply of medical oxygen in the country. This knowledge was used to engage relevant stakeholders, especially the duty bearers, who are largely county governments, as health is devolved, but also the National government, due to its responsibility in policy direction, and National Parliament (National Assembly and Senate), for their legislative policy and legal direction, as well as budgeting.

1.2 Rationale for the project and study

The prevalence of severely limited or unreliable oxygen services persists in many low-and middle-income countries (LMICs), with the most deleterious effects on small health facilities serving impoverished, rural, and marginalized populations. In Kenya, most of the medical liquid oxygen (LOX) is produced in Nairobi, yet existing logistics and distribution networks prioritize urban areas, leaving rural and peri-urban hospitals underserved. Moreover, smaller-scale oxygen manufacturers face a burdensome 16 percent taxation, inflating production expenses and rendering medical oxygen inaccessible to the majority.

The recent proposal in the Finance Bill 2022 to exempt medical supplies (including medical oxygen) from VAT aims to alleviate healthcare costs and is aligned with the Big Four Agenda. However, the exemption primarily benefits small-scale oxygen manufacturers in Nairobi, burdening smaller-scale producers with taxes and levies and exacerbating their operational costs. Additionally, crucial inputs for medical oxygen distribution and utilization in public health facilities remain subject to VAT, perpetuating inaccessibility, particularly for rural and peri-urban populations. Notably, while countries like Ethiopia and Nigeria have national oxygen policy roadmaps, including plans for large-scale oxygen production (Stein et al., 2020), Kenya lacks such strategic frameworks, contributing to systemic challenges in oxygen access.

Furthermore, although oxygen gas cylinders are integral to the medical oxygen value chain and are exempted from taxes under the East African Community Customs Management Act, regional policies specifically targeting an increase in medical oxygen access are absent. These disparities underscore significant gaps in understanding the underlying incentives and institutional norms shaping Kenya's medical oxygen investment and supply chain efficiency. A comprehensive insight into the motivations driving low investments in medical oxygen and the factors influencing supply chain dynamics is imperative to address these complexities. By bridging these knowledge gaps, informed policy advocacy can improve investment, availability, accessibility, and affordability of medical oxygen services.

1.3 Objective of the Project and Study

The main objective was to understand the policy and institutional frameworks governing medical oxygen regulation, access, and affordability in Kenya. The following objectives guided the study:

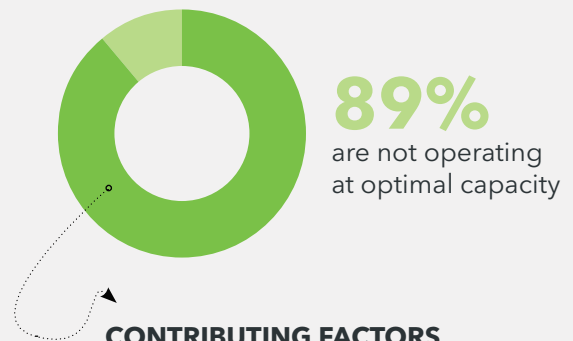
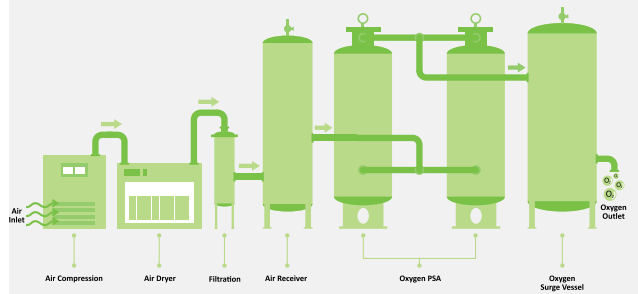
- 1 To identify the gaps and constraints within health facilities regarding access to and utilization of medical oxygen in Kenya.
- 2 To map out and examine the key stakeholders involved in the medical oxygen ecosystem in Kenya.

- 3 To investigate the institutional arrangements governing stakeholder behavior, values, incentives, and interests within the medical oxygen ecosystem in Kenya.
- 4 To assess the impact of existing institutional arrangements on the availability, accessibility, and affordability of medical oxygen services in Kenya.
- 5 To identify and analyze policy gaps or constraints that hinder investments in and the supply of oxygen to health facilities in Kenya.

The project and study aimed to utilize the information and evidence generated to trigger and steer national conversations on making medical oxygen accessible and affordable to the public. We convened a major public engagement forum with partners in the health sector to champion access to medical oxygen in Kenya with the intention to:

- 1 Sustain stakeholder engagements on medical oxygen to provide insights and raise awareness on the classification and taxation of medical oxygen.
- 2 Co-create a policy intervention strategy with relevant decision-makers such as the Ministry of Health, Ministry of Finance, Ministry of Energy and Petroleum, parliamentarians, and the Council of Governors.
- 3 Develop a policy framework, jointly with the government and other stakeholders, to accelerate the expansion of access to medical oxygen to underserved populations and regions in Kenya.

Kenya has 70 pressure swing adsorption (PSA) plants



- 1. Obsolete technology
- 2. Inadequate maintenance capabilities
- 3. Failure to account for population growth in planning
- 4. Lack of prioritization of oxygen as an essential medicine





2 Methodology

2.1 Study design

This study employed a qualitative research design to gather in-depth insights into Kenya’s availability, supply, and utilization of medical oxygen. The qualitative approach allowed for a comprehensive understanding of the contextual factors influencing medical oxygen access and the experiences of healthcare providers and consumers. In addition, we conducted a comprehensive desk review of previous reports and published budget data to enrich our findings.

2.2 Data collection

1. Key Informant Interviews (KIIs): We collected data through Key Informant Interviews (KIIs) across seven counties: Kisii, Bungoma, Nakuru, Uasin Gishu, Embu, Isiolo, and Nyeri. Additional interviews were conducted with national

stakeholders based in Nairobi. Key informants were recruited from county health departments, public health facilities, and other relevant institutions. These included clinicians, nursing staff, anesthesiologists, biomedical engineers, and officials from organizations like AMREF, the Kenya Medical Association (KMA), the Ministry of Health, and the Oxygen Hub (Table 1).

Table 1: Distribution of KIIs by County

County	Institution	Female	Male	Total
Kisii	KTRH	-	2	2
Bungoma	BTRH	4	3	7
Nakuru	NTRH	-	6	6
Embu	ETRH	4	4	8
Isiolo	ITRH	1	3	4
Nyeri	NTRH	2	2	4
Nairobi	AMREF	1	-	1
Nairobi	KMA	-	1	1
Nairobi	MoH	-	1	1
Nairobi	Oxygen Hub	1	-	1
Total				35

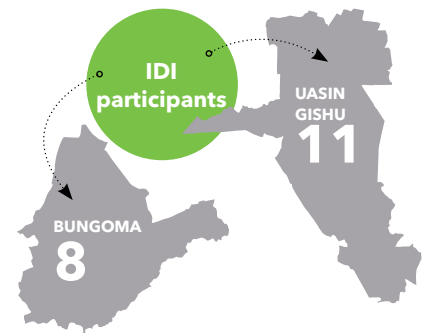


2. In-depth Interviews (IDIs): We also conducted in-depth interviews with healthcare consumers (community members) who had benefited from medical oxygen at public health facilities over the past three years. These interviews also included healthcare providers at various health facilities, including county teaching and referral hospitals and sub-county hospitals in Bungoma and Uasin Gishu (Table 2).

In each county, interviews were conducted over two days, with the research team making prior contact with respondents to schedule the sessions. Informed consent was obtained from all participants, and interviews were recorded with their permission. Interviews averaged 45 minutes, and in some cases, key informants were interviewed in groups if this was the preferred method.

Table 2: Distribution of IDI participants

County	Institution	Female	Male	Total
Bungoma	Cheptais Sub-County Hospital staff	-	3	3
	Community members	-	2	2
	Kimilili Sub-County Hospital Staff	2	1	3
Uasin Gishu	Uasin Gishu County Hospital staff	1	1	2
	Ziwa Sirikwa Sub-County Hospital staff	2	2	4
	Burnt Forest Sub-County Hospital staff	1	2	3
	Community Members	2	-	2
Total				19



2.3 Data analysis

All audio recordings were transcribed verbatim. Three researchers independently reviewed the transcripts against the original audio recordings to ensure accuracy and completeness. A senior researcher then compiled and collated notes from each interview. The data was organized into categories, themes, and sub-themes, which were used to prepare the study’s findings.

2.4 Ethical considerations

Ethical approval for the study was obtained from the Amref Health Africa Ethics and Scientific Review Committee (ESRC P1577/2023), and a research permit was granted by NACOSTI (Ref No. 336669). Additional approvals were obtained at the county level to facilitate access to study participants. Before each interview, the study’s purpose and the data’s intended use were explained to the respondents, and informed consent was obtained.

2.5 Study limitations

The study’s qualitative nature presents certain limitations. First, the respondents were purposively sampled based on their expertise, availability, and willingness to participate, which may introduce selection bias. Additionally, the seven counties selected for this study may not fully represent the situation across all 47 counties in Kenya. While the qualitative approach provides rich, descriptive data, it does not easily lend itself to quantification, which may limit the generalizability of the findings.

2.6 Triangulation

To enhance the validity of the findings, information was triangulated from various sources, including reports, published budget data, and key informant interviews with government officials, suppliers, and manufacturers involved in providing medical oxygen.



3 Results

3.1 Planning and Budgeting for Medical Oxygen in Kenya

3.1.1 Health Sector Budgetary Allocations

Health financing in Kenya is primarily through government funding and out-of-pocket (OOP) expenditures. While domestic government spending has been increasing over the years, it still falls short of the threshold for Universal Health Care (UHC) attainment. Government spending should account for at least 5 percent of the GDP for UHC attainment. However, in FY 2021/22, the allocation was 1 percent of GDP. This is about a fifth of the requirement for UHC attainment¹.

A growing concern within the health sector is the withdrawal of donor funding. It is anticipated that more than 30 programs will have to transition from donor funding to domestic

financing by 2030. This is due to the withdrawal of funding by donors such as the Global Fund and GAVI. This is expected to significantly impact the country's health budget as these costs will have to be covered by the government. Some programs to be transitioned heavily rely on external funding, with some, such as Malaria and Nutrition, having 97 percent and 94 percent of their total costs financed externally.

Additionally, donor funding has significantly impacted Kenya's health sector development budget. This is primarily in developing infrastructure, such as medical equipment, construction, and refurbishment. In FY 2018/19, donor funding accounted for 58 percent of the sector's development budget. There is, therefore, a need to have a properly planned and, in turn, implemented donor transition plan to avoid losing gains made over the years. This remains a



¹Annual National Shadow Budget for FY 2023/24. [Link](#)

²Development Finance in Transition: Donor Dependency and Concentration in Kenya's Health Sector. [Link](#)

³From Opacity to Clarity: A Comprehensive Review of Health Sector Budget Transparency in Kenya's Counties. [Link](#)

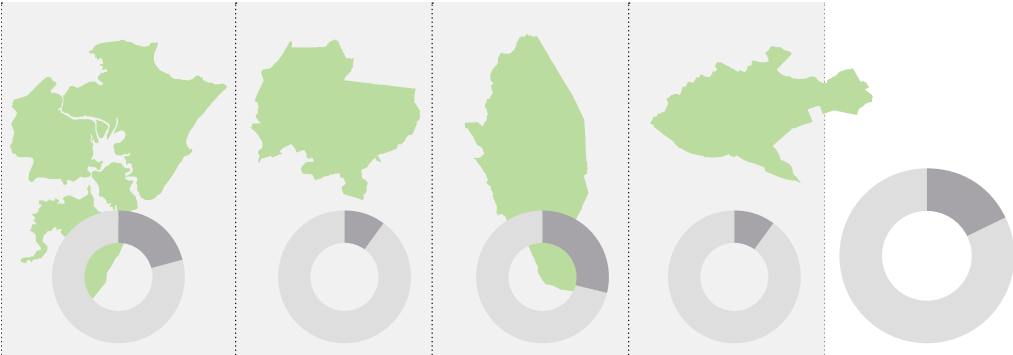
valid concern as some gains reversals have been observed in countries such as Romania that had a resurgence of HIV/AIDS after the withdrawal of financing by the Global Fund².

Health sector budgets at the county level make up a substantial portion of the total budgetary allocation, averaging at approximately 24 percent of the counties’ total budget³. From FY 2018/19 to FY 2021/22, the four study counties,

Mombasa, Laikipia, Kitui, and Nairobi allocated an average of 18 percent of their total budget to the health sector. Among these counties, Kitui had the highest allocation, with an average of 29 percent of the total budget dedicated to healthcare. Mombasa County followed closely, with an average allocation of 21 percent. The allocations are shown in the table below.

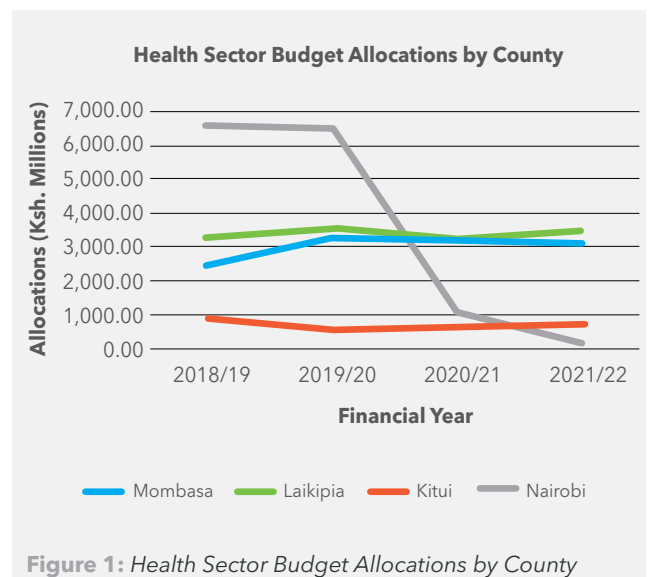
Table 3: Health Sector Allocations as a Percent of Total County Budget Allocations

	Mombasa County	Laikipia County	Kitui County	Nairobi City County	Average by FY
FY 2018/19	18%	14%	29%	20%	20%
FY 2019/20	24%	10%	32%	18%	21%
FY 2020/21	21%	9%	29%	3%	15%
FY 2021/22	22%	9%	28%	1%	15%
Average (By County)	21%	10%	29%	10%	18%



Source: Office of the Controller of Budget (OCOB) Reports FY 2018/19 - FY 2021/22

In FY 2019/20, there was an increase in the government’s allocation to the health sector in response to the COVID-19 pandemic. Specifically, there was a 30 percent increase in government allocation towards the health sector at the national level. This is also evident at the county level, as the highest average allocation towards the sector was in FY 2019/20, at 21 percent, as shown in Table 3. Contrary to the upward trend at the national level, some county budgets remained unchanged while others decreased from the FY 2018/19 allocations. Mombasa and Kitui counties had health sector budgetary increases. On the other hand, Nairobi City County’s health budget remained unchanged (as explained in the following sections), while Laikipia County’s budget declined.





Allocations towards the health sector in Nairobi City County have been declining since FY 2019/20. This can be attributed to the formation of Nairobi Metropolitan Services (NMS) on 9th March 2020 through Executive Order No.1 of 2020. This order transferred four core functions from the Nairobi City County Government to the National Government, including the County Health Services⁴. This move implied that the primary responsibility for budgeting and financing health in Nairobi County became a function of NMS.

Recurrent expenditures account for a significant proportion of the health sector allocations (89 percent), leaving little fiscal space for development expenditures such as the purchase of medical oxygen. Nairobi City County had the highest recorded average proportion of recurrent expenditures at 99 percent, followed by Kitui, Mombasa, and Laikipia at 91 percent, 88 percent, and 78 percent, respectively. In FY 2020/21 and FY 2021/22, recurrent expenditures accounted for 100 percent of the health sector expenditures in Nairobi City County. This was also the case for Laikipia County in FY 2020/21.

At the national level, recurrent expenditures still account for a more significant proportion of the health sector expenditures. There had been a decline in recurrent expenditures within the sector, with the expenditures declining from

65 percent of the total allocations in FY 2014/15 to 53 percent in FY 2016/17. However, the recurrent expenditure increased between FY 2017/18 and FY 2019/20 as there was an increase in allocations towards UHC-related activities as well as grants to semi-autonomous agencies (SAGAs) that primarily covered the salaries and wages of employees that had been revised upwards⁵.

Besides, the primary, recurrent expenditure within the sector is in wages and salaries, and it has been growing steadily over time. This expenditure accounted for approximately 77.2 percent of the counties' health sector budgets in FY 2020/21, increasing from 75.8 percent in FY 2018/19. However, counties generally do not publish details of the number of staff working within the sector, their designations, and the necessary personnel requirements per job cadre. Laikipia County is one of the few counties that provides disaggregated health sector data in its budget documents, indicating the share of the health budget channeled towards personnel. In FY 2021/22, the total allocation to salaries within the health sector was KES 1.88 billion. This is approximately 76 percent of the total health sector budget and 83 percent of the recurrent allocations. A similar pattern is observed in FY 2022/23 as salary allocations increased to KES 1.95 billion, accounting for 72 percent of the total budget and 86 percent of the recurrent allocation.



⁴National Metropolitan Services (NMS). [Link](#)

⁵Staying Ahead of the Curve: Challenges and Opportunities for Future Spending on Health in Kenya. [Link](#)

Despite the increases in the wage bill, the health institutions have inadequate staff with the knowledge and technical expertise required for the running and maintenance of medical oxygen equipment and plants. This, in turn, compounds the medical oxygen device maintenance challenges that are already propagated by insufficient funding. As of 2014, the Ministry of Health estimated the ideal number of medical engineering technologists required within the public sector to be 1,187. However, the current staffing is a mere 14 percent of the requirement as there are only 169 in-post technologists. A similar understaffing trend is observed for the medical engineering technicians - current staffing is approximately 20 percent of the requirement, as there are 167 technicians against an ideal requirement of 847. The distribution of the health personnel across regions in Kenya is as follows:

Table 4: Distribution of Medical Engineering Personnel in Public Facilities by Region

Region	Medical Engineering Technologists	Medical Engineering Technicians	Total
Nairobi	28	4	32
Eastern	43	49	92
Rift Valley	33	71	104
Nyanza	13	9	22
Western	25	11	36
Coast	38	68	106
North Eastern	3	4	7
Central	19	19	38
Regional Total	202	235	437
National Level	37	21	58
Country Total	239	256	495

Source: Ministry of Health (2014)

In addition to accounting for a lower proportion of the budget, development expenditures have lower absorption rates than recurrent expenditures, as shown in Table 5 below. This is a concern because medical oxygen is categorized under development expenditures. The lower absorption rates of development expenditures imply that funds allocated for developing medical oxygen infrastructure and related projects may not be fully utilized or effectively implemented within the expected timeframe. However, it is difficult to ascertain this as specific allocations and expenditures for medical oxygen are not presented in the publicly available budget documents.

Equally, at the national level, for the period between 2017/18 to 2021/22, budget absorption averaged 81 percent. The recurrent budget had a higher average absorption rate at 87 percent compared to 74 percent for the development budget⁶. In FY 2021/22, the recurrent budget not only accounted for a higher proportion of the total sector's budget at 51 percent of the total allocation and had a higher absorption rate of 100 percent. This is in contrast to the development budget, which accounted for 49 percent of the health sector allocations and had an absorption rate of 68 percent.

One of the major obstacles towards development budget absorption is delayed exchequer releases. A striking example can be observed in the case of Laikipia County during the fiscal year 2020/21, where the absorption rate was exceptionally low at 0.8 percent. According to the Office of the Controller of Budget (OCOB) report the same fiscal year, despite a budgetary allocation of KES 140 million designated for the county's health sector, no exchequer releases were made for this specific allocation. Delayed or absent exchequer releases for allocated funds significantly hampers the counties' ability to implement vital development projects and programs within the health sector.

⁶Macro-Fiscal Analytic Snapshot 2023. [Link](#)



Table 5: Counties' Health Sector Budget Absorption Rates (%)

County	FY 2018/19		FY 2019/20		FY 2020/21		FY 2021/22	
	Rec.	Dev.	Rec.	Dev.	Rec.	Dev.	Rec.	Dev.
Mombasa	118.7	86.5	141.4	23.3	89.8	208.8	103.10	197.7
Laikipia	73.9	48.4	92.5	50.5	92.9	0.8	71.5	65.2
Kitui	96.2	77	95.3	75.7	96.60	84.9	94.1	65.9
Nairobi City	86.6	50.8	84.6	10.8	58.3	0	33	0

Source: OCOB Reports FY 2018/19 - FY 2021/22

3.1.2 Prioritization of Medical Oxygen at the County level

A closer investigation of the county budgets reveals that despite COVID-19 highlighting the critical importance of medical oxygen, it has remained largely un-prioritized by county governments. Only a few counties have implemented medical oxygen projects as development priorities. Notably, there was a significant increase in the number of medical oxygen projects undertaken during

FY 2019/20, primarily driven by the increased demand for oxygen due to the pandemic. The medical oxygen projects categorized as top development priorities and implemented across the different counties from FY 2018/19 to FY 2021/22 are summarized in the table below. The comprehensiveness of this report is questionable as some projects, such as the installation of the oxygen plant at Coast General Teaching and Referral Hospital, are not accounted for in the budget implementation reports.

Table 6: Medical Oxygen Projects Across Counties

FY	County	Project Name	Budget (Ksh)	Expenditure (Ksh)	Absorption
FY 2018/19	Nyamira	Proposed Delivery, Installation, Testing, and Commissioning of Medical Oxygen Generating Plant at Nyamira County Referral Hospital	26,000,000	26,000,000	100%
	Embu	Upgrading of oxygen plant	88,000,000	17,000,000	19%
FY 19/20	Migori	Completion and Installation of oxygen plant MCRH	30,000,000	42,756,970	143%
FY 2020/21	Busia	Equipping of Accident & Emergency-Oxygen Plant	15,900,000	15,300,000	96%
	Elgeyo Marakwet	Purchase of oxygen plant	16,500,000	8,993,280	54%
	Homa Bay	Oxygen Plant	20,000,000	20,000,000	100%
COVID-19 Budget					
	Nyeri	Medical Oxygen	1,200,000	-	-
	Samburu	Construction of donning and doffing units and oxygen piping at Maralal Referral Hospital		3,589,740	
		Purchase of oxygen manifold for ICU facility		976,387	
		Refilling of medical oxygen for ICU and cylinder caging		2,650,280	
	Bungoma	Procurement of oxygen compressor for Webuye County Hospital	4,500,000	-	-

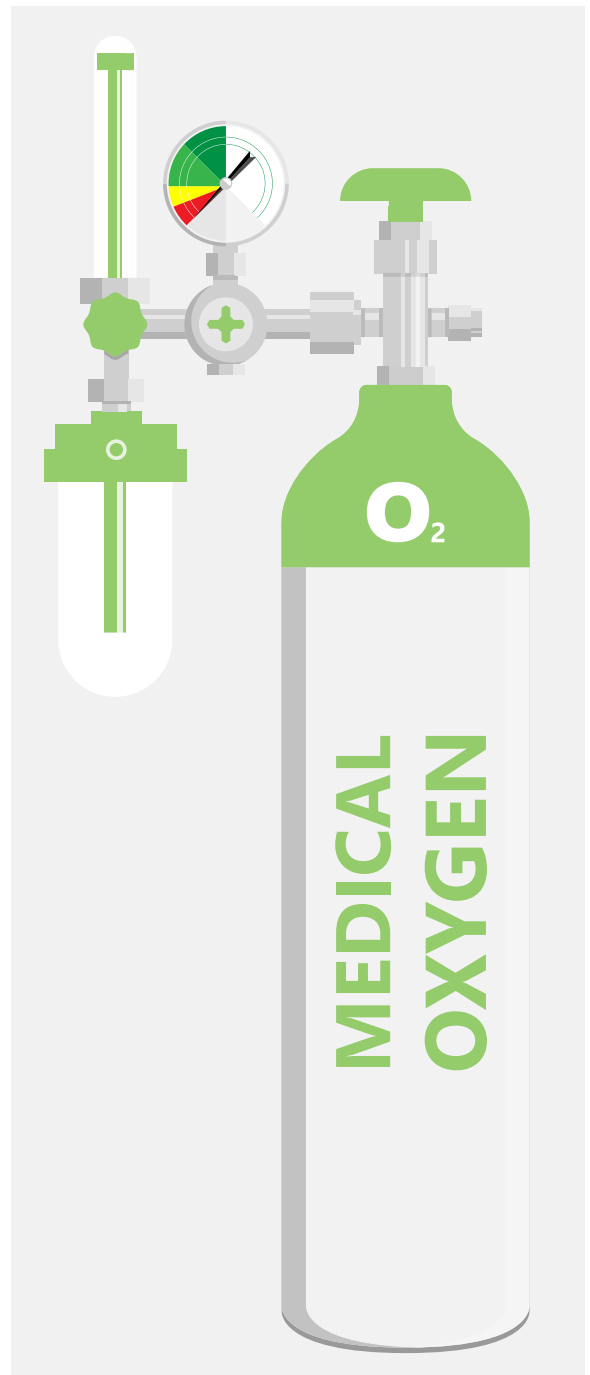
FY 2021/22	Nakuru	Acquisition, installation, and commissioning of a 2000 liter/pm oxygen plant in PGH	119,019,995	102,757,514	86%
	Samburu	Supply, Delivery, and Commissioning of Oxygen Plant to Samburu Referral Hospital	24,500,000	24,500,000	100%
	Wajir	Supply, delivery, installation, and commissioning of oxygen plant in Wajir Referral Hospital	20,600,000	20,600,000	100%

Source: OCOB Reports FY 2018/19 - FY 2021/22

For some counties, medical oxygen projects are occasionally referenced in the Annual Development Plans (ADPs) and County Integrated Development Plans (CIDPs). However, as previously mentioned, it is difficult to determine the specific allocations and track implementation as there is no specific budget line for these projects in the budget documents. This lack of specificity hinders transparency and accountability, making it difficult to ascertain the extent to which these medical oxygen initiatives are being prioritized and effectively executed.

Additionally, for most counties, medical oxygen is not budgeted for as it is currently funded by donors such as AMREF. This raises sustainability concerns of the projects due to the eventual withdrawal of donor funding. In the event of these withdrawals, counties will need to allocate more funds to the health sector to cover the costs previously covered by the donor. Consequently, the adequacy of the budgets is a key question, as medical oxygen had been largely underfunded before the intervention of donors, which in turn contributed to the accumulation of pending bills and shortage of oxygen supply.

Donor support has primarily been received from the COVID-19 Response Mechanism financed by the Global Fund and initiated at the height of the COVID-19 pandemic. Kenya’s initial C19RM base allocation was US\$62,296,526. The allocations were for response to the outbreak and mitigation of the impact of COVID-19 on the gains made in the fight against HIV, tuberculosis, and malaria. In May 2021, Kenya applied for a fast-tracking of funds to procure medical oxygen, diagnostics, and PPEs⁷. The specific medical oxygen activities that the facility supported include bulk medical oxygen supply, oxygen storage and distribution, oxygen delivery and respiratory care, oxygen support systems; implementation of national medical oxygen demand and gaps assessments, and the regular preventive maintenance of all medical equipment, including medical oxygen equipment⁸.





The inefficiencies in operating medical oxygen plants across counties are compounded by the lack of technical expertise, unreliable power supply, tendering wars, and prohibitive replacement/repair costs. Some of the stalled medical oxygen plant operations due to the factors mentioned above are presented below.

Table 7: Stalled Medical Oxygen Projects in Different Counties

County	Facility	Status
Kakamega County	Kakamega Level VI County Teaching and Referral Hospital	Importation of Ksh 100 million medical oxygen equipment from France in July 2021 that remains unused and packed in boxes. Despite having the equipment, the facility acquires oxygen from Kisumu, incurring a monthly cost of Ksh. 2.8 million.
Taita Taveta County	Moi Hospital Referral	Frequent breakdowns of the Ksh. 14 million plants are making it unreliable and breaking down the compressor.
Isiolo County	Garbatulla Hospital Isiolo Referral Hospital	Tendering bottlenecks were experienced as the Ethics and Anti-Corruption Commission (EACC) found that the plant installation costs were inflated.
Homa Bay County	Homa Bay Referral Hospital	Breakdown of the medical oxygen plant before use. The facility relies on support from Amref, and upon withdrawal of the financing, it will have to incur Sh. 800,000 monthly.
Busia County	Busia County Referral Hospital	The medical oxygen plant has been non-functional for close to 2 years.

⁷COVID-19 Response Mechanism Kenya Country Dialogue for Key Affected Population Workshop Report. [Link](#)

⁸COVID-19 Response Mechanism Information Note. [Link](#)



3.2 Medical Oxygen Infrastructure in Public Health Facilities

Currently, medical oxygen infrastructure in public health facilities is insufficient. This could be attributed to the low allocations by governments towards medical oxygen. In Kenya, oxygen cylinders are the primary method of supplying medical oxygen to these facilities. It is important to note that most of these cylinders are not owned by the health facilities themselves but rather by the oxygen suppliers, who supply them to the facilities and charge rental fees for their use. Consequently, this leaves the health facilities vulnerable if the cylinders are in high demand, as was the case during the COVID-19 pandemic, where over 20,000 medical oxygen cylinders were hoarded in private facilities, homes, and institutions, thus disrupting supply to public health facilities⁹. Additionally, most of the cylinders are made of steel, while advanced economies have transitioned to using longer-lasting aluminum cylinders.

To address some of these constraints, the president flagged off the distribution of 20,620 medical oxygen cylinders to the counties on 17th April 2023¹⁰. The distribution of the cylinders was across 47 counties, including 320 primary healthcare facilities, and was worth approximately KES 1 billion¹¹. Through AMREF Medical, the Global Fund provided an investment of US\$41.7 Million to support the supply of medical oxygen within the country, which is to cover the refilling of compressed and cryogenic oxygen, medical oxygen tanks and cylinders, installation of high-volume PSA oxygen generation plants and the piping and installation of manifolds as well as oxygen outlets to health facilities. Twenty-two (22) oxygen-generating plants and 14 bulk storage tanks will be installed across the country¹².

Laikipia County was supplied with 305 medical oxygen cylinders, of which 200 can deliver 8,500 litres, 75 can deliver 3400 litres, and 30 can deliver 1360 litres of oxygen to the patients. Since the project's inception, there has been support worth over KES 19 million for the supply of over 38 million litres of medical oxygen. The support is, however, expected to end before June 2024¹³. In preparation for this, the county government intends to install a new PSA oxygen plant. However, this needs to be evident in the county's annual development plan.

Kitui County is also a beneficiary of the AMREF medical oxygen program, with the Kitui County Referral Hospital being the main ordering point for all the facilities under the program. The other beneficiary facilities include Ikanga, Katulani, Ikutha, Migwani, Tseikuru, and Kyuso Level IV Facilities. Furthermore, KCRH has received support from the World Bank for the installation of a central manifold as well as oxygen piping to the pediatric ward, maternity ward, Newborn Unit (NBU), Intensive Care Unit (ICU), and the main operation theatre.

Additionally, the county has two functional oxygen plants, acquired through donor support. In 2022, Kitui County Referral Hospital (KCRH) received its first oxygen plant worth KES 23.7 million (USD 200,000) that Climate Fund Managers funded through Epicenter Africa Engineering¹⁴. The plant has a production capacity of 300 litres per minute, which is then delivered to the patients through oxygen pipes, thus minimizing the use of oxygen cylinders. In addition to this, oxygen piping was done to the male surgical ward and isolation ward, with a total of 26 terminal units. Additionally, in 2023, another oxygen plant was installed at Mwingi Level IV Hospital with support from USAID in partnership with JHPIEGO and Chemonics International.¹⁵ The plant can fill ten cylinders of 50 kg daily¹⁶.

⁹Covid hurdles: Kenyans are 'hoarding' more than 20,000 oxygen cylinders. [Link](#)

¹⁰Remarks by His Excellency William Samoei Ruto, C.G.H, President of the Republic of Kenya and Commander in Chief of the Defence Forces During the Flagging Off of Oxygen Cylinders to Counties. [Link](#)

¹¹ Kenya can now dream bigger with new Medical Oxygen Initiative. [Link](#)

¹²Global Fund Investment in Medical Oxygen Infrastructure Launches in Kenya. [Link](#)

¹³ County Government of Laikipia (2023). 121 M Global Fund Support To Laikipia To Improve Oxygen Service In The Post Covid Pandemic Period. [Link](#)



For facilities that are beneficiaries of the AMREF program, the provision of the cylinders has offset the acquisition costs of hospital-owned cylinders that would have been incurred. This places them at an advantage over facilities that are yet to benefit from the project. However, BOC has faced criticism for having higher medical oxygen prices than its competitors and tends to have occasional inconsistencies in delivery.

While the supply of medical oxygen through piping is a more efficient distribution mechanism, few public health facilities are equipped with the medical oxygen piping infrastructure. A piped oxygen system minimizes the dependency on rented cylinders and ensures a more efficient and cost-effective supply of medical oxygen. Despite this, it is estimated that only 1 percent of tertiary health institutions in Kenya have medical oxygen piping systems, and approximately 90 percent of emergency care centers nationwide do not have medical piping¹⁷.

Additionally, while there might be piping systems in some of the facilities, they are done using suitable materials such as copper pipelines, which are the preferred pipelines and tend to be costly. Therefore, this implies that most facilities will have to incur piping installation costs.

Despite the high initial setup costs, a cost-comparison analysis undertaken for the different oxygen supply methods indicates that reliance on a piping system is significantly cheaper than cylinders. It is, therefore, a budget-friendly option for the county governments in the long term as it would cut down the costs incurred by public health facilities for medical oxygen. The difference in costs incurred through reliance on oxygen cylinders vs piping is shown below. The costs are estimated for the delivery of oxygen produced at an LOX plant and transported for 100km. Figure 2 shows the total cost of oxygen delivery through cylinders, while Figure 3 shows the total cost of delivery using a piped system.

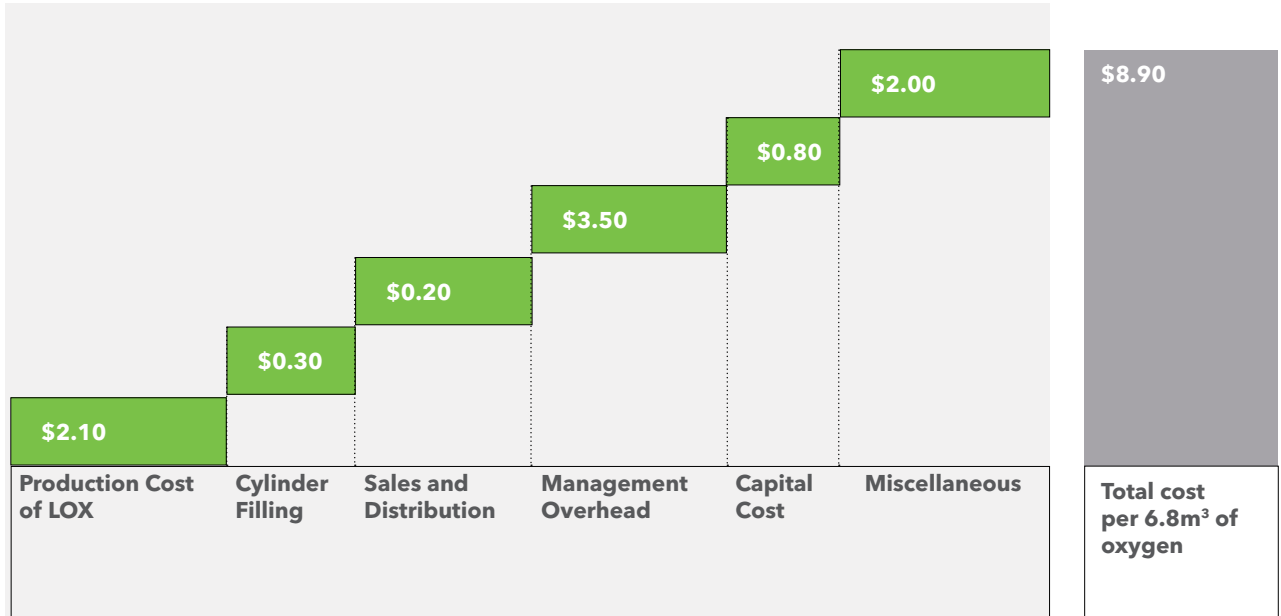
Figure 2: Cost of each 6.8 m3 oxygen cylinder at the point of use in clinics or hospitals



Source: Institute of Transformative Technologies (ITT) and Oxygen Hub (2021)

¹⁴ Kitui gets Sh. 23 million oxygen generator. [Link](#)
¹⁵ New Sh.27 million oxygen plant for hospital in Mwingi. [Link](#)
¹⁶ Mwingi Level IV Hospital Gets Oxygen Generating Plant. [Link](#)
¹⁷ 90pc of emergency facilities in Kenya lack piped oxygen. [Link](#)

Figure 3: Cost of 6.8m3 of oxygen via piped system (without cylinder)



Source: Institute of Transformative Technologies (ITT) and Oxygen Hub (2021)

From the analysis above, oxygen delivery through piping systems cuts medical oxygen costs by nearly 50 percent. A major constraint associated with this is that very few health facilities have the required piping system, as in Kenyan health facilities. In addition, transporting LOX using tanks in the warm weather experienced in tropical countries results in some evaporation of the liquid oxygen from the cryo tanks. About 15 percent of LOX is estimated to be lost per filling cycle¹⁸.

A factor that is likely to increase piping costs within Kenyan public health facilities is the infrastructural design of the facilities. Most facilities are located on relatively sizable land, and therefore, the different medical units are spread out over a large area. With this design, the distances to be covered by piping are longer; thus, more piping material and labor will be required, leading to higher installation costs. This contrasts with health facilities with a storey design with different units on different floors, which will be cheaper due to the proximity of the various units requiring medical oxygen piping.

For facilities with medical oxygen plants, it is not uncommon to find that they are not operational or they are underutilized. It has been stated that for most developing countries, medical devices will most likely cease to be functional as soon as there is a need for the first replacement part¹⁹. Thus, it is not surprising that one of the main factors contributing to the non-functionality of the plants is a lack of spare parts. In many facilities with medical oxygen plants, a prevalent issue is the inability of the plants to refill oxygen cylinders due to a lack of compressors. As a result, these plants solely provide oxygen through piping systems, which often proves insufficient because certain health units within the facilities may not be connected to the piping network. As a result, these units face challenges in accessing a reliable and readily available oxygen supply.

¹⁸ Closing the medical oxygen gap in Sub-Saharan Africa. [Link](#)

¹⁹ Barriers for medical devices for the developing world. [Link](#)



The health facilities not only have inadequate medical oxygen infrastructure but also lack supporting infrastructure such as electricity.

A national healthcare facility survey conducted across Kenya found that only 54 percent of all healthcare facilities (including hospital and non-hospital facilities) had reliable access to electricity. In comparison, 11 percent had no access, and 35 percent had unreliable access. For hospitals only, 6 percent had no electricity access, 41 percent had unreliable access, and 53 percent had reliable access²⁰. The figures are disaggregated, as shown in the table below.

Table 8: Electricity Access by Health Care Facilities

Category	No Access	Unreliable Access	Reliable Access
All healthcare facilities ²¹	11%	35%	54%
Hospitals ²²	6%	41%	53%
Non-Hospitals ²³	13%	32%	55%
Urban Health Care Facilities ²⁴	2%	34%	64%
Rural Health Care Facilities ²⁵	15%	35%	50%

Source: World Health Organization [WHO], 2023

The unreliability of the electricity supply limits the extent to which health facilities can utilize medical oxygen plants and oxygen equipment, such as oxygen concentrators.

In 2021, an oxygen plant in Vihiga County was not operational due to the low supply of electricity to the referral hospital. To resolve this, Kenya Power recommended the installation of a larger transformer to run the medical equipment²⁶. This was also the case for the medical oxygen plant at the Nyahururu County Referral Hospital (NCRH) in Laikipia County.

Oxygen concentrators that require electrical power are preferred for areas within the country where the supply of cylinders is difficult due to supply chain constraints and infrastructure.

For this reason, they are more likely to be found in remote counties and rural areas. However, as noted in the table above, half of the rural healthcare facilities either have no access to electricity (15 percent) or have unreliable access (35 percent). A study conducted in rural Western Kenya highlights the impact of unreliable electricity on oxygen delivery²⁷. The facilities under study experienced a high frequency of power outages, with one of the facilities having 147 outages in one week. Some outages lasted up to 6 days, with some lacking backup generators to use in such instances. The consequent interruptions in the delivery of oxygen and mortality rates are shown in the table below.



Table 9: Oxygen Delivery Interruptions and Mortality

Category	Entire Cohort, N=57	Fatal, N=11	Recovered, N=42
Oxygen therapy, median hours	4.6	4.6	4.8
Oxygen delivery interruptions	18	3	14
Oxygen Interruption durations, median minutes	11	28	10
Backup cylinder used	5	1	4

Source: Otiangala et al. (2020)

²⁰ Energizing Health: Accelerating Electricity Access in Health-Care Facilities. [Link](#)

²¹ A data source was considered to have included all health-care facility types when it sampled both hospital and non-hospital facilities.

²² Health facilities were defined as hospitals if the survey data source identified them as such.

²³ Any health-care facilities that were not defined as hospitals by the survey data source were classified as non-hospitals, e.g., health centres, health posts, clinics, maternity care clinics, etc.

²⁴ Any facilities that are in a location that is not (or not purely) rural was classified as urban

²⁵ Any facilities that are in a location that the survey labelled as rural were classified as rural.

Out of the 57 patients observed, there were 11 fatalities, accounting for approximately 19 percent of the observation group. Thirty-two percent of the patients experienced interruptions in the supply of oxygen. Throughout the observation period, there were 18 recorded instances of oxygen supply disruptions, with the interruptions lasting for an average duration of approximately 11 minutes. Notably, fatal cases experienced longer periods of oxygen interruptions, lasting around 28 minutes, whereas the recovered cases experienced interruptions for a duration of 10 minutes. Back-up cylinders were utilized in 5 instances of the 18 disruptions, with a majority of their usage (4 out of 5) occurring in the recovered patients' group.

Notably, fatal cases experienced longer periods of oxygen interruptions, lasting around 28 minutes, whereas the recovered cases experienced interruptions for a duration of 10 minutes.



²⁶ Counties used millions for oxygen plants, delivered air. [Link](#)

²⁷ Oxygen insecurity and mortality in resource-constrained healthcare facilities in rural Kenya. [Link](#)



3.3 Access and availability of medical oxygen in public health facilities

3.3.1 Access to medical oxygen

There has been a spike in the uptake of medical oxygen in health facilities in Kenya since the outbreak of COVID-19. The pandemic sensitized health personnel on the importance of medical oxygen in saving lives, and many medics now see oxygen as an essential drug in saving patients' lives. Moreover, many ordinary citizens were not previously sensitized about the importance of medical oxygen, but now there is growing awareness about it. COVID-19 exposed many to the vital role that medical oxygen plays in alleviating symptoms associated with breathing difficulties. Both factors have led to an increase in the demand and utilization of medical oxygen in health facilities in Kenya. Nevertheless, there are still isolated cases in which citizens associate being put on medical oxygen therapy with end-of-life health complications.

Other than increasing awareness about medical oxygen and its life-saving benefits, other factors are at play. There seems to be a growth in the incidence of pulmonary hypertension in the community, partly as a result of changing lifestyles, and this comes with attendant complications like chronic pulmonary obstruction disease, which puts pressure on available medical oxygen resources. Other lifestyle diseases such as cancer and renal conditions, among others, might similarly require hospitalization and, therefore, administration of medical oxygen to patients. These and other related factors have created an upsurge in the number of patients needing oxygen as part of their treatment. Indeed, most respondents at the facilities that participated in the survey emphasized that oxygen should be seen as any other essential drug and should be available at all levels of the health system, even at the dispensary level.

It emerged that seasonality also plays a part in the incidence of conditions requiring the administration of medical oxygen. Such conditions usually increase in agricultural areas due to pollen from flowering food crops during dry weather and at the peak of rainy seasons. Healthcare providers reported patterns of increased hospitalization

due to hypoxemia during these seasons. Most health facilities have identified this seasonality in morbidity patterns, and they prepare accordingly to meet the increased demand for oxygen.

The availability or otherwise of medical oxygen, or when a patient gets to be put on oxygen, is a matter of life and death. Patients who come to a facility with low peripheral capillary oxygen saturation levels (SpO₂) need to be put on medical oxygen immediately, and any delays might be life-threatening, resulting in death. Besides, timely administration of medical oxygen is often life-saving for victims of road accidents, neonates with breathing distress, or women experiencing birth complications.

"You can't take chances. A slight delay in administering oxygen to a patient at the required level or quantity could result in severe brain damage or even death. For us clinicians, that's the most traumatic experience you can have. Knowing you could save a patient's life, and then being unable to because there is no oxygen",

(Medical doctor in a pediatric ward, CGHD2).

Patients generally had positive views towards the quality of care they received at public health facilities. For most patients, medical oxygen made the difference between life and death. Many observed that if it were not for the availability of medical oxygen, they probably would not have survived.

In all interviews, cost was a major issue for most patients. The interview revealed patients' significant financial burden, particularly in accessing medical oxygen services. In one particular case, the absence of medical oxygen at a sub-county hospital led to a dire situation for one patient's child, necessitating referral to

a distant county hospital. The patient incurred multiple expenses, including the referral facility's ambulance service fees and admission charges at the referral facility. The caregiver had to lease land and additionally fundraise from family and friends to meet the cost of treatment for the child. This incident highlights the critical importance of ensuring the availability and affordability of essential medical resources, such as medical oxygen, to prevent financial hardship and improve access to life-saving treatments for patients in resource-constrained settings.

3.3.2 Availability of medical oxygen

All the seven counties surveyed have medical oxygen at the county teaching and referral hospitals. One of the facilities is a county hospital, but the teaching and referral aspects are done at a national teaching and referral hospital within the same county. Two of the county referral hospitals were former provincial hospitals and, therefore, serve health facilities beyond the designated county in which they are based. Hospitals vary

in size and endowment – six of the seven health facilities (except CGHD2) have medical oxygen plants installed within their premises. CGHD1 has three medical oxygen plants at the county teaching and referral hospital. At CGHD4, a new plant has been installed, but it remains non-operational due to funding limitations and staff shortages. If the plant were to be fully operational, it would serve between 60-80 percent of the facility's medical oxygen needs once piping has been done to the wards.

The predominant form of medical oxygen used at the facilities surveyed is produced via pressure swing adsorption (PSA) technology. The preference for PSA plants for producing medical oxygen is driven by the affordability of the initial installation costs of PSA technology compared to medical liquid oxygen (LOX). PSA plants, however, incur heavy routine operational and maintenance costs. During the interviews, only one supplier of LOX was mentioned repeatedly: the British Oxygen Company (BOC). An overall assessment is that at least the county teaching and referral





hospitals (Level 5) have a more or less adequate supply of medical oxygen, either via pressure swing adsorption plants installed on-site or LOX tanks regularly replenished, mostly by BOC. The referral hospitals have intensive care unit (ICU) and high dependency unit (HDU) beds; hence, the need for a regular and predictable supply of medical oxygen is imperative.

Whereas there is an adequate supply of oxygen in most level 5 health facilities, there are areas within these facilities where the supply is intermittent. Not all critical areas or departments always have an adequate supply of oxygen. The triage/casualty area, radiology, and certain wards have no piped oxygen or dedicated oxygen cylinders serving them in certain facilities. Such areas rely on portable oxygen cylinders, typically serving several points within one facility. During stock-outs, which are frequent, clinicians and nurses find it extremely difficult to handle emergencies requiring medical oxygen. At times, oxygen may be available, but equipment malfunctions commonly occur, complicating patient oxygen

administration.

A mixed picture emerges when it comes to the sub-county referral hospitals (Level 4). Across the board, many of these facilities have inpatient wards, but not all have a regular supply of medical oxygen. During the study, it emerged that most sub-county hospitals rely on the county teaching and referral hospitals to supply them with oxygen cylinders. Most critically ill patients requiring specialized ICU or HDU care are referred to level 5 or national referral hospitals. Interviews at a public health facility in CGHD3 revealed that a sub-county (Level 4) referral hospital with an installed inpatient capacity of 77 beds but with a potential of up to 140 beds still relied on oxygen cylinders supplied by the county teaching and referral hospital. The facility has a PSA plant with the capacity to produce 500 cubic litres per hour, but the power voltage from KPLC's transformer serving the area is too low to power the plant. Operationalizing the plant will require a power upgrade that will cost approximately KES 10,000,000.



Oxygen concentrators were being used at yet another facility at the sub-county level in county CGHD2. While this option is not optimal, it is ideal for health facilities in remote rural areas where installing a PSA plant, liquid oxygen tanks, or cylinders may be too expensive to afford and sustain. Oxygen concentrators, however, require a steady supply of electric power, which is not always reliable in the Kenyan setup. There was also widespread use of manifolds where oxygen cylinders were stored and then piped to the wards. This was the case whether the oxygen was produced onsite or supplied via an LOX tank.

Persistent gaps remain in the administration of medical oxygen in Kenyan public health facilities, potentially endangering patients' lives. Resource constraints might lead to inappropriate masks being used. In cases where masks dispense more oxygen than the prescribed dosage, oxygen toxicity can easily occur. Nasal prongs dispense less oxygen compared to the face-masks or non-rebreather masks. In level 3 in public facilities, oxygen - when it is available - is primarily delivered

through cylinders, although some may also utilize concentrators. However, using concentrators poses several challenges. One major issue is the lack of biomedical engineers in remote areas where these facilities are located. Additionally, some facilities rely on solar power to operate concentrators and face challenges when these solar systems are not properly serviced. This can result in power interruptions, further complicating oxygen delivery.

In practice, though, the lower levels of the health system, from health centers to dispensaries, hardly have any access to medical oxygen. Paradoxically, at these levels, most patients interact first with the health system. The explanation given by most respondents is that the health personnel at these levels lack the expertise to administer medical oxygen and that scarce resources within any one county would be stretched too thin by equipping lower levels with medical oxygen. The existing policy also does not support the supply and stocking of pulse oximeters at these health system levels, making it difficult for health personnel to





measure and detect oxygen fluctuation in patients. Most respondents recognized the need to equip lower health system levels with pulse oximeters and medical oxygen. The difficulty they saw was how to recover the costs because services at these levels should ideally not be charged.

Counties report having very effective referral systems. CGHD1 reported having the most advanced referral system, with all sub-county hospitals connected through good road networks. Besides, the county has ambulatory services with Advanced Cardiovascular Life Support (ACLS) systems equipped with a vent, 2 oxygen cylinders, and a cardiac monitor. The county also has ambulances with basic life support equipment. Trained personnel with basic and advanced cardiovascular support skills are assigned to either type of ambulance. The other six counties reported having ambulatory services with basic life support services, but adjustments are made if a patient needs ambulatory services with advanced cardiovascular life support.

Few innovations were noted that could potentially improve the availability and accessibility of medical oxygen. In one county, the biomedical engineering department has created a WhatsApp forum that facilitates the collation of a weekly oxygen consumption report from all health facilities within the county. Moreover, the county has a system of referring non-critical inpatients downwards to lower health facilities when the referral hospital faces an upsurge in admissions and cannot cope with the demand for the available inpatient beds. This referral system eases pressure and leaves only the most critical inpatients at the referral health facility. The county referral facility is exploring establishing a pricing structure for oxygen cylinders in yet another county. This will allow them to sell oxygen to private facilities in the county, creating a potential income stream.

A general observation is that health is devolved in Kenya. Still, the COVID-19 pandemic demonstrated that poor health in one area of the country or weakness in one aspect of the health system can have severe repercussions for the entire country. The pandemic revealed a shortage of healthcare workers, highlighting the need for a coordinated approach to their employment, training, production, and, more importantly,



coordination. Additionally, having a reliable supply chain for healthcare commodities is crucial. At some point during the pandemic, getting essential supplies became extremely difficult, highlighting the need for a centralized registry to track and manage these commodities. Thus, a major lesson from COVID-19 is the importance of ensuring comprehensive healthcare provision across the board. Besides, establishing and strengthening local manufacturing capabilities is vital. When some countries halted exports of essential medications, it resulted in shortages in Kenya. Developing local manufacturing capacity can mitigate such risks and ensure a stable supply of essential healthcare products.



3.4 Gaps and challenges in the production, supply, and utilization of medical oxygen

3.4.1 Facility-based challenges

At the level of facilities, the major challenge is the inability of hospitals to recover the costs of oxygen administered to patients fully. Unlike private health facilities, where medical oxygen administered to patients is monitored and billed accordingly, public health facilities charge a uniform fee for the services offered. Regardless of how long or intensively a patient uses medical oxygen at a facility, there is no unbundling of oxygen in the treatment costs. Respondents noted that when patients are admitted to the ICU or HDU, most tend to consume large quantities of oxygen, depending on the disease and the patient's condition at the time of admission. However, when the patient is discharged, the facility can never fully cost and charge for the amount of oxygen used. This should be seen against the high refilling and maintenance costs involved in ensuring adequate oxygen supplies at the facility. On average, BOC charges KES 17,000 for hiring its cylinders and KES 4,000 to refill the cylinder.

These costs are compounded by frequent waivers to patients who cannot pay for their hospitalization costs. Oxygen is also free if administered to children five years and below, yet children and women constitute the most significant proportion of hospital admissions. The county teaching and referral hospitals have a Facility Improvement Fund (FIF), but the amounts available are often inadequate to meet the total cost of the hospital's operations in general, of which medical oxygen is just a tiny component. Where hospitals must make significant investments in medical oxygen, external funding is often sourced from the national government or donors. Where funding is from donors, there might be compatibility issues with the equipment supplied and the sustainability of operating the oxygen plant or equipment. For instance, the study noted that a supplier contracted to supply oxygen to health facilities under the Global Fund initiative in one county provided gas cylinders incompatible with the facility's refilling tanks. Consequently, health facilities are required to purchase valves worth KES 14,000 per cylinder in order to refill their cylinders.

Most facilities rely on gas cylinders of various sizes and weights. This is because the original design of health facilities did not factor in oxygen piping. Moreover, it is expensive to do piping for most facilities. Nonetheless, the World Bank reportedly supported some facilities to piping oxygen to the wards and casualty/triage areas. Oxygen gas cylinders can be cumbersome, especially when they have to be hauled along the corridors into wards without cylinder carriers or carts or when they must be lifted onto higher floors. Most nursing staff tend to be female, and carrying heavy gas cylinders was mentioned as a major problem. Furthermore, oxygen cylinders present a major potential hazard of fire breaking out in the wards, should there be a leakage that is not managed in good time. Ideally, oxygen is piped to bedsides or manifolds built at a reasonable distance from which oxygen can be piped to the patients' beds as appropriate.

County teaching and referral hospitals reported a shortage of oxygen consumables such as wall and cylinder flowmeters, backup cylinders, cylinder carriers/trolleys, gauges, and valves. In certain facilities, it was reported that each ward had only two gauges even when 6-10 patients might need oxygen, especially in newborn units. The absence of oxygen splitters compounds the problem. Moreover, some facilities have no acute rooms where patients with severe conditions can be handled. Administering oxygen to a patient in critical condition within a ward area with other patients watching creates panic and anxiety among different patients and could be avoided by creating acute rooms or spaces in maternity wards, newborn units, or wards with critically ill patients.

Nursing staff also mentioned that gauge kits are delicate and, if mishandled, are prone to breaking down. Some facilities lack secure places to lock the gauges, which are misplaced when staff change shifts. Another challenge reported often was that where oxygen has been piped to the bedsides, oxygen ports often break down. Hence, medical and clinical staff reverted to using oxygen cylinders. Connecting the gauges to the port can be challenging for some nurses and clinicians, and they have to depend on biomedical engineers. Oxygen is mainly needed for emergency care, and having to depend on biomedical engineers can



be time-consuming and not practical, especially during night shifts or over the weekends, when the biomedical engineers might be unavailable.

Health facilities also experience occasional wastage of oxygen due to staff negligence as they leave the cylinders running. There were complaints from biomedical engineers that some cylinders delivered by suppliers had less quantity of oxygen and could run out in the middle of oxygen being administered to a patient, endangering the lives of patients.

Some county health facility managers and directors also pointed out that technical staff sometimes lacked the capacity to accurately diagnose, prescribe, and administer medical oxygen and properly handle equipment to avoid wastage. It was highlighted that some new medical and clinical personnel cannot detect oxygen saturation levels, which cannot be detected with the naked eye. Facilities require oxygen monitoring equipment to determine patient oxygen needs, regulate the

flow, and ensure safe usage. This is also important for avoiding oxygen toxicity if the correct dosage is not administered.

Another major challenge is the shortage of personnel, particularly biomedical engineers. Most facilities have inadequate numbers, far below the World Health Organization (WHO) recommendation for referral and training hospitals to have a biomedical engineering team of 8 permanent and 6 contracted biomedical engineers.

3.4.2 Systemic and institutional challenges

The wider systemic policy constraints include low prioritization by county and national governments of medical oxygen, poor coordination of the medical oxygen landscape, constraints arising from the unstructured production and supply chain of medical oxygen, lack of standardization, and the taxation regime. Each of these is discussed in turn.



1 Low prioritization of medical oxygen

Medical oxygen is not prioritized, especially with the decline in COVID-19-related complications. Health facilities reported challenges with frequent stock-outs of essential supplies related to medical oxygen (valves, gauges, oximeters), delays in refilling oxygen tanks or cylinders, and poor maintenance of existing medical oxygen production and supply equipment. A classic example of this lack of urgency is the case of CGHD7. The County Government received 350 cylinders from AMREF, distributed amongst the various health facilities across the county, from level 5 to level 2. However, a month after receiving the cylinders, a directive was issued by the Council of Governors (CoG) restricting the use of the donated cylinders until they are certified. To date, the cylinders remain unused. An additional handicap was that the donated cylinder valves are incompatible with BOC's refilling system, which will require the valves to be changed at an estimated cost of about KES 10,000 per cylinder.

The complacency that COVID-19 ended and the perception that there is no urgency is misplaced. As noted earlier, there has been growing awareness and demand for medical oxygen by the population for medical oxygen since COVID-19. The complacency, therefore, puts healthcare providers in a difficult position, especially in case of emergencies, because they find themselves unprepared and unable to cope with a surge in patient numbers requiring medical oxygen support. Outbreaks of diseases and accidents are common occurrences, requiring extensive use of medical oxygen.

Besides, equipment and medical oxygen infrastructure maintenance is problematic across the board. Most of the infrastructure is donated mostly by donors. Once the donors transfer the equipment to health facilities, maintenance becomes a problem, partly because counties hardly earmark any budgets for this and also because the biomedical engineers are few and underutilized. On average, it costs KES

300,000 every quarter to service a ventilator. Several respondents underscored the need to pay attention to maintenance:

"It is now time to pay greater attention to sustainability. The focus for a long time has been majorly on the hardware. It is now time to shift this focus to hardware maintenance, especially those that were put up during COVID-19. Some of it is not in use. For instance, out of 10 PSA plants installed, 8 are not running. Therefore, sustainability measures need to be implemented to manage the infrastructure and reduce the over-reliance or dependence on donor funding for supplying and delivering oxygen infrastructure. Only this kind of mindset will ensure continuity beyond the life of the projects supported by various stakeholders in the space".

(Key Informant, national level).

Maintenance easily gets entangled in the politics of resource allocation and procurement at the county level. At yet other times, contractual arrangements under which equipment is donated can be a bottleneck. In one county, for instance, ownership of the MES-funded ICU equipment has not been transferred to the county referral facility; hence, they are currently unable to service the equipment. The working shelf life of most of the equipment has expired. Therefore, the politics around equipment donation can hamper service delivery. Maintenance problems are worse at health facilities in far-flung areas of the county, which often have no biomedical engineer.

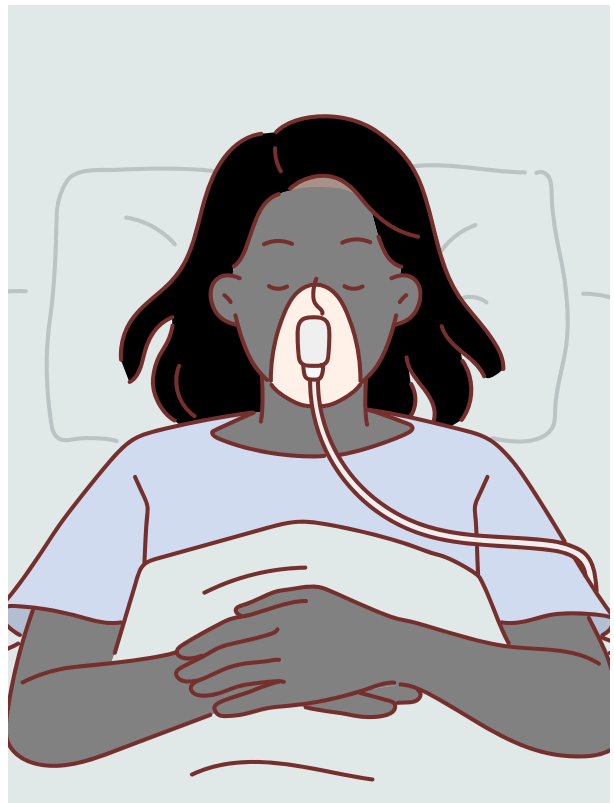


The low prioritization of medical oxygen is similarly reflected in the neglect of public health facilities below the county teaching and referral hospitals. Only some level 4 facilities have supplies of medical oxygen, and even then, stock-outs are frequent even though these facilities have maternity wards where newborns are delivered almost daily. Facilities lower than level 4 - health centers and dispensaries - typically have no access to medical oxygen. A few do have oxygen cylinders or concentrators, but most do not. As mentioned, most patients in the lowest socioeconomic quintile interact chiefly with the health system at these levels. Where there are complications of hypoxemia at these levels, patients must be referred to higher-level health facilities. The difficulty with this arrangement is ambulatory services are not always readily available to populations living in far-flung county areas, which could be many kilometers from the main public hospitals. The result is unnecessary and preventable loss of lives for women with birth complications or newborns in need of life support at birth.

2 Poor coordination and lack of standardization

The medical oxygen and supply landscape in the public health sphere is quite unstructured. The initiatives seem to be mostly donor-driven, with little harmonization. Coordination was much better at the height of COVID-19. The Country Oxygen Committee was better organized and coordinated. With COVID-19 no longer posing any public health threat, stakeholders have reverted to working in silos. The study revealed ongoing discussions with the Ministry of Health to reignite the platform for coordinating actors on medical oxygen. Still, there were no tangible signs that this has yielded fruits.

The lack of coordination manifests in the realm of equipment donation and donor support. It was common during the study to find more than three development partners supporting a specific county teaching and referral hospital. For instance, a public-



private partnership framework was used in one facility to run a PSA plant. Another funding agency had installed a PSA plant, which was not fully operational. Within the same county, another donor had supported the installation of a liquid oxygen storage tank at a level 4 facility, but refilling the tank once the donor pulled out was beginning to be a challenge. The ideal would have been a proper projection of medical oxygen needs across the entire county, then deciding on whether to install a PSA plant with the capacity to supply all facilities in the county or whether to have PSA plants strategically located across other hospitals but serving nearby health facilities in a more structured and coordinated way.

The Ministry of Health is developing draft guidelines with the support of JHPIEGO and CHAI. The research team did not have access to the draft guidelines, but it is understood that they address most of the coordination gaps in the production, supply, and utilization of medical oxygen.

Another difficulty with the supply chain is the lack of harmonization among suppliers, which exerts an added cost on the operations of public health facilities. Often, county governments are supplied with cylinders by different parties. Still, the valves vary and are usually incompatible - necessitating incurring costs in either buying valves or hiring them from another supplier. This has spawned a monopoly, with one supplier dominating the market and setting the terms and standards for medical oxygen utilization. The most acute form of this monopoly was felt at the onset of the COVID-19 pandemic.

The main supplier employed a lock-in strategy in which they only leased the storage tanks and cylinders for liquid oxygen to hospitals. They installed the medical oxygen

tanks free of charge, on condition that the supplier would refill the oxygen tanks for hospitals. This strategy vested ownership of the tanks and cylinders in the supplier, who equally fitted the tanks and cylinders with special valves. In essence, no other supplier could refill the tanks or the cylinders.

At the onset of COVID-19, Kenya faced a situation in which 99,000 new cylinders were needed, but only 20,000 were available from the main supplier. Even after sourcing from other suppliers, only 55,000 cylinders could be availed. Besides, the main supplier ran out of liquid oxygen. This prompted the government to liberalize the market. With support from the World Bank, the government bought its tanks and opened the market to new entrants to





import or manufacture oxygen. By buying its tanks and cylinders, the government reduced monopoly in the market as public health facilities were free to source from any supplier. Furthermore, through the PSA refilling modules, public health facilities were able to fill the small cylinders from BOC. In retaliation, the supplier withdrew the leased cylinders from the hospitals.

The realization that over-reliance on one supplier could be deleterious in the face of a pandemic gave rise to the government collaborating with AMREF to procure cylinders that are compatible with the PSA refilling systems. Once more, the dominant supplier retaliated by not refilling the MoH-owned cylinders. Vested economic interests persist, and their effects continue to hamper service delivery. Where facilities rely on liquid oxygen, they often have to wait for several cylinders to empty before refilling to restock. It is expensive to travel long distances to refill just a few cylinders. This leads to frequent stock-outs of medical oxygen for public health facilities that rely on cylinders refilling with liquid oxygen. Likewise, suppliers often refuse to refill cylinders or oxygen tanks until they are paid outstanding arrears, which can run into months. While this makes economic sense for suppliers of medical oxygen and related equipment and accessories, it can potentially be crippling for health facilities.

There is also little systematization in procurement, and it is often difficult to get market information on technical specifications for various products and assess the comparative market prices for various items needed in the administration of medical oxygen. The way the procurement system works at the county level also means that there are delays, private business interests, and a race to the bottom in terms of equipment purchase. It is not uncommon to find items purchased falling below required technical specifications and standards, which turns out to be eventually wasteful and inefficient. The politics of procurement and the attendant hidden business interests thus compromise medical oxygen availability and service quality.

At times, external influence also comes into play when local leaders interfere with the running of health facilities. In one health facility, staff reported that a few county government staff and local leaders often pressure healthcare providers to give oxygen cylinders to community members for home use. This heightens the shortage of medical oxygen at the facility. Likewise, informal lobbying by government officials and business people during the procurement of various supplies related to medical oxygen often leads to unnecessary delays, inflated prices of items, and over-or under-supply of essential equipment and other accessories.

3 Taxation

Medical oxygen is VAT exempt, but inputs needed to administer medical oxygen, such as cylinders and other consumables, are taxable. Kenya does not currently manufacture its own gas cylinders; all cylinders are imported, making them subject to excise duty and Value Added Tax (VAT). Respondents in a complementary study to the current one estimated that approximately 75 percent of the cost of a medical gas cylinder is attributed to taxes. Likewise, other respondents interviewed for this study cited taxation on medical oxygen accessories, supplies, and equipment as a major constraint compounded by the weakening shilling against the US dollar. These costs limit the purchase of equipment and supplies needed for maintenance and accessories needed for administering medical oxygen to patients.

The best approach would be to list and zero-rate all items needed in administering medical oxygen. This would lower the production, supply, and maintenance costs of medical oxygen. The current dispensation might not favor zero-rating medical oxygen products but continued taxation heightens the inefficiencies already inherent in the supply and utilization value chain. The most disadvantaged are the poorer segments of the population who cannot afford privately provided healthcare services.

3.5 Emerging Trends

- 1 The promulgation of the 2010 constitution marked a shift in the Kenyan governance system, with the ushering in of the devolved government system.** While this was a good turning point towards improving service delivery to citizens, it also decreased financial autonomy for public health facilities. This directly resulted from the change in facility financing agreements brought about by devolution. Before devolution, health facilities had the independence to retain and utilize the revenue obtained from user fees, insurance payments, and other sources. However, with the implementation of devolution and abolishment of user fees, the facilities were required to channel their revenue to a county revenue fund (CRF), as the PFM Act 2012 mandated that all county-generated revenues be channeled to the fund²⁸. This meant that the revenue obtained from the health facilities could then be reallocated and used to finance other activities rather than just health.
- 2 However, there was an exception to the rule, which allowed for the retention of revenues by the county government entity that received it if there was county legislation approving such retention.** As such, the extent to which the facilities were financially autonomous varied across the counties. Of the 47 counties, only 10 allowed facilities to retain 100% of their own-source revenue, while 16 allowed access to a portion. In the case of most counties (21 of the 47), facilities were required to channel all their revenue to the CRF.²⁹ Consequently, they relied primarily on budget allocations to cover their operational costs. Even in the 10 counties that allowed retention, the facilities did not receive all their funds directly. Instead,
- 3 The new Facilities Improvement Financing Act 2023, establishes a framework for the collection, retention, and management of all revenue generated by public health facilities in Kenya.**³⁰ This applies to all health facilities from level 1 to level 5 within the public health sector. The act also emphasizes that the generated revenue shall be supplementary to the budgetary appropriation rather than serve as a substitute. Consequently, facilities' revenue sources will be their own source revenue, budgetary appropriations, conditional grants, donations, and grants. To facilitate this process, each facility will be required to open and maintain a dedicated facility improvement financing account to which all the revenue will be channeled.
- 4 Granting health facilities this level of financial autonomy is highly advantageous. It enables facilities to independently raise and use funds to meet their financial obligations.** This leaves them greater fiscal flexibility to procure medical products, including medical oxygen, compensate their workforce, and improve the quality of care provided to citizens. Moreover, it allows these facilities to expand their expertise through training and hiring technical specialists, including biomedical engineers. This autonomy is particularly important in counties where health sector revenues account for the largest proportion of OSR.

²⁸ Public Finance Management Act, 2012. [Link](#)

²⁹ Facility Autonomy in the Age of Devolution: County-Level Arrangements for Managing Health Facility Revenue in Kenya. [Link](#)

³⁰ Facilities Improvement Financing Bill, 2023. [Link](#)



4

Conclusions, Successes and Recommendations

4.1 Conclusions

A number of conclusions can be made based on the evidence gathered so far. These include:

a There is increased and growing awareness among the population and healthcare providers of the life-saving capabilities of medical oxygen. The advantage is that health-seeking behavior has improved, and patients present themselves in time for medical intervention when it is still possible for medical personnel to intervene and save lives. There is also growing appreciation of and confidence in the quality of services provided in public health facilities among the population. However, this confidence can quickly be eroded when public health

facilities face frequent stock-outs of medical oxygen or other equipment and accessories critical to administering medical oxygen.

b Access to medical oxygen has improved across public health facilities in nearly all counties in Kenya, compared to the pre-COVID-19 period or during the pandemic itself. Generally, diagnosis for hypoxemia has improved as well, aided by the availability of pulse oximeters in many public health facilities. On the downside, medical oxygen remains accessible mostly at the higher levels of the public health system, typically at level 4 and above. This disenfranchises the poorest segments of the population who can hardly afford healthcare in private health facilities.





c With the support of development partners, it has invested in medical oxygen infrastructure across all seven counties. New PSA plants have been installed, LOX oxygen tanks installed as well, and there has been a commendable supply of medical oxygen cylinders and other accessories. Despite this, maintenance remains a challenge, and the amount of investments directed towards this remains sub-optimal. There are likely to be high sunk costs incurred on non-functional equipment and other medical oxygen infrastructure, with public health facilities turning into junk heap yards for disused medical oxygen equipment.

d The sector needs to be more coordinated. This is most evident in the investments made by different sector players in equipment and infrastructure. There is a lack of equipment standardization, non-compatibility and interoperability of equipment and accessories, and unnecessary duplication of supplies. Pockets of over-supply co-exist with swathes of the population without any access to medical oxygen, at times, within the same county. A good example is when a sub-county hospital supplied an oxygen tank whose capacity surpassed its needs. Yet, the county referral hospital had a much smaller oxygen tank.

e Major funding gaps remain due to laxity and complacency by both the national and county governments. Resources are needed to extend and expand access in lower-level health facilities, maintain existing infrastructure at higher-level facilities, and fully equip critical points in public health facilities with medical oxygen. Moreover, investments are needed to recruit more staff and train and upgrade existing staff's skills. These actions are necessary to broaden access while preparing for future pandemics that require massive use of medical oxygen.

f Vested commercial interests hinder the growth and optimal functioning of the medical oxygen landscape. Such interests heighten entry costs for newer private sector players, stifle harmonization of standards,

and have a net debilitating effect on sub-sector efficiency and equitable distribution and access to services. The absence of policies on standards and regulations to enforce such standards continues to be an operational and policy bottleneck.

g Medical oxygen forms part of a critical care package for patients with acute conditions arising from diverse causes. In this regard, medical oxygen is only useful and meaningful when there is a concomitant quality of service improvement in the other components of that care package.

h Persistent inefficiencies remain in procuring, delivering, administering, and storing medical oxygen. Addressing these inefficiencies is a growing need for health facilities. It must be tackled because of the increasing demand for medical oxygen against the backdrop of resource constraints most public health facilities face.





4.2 Successes

As evidenced by the National Validation meeting, attendance was high-level and purposeful. Apart from attending the meeting, the participants sat through all the sessions and engaged. Participation was from the National Parliament (National Assembly and Senate), county governments, including a sitting deputy governor, the National Ministry of Health, and Partners in the sub-sector.

This event was publicized on many media platforms, including social media, and discussed

in high government offices and with partners.

Consequently, the National Parliament, the National Ministry of Health, and County governments have indicated they would happily work with us to support the recommended interventions.

Further, arising out of the issues raised about projects initiated and not completed, one week after the National meeting, tendering went out for the certification of medical infrastructure across different counties.

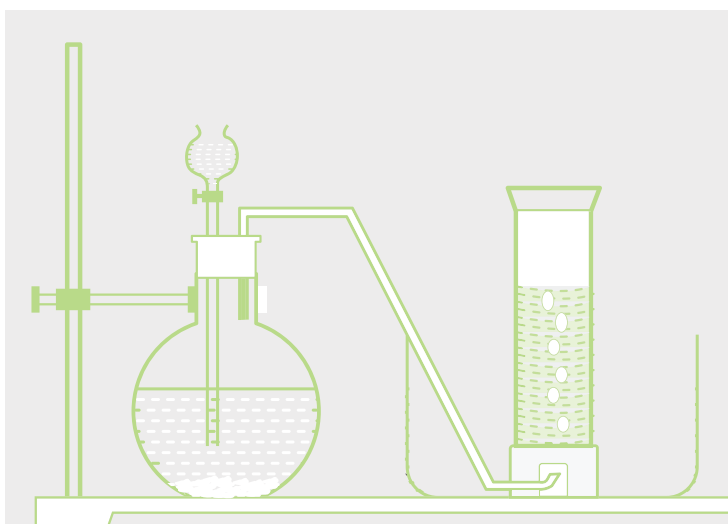




4.3 Recommendations

- i Establishment of a dedicated budget line:** Both national and county governments should have a specific budget line for medical oxygen products within the budget documents developed and include a unique Integrated Financial Management System (IFMIS) code for medical oxygen. This will allow for transparency and accountability, better tracking of allocations, and monitoring of the implementation of medical oxygen projects.
- ii Better absorption and utilization of health sector development budgets:** Counties should ensure the full utilization of allocated funds is within the expected timeframe. This will help improve medical oxygen infrastructure, such as piping, and supporting infrastructure, such as electricity. To ensure efficient implementation, the national and county governments should develop and implement a robust monitoring and evaluation system to track the progress of development projects. Ensuring timely exchequer releases is also necessary as they are vital in achieving higher absorption rates.
- iii Government investment in liquid oxygen plants:** Currently, there is only one Liquid oxygen plant in the country, which is approximately five decades old and operating below its maximum efficiency. Dependency on a single, aging, and inefficient plant leaves the healthcare system susceptible to various risks, such as technical failures or unforeseen emergencies. The government should, therefore, invest in more LOX plants, as they offer numerous benefits.
- iv Development of a better regulatory framework for medical oxygen equipment:** Most imported medical oxygen plants tend to operate for a short time before breaking down or experiencing operational issues. The recurrence of these issues suggests the possibility of substandard equipment being imported. Therefore, there is a need to subject the equipment to more stringent scrutiny to ensure that it adheres to high-quality and safety standards.

- v Strengthening local production capacity:** The government should encourage and support the establishment of local oxygen production facilities to reduce dependence on imported oxygen. This can be achieved by providing financial incentives, streamlining regulatory processes, and fostering a favorable business environment. For example, power rebates could be offered to medical oxygen manufacturers to reduce the final cost of medical oxygen to hospitals. Investing in local production capacity will enhance self-sufficiency, reduce costs, and ensure a reliable supply of medical oxygen.
- vi Capacity Building and Strengthening:** To effectively maintain and optimize equipment functionality, the staffing of biomedical engineers within health facilities needs to be increased. In addition, engineers need further training in handling, maintaining, and repairing machinery.
- vii Advocacy:** There is a need to raise awareness of the importance of medical oxygen and the need for adequate budgetary allocations. This calls for collaboration among policymakers, civil society organizations, and healthcare professionals to advocate for policy reforms that prioritize the provision of affordable and accessible medical oxygen to all patients in need.





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