Strengthening Oxygen Data Management Systems

Zambia Oxygen Data Dashboard Report

October 2022

PATH

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

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Abbreviations

DHIS2	District Health Information System 2
HMIS	health management information system
KAP	knowledge, attitudes, and perceptions
MOH	Ministry of Health
PSA	pressure swing adsorption
UNICEF	United Nations International Children's Emergency Fund
UTH	University Teaching Hospital

Executive summary

The Zambia Ministry of Health (MOH) and PATH have been exploring ways to support an efficient, resilient, and safe oxygen delivery system with high-quality evidence and data. Toward this goal, the MOH, under the Department of Clinical Care and Diagnostics Services through the office of the National Oxygen Coordinator, developed an oxygen dashboard. The oxygen dashboard is an online application designed to collect data on oxygen demand and supply during and after the COVID-19 pandemic. The oxygen dashboard uses the DHIS2[a] software platform and produces data visualizations for each health facility based on select oxygen indicators. The dashboard was tailor-made to encourage regular data collection on oxygen demand and supply within health facilities. The users of the oxygen dashboard include biomedical engineers, biomedical technologists, and medical equipment officers. As part of this effort, from August 2 to 5, PATH, with support from the MOH, conducted a short user survey to:

1. Investigate knowledge, attitudes, and perceptions of users related to the oxygen dashboard.
2. Gauge the user challenges with reporting data into the oxygen dashboard.
3. Generate recommendations for further improvement of the oxygen dashboard.

Key findings

- The majority of respondents (81.8 percent) are aware of the oxygen data dashboard; only 18.2 percent had not heard about it.
- **There is no effect of oxygen dashboard knowledge on the rate of use.** Even with full knowledge of the oxygen dashboard, 67 percent of respondents reported that they had never used the dashboard. A few reasons for not using the dashboard included the time it takes to enter data, moving from the existing paper-based system to a new one, and not having assigned data collectors for this role.
- The respondents have many other tasks to fulfill on a day-to-day basis outside of reporting data into the oxygen data dashboard. Most respondents reported having several tasks to complete during their workday. More than half (72 percent) of the respondents reported having to conduct repair and maintenance work daily. All the respondents have very technical roles that require operations around the facility.
- **Health facilities that have been using the oxygen dashboard reported its benefits.** These include the ability to effectively quantify the medical oxygen available, monitor shifts in oxygen demand over time, effectively plan for procurement of medical oxygen, and perform risk mitigation in case there is a sudden spike in demand for medical oxygen for their facilities.

[a] The District Health Information Software (DHIS) is an open source software platform for reporting, analysis, and dissemination of data for all health programs, developed by the Health Information Systems Programme.

Overall, these findings highlight opportunities for improvement in the oxygen data dashboard. Strategies to improve the dashboard will be executed in partnership between the MOH and PATH. Proposed recommendations to improve the dashboard include:

1. Blend the oxygen dashboard into the HMIS to release the burden of data collection from the biomedical engineers who have many tasks filling their time daily.
2. Conduct a thorough review of the oxygen indicators to refine a list of data points that would be essential for decision-making.
3. Add select oxygen indicators (patient data, oxygen equipment functionality, oxygen plant status) into routine data collection at each facility.
4. Conduct practical training on the data dashboard and review the initial content used to train users.

Introduction

Oxygen therapy is vital for ending preventable deaths among children and adults globally. Oxygen is a lifesaving medicine used by health care professionals to treat various respiratory illnesses, like COVID-19 and pneumonia. Oxygen is also essential for surgery and trauma and vulnerable groups such as the elderly, pregnant women, and newborns in need of oxygen therapy regularly. Despite being classified as an essential medicine by the World Health Organization,[1] oxygen availability is not currently a standard health system indicator like vaccine or bed net coverage in most countries.[2]

In Zambia, the Ministry of Health, under the Department of Clinical Care and Diagnostics Services through the office of the National Oxygen Coordinator, developed an oxygen data dashboard. The purpose of this dashboard was to encourage routine data collection on oxygen demand and supply within health facilities. The main goals of the oxygen data dashboard were to pursue the following:

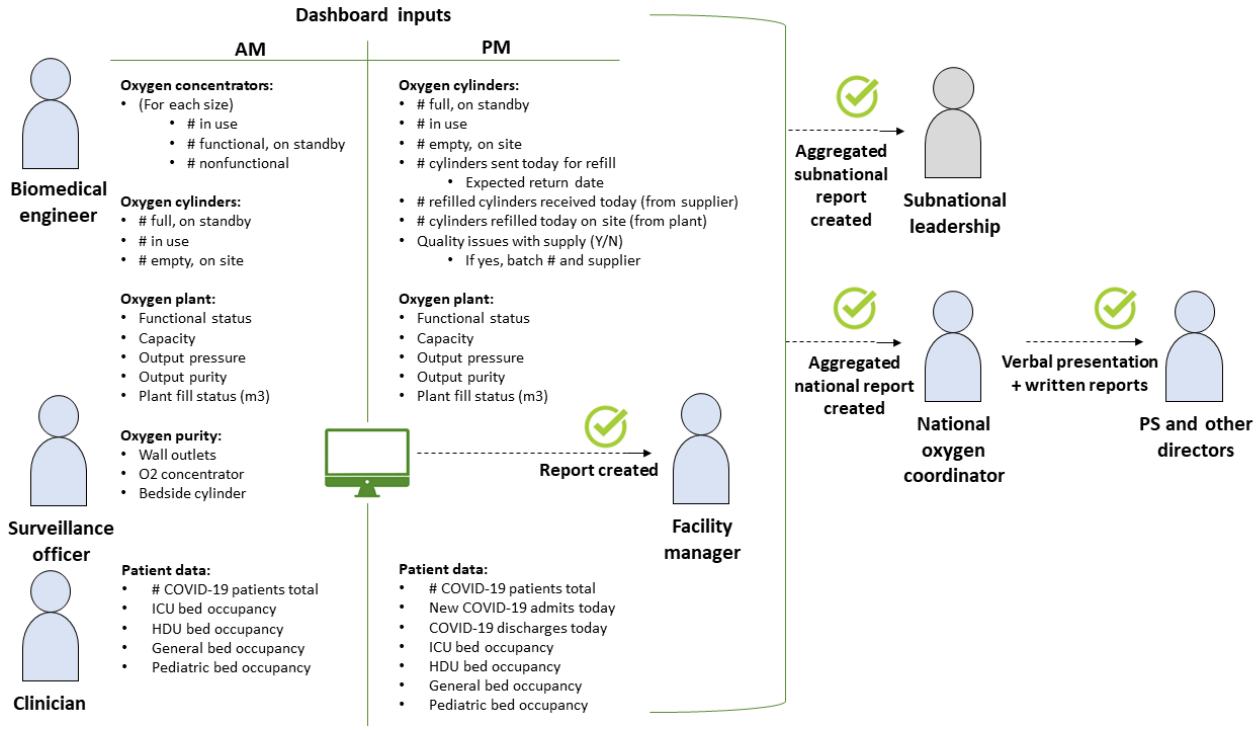
1. Estimate facility-level oxygen demand and track cylinder consumption.
2. Track oxygen supply from cylinders, concentrators, and pressure swing adsorption (PSA) plants.
3. Create reports on oxygen demand, consumption, and supply availability for facility and national-level decision-makers.

The reports generated by the oxygen data dashboard will help decision-makers at the facility level to predict oxygen needs and procure appropriate volumes, improve patient referrals based on real-time data on the availability of oxygen supplies, and allow for estimation of oxygen gaps in real time. For the national-level decision-makers, the data from the oxygen data dashboard provide an evidence base to inform decisions on the reallocation of supplies to facilities with the greatest need. Additionally, national decision-makers can help enforce accountability of suppliers to supply high-quality medical oxygen by monitoring the purity of oxygen.

The introduction of the oxygen data dashboard could eventually contribute to data collection on oxygen indicators as a standard practice within health facilities nationwide. The MOH conducted user training on the oxygen data dashboard in June 2021. The user training aimed to orient participants on use and reporting of oxygen indicators into the dashboard. However, after conducting the user training, the reporting frequency in the oxygen data dashboard was low. Therefore, the MOH and PATH decided to examine solutions that would improve the data quality and reporting frequency of the oxygen data dashboard. The decision is in line with one of the pillars of the *Zambia National Medical Oxygen Strategic Plan*. The pillar seeks to ensure an efficient, resilient, and safe oxygen delivery system by systematically collecting high-quality data on time to provide information for decision-making.[3]

The first step to improving the oxygen data dashboard was to review the data dashboard, examine the implementation, and understand the current data culture in health facilities in Zambia. Understanding the baseline allows us to identify what changes are needed and how to roll out a data collection project that will be successful. One critical step in the review was to map out the oxygen data dashboard users and information flow because it helped us determine what data points to collect and what content to include in reports that are generated for stakeholders, as shown in Figure 1:

Figure 1. Flow of data in the oxygen dashboard to drive decision-making.



Abbreviations: AM, morning; HDU, high-dependency unit; ICU, intensive care unit; m3, meter cubed; O2, oxygen; PM, afternoon and evening; PS, Principal Secretary; Y/N, Yes/No.

Once the Ministry of Health and PATH understood how the data generated by the oxygen data dashboard would influence decision-making, it was imperative to gauge the user experiences of the dashboard through a user survey. Implementing a dashboard user survey would help the Ministry to understand what challenges still exist for facilities to collect quality data routinely and effectively. As such, the MOH, through the Department of Clinical Care and Diagnostic Services and working in collaboration with PATH Zambia, conducted a user survey of the knowledge, attitudes, and perceptions (KAP) on the oxygen data dashboard.

The purpose of the user survey was to gauge the user challenges, understand the data culture, and investigate why data quality and reporting frequency in the oxygen data dashboard is low. In addition, the findings of this study will help the government to develop strategies to increase the frequency of reporting into the data dashboard. The KAP toward the oxygen data dashboard largely determine the utilization of the users to accept the new reporting platform advocated by the MOH. KAP studies provide the foundation for interventions required to correct misinformation, misconceptions, and challenges about a particular subject matter. This report discusses the data collection methodology, the findings on the KAP of users of the dashboard, and finally, makes recommendations for improving the oxygen data dashboard.

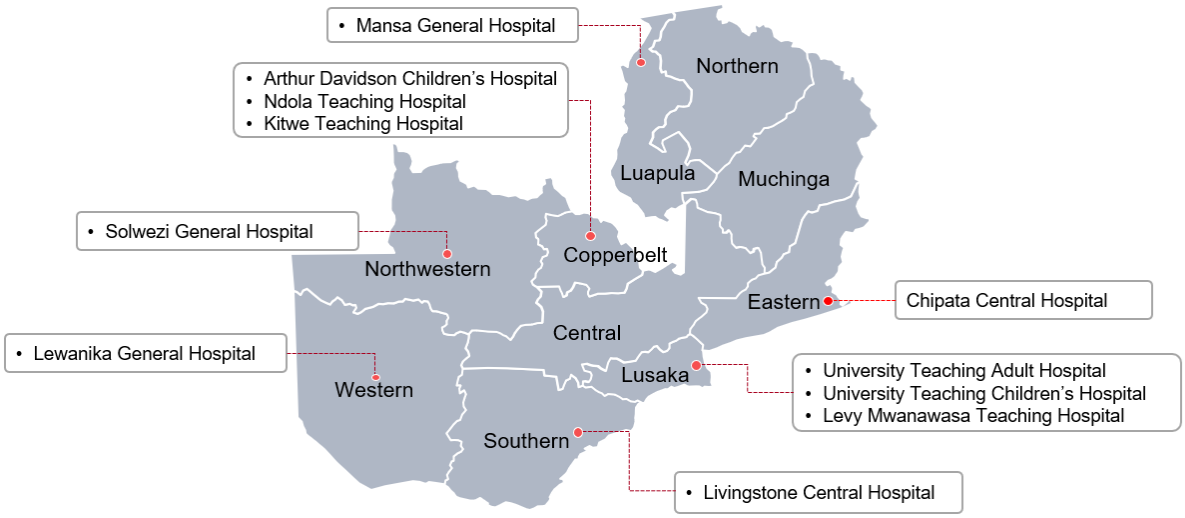
Methods

Data collection

The user survey used a data collection tool created by PATH in collaboration with the Zambia MOH Department of Clinical Care and Diagnostic Services. The SurveyCTO data collection platform hosted the user survey. The user survey questions were designed based on the principles of KAP surveys[4] and were reviewed and approved by the MOH. Data collection was done electronically using computer assisted telephone interviewing from August 2 to August 5, 2022, by a team of PATH program officers. Therefore, the results from the analysis reflect the status of the surveyed facilities at that time.

The health facilities in the survey include the University Teaching Hospitals, or UTHs (UTH Adult, UTH Children's, and Levy Mwanawasa UTH); Ndola Teaching Hospital; Arthur Davidson Children's Hospital; Kitwe Teaching Hospital; Chipata Central Hospital; Lewanika General Hospital; Livingstone Central Hospital; Mansa General Hospital; and Solwezi General Hospital (see Figure 2 for the location of facilities by province). The Lusaka and Copperbelt provinces had the highest density of facilities in this survey due to the influx of patients requiring oxygen.

Figure 2. Distribution of the number of health facilities surveyed by province.



The MOH recommended these facilities for the oxygen user survey because most of them are referral (tertiary and secondary) hospitals to which patients are likely to be referred when in need of critical respiratory care (see Table 1). Additionally, most of these facilities have a PSA plant or will have liquid oxygen tanks installed soon. For instance, Levy Mwanawasa UTH was designated as a COVID-19 treatment center because it has an 850-bed capacity and is now the largest hospital in the country. Mansa and Lewanika General Hospitals have PSA plants with filling capacity within their respective provinces. Livingstone Central Hospital expects to receive a liquid oxygen tank to increase oxygen access within the Southern Province.

Table 1. Facility characteristics.

Province	District	Facility name	Facility type	Geography
Lusaka	Lusaka	Levy Mwanawasa UTH	Tertiary	Urban
		UTH Adult	Tertiary	Urban
		UTH Children's	Tertiary	Urban
Eastern	Chipata	Chipata Central Hospital	Tertiary	Urban
Luapula	Mansa	Mansa General Hospital	Secondary	Urban
Copperbelt	Ndola	Ndola Teaching Hospital	Tertiary	Urban
		Kitwe Teaching Hospital	Tertiary	Urban
		Arthur Davidson Children's Hospital	Tertiary	Urban
Northwestern	Solwezi	Solwezi General Hospital	Secondary	Urban
Western	Mongu	Lewanika General Hospital	Secondary	Urban
Southern	Livingstone	Livingstone Central Hospital	Tertiary	Urban

Limitations of the survey

This survey obtained its sample through convenience sampling from a nominated list of the selected facilities. The sample for the health facilities was selected based on their likelihood to use the most oxygen/see the most patients in need of oxygen therapy, as well as the human resources for data collection of oxygen indicators. Furthermore, the implementation of an improved oxygen data dashboard would be most successful if introduced according to a tiered approach with a focus on the surveyed facilities first. Therefore, there may be a bias since this sample is not nationally representative in reflecting the knowledge, attitudes, and perceptions of the oxygen data dashboard from all the facilities around the country.

Findings

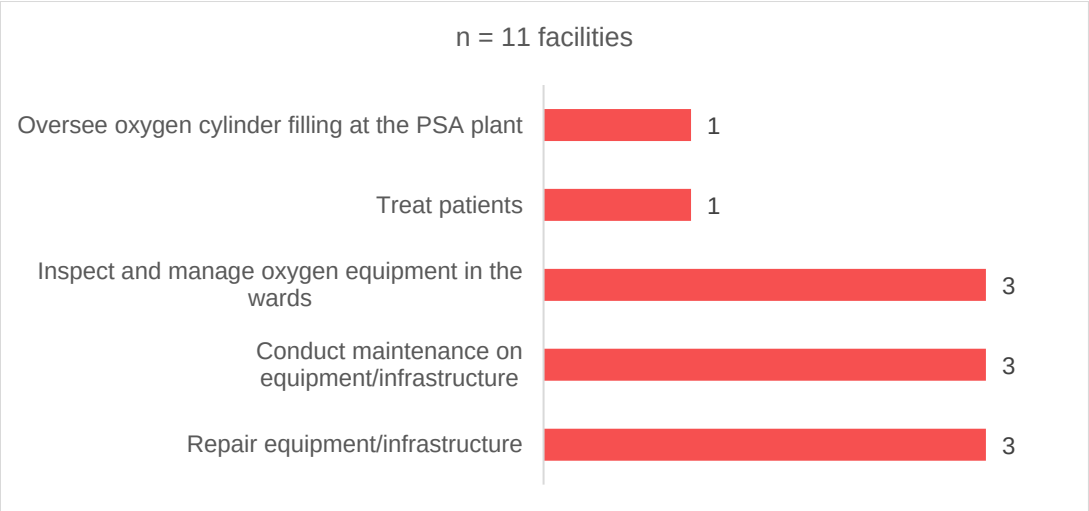
Profile of the survey's respondents

A total of 11 participants completed the survey representing tertiary (three) and secondary (eight) health facilities. Most respondents reported having several tasks to complete during their workdays. More than half (72 percent) of the respondents reported having to conduct repair and maintenance work daily. On average, respondents reported splitting their time among various activities. These activities include supervising oxygen cylinder filling at the PSA plant, collecting data for the health information management system (HMIS), assisting clinicians and nurses in the delivery and management of medical oxygen equipment, planning and budgeting for medical equipment for the facility, supervision of oxygen plant operations, and routine monitoring of oxygen management in the wards. **The respondents have many other tasks to fulfill on a daily basis besides reporting data into the oxygen data dashboard.**

Table 2. Summary of respondent job title by health facility.

Facility	Job title
Chipata Central Hospital	Medical equipment technologist/biomedical engineer
UTH Adult Hospital	Chief medical equipment officer
UTH Children's Hospital	Biomedical equipment technologist
Mansa General Hospital	
Lewanika General Hospital	Medical equipment officer
Arthur Davidson Children's Hospital	Biomedical engineering technologist
Levy Mwanawasa University Teaching Hospital	
Livingstone Central Hospital	Anesthesiologist and intensive care
Kitwe Teaching Hospital	Biomedical equipment officer
Solwezi General Hospital	Biomedical engineer
Ndola Teaching Hospital	Senior biomedical equipment technologist

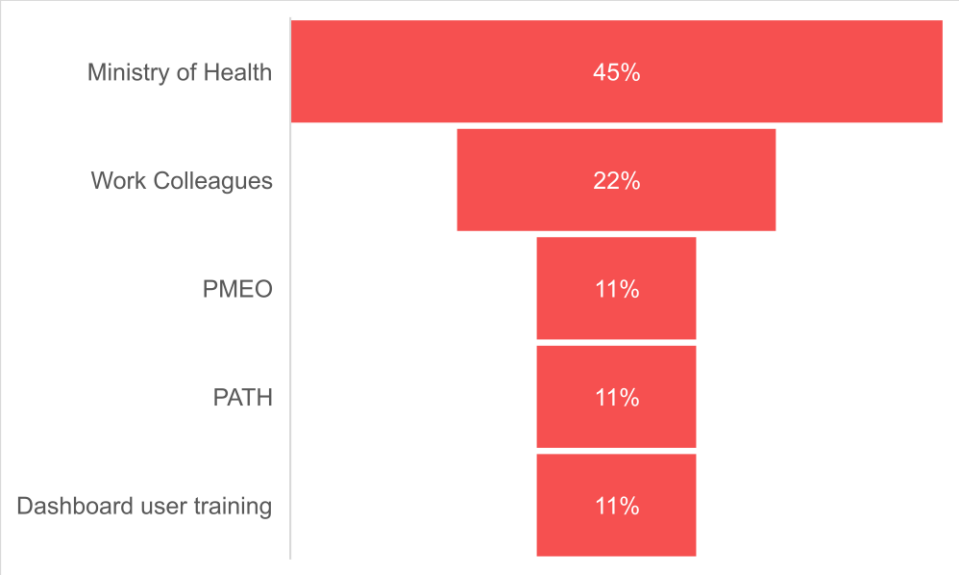
Figure 3. Activities that respondents reported devoting most of their time to on a daily basis.



Knowledge, attitudes, and perceptions about the oxygen dashboard

Almost all the participants (81.8 percent) have good knowledge of the oxygen data dashboard, and only 18.2 percent had not heard about it. Regarding where they heard about the oxygen data dashboard, 45 percent of study participants heard about it from the Ministry of Health, 22 percent from work colleagues, 11 percent from PATH, 11 percent from the provincial medical equipment officer, and another 11 percent from a dashboard user training.

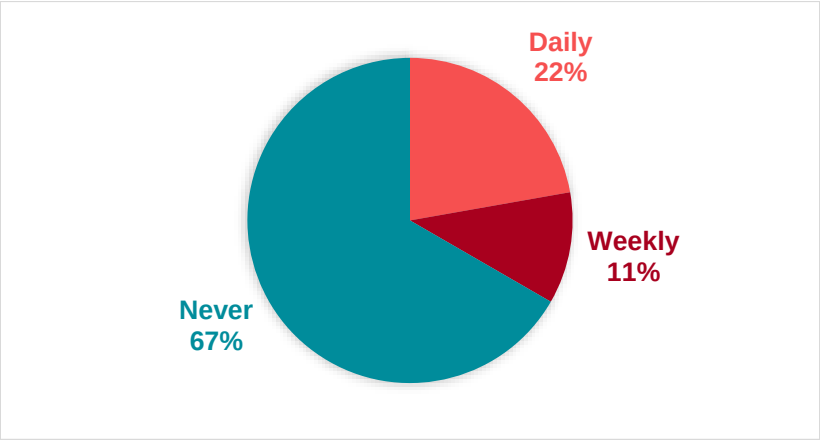
Figure 4. Percentage of respondents reporting on where they heard about the oxygen data dashboard.



Abbreviations: PMEO, provincial medical equipment officer.

There is no effect of oxygen dashboard knowledge on the rate of use. Some respondents reported not using the dashboard even though they had heard about it. A few reasons were the high investment of time to record data into the dashboard among the many tasks they would have to fill in a day's work. Other facilities reported that they abandoned reporting into the oxygen dashboard because of the paper-based reporting system already set up within the facilities. Figure 5 shows the rate at which participants who heard about the oxygen dashboard have used it.

Figure 5. Rate at which respondents reported that they use the oxygen data dashboard.



Health facilities that have been using the oxygen dashboard reported having various benefits from it. These include the ability to effectively quantify medical oxygen, monitor oxygen demand, effectively plan for procurement of medical oxygen, and perform risk mitigation for their facilities.

> "Before the dashboard, we did not generate any reports on oxygen management. After we started using the dashboard, we were able to monitor the oxygen supply and usage in real time and respond accordingly. It changed things for us because there were reports available for everything that was used and helped us plan ahead."
>
> "We see utilization and quantify for the next purchase early enough."
>
> "The dashboard is able to tell what is happening on the ground and other facilities can come through and help."
>
> –Respondents reporting on benefits of the oxygen dashboard

Moreover, respondents consistently reported that the main feature of the oxygen data dashboard would be to monitor the oxygen supply status in real time and track the patient's use of the drug.

Health facilities that do not use the dashboard reported that oxygen issues were communicated via WhatsApp, emails, and paper-based reports and submitted to management. Of the 18.2 percent of participants who did not know about the oxygen data dashboard, respondents indicated that it would be essential to track oxygen consumption within the facilities and the quantity and quality of oxygen cylinders from private suppliers.

Respondents also reported various recommendations for ways in which the Ministry of Health can ensure that there will be a response when facilities raise an oxygen issue (see Table 3).

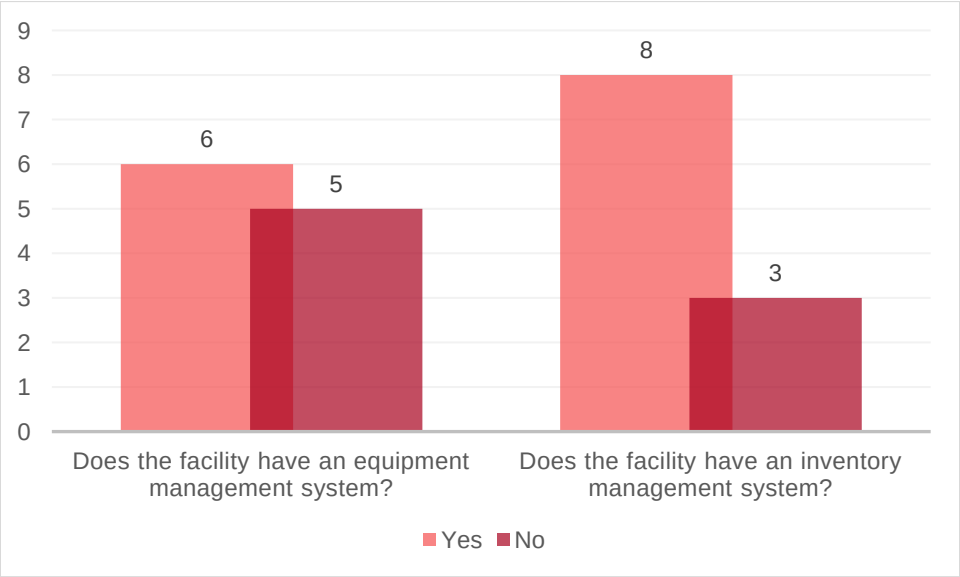
Table 3. Summary of best methods to ensure a response to oxygen issues by facility.

Facility	What do you feel is the best method to ensure a response to an oxygen supply/oxygen issue?
Levy Mwanawasa University Teaching Hospital	Oxygen data dashboard and WhatsApp
UTH Adult Hospital	Telephone
UTH Children's Hospital	WhatsApp
Lewanika General Hospital	Tool for tracking and reporting these issues. It will reduce the various channels that currently exist in reporting and solving issues.
Mansa General Hospital	We do not have any issues when it comes to reporting and getting responses. Our main challenge has been when the oxygen was not paid for by our partners to collect the oxygen on time.
Arthur Davidson Children's Hospital	WhatsApp for day-to-day activities and a proper dashboard for statistics on all oxygen equipment in the facility. A report with statistics helps a lot for monitoring, planning, and costing. A dashboard is more ideal, but it has to be very well designed and thought out. UNICEF was working on a dashboard that would give alerts for non-functional equipment through emails and SMSs but hasn't been launched yet.
Chipata General Hospital	Email and WhatsApp the issues to Mr. Mphande.
Livingstone Central Hospital	Data dashboard.
Kitwe Teaching Hospital	Through WhatsApp messages and calls to the oxygen coordinator.
Solwezi General Hospital	A software to track where oxygen is needed and support it. There should be people responsible for this so that issues are resolved quickly.
Ndola Teaching Hospital	WhatsApp is quicker. For storage of data a laptop is better.

Data management systems

Of all the facilities represented in the study, just over half of the respondents (six) indicated that their facilities had an equipment management system, and five reported not having an equipment management system. However, facilities recorded higher proportions (eight) using an inventory management system, with only three without at their facility (see Figure 6).

Figure 6. Distribution of equipment and inventory management systems by facility.



Recommendations

Integrated data management systems

The oxygen data dashboard is hosted on the open source platform DHIS2. The Ministry of Health DHIIS2 platform hosts two data dashboards:

1. The health information management system (HMIS) hosts (1) disease aggregation for users to access data on the number of cases per condition and (2) service delivery for users to access data on services provided by facilities, such as antenatal care, vaccination, and antiretroviral treatment. Data collection on the HMIS is performed by assigned personnel stationed within the facilities. Each facility will generate a paper-based report and send it to the district health office. The district health information officers will then transfer the data from the paper-based report into the HMIS. Afterward, the HMIS will generate a monthly report for monitoring and decision-making for the MOH.
2. The COVID-19 Vaccination Dashboard hosts (1) COVID-19 vaccination data nationwide and (2) an oxygen dashboard where users can report data on oxygen demand and supply.

We recommend integrating the oxygen dashboard into the HMIS to release the burden of data collection from the biomedical engineers, who have many tasks filling their time daily. Also, the implementation of a centralized system for reporting will increase efficiency and accuracy. We propose the integration to:

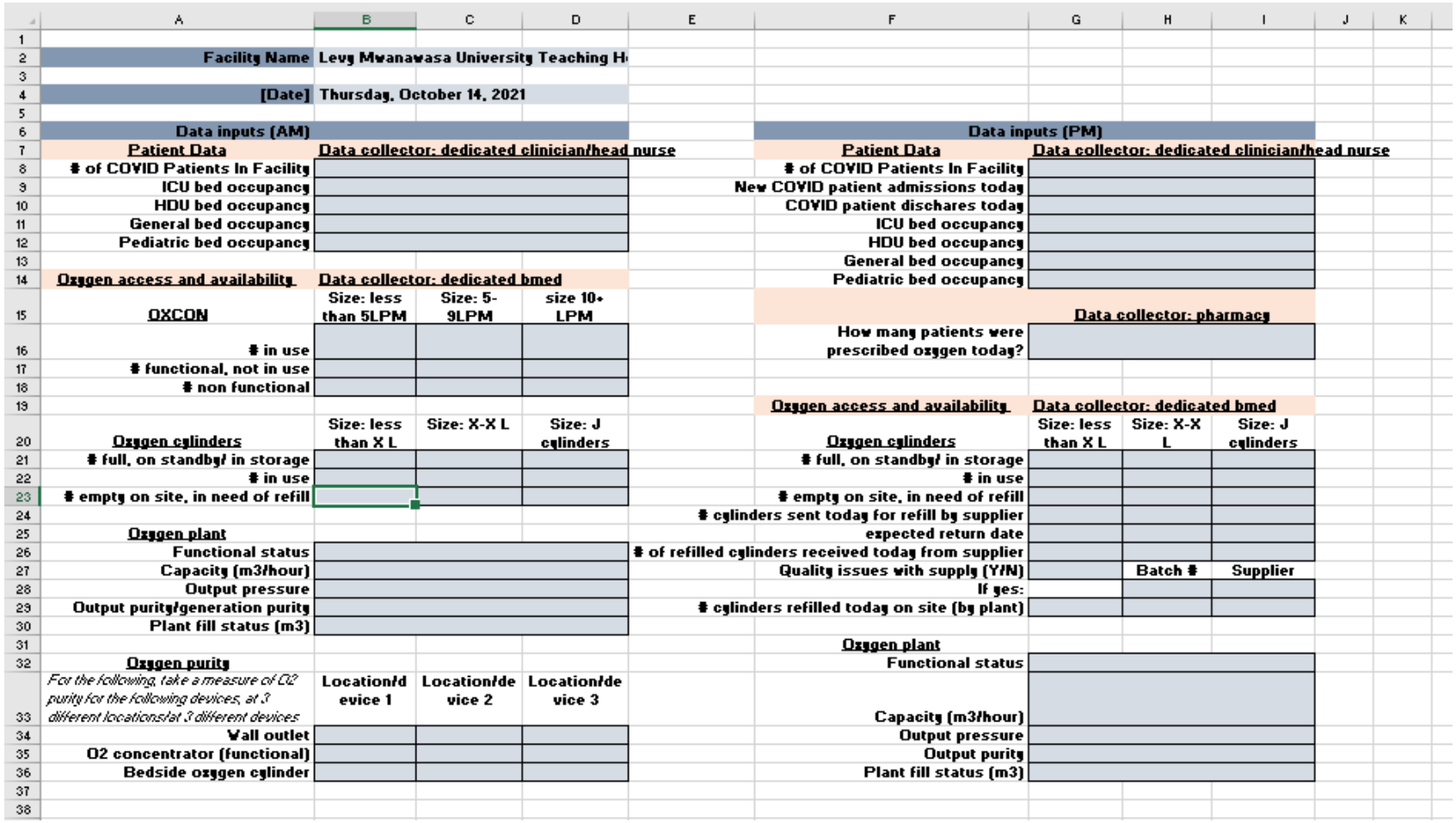
- Include oxygen indicators (patient data, oxygen equipment functionality, oxygen plant status) into routine data collection at each facility.[b]
- Include alarm features to show urgency to act on data provided. For example, there could be a feature that sends a red-flagged email to management or the oxygen coordinator when there is a crucial need to supply oxygen to a facility.

Additionally, we recommend a thorough review of the entire data collection process from top to bottom, which would include:

- Reviewing the oxygen indicators thoroughly to refine a list of data points. This is essential for decision-making and to reduce the burden on the data collectors. For example, Figure 7 shows a mock-up of a list of data points that could be collected daily in a facility, and Figure 8 shows a mock-up of the output generated from the data collection. We propose to review the oxygen indicators with the users to encourage a collaborative effort for all the stakeholders working with the oxygen dashboard. This effort will contribute to assisting stakeholders to align the goal, strategy, and outcomes for the oxygen dashboard.

[b] A good reference point on building additional indicators would be the report by the Every Breath Counts Coalition at https://stoppneumonia.org/wp-content/uploads/2020/06/EBC-Indicators-recommendations_6AUG18.pdf.

Figure 7. Mock-up of dashboard inputs.



Facility Name	**Levy Mwanawasa University Teaching H**										
[Date]	**Thursday, October 14, 2021**										
Data inputs (AM)						**Data inputs (PM)**					
Patient Data	**Data collector: dedicated clinician/head nurse**					**Patient Data**	**Data collector: dedicated clinician/head nurse**				
# of COVID Patients In Facility						**# of COVID Patients In Facility**					
ICU bed occupancy						**New COVID patient admissions today**					
HDU bed occupancy						**COVID patient dischares today**					
General bed occupancy						**ICU bed occupancy**					
Pediatric bed occupancy						**HDU bed occupancy**					
						General bed occupancy					
Oxygen access and availability	**Data collector: dedicated bmed**					**Pediatric bed occupancy**					
OXCON	**Size: less than 5LPM**	**Size: 5-9LPM**	**size 10+ LPM**				**Data collector: pharmacy**				
# in use						**How many patients were prescribed oxygen today?**					
# functional, not in use											
# non functional											
						Oxygen access and availability	**Data collector: dedicated bmed**				
Oxygen cylinders	**Size: less than X L**	**Size: X-X L**	**Size: J cylinders**			**Oxygen cylinders**	**Size: less than X L**	**Size: X-X L**	**Size: J cylinders**		
# full, on standby/ in storage						**# full, on standby/ in storage**					
# in use						**# in use**					
# empty on site, in need of refill						**# empty on site, in need of refill**					
						# cylinders sent today for refill by supplier					
Oxygen plant						**expected return date**					
Functional status						**# of refilled cylinders received today from supplier**					
Capacity (m3/hour)						**Quality issues with supply (Y/N)**		**Batch #**	**Supplier**		
Output pressure						**If yes:**					
Output purity/generation purity						**# cylinders refilled today on site (by plant)**					
Plant fill status (m3)											
						Oxygen plant					
Oxygen purity						**Functional status**					
For the following, take a measure of O2 purity for the following devices, at 3 different locations/at 3 different devices	**Location/device 1**	**Location/device 2**	**Location/device 3**			**Capacity (m3/hour)**					
Wall outlet						**Output pressure**					
O2 concentrator (functional)						**Output purity**					
Bedside oxygen cylinder						**Plant fill status (m3)**					

Figure 8. Mock-up of dashboard outputs.

Key Actions							
Action							
Facility should order at least	101	6,800L J cylinders or a mix of other volume cylinders resulting in an equivalent volume of oxygen to meet the minimum O2 reserve capacity requirement					
Facility should address that it only has approximately	1	full cylinder on standby for every cylinder that is currently in use					
Facility should address	3	non-functional concentrators to increase o2 availability					

Cylinder Indicators							
Indicator Number	Indicator						Description
1	O2 Volume of Full Cylinders on Hand	276000	Liters of Gaseous O2				Volume of all full cylinders on standby at the facility
2	Number of Full Cylinders on Hand	50	Cylinders				Number of full cylinders on standby at the facility
3	Target O2 Volume Reserve Capacity	1252800	Liters of Gaseous or equivalentl		185	6,800L J Cylinc	Target volume of cylinder oxygen to be on standby at facility based on current patient counts. Shown in liters and equivalent 6,800L J cylinders.
4	Gap/Surplus Between Current Cylinder O2 Volume and Reserve Capacity Target	-976800	Liters of Gaseous or equivalentl		144	6,800L J Cylinc	Gap between current O2 volume of full cylinders on standby (1) and target (3). Shown in liters and equivalent 6,800L J cylinders.
5	Minimum additional liters of oxygen required (70% of gap)	683760	Liters of Gaseous or equivalentl		101	6,800L J Cylinc	Additional liters of oxygen required to address 70% of the gap (4). 70% of the gap is defined as the minimum volume of oxygen required for the facility to not be at risk of O2 shortage
6	Cylinder replacement ratio (Full, on Standby Cylinders / In Use Cylinders)	1					Denotes number of full cylinders on standby at the facility (2) over the number of cylinders currently in-use. Representative of how many backup cylinders exist for every current cylinder use.
7	Number of empty cylinders on site	140	Cylinders				Number of empty cylinders stored on-site requiring refill
8	Volume of empty cylinders on site	824000	Liters of Gaseous O2				Potential O2 volume of empty cylinders stored on-site requiring refill
9	Cylinder turnover (new empties over 24hr period)	Small - 140	Medium - 3600L	Large - 6800L			Number of new empty cylinders in a 24 hour period
		0	5	10			

Concentrator Indicators				
Indicator Number	Indicator			Description
10	Total # of Available Concentrators (Functional,	4	Concentrators	Total number of available functional concentrators (on standby)
11	Total # of Available High Flow Concentrators (Functional, not in use)	1	Concentrators	Total number of available functional high flow concentrators (10 LPM) (on standby).
12	Non-Functional Concentrators	3	Concentrators	Total number of non functional concentrators

PSA Plant Indicators			
Indicator Number	Indicator		Description
13	PSA Plant functionality status	Operational	Denotes whether PSA plant is operational or not
14	PSA plant output pressure		Denotes heaviness of usage of PSA plant

Oxygen Demand Analytics							
Indicator Number	Indicator						Description
14	Estimated O2 Daily Demand (Liters)	146880	Liters of Gaseous or equivalentl		22	6,800L J Cylinc	Estimates 24hr demand for oxygen based on current patient census, estimated rates of hypoxemia prevalence, and predefined o2 flowrates.
15	O2 Instantaneous LPM Demand	102	Liters per Minute				Estimates oxygen requirement for a single point in time based on current patient census, estimated rates of hypoxemia prevalence, and predefined o2 flowrates

- Aligning the time frame for report generation for select indicators. The HMIS currently produces only monthly reports. Therefore, the COVID-19 vaccination dashboard was created separate from the HMIS because facilities relied on daily reports for emergency response. We propose aligning the time frame of generating reports for select indicators that may require more frequent reporting. This practice will increase emergency preparedness for the country as it evolves to create a more resilient health care system for its citizens.
- Introducing electronic-based reporting within facilities.[c] We propose creating a standard of reports that would be automated into an electronic system for every facility to use.
- Allowing facilities to download an Excel template of the oxygen dashboard. The DHIS2 software has an option to download forms for data entry. Therefore, users can enter data offline and upload it to the server when connectivity is present. The user could fill in the Excel sheet based on the required oxygen indicators and then upload the sheet into the oxygen dashboard on DHIS2. This practice could encourage reporting using the familiarity of Excel and the use of the oxygen dashboard in DHIS2.

Capacity-building training and rollout of the improved dashboard

The results from the dashboard survey showed that only 11 percent of respondents heard about the dashboard through user training. The user training was conducted virtually and instructed users to record data into the dashboard. However, users were not given the opportunity to have a practical session with the instructor where they entered the data into the dashboard themselves and asked questions during their interaction. Therefore, we recommend practical training on the data dashboard and reviewing the initial content used to train users. In this regard, the dashboard users will actively participate in the dashboard training and increase their knowledge retention and efficiency.

[c] This is already underway within a few facilities in Lusaka.

Conclusion

The knowledge, attitude, and perceptions among users of the oxygen data dashboard are of strategic importance to expanding and improving its use. This user survey sought to assess knowledge, attitudes, perceptions, and challenges users face on reporting into the oxygen data dashboard in selected health facilities in Zambia. The sample used in the survey was contingent on each facility's ability to cater to oxygen patients.

The survey results show that most respondents are knowledgeable about the oxygen data dashboard (81.8 percent). Respondents reported that Ministry of Health officials, work colleagues, and PATH were the leading sources of information about the oxygen data dashboard among the selected health facilities. The user survey results showed that biomedical technologists and equipment medical officers are responsible for data collection of oxygen indicators, adding to their existing daily responsibilities. Our study found that even though knowledge of the oxygen data dashboard was predominantly high, more than half of the respondents (67 percent) reported they had never used the oxygen dashboard. Therefore, most respondents have not interacted much with the oxygen data dashboard. This study also found that most health facilities would greatly benefit from an oxygen data dashboard that helps them quantify oxygen demand and supply.

Thus, the study recommends that the Ministry of Health considers integrating the oxygen dashboard into the HMIS to release the burden of data collection from the biomedical engineers with many tasks filling their time daily. Secondly, the study recommends conducting a thorough review of the oxygen indicators to refine a list of data points that would be essential for decision-making. Furthermore, adding select oxygen indicators (patient data, oxygen equipment functionality, oxygen plant status) into routine data collection at each facility would support improved supply planning and management of oxygen long-term. Finally, the study recommends reviewing the initial content used to train users and conducting practical training on the data dashboard and the HMIS integration.

Annexes

Annex 1. Survey instrument

KNOWLEDGE, ATTITUDES AND PERCEPTIONS SURVEY		
#	QUESTION	RESPONSES
	(Facility information)	
	(Data collector information)	
1	What is your job title?	Short answer
2	Which of the following activities do you do regularly at this facility?	Select multiple a) Collect data for the oxygen dashboard b) Collect data for a health management information system c) Repair equipment/infrastructure d) Conduct maintenance on equipment/infrastructure e) Treat patients f) Assist clinicians or nurses with patient care g) Assist biomedical engineers or technicians with equipment/infrastructure maintenance and repair h) Work in, or with, the pharmacy i) Oversee the PSA plant operations j) Oversee oxygen cylinder filling at the PSA plant k) Oversee oxygen cylinder supply from the private sector l) Other (specify)
3	Out of the activities you selected, which takes up the most of your time over the course of a week?	Select one (repeat list above)
4	Have you ever heard about the oxygen data dashboard?	Yes/No
5	(if yes to #4) How did you hear about the oxygen data dashboard?	a. Ministry of Health b. From work colleagues c. Through a dashboard user training d. Other (specify)
6	(If yes to #4) How often do you use the dashboard?	a. Daily b. Weekly c. Monthly d. Never
7	(If yes to #4) What feature of the dashboard do you think is most important?	a. tracking patient's oxygen use b. tracking equipment functional status (for oxygen concentrators and PSA plants) c. monitoring oxygen supply status in real time d. "other (specify)" option, then short answer response
8	(If yes to #4) Has the dashboard changed how your facility responds to oxygen needs?	Yes/No
9	(If yes to #8) How has the oxygen dashboard changed how your facility responds to oxygen needs?	Short answer question
10	(If no to #4) Do you think your facility would benefit from an oxygen data dashboard if implemented at your facility?	Yes/No
11	(If no to #4) If there was an oxygen data dashboard available, what data/information would you like for it to track?	Short answer response
(following questions are not dependent on response to question #4)		

12	Does this facility use an equipment management system? (In a note, we will give an example of EM systems/key characteristics)	Y/N
13	Does this facility use an inventory management system? (In a note, we will give an example of IM systems/key characteristics)	Y/N
14	Do you have regular and reliable access to a device for collecting data? (i.e., patient admin data, facility level data, equipment and supplies availability and functionality)	Y/N
15	What device do you use?	a) My personal phone b) My personal tablet or computer c) A mobile tablet/computer belonging to the facility d) A desktop computer belonging to the facility
16	Do you feel like oxygen supply issues are quickly identified at this facility?	Y/N
17	Do you feel like oxygen supply issues are easy to report to health facility management?	Y/N
18	How do you currently report an oxygen supply issue?	a) Through the oxygen dashboard b) Through Whatsapp or email c) Other (specify)
19	What do you feel is the best method to ensure a response to an oxygen supply/oxygen equipment issue?	Short answer

Reference for selecting facilities

Facility	**Source of oxygen**
Arthur Davidson Children's Hospital	Planned installation of liquid oxygen tanks
Solwezi General Hospital	
Chipata Central Hospital	
Livingstone Central Hospital	
Ndola Teaching Hospital	
Kitwe Teaching Hospital	
Levy Mwanawasa University Teaching Hospital	PSA plant
University Teaching Adult Hospital	PSA plant—nonfunctional
University Teaching Children's Hospital	PSA plant
Lewanika General Hospital	PSA plant
Mansa General Hospital	PSA plant

References

1. World Health Organization (WHO). *WHO Model List of Essential Medicines for Children*. Geneva, Switzerland: WHO; 2021.
2. Lam F (Clinton Health Access Initiative), King C (Karolinska Institutet), Graham H (Murdoch Children's Research Institute & University College Hospital Ibadan, Nigeria), Smith L (PATH), Olayo B (Center for Public Health and Development Kenya), on behalf of the Every Breath Counts Coalition Indicators Working Group. Good data is critical to equitably improve oxygen access. A call to action to fill data gaps & ensure every breath counts [blog post]. Every Breath Counts Coalition website. https://stoppneumonia.org/good-data-is-critical-to-equitably-improve-oxygen-access-a-call-to-action-to-fill-data-gaps-ensure-every-breath-counts/#fn2.
3. Zambia Ministry of Health. *Zambia National Medical Oxygen Strategic Plan 2022–2026*. Lusaka, Zambia: Zambia Ministry of Health; 2022.
4. US Agency for International Development (USAID), Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING). *The KAP Survey Model (Knowledge, Attitudes, & Practices)*. Washington, DC, USA: USAID, SPRING. https://www.spring-nutrition.org/sites/default/files/publications/annotation/spring_kap_survey_model_0.pdf.