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Ministry of Health

Department of Hospital Services

Cambodia
Oxygen Preparedness Plan

2022 - 2025

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Acronyms & Abbreviations

ADB	Asian Development Bank
BME/T	Biomedical Engineer/Technician
BiPAP	Bilevel Positive Airway Pressure
CHAI	Clinton Health Access Initiative
CENAT	National Center for Tuberculosis and Leprosy Control
CMS	Central Medical Store
CPA	Complementary Package of Activities
CPAP	Continuous Positive Airway Pressure
DHS	Department of Hospital Services
ER	Emergency Room
FHI 360	FHI 360 Organization
GF	The Global Fund
C19RM	Covid-19 Response Mechanism (C19RM)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMS	Great Mekong Subregion
H-EQIP	Health Equity and Quality Improvement Project
HC	Health Center
HF	Health Facility
HFNC	High Flow Nasal Cannula
HMIS	Health Management Information System
ICU	Intensive Care Unit
JICA	Japan International Cooperation Agency
LMIC	Low-to-middle-income country
LMIS	Logistic Management Information System
LTA	Long Term Agreements
MEDEM	Medical Equipment Management System
MoH	Ministry of Health
MPA	Minimum Package of Activities
NMCHC	National Maternal and Child Health Center
Nm3/hr	Normal meter cubed per hour
NGO	Non-Governmental Organisation
NIV	Non-invasive Ventilation
OOP	Out-of-pocket
OPP	Oxygen Preparedness Plan
RGC	Royal Government of Cambodia
PSA	Pressure Swing Adsorption
RH	Referral Hospital
SOP	Standard Operating Procedure
TOT	Training of Trainers
TWG	Technical Working Group
UHS	University of Health Sciences
UNOPS	United Nations Office for Project Services
UNICEF	United Nations Children's Fund
VAT	Value-Added Tax
WHO	World Health Organization
WPRO	WHO Western Pacific Regional Office

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Executive Summary

Even with our best efforts, globally, the COVID-19 virus will not disappear soon. As long as transmission continues, the virus can continue to mutate - as the emergence of Omicron has demonstrated. As of 16th December 2021, the Omicron VOC has been identified in 89 countries across all six WHO regions including Cambodia.

There is consistent evidence that Omicron has a substantial growth advantage over Delta leading to rapid spread in the community, subsequent increase in hospitalizations, and the possibility that many healthcare systems may become quickly overwhelmed.

In anticipation of increased COVID-19 caseloads and associated pressure on the health system, all WHO's member states are being asked to ensure mitigation plans are in place to respond to surge capacity. Necessary tools such as the COVID-19 Oxygen Preparedness Plan should be ready and other available tools should be used to estimate needs in PPE, diagnostics, and therapeutics.

Oxygen is more than just a life-saving medicine for COVID-19. Oxygen therapy relies on a constant supply of oxygen, which requires transportation, electricity, supply chain management, maintenance, qualified human resources, trained clinicians, biomedical engineers and technicians (BME/T). These interventions will contribute to strengthening the health system in terms of oxygen delivery, benefitting any patient in need of oxygen therapy including COVID-19 patients.

In 2020, as the COVID-19 pandemic hit, the Cambodian Ministry of Health (MoH) carried out an oxygen field assessment in collaboration with members of Oxygen Technical Working Group (Oxygen TWG) partners to identify the availability of equipment and supplies for delivery of oxygen therapy in public health facilities.

Aim

The aim of this Oxygen Preparedness Plan is to identify and implement priority activities which urgently need to be undertaken to respond to the current COVID-19 outbreak in Cambodia.

Methodology

The Oxygen Preparedness Plan was developed by the Department of Hospital Services (DHS) at the Ministry of Health, with support from the Oxygen TWG partners (WHO, Clinton Health Access Initiative (CHAI), FHI 360, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), University of Health Sciences (UHS), Asian Development Bank (ADB), World Bank, United Nations Office for Project Services (UNOPS)). The plan was developed based on (a) findings from the situation analysis which included the oxygen baseline capacity assessment, Oxygen Demand Quantification and Oxygen Private Supplier Survey; (b) review of recent procurement and investments secured by the Royal Government of Cambodia (RGC) and donors since the baseline capacity assessment; (c) discussions held during the biweekly oxygen TWG meetings.

The situation demonstrated that, although the DHS and MoH has already progressed in its resource mobilization efforts to respond to the gaps identified in the oxygen baseline capacity assessment, there are still challenges that need to be addressed spanning all oxygen-related systems: oxygen supply, distribution of oxygen equipment and consumables, maintenance of equipment, healthcare worker capacity to detect hypoxemia and provide oxygen therapy for COVID-19 and other respiratory diseases, data systems and financing for oxygen supply.

The below proposed key priorities were discussed, elaborated, and agreed. Objectives and some key outputs are listed below. Main interventions and outputs corresponding to each objective are detailed in the core text of the Oxygen Preparedness Plan.

Key priority areas and objectives

- **Oxygen Supply**
  1. Objective 1: Efficiently increase supply sources of oxygen by optimizing domestic supply solutions
     - Output: Pressure Swing Adsorption (PSA) plants in high oxygen consumption hospitals procured and set up, followed by the operationalization of a hub and spoke model to distribute excess oxygen production to CPA 2 and CPA 1 hospitals.

- Output: Liquid oxygen infrastructure built with liquid oxygen tanks, piping, and vaporization for converting liquid oxygen to gas oxygen for consumption.
- Output: Piping system to upgrade intensive care units (ICUs) built to ensure uninterrupted oxygen therapy for severe and critical patients
- Output: A supply base of refillable oxygen cylinders established for health facilities to procure oxygen from sellers and share the cost of refilling

2. Objective 2: Identify and support efficient ways for domestic suppliers to increase access to existing oxygen sources internationally
    - Output: Increased utilization of liquid oxygen infrastructure in neighbouring countries in a cost-effective way which can augment existing and planned increases to domestic oxygen supply. Achieved by (but not limited to) planning and support for the procurement, repair and maintenance of liquid oxygen transport, storage tanks, piping, and vaporizors for converting liquid oxygen to gaseous oxygen
    - Output: Private sector evaluated to identify key barriers and opportunities for the government to utilize domestic oxygen production in a cost effective and sustainable manner.

- **Equipment**

3. Objective 3: Accelerate procurement and roll-out of new biomedical equipment for diagnosing hypoxemia and oxygen delivery
    - Output: Requested oxygen equipment and materials procured
4. Objective 4: Strengthen the supply chain & equipment management for oxygen therapy (diagnostic devices, oxygen equipment, consumables, etc.).
    - Output: equipment asset tracking, maintenance and work order management for durable oxygen equipment evaluated and interventions developed to support.
    - Output: List of existing equipment with the detailed projection of equipment and materials needed by the different health facilities

- **Maintenance**

5. Objective 5: Increase output of existing oxygen production plants and lifespan of oxygen equipment through enhanced maintenance and operations systems
    - Output: Existing oxygen production plants and oxygen equipment repaired, and spare parts procured to ensure uninterrupted oxygen therapy
    - Maintenance contracts are put in place for extended warranty and comprehensive maintenance for onsite and timely repair of hi-end capital equipment
    - MOH to explore options for a centralized service contract or workforce to repair equipment in all provinces throughout the country.

- **Capacity Building**

6. Objective 6: Improve clinical skills & practices of healthcare workers for management of hypoxemia and referral of patients
    - Output: Capacity of healthcare workers on delivering oxygen therapy and COVID-19 case management are built
7. Objective 7: Expand network of BME/Ts and improve technical skills & practices of BME/Ts and operators to maintain oxygen equipment
    - Output: Capacity of BME/Ts for preventive maintenance of oxygen equipment built.

- **Data systems**

8. Objective 8: Improve and/or develop data systems to incorporate oxygen related indicators for interventions planning on clinical uses of oxygen, assets, and consumables
    - Output: Health Management Information System (HMIS) to capture case management data points are developed and integrated for action points

- Output: Logistic Management Information System (LMIS) to track stock on hand status of oxygen consumable is operationalized
- Output: Medical equipment asset and maintenance tracking system to signal broken equipment and decrease equipment downtime through accelerated repair updated and operationalized

- **Sustainable Financing**

9. Objective 9: Mobilize funding resources and put in place systems to support sustainable oxygen investment with a focus on operational cost recovery at hospital level
    - Output: Gaps in funding identified to execute 1-year oxygen preparedness plan for new funding application submission
10. Objective 10: Secure consistent domestic financing for oxygen services by advocating for inclusion into funding schemes such as national insurance system
    - Output: oxygen equipment included in startup infrastructure for health facilities transitioning to higher level of care (health centre to CPA 1 hospital to CPA 2, CPA 2 to CPA 3, etc.)
11. Objective 11: Ensure oxygen is affordable to patients with a focus on women and children under 5
    - Output: Annual hospital budget to include budget line for oxygen related expense usage
12. Objective 12: Advocate for improvements in the regulatory and taxing approval system of oxygen related commodities through cross sector collaboration

- **Long-term plan**

13. Objective 13: Establish post-COVID-19 plan for oxygen including developing a long-term national strategy for oxygen scale-up and adequate use

Operationalization and Monitoring and Evaluation (M&E)

The workplan lists out all interventions highlighted in the Oxygen Preparedness Plan along with the M&E Indicators. The workplan be regularly tracked, and reviewed during monthly review meetings led by DHS, to ensure that DHS, other MoH Institutions, and development partners are on track.

Introduction

Even with our best efforts, globally, the COVID-19 virus will not disappear soon. As long as transmission continues, the virus can continue to mutate - as the emergence of Omicron has demonstrated. As of 16th December 2021, the Omicron VOC has been identified in 89 countries across all six WHO regions including Cambodia. Cumulatively, as of 19 Dec 2021, Cambodia has reported totally 120,423 COVID-19 cases and 3,005 deaths and 4 Omicron cases were identified among international travellers in one week.

This is a reminder to stay vigilant by: implementing calibrated public health and social measures, ensuring the effective use of vaccines, operationalizing systems for early detection and rapid, targeted responses and strengthening health system readiness to deal with future surges.

There is consistent evidence that Omicron has a substantial growth advantage over Delta leading to rapid spread in the community.In anticipation of increased COVID-19 caseloads and associated pressure on the health system, all WHO's member states are being asked to ensure mitigation plans are in place to respond to surge capacity and maintain essential health services (EHS), necessary healthcare resources are available including infrastructure, healthcare workers (HCWs) equipped with necessary skill, medical equipment, supplies and medicines. Necessary tools such as the COVID-19 Oxygen Preparedness Plan should be ready and other available tools should be used to estimate needs in PPE, diagnostics, and therapeutics.

Until early 2020 and prior to the start of the COVID-19 pandemic, Cambodia had little baseline information on the availability of equipment and supplies for delivery of oxygen therapy in public health facilities. As the COVID-19 pandemic hit, the Cambodian Ministry of Health (MoH) carried out an oxygen field assessment, as detailed in Section 1 below, in collaboration with WHO, Clinton Health Access Initiative (CHAI), FHI 360 and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The MoH subsequently fundraised to increase the availability of medical oxygen, notably through the procurement of Pressure Swing Adsorption (PSA) plants by the Japanese Government, WHO, Asian Development Bank (ADB) and Global Fund (GF).

Oxygen is more than just a life-saving medicine for COVID-19. While most medications are provided through a supply chain which ends when the medicine gets to the patients, Oxygen therapy relies on a constant supply of oxygen, which requires transportation, electricity, supply chain management, maintenance, qualified human resources, trained clinicians, biomedical engineers and technicians (BME/T). These interventions will contribute to strengthening the health system in terms of oxygen delivery, benefitting any patient in need of oxygen therapy including COVID-19 patients.

The objective of this Oxygen Preparedness Plan is to identify and implement priority activities which urgently need to be undertaken to respond to the current COVID-19 outbreak in Cambodia. A longer Oxygen National Strategic Plan will subsequently be developed in collaboration with provinces and key health stakeholders for the country.

The Oxygen Preparedness Plan was developed by the Department of Hospital Services (DHS) at the Ministry of Health, with support from the Oxygen Technical Working Group (TWG) partners (WHO, CHAI, FHI 360, GIZ, University of Health Sciences (UHS), ADB, World Bank and United Nations Office for Project Services (UNOPS)) with the following specific aims:

- Ensure uninterrupted oxygen supply to patients, including COVID-19 patients

- Improve management and monitoring of moderate, severe and critical patients through investment in invasive and non-invasive equipment and capacity building of healthcare workers.
- Improve maintenance systems to ensure the longevity of newly procured equipment for oxygen therapy.

1. Situational analysis of medical oxygen and oxygen therapy in Cambodia

This section highlights the situation of oxygen therapy in Cambodia, in turn looking at demand (section 1.1) and supply from both public and private sources (section 1.2).

1.1 Methodology

The situational analysis is based on:

- **Oxygen Baseline Capacity Assessment**: conducted in October 2020 and led by the Department of Hospital Services across 122 Cambodian public hospitals[1] with support from the Oxygen TWG partners (WHO, CHAI, FHI 360, GIZ, UNICEF and UNOPS) to assess the oxygen capacity, availability of medical oxygen supply and of oxygen equipment across public health facilities in Cambodia. It should be noted that this assessment was conducted when one Covid-19 treatment centre existed (Chak Angrae Health Centre) in Cambodia. Since this assessment, multiple Covid-19 treatment centres have been set up nationwide to treat Covid-19 patients and the results of this assessment do not include the new Covid-19 treatment centres and only from Chak Angrae Health Centre.
- **Oxygen Demand Quantification:** using the information collected from the oxygen baseline capacity assessment, an expected demand for oxygen therapy was calculated under specific hypothetical COVID-19 scenarios, using the UNICEF Oxygen System Planning Tool[2]. The quantification formula is based on the numbers of beds in a facility, the average bed utilization rate by patient in each ward which requires oxygen, the average flow rate used when a patient occupied each type of bed (formula outlined below) (See Annex A for more details).

Quantification of the oxygen demand is calculated with the following formula:

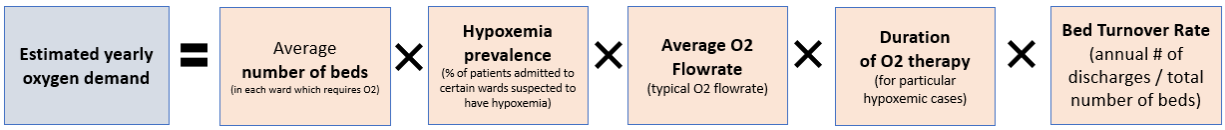


Figure 1: Formula for the quantification of oxygen demand

A baseline scenario was considered along with three scenarios: Low, Medium and High cases of COVID-19. The high COVID-19 scenario was selected as the primary basis for resource mobilization (e.g. Global Fund C19 RM application) because of the ongoing COVID-19 outbreak in the country since the February 20th community transmission event.

- **Oxygen Private Suppliers Survey:** to complement the results of the Oxygen baseline capacity assessment, DHS carried out a private supplier survey in May 2021 to assess the availability and prices of medical oxygen through private providers registered as domestic and international suppliers.

[1] 5 national hospitals, 19 CPA3 hospitals, 33 CPA2 hospitals, 64 CPA1 hospitals and Chak Angre Health Centre were included in the Oxygen Baseline Assessment. As all but one facilities surveyed were hospitals, we refer to 122 hospitals throughout this document.

[2] Oxygen System Planning Tool, UNICEF, https://www.unicef.org/innovation/documents/oxygen-system-planning-tool

1.2 Medical Oxygen Demand

Medical oxygen demand at public health facilities

As of October 2020, an estimated 20,611 cylinders (40L) were consumed monthly in the 122 Cambodian public hospitals assessed, with 60% of these consumed in the 5 national hospitals in Phnom Penh. Oxygen consumption varies widely by facility level.

However, based on the oxygen demand quantification calculation, under the "high" demand scenario (corresponding to the COVID-19 outbreak), the estimated monthly demand of oxygen in Cambodia is estimated 113,634 cylinders (40L), i.e. a four-fold increase.

	Severe beds	Critical (ICU) beds
Base case (No COVID)	No COVID patients	No COVID patients
Scenario 1 (Low caseload):	+ 10% allocated beds (=888+88 beds)	+ 5% of allocated ICU beds (=112+5 ICU beds)
Scenario 2 (Medium caseload):	+ 50% of allocated beds (=888 + 444 beds)	+ 25% of allocated ICU beds (112+28 ICU beds)
Scenario 3 (High caseload)	+ 100% of allocated beds (=888+888 beds)	+ 50% of allocated ICU beds (112+56 ICU beds)

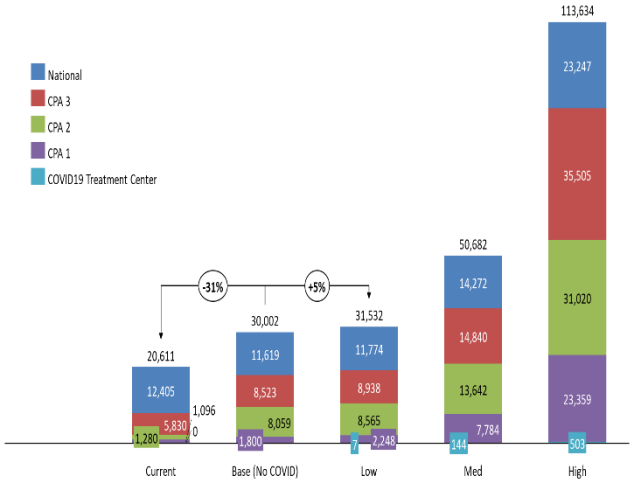


Figure 2: Breakdown of oxygen demand per month across different COVID scenarios and levels of healthcare (reported in # of 40L cylinders)

Medical oxygen demand at private and Non-Governmental Organization (NGO) health facilities

Oxygen demand by private and NGO health facilities hasn't been assessed yet in terms of needs related to COVID-19. With the surge of severe cases, the MoH has now also allowed the private health facilities to manage COVID-19 patients. As these facilities are the most used by the Cambodian population for curative care, it is likely that their needs in oxygen have also significantly increased, which might contribute to an inflation of prices.

A substantial portion of health spending in Cambodia is financed by household Out Of Pocket (OOP) payments (over 60% OOP), which is highest in the region. The two health insurance schemes, Health Equity Fund and National Social Security Fund, cover some of the Cambodian population, however over 10.5 million people (70% of the Cambodian population) have no financial protection coverage. More than half a million people suffer catastrophic health expenditures each year, and more than 300,000 people are driven into poverty by health payments (health impoverishment) (2016). Additionally household spending per capita on health increased from 186 to 216 USD (from 2009 to 2016), driven by more care-seeking, preference for private sector and lack of social protection of all poor people. People above 60 years (which are also the most vulnerable for severe COVID-19 disease) constitute 8% of the population, while accounting for 30% of private health spending (2016). With the lowest government spending on health per capital in the region, at $19 (2018), there is a critical need

to consider how to regulate, coordinate and deliver oxygen without causing financial hardship to patients in a difficult macro fiscal environment.[3,4]

1.3 Oxygen Supply

This estimated demand can now be compared with oxygen sources currently available in Cambodia. This analysis points to a need to greatly expand oxygen supply sources to meet the "high" scenario demand given the current outbreak.

The oxygen supply available was compared with the expected demand for oxygen therapy under three hypothetical COVID-19 case load scenarios: Low, Medium and High. These scenarios were determined based on the number of beds that are forecasted to be used by COVID-19 patients and the expected hypoxemia prevalence. A more detailed explanation is available in Annex A.

[3] WHO's Global Health Expenditure Database, https://apps.who.int/nha/database/Home/Index/en
[4] World Bank's Health Nutrition and Population Database, https://databank.worldbank.org/source/health-nutrition-and-population-statistics

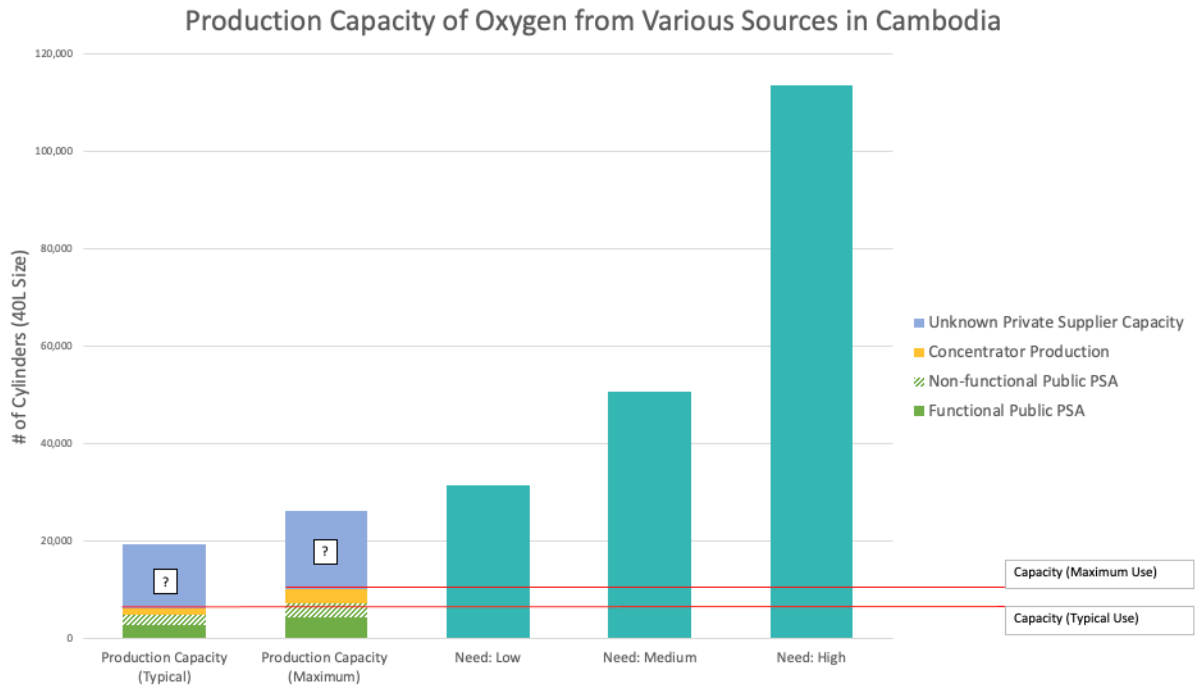


Figure 3: Comparison of production capacity vs COVID-19 need[5]

1.3.1. Public Oxygen Sources

Access to several types of oxygen sources was analyzed during the Oxygen baseline capacity assessment in October 2020:

PSA plants were reported at only two of the surveyed hospitals, Kossamak Hospital and National Paediatric Hospital. However, the plant at National Paediatric Hospital was not functional at the time

5

Oxygen Source	Current Typical Production Capacity	Maximum Typical Production Capacity
Private sector PSA/Liquid Oxygen production	Plant Capacity (# cylinders (40 L)) * 15 hrs/day * 7 days per week * # Functional PSA Plants {Repeat for each plant & sum)	Plant Capacity (# cylinders (40 L)) * 24 hrs/day * 7 days per week * # Functional PSA Plants {Repeat for each plant & sum)
Non-functional public PSA plant production	Plant Capacity (# cylinders (40 L)) * 15 hrs/day * 7 days per week*# Non-functional PSA Plants {Repeat for each plant & sum)	Plant Capacity (# cylinders (40 L)) * 24 hrs/day * 7 days per week*# Non-functional PSA Plants {Repeat for each plant & sum)
Functional public PSA plant production	Plant Capacity (# cylinders (40 L)) * 15 hrs/day * 7 days per week * # Functional PSA Plants {Repeat for each plant & sum)	Plant Capacity (# cylinders (40 L)) * 24 hrs/day * 7 days per week * # Functional PSA Plants {Repeat for each plant & sum)
Concentrator production	Flowrate (LPM) * 60 min/hr * 12 hrs/days * 7 days per week * # Concentrators of that Flowrate {Repeat for each flowrate & sum)	Flowrate (LPM) * 60 min/hr * 24 hrs/days * 7 days per week * # Concentrators of that Flowrate {Repeat for each flowrate & sum)
Unknown private supplier oxygen production capacity	Unknown capacity – Data collection needed	Unknown capacity – Data collection needed
Need: Low, Medium, High	UNICEF Quantification Tool	

Note:

- Typical use determined from data available from other LMICs
- Plant capacity is converted from Nm3/hr to # cylinders (40 L)
- Data on # of public sector PSA plants and concentrators derived from BME Assessment data
- Data on # of private sector PSA plants and liquid oxygen derived from private supplier survey data

of the assessment. If both the plants were functional, they reported to run at 14% and 21% of maximum capacity (respectively), filling 500-600 cylinders per month. This is not enough to meet monthly needs of these hospitals, which is estimated to be around 3,000 cylinders each.

Concentrators were available at only 15 of 122 hospitals (12%), with a total of 178 concentrators reported. Of this total, only 45 (25%) of the concentrators from 15 hospitals were functional at the time of the assessment.

Liquid Oxygen was not available from any public sources in Cambodia, despite being a cost-effective option.

1.3.2. Private Oxygen Sources

The primary source of oxygen supply in public hospitals in Cambodia is via private suppliers in the same province (See Figure 3). Most of these private sector suppliers are distributors only and do not produce oxygen. Indeed, the Oxygen baseline assessment identified that

- 83 (72%) out of 116 hospitals bought oxygen cylinders from private supplier agents within the same province
- 28 (24%) hospitals we surveyed bought oxygen cylinders from suppliers in Phnom Penh
- 5 (4%) hospitals procure oxygen from oxygen suppliers in nearby provinces.

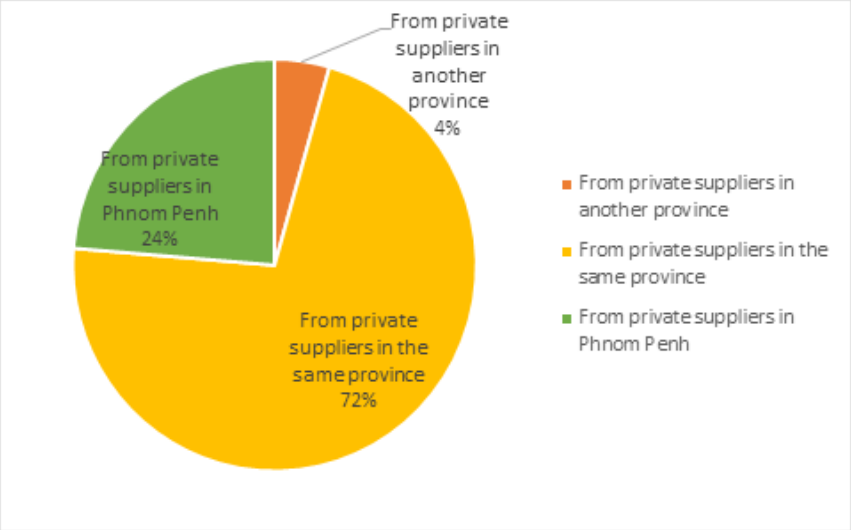


Figure 4: Primary Procurement Source of Oxygen by Hospitals

To complement the results of the baseline oxygen capacity assessment, DHS carried out a **private supplier survey i**n May 2021 to assess the availability and prices of oxygen through private providers, registered as domestic and international suppliers.

Domestic suppliers

Domestic producers: Two local oxygen producers which are also wholesalers/direct suppliers were identified in Cambodia. One local producer reported to have a PSA plant which can fill around 400-500 cylinders per day.

International importers: One main importer imports liquid oxygen from Vietnam and Thailand for local oxygen distribution in and around Phnom Penh. No liquid oxygen producers were identified, however three distributors did sell liquid oxygen.

Local Distributors: 35 of 38 companies interviewed were local distributors only.

- These distributors get oxygen either from the two local producers or the two wholesalers, which import oxygen from other countries. This means Cambodia is very reliant on oxygen imports from other countries.
- There is a large oxygen distribution network in Cambodia, reaching every province.
- Nearly every province has at least two suppliers that are supplying oxygen in the province. Prey Veng, Battambang and Kampong Cham had the most supplier options (9, 7 and 7 suppliers, respectively). Koh Kong, Oddar Meancheay, Pailin, and Preah Sihanouk had the least number of suppliers (2 suppliers in each).

Distribution mechanism:

- Most companies rely on the customer to provide transportation for oxygen. Only nine companies reported having a cylinder truck.
- The distributors had on average sixty 40L cylinders on hand at the time of the survey (ranging from 8-200)
- Most distributors will control the quality of cylinders before transportation to clients through inspection for leaks and damages.

Supplier business model and pricing

The most commonly used cylinder size is the 40L, although some distributors will sell 10L, 15L, and 20L sized cylinders.

23 distributors sell cylinders, 11 lease cylinders. A deposit is sometimes required by some suppliers when hospitals/buyers rent cylinders from them. This ranges between, $100 to $120 for each cylinder. This is normally returned when buyers return cylinders back to suppliers.

The average price for a 40L cylinder was $10, with prices ranging between $6-$15. Typically, prices do not include transportation. Of the 38 companies interviewed, 31 provided the price for refilling cylinders which ranged between **6-10 USD (19 companies)** and **11-15 USD (11 companies).**

Typically, orders are received weekly and distributors receive orders from hospitals separately (21 distributors). However, some receive orders from numerous hospitals that aggregate together (12 distributors). This sets an **interesting precedent for coordinated procurement** to achieve lower prices.

International suppliers

From interviews conducted with private oxygen suppliers from Vietnam, Singapore and Thailand, it was identified that of the six largest oxygen producers in Vietnam, only one exported to Cambodia, although several expressed potential willingness to do so. Fiver suppliers could provide liquid oxygen, whilst only one company was selling to wholesalers in Cambodia who arrange transportation & export procedures themselves.

Most international suppliers do not currently export to Cambodia due to high transportation costs, complicated border procedures and unpredictable changes in protocol due to COVID-19. There is

anecdotal evidence that downstream suppliers are crossing the border to receive supply from small wholesalers in Vietnam.

Data suggests the presence of highly fragmented market, where most of the largest exporters are not connected to suppliers in Cambodia. Large and small suppliers in Cambodia may be purchasing oxygen from downstream resellers in Vietnam.

Opportunities may exist to aggregate demand across public hospitals for more favourable prices, particularly for liquid oxygen. Potential constraints in Cambodia are supplier capacity/willingness to scale up transport and/or distribute oxygen. In addition, despite all considerations, and adequate contracts/protections and guarantees in place, the supply from neighboring countries, such as Thailand and Vietnam, could be disrupted if these countries experience or anticipate a surge in cases.

1.4 Oxygen Storage

As described above, the Oxygen capacity assessment found that most hospitals provided oxygen to patients via cylinders (83% of surveyed hospitals). Nationwide, 2,355 cylinders (size 40L) were reported available on sites at hospitals. However, only 9 (7%) hospitals reported having the ability to have cylinders connected to the sub-central manifold system while 3 (2%) hospitals were able to provide oxygen to patients through intra-hospital pipeline distribution networks (Table 1).

Moreover, no hospitals reported having bulk liquid storage tanks, vaporizers, means for transporting liquid oxygen or any other liquid oxygen equipment on-site.

Health Facility Level	# of HFs	Number of Health Facilities which can Provide Oxygen to COVID-19 Patients		
		Via Cylinders	Via Cylinders Connected to the Sub-Central Manifold System	Via Copper Pipeline IntraHospital Distribution
National	5	2	3	2
CPA 3	19	18	1	1
CPA 2	33	26	3	0
CPA 1	64	36	2	0
MPA	1	0	0	0
Total	**122**	**82 (67%)**	**9 (7%)**	**3 (2%)**

Table 1: Number of Health Facilities Providing Oxygen Using Various Distribution Systems

1.4 Oximetry equipment

The Baseline oxygen capacity assessment highlighted an acute need to expand the availability of devices to effectively monitor patients' oximetry in the wake of the COVID-19 outbreak.

A total of 769 pulse oximeters were reported available across all hospitals with 7 hospitals (6.6%) without pulse oximeters. 52 hospitals (43%) had only between 1-4 pulse oximeters and 14 hospitals (16%, mainly at Complementary Package of Activities 3 (CPA 3) level) had 10 or more pulse oximeters available. Thus, even if pulse oximeters were available, the number remains low (below 10

in 81% of the hospitals) to efficiently monitor severe COVID-19 cases in case of COVID-19 surge, identify mild/moderate patients with worsening conditions, and possibly support pulse oximetry for patients treated at home through outreach. Moreover, many hospitals reported issues with breakage of pulse oximeters.

A total of 533 patient monitors were reported in the surveyed public hospitals. The five national hospitals in Phnom Penh were reporting 208 patient monitors for 170 intensive care unit (ICU) beds giving approximately one patient monitor for 1 ICU bed while it is one for two ICU beds (158 for 355 ICU beds) at CPA3 level, almost one for three ICU beds (90 for 248) at CPA2 level and one for four ICU beds (76 for 285) at CPA1 level. Outside Phnom Penh, the provinces that reported the highest numbers of patient monitors (between 20 and 40 monitors) are Banteay Meanchey, Siem Reap, Kampong Cham, Prey Veng, Kandal, and Battambang (Figure 13). Many provinces besides these locations reported fewer than 10 patient monitors. Patient monitors with or without ECG are important devices to monitor vital signs. Ideally, every ICU bed and surgery bed should be equipped with one patient monitor.

1.5 Oxygen Delivery – Patient Interfaces

Invasive & Non-Invasive Ventilation Equipment

Only 34 Continuous Positive Airway Pressure (CPAP)/ Bilevel Positive Airway Pressure (BiPAP) non-invasive ventilation (NIV) devices were found available, mostly at National (17) and CPA3 hospitals (13). There was no High Flow Nasal Cannula (HFNC) reported at the time of the assessment.

Across 122 hospitals, a total of 176 functional ventilators were reported. 149 of them (85%) were for general patients including intensive care adult type (n=110, 62%) and intensive care pediatric type (n=14, 8%) patients, as well as transportable ventilators (n =25, 14%) and only 27 (15%) could be allocated for COVID-19 patients

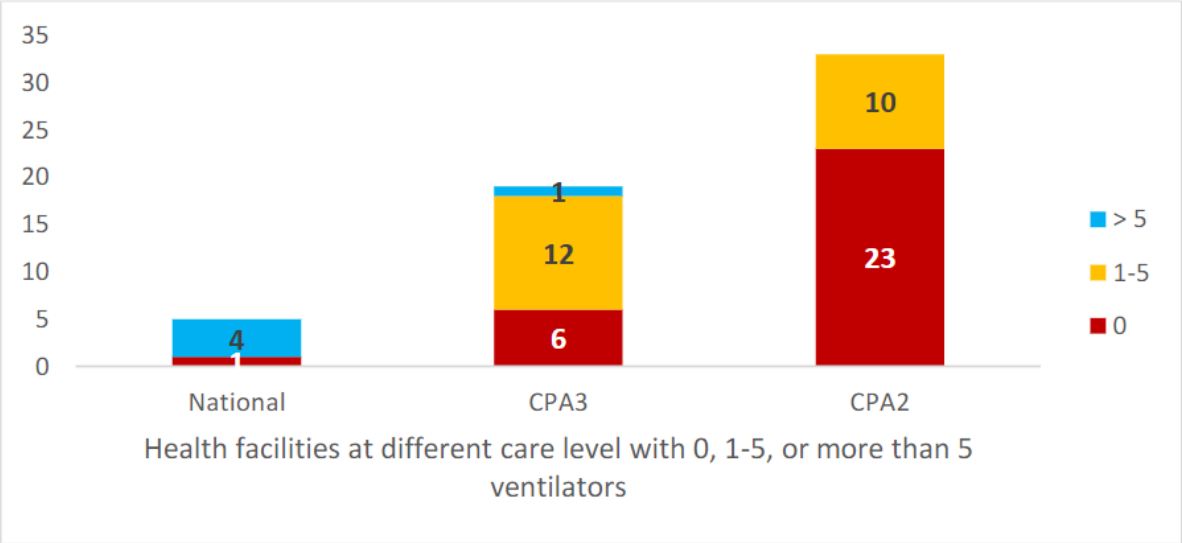


Figure 5: Number of Hospitals at Different Care Level With or Without Ventilators

Low Flow Oxygen Delivery Interfaces

CPA 2 hospitals had a better availability on average per bed for each of the oxygen delivery interfaces (between 4-100 per facility) as compared to CPA3 hospitals (between 10-100 per facility) and CPA 1 hospitals (between 0-50 per facility).

However, for each level, there is a **very large gap of available interfaces** compared to the estimated need, even for the base scenario (no COVID-19), and even more marked compared to the high COVID-19 scenario.

Health Facility Level	Nasal Prongs		Nasal Catheters		Simple Oxygen Masks		Oxygen Masks with reservoir bag		Facial Masks for NIPPV (BiPAP, CPAP)	
	#	Range	#	Range	#	Range	#	Range	#	Range
National	10,650	50-10,000	10,360	10-10,000	10,675	50-10,000	10,175	0-10,000	10,080	0-10,000
CPA 3	794	10-100	162	0-50	461	0-100	275	0-50	155	0-100
CPA 2	880	4-100	170	0-50	642	0-100	317	0-50	131	0-50
CPA 1	640	0-50	240	0-53	373	0-40	164	0-20	123	0-20
Chak_Angrae	1	1	0	0	1	1	1	1	0	0
Total	**12,965**		**10,932**		**12,152**		**10,932**		**10,489**	

Table 2: Number of Low Flow Oxygen Delivery Interfaces at Each Level of Facility

Table 3 and 4 displays the estimated demand of nasal cannulas and oxygen masks with reservoir bags in various COVID-19 scenarios by level of health facility.

	Estimated demands in various scenarios (for 1 year supply)				
	Available*	Base	Low	Med	High
National Hospitals	1,155	37,809	37,892	39,556	44,693
Provincial Hospitals	930	27,883	28,076	31,900	43,733
Referral CPA2	749	19,216	19,391	22,310	30,898
Referral CPA1	635	10,598	10,923	15,018	26,463
Total	**3,469**	**95,506**	**96,282**	**108,784**	**145,787**

Table 3: Estimated demand of Nasal Cannulas (Adult) in various COVID-19 scenarios[6]

[6]Oxygen delivery requires the use of consumable interfaces. For the charts,

- **Available** is the sum of all equipment/consumables currently available at different facility level during the assessment in October 2020.
- **Base demand** is the sum of all estimated needs (at each facility level) of equipment/devices for when there's no COVID-19 patient hospitalized.
- **Low, Medium, High** are estimated demands for when hospitals prepare to treat COVID-19 patients as discussed in how case scenarios are defined. The current outbreak situation means the "High" scenario should be used for project planning.

	Estimated demands in various scenarios (for 1 year supply)				
	Available*	Base	Low	Med	High
National Hospitals	1,095	4,112	4,120	4,288	4,800
Provincial Hospitals	320	2,944	2,963	3,347	4,530
Referral CPA2	272	2,107	2,128	2,419	3,278
Referral CPA1	164	1238	1268	1,681	2,826
Total	**1,851**	**10,401**	**10,479**	**11,735**	**15,434**

Table 4: Estimated demand of Oxygen Masks with Reservoir Bags in various COVID-19 scenarios

		Total number of equipment needed in various scenarios			
Category		**Base (No COVID)**	**Low**	**Medium**	**High**
Produce	Concentrators (of all types)	104	79	101	133
Deliver	Nasal prongs/cannula (Adult)	95,506	96,282	108,784	145,787
Deliver	Nasal prongs/cannula (Pediatric)	7,974	7,974	7,974	7,974
Deliver	Masks with resevoir bags or Venturi masks	10,401	10,479	11,735	15,434
Deliver	Simple oxygen masks	10,401	10,479	11,735	15,434
Monitor	Pulse oximeters (Handheld)	950	1,006	1,008	1,017
Monitor	Pulse oximeters (Fingertip)	428	445	480	525
Monitor	Patient monitor multiparametric	1,077	1,133	1,135	1,144
Advanced	CPAP/BiPAP machines	84	84	89	91
Advanced	Ventilators	492	515	517	526
Advanced	High Flow Nasal Cannula (HFNC)	84	89	89	91
Advanced	Laryngoscopes	164	171	172	175
Advanced	Suction device	492	529	573	635
Advanced	Laryngeal mask airway (LMA)	14,997	15,016	15,093	15,572
Advanced	Endotracheal tubes	90,880	90,992	91,460	94,364
Advanced	Oro/naospharyngeal airway resuscitator	45,760	45,816	46,050	47,502

Table 5: Summary of total equipment needed in various scenarios (December 2020)

2. Procurement and investments secured by Government and Donors

Since the start of the pandemic and obtaining the results from the oxygen capacity assessment, the Ministry of Health has already progressed in its resource mobilization efforts, in order to respond to the key gaps identified during the oxygen capacity assessment including the procurement of 12 PSA plants. In this section, current procurement efforts are either underway or planned and subject to procurement and international market availability.

The oxygen procurement tracker (see Annex B) displays consumables and equipment to be procured and distributed in Cambodia, as of the publication of this plan. The tracker will be updated periodically every month and used to coordinate incoming procurements and manage ongoing resource mobilization.

2.1 Global Fund

From its successful COVID-19 Response Mechanism proposal (C19RM), Cambodia has been awarded USD $7.3 million by the Global Fund (GF) for supply, equipment, consumables and activities for oxygen therapy.

- $1.25 million for oxygen supply including 3 PSA plants, 2 liquid oxygen tanks
- $5.8 million for oxygen equipment, consumables and drugs (see Annex B Procurement Tracker for more details).

Table 6 outlines the **oxygen activities** funded by GF C19RM:

Oxygen Topics	Global Fund (Pillar 7- Oxygen Activities)
Oxygen Source	Supplier landscaping assessment in both public and private suppliers to determine other source of oxygen supply within Cambodia and nearby countries in case of the surge of COVID-19 cases/need for oxygen.
Oxygen Supply & Maintenance	Semesterly maintenance/repairing visits by bio-medical staff at provincial level to support referral hospitals in their assigned catchment area to troubleshoot the broken equipment, provide on-the-job training, and strengthening maintenance management system.
	Semesterly maintenance visits by staff of Biomedical Engineering Unit from DHS (central level) to sub-national hospitals to troubleshoot the broken equipment, on-the-job training, and strengthening maintenance management system.
Data	Upgrade the Health Information System (HMIS) to integrate # of mild, severe, critical patients to surveil the trend of COVID-19 treated cases and patients who have received oxygen therapy.
	Develop a system for medical equipment asset tracking & maintenance including trainings at the site level.
	Upgrade/integrate into existing Logistic Management Information System (LMIS) to include oxygen consumables to create visibility of consumable stocks at health facility.
Data/M&E	Conduct monitoring and supervision on the use of new reporting tools for hospitals with the objective: Monitoring & supervision on the use of new reporting tools for hospitals.

Training	Virtual training of trainers to further conduct cascade trainings to capacity-build health care workers to provide both NIV and Ventilation oxygen therapy for COVID-19 patients and case management of COVID-19 patients.
	Virtual cascade trainings of healthcare workers at National Hospitals & CPA3 hospitals on non-invasive and invasive ventilatory support to severe & critically ill COVID-19 patients.
	Virtual cascade trainings of healthcare workers at sub-national hospitals (CPA3, CPA2, CPA1 hospitals) on basic oxygen therapy and case management for mild to severe.
	In-person training of bio-medical technicians/staff at national hospital and CPA 3 level on basic preventative maintenance and repairment to troubleshoot issues for oxygen therapy and other medical equipment.
Beyond COVID-19	Virtual dissemination workshop of oxygen roadmap for COVID-19 treatment and beyond.

Table 6: Oxygen activities funded by GF C19RM to Cambodia

2.2 World Health Organization (WHO)

WHO provides technical assistance and funding to the MoH for COVID-19 in 9 different strategic pillars depending on MoH needs; however, only Pillar 7 and 8 where oxygen therapy is included have been outlined below:

- Pillar 1 - Leadership, coordination, planning, and monitoring
- Pillar 2 - Risk communication and community engagement
- Pillar 3 - Surveillance, case investigation and contact tracing
- Pillar 5 - Diagnostics and testing
- Pillar 6 – Infection prevention and control
- Pillar 7 - Case management and therapeutics
    - Case management of COVID-19
    - Oxygen therapy training of clinicians at national, provincial and referral hospitals (CPA3 and CPA2 level in collaboration with FHI360 and Clinton Health Access Initiative (CHAI) in 25 provinces
- Pillar 8 - Operational support and logistics
    - Procurement of oxygen equipment (concentrators, oximeters) and materials (cannula, Venturi masks)
    - An additional 360 units O2 concentrators dispatched from WHO/ WHO Western Pacific Regional Office (WPRO)
    - Procurement of 9,602 Pulse Oximeters for Cambodia from WHO/WPRO
    - Procurement of PSA plant (capacity of 69m3/h) with refilling station for National Center for Tuberculosis and Leprosy Control (CENAT) hospital in Phnom Penh, as joint action support with the Japanese government and UNOPS.
- Pillar 9 - Essential health systems and services

2.3 Japanese Government through UNOPS

Donation by the Government of Japan: 11 PSA plants to be installed across 10 provincial referral hospitals:

- 30-35 Nm3/h O2 capacity: 4 Containerized PSA plants
  (Siem reap Provincial, Battambang Provincial, Khmer Soviet Friendship hospitals)
- 22-25 Nm3/h O2 capacity: 3 Containerized PSA plants
  (Kampong Cham Provincial, Sihanoukville Provincial, National Maternal and Child Health Center (NMCHC) hospitals)
- 9.5-13 Nm3/h O2 capacity: 4 Containerized PSA plants
  (Phnom Penh Municipal, Mongkul Borey, Svay Rieng, Chak ANgre Krom hospitals)

UNOPS is responsible for the procurement, delivery, installation of the PSA plants as well as the civil work foundations for each location. UNOPS scope includes staff training and a 2 year service maintenance guarantee by the suppliers. The project implementation period is to be finished by August 2022.

2.4 ADB

The Great Mekong Subregion (GMS) Health Security Project is implemented by the Ministry of Health with loan financing from the Asian Development Bank. The MOH has requested $30 million in additional financing to strengthen the health systems response to COVID-19 and other emerging disease threats. The project includes grant financing from the Japan Fund for Poverty Reduction for support to oxygen activities, including:

- $2.5 million allocation for oxygen plants and oxygen equipment at 14 provincial referral hospitals
- $70,000 allocation to trainings for (i) hospital staff on the clinical management of moderate to severe COVID-19 illness, including the provision of oxygen therapy; (ii) hospital technicians on the operation and maintenance of oxygen plants.

The project implementation period is November 2021 to October 2023.

2.5 FHI360

Procurement of:

- Pre-refilled oxygen cylinders 40L (650 units) including flow meter (650 units).
- Some items for oxygen deliveries interfaces (simple oxygen face mask, nasal canular, and oxygen mask with reservoir bag)
- Pulse oximeters (700 units) with additional probes (1,200 units)

2.6 GIZ

Installation of oxygen 10 liquid tanks (210 liters) and systems at COVID-19 IPD ward of Khmer Soviet Friendship Hospital

Procurement of:

- 80 oxygen concentrators (Kep: 10 sets, Kampot : 30 sets, National Pediatric Hospital 10, Kampong Thom: 30)
- 30 patient monitors (Kep province: 5 sets, Kampot province: 25 sets, Kampong Thom: 18 sets)
- 36 pulse oximeters (Kampong Thom 19, Kampot 15, Kep 2)

2.8 World Bank

Procurement of the following items:

No	Items	Qty		Project Funded
1	Ventilators	Unit	60	CERC of Health Equity and Quality Improvement Project (H-EQIP)
2	Stainless Steel Laryngoscope Blade with handle -Adult	Set	49	CERC of H-EQIP
3	Patient monitor	Unit	370	CERC of H-EQIP
4	Ventilators	Unit	125	Covid-19 Emergency Response Project
5	Suction pumps	Unit	185	Covid-19 Emergency Response Project

2.9 UNICEF

UNICEF will procure the following items for Prey Vihear Provincial Hospital:

- PSA plant (18 Nm3/hr) with 15Nm3/hr cylinder-filling station. PSA plant will be supplied with preventive maintenance parts and consumables required for an operation period of 2 years
- 150 Oxygen cylinders (size 20L)
- 50 Oxygen cylinders (size 40L)
- 80 regulators, flowmeters and humidifiers

2.7 CHAI

CHAI is supporting the following activities:

- Effective policy, planning and coordination
    - Support DHS in establishing a national strategy for oxygen scale-up and adequate use
    - Strengthen the MoH capacity to conduct monitoring, mentoring and supervision of healthcare providers to improve service delivery and strengthen compliance to national diagnosis and treatment guidelines
    - Assist MoH and relevant departments in the establishment of post-COVID-19 planning for oxygen
- Sustainable Financing
    - Support MoH to secure consistent domestic financing for oxygen services by advocating for inclusion into funding schemes such as national insurance system
    - Mobilize resources and put in place systems to support oxygen investment for sustainable financing of oxygen with a focus on operational cost recovery at hospital level
- Data systems
    - Support relevant departments of MoH to improve existing data systems to incorporate oxygen related indicators for interventions planning on clinical uses of oxygen, assets, and consumables
- Market shaping
    - Establish coordinated, long-term oxygen supply partnerships to reduce cost of oxygen supply to facilities

    - Build service and maintenance regimes to keep equipment functional for its full lifespan
- Clinical and engineering capacity building
    - Support DHS to improve clinical skills & practices of healthcare workers for management of hypoxemia and referral of patients
    - Expand network of BME/Ts with improved technical skills & practices to operate and maintain oxygen equipment

3. Challenges in the healthcare system in providing safe and efficient oxygen therapy

This section includes a brief summary of the main challenges to be addressed by the Oxygen Preparedness Plan spanning all oxygen-related systems: oxygen supply, distribution of oxygen equipment and consumables, maintenance of equipment, healthcare worker capacity to detect hypoxemia and provide oxygen therapy for COVID-19 and other respiratory diseases, data systems and financing for oxygen supply.

3.1 Oxygen Supply

Oxygen Suppliers: Private Sector

Production of oxygen in Cambodia is limited. As highlighted in section 1, most private sector suppliers in Cambodia are distributors only and do not produce. There is a high reliance on oxygen imported from other countries, likely from downstream distributors in Vietnam or Thailand who purchase through larger importers.

Major challenges noted by one main importer/distributor in Cambodia that drove up the price of oxygen included:

- High tax on oxygen
- High electricity cost
- High cost of transportation
- High cost of informal fee for importation documents

Despite all considerations, and adequate contracts/protections and guarantees in place, the supply from neighboring countries, such as Thailand and Vietnam, could be disrupted if these countries experience or anticipate a surge in cases.

The presence of oxygen suppliers in every province provides a vital distribution network to hospitals, however it could also indicate further market fragmentation leading to high costs from numerous “middlemen”.

Oxygen Suppliers: Public Sector

At the moment, there is no national refilling strategy for oxygen to public health facilities and therefore. as noted with the Oxygen capacity assessment, the country is reliant on the refilling of oxygen cylinders from the private sector, which is usually funded by the health facility's income generated. With the current outbreak of COVID-19, income generated by health facilities has drastically reduced, because of the COVID-19 control measures (e.g. lockdown, population reduced mobility, patient’s self-isolation in fear of COVID-19, etc.) health facilities are struggling to mobilize funding to support the provision of oxygen to patients.

Oxygen Concentrators

Bedside oxygen concentrators are a useful source of oxygen in all levels of care and especially in remote areas. However, they require consistent source of electricity, do not provide high pressure or high flowrates necessary for some severely ill patients, e.g. critical COVID. In most cases,

concentrators are designed to be used with single patient, therefore a very large number of concentrators would be required to produce the volume of oxygen needed for secondary and tertiary facilities.

PSA Plants

Procurement challenges:

As noted in section 1, funding for the installation of around 30 PSA plants has been secured from the Japanese government, Global Fund and WHO and will be implemented by DHS, UNOPS, ADB. However, some of these procurements have been jeopardized by the significant inflation of PSA plant lead times/prices because of the increased global demand. In addition, there may be delays in installation due to limited availability of PSA plants (waiting time of 6-9 months, at the time of writing). Moreover, installing PSA plants will require detailed conversations and plans to identify precise requirements and operationalize execution. For now, the lead time for these PSA plants to be functional is uncertain and a gap remains in the interim, especially for 2022.

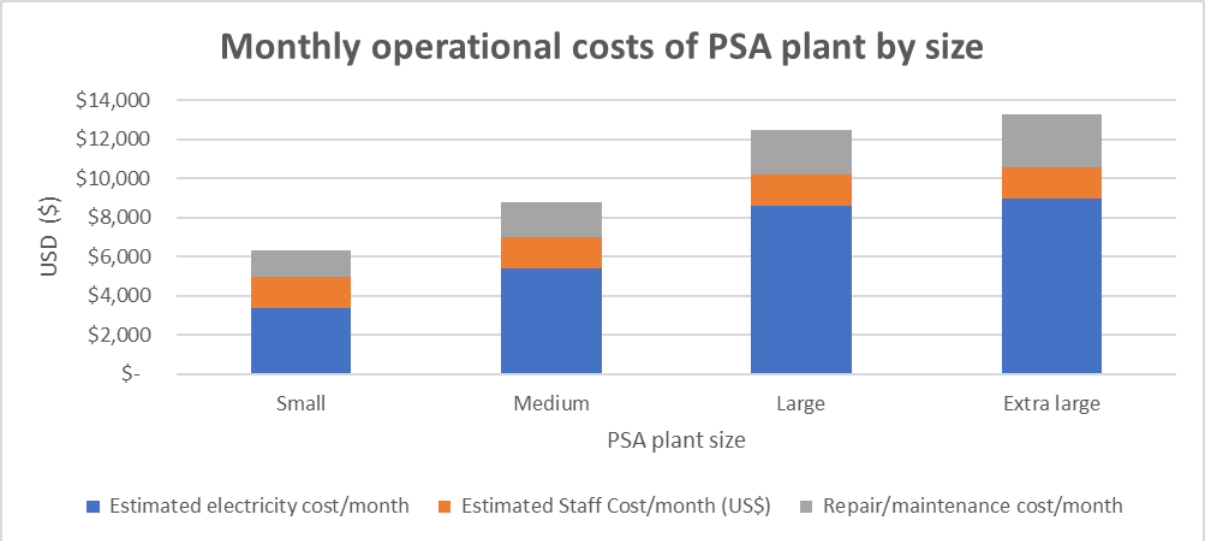
Once installed, there is a risk of PSA plants not being cost-efficient if the realized demand from the hospitals is below projections due to operational bottlenecks. This could lead to PSA plants not being used, as was the case at the National Pediatric Hospital during the Oxygen capacity assessment, where the lack of comprehensive piping or a booster compressor severely limited the utilization of the plant, and the plant was run at 21% capacity.

Example of Operational Challenges[7]:

- **Poorly sized and configured plants**: this can drive up operational overheads or result in the abandonment of plants.
- **Operating environments**: hot and/or humid climates and dust can cause premature damage to the system impacting production capacity, this can be mitigated to some degree with appropriate and regular planned preventive maintenance and properly constructed housing for the plant
- **Lack of technical guidance for system operations and for preventive and curative maintenance**: planned preventive maintenance can be complex and there are product specific nuances that need to be considered during planning and procurement to ensure sufficient budget for installation (e.g. power back-up, housing, piping) and preventive maintenance (e.g. spare parts) (see 3.3 Maintenance of equipment).
- **Lack of publicly available guidance for the system post-installation**: including frequency, procedures and tools for testing the output of oxygen purity and impurities and/or contaminants.
- **Inadequate staffing**: insufficient staff or limited capacity and planning to manage operational, maintenance and administrative needs of the plant
- **Bottlenecks in oxygen delivery**: limited capacity of clinicians and tools to diagnose hypoxemia and provide oxygen therapy, absence of or limited piping to efficiently delivery oxygen to wards with high need, lack of supplies to for cylinder refilling to support non-piped wards or transfer/store excess oxygen, lack of equipment and consumables for appropriate delivery to patient

[7] WHO technical consultation on oxygen access scale-up for COVID-19, 2021

- **Insufficient funds**: lack of funds to fund operations, repair and maintenance of PSA Plant. Annual operational costs of PSA plants in Cambodia are currently (as of November 2021), based on estimations, 16-46% of the procurement cost depending on PSA plant size. This equates to between $6,300 and $13,300 per PSA plant per month depending on the size of the PSA plant[8].



Small: 9.5-15 Nm3/hr; Medium: 22-25 Nm3/hr; Large: 30-35 Nm3/hr; Extra-large: 69 Nm3/hr

Figure 6 Estimated monthly operational costs of running a PSA plant in Cambodia by size (oxygen production capacity)[9]

3.2. Distribution of oxygen equipment and consumables

Procurement and distribution of oxygen equipment and consumables are managed by more than one department at the MoH creating challenges in a centralized coordination effort.

In addition, there is no national plan of action yet for the distribution of oxygen equipment and consumables, including those that have been donated. These items have not yet been included into the stock management of the Central Medical Store (CMS).

Public health facilities are in need of oxygen supplies and consumables for the management of COVID-19 patients and have difficulties procuring them through the private sector. A national forecasting of needs for these items has not been developed.

In the private and NGO sectors, this activity is left to their own and specific management to be ensured.

3.3 Maintenance of equipment

Equipment: Field visit reports have identified that oxygen concentrators break frequently. They need to be repaired or replaced or supplied with consumables. In addition, the new PSA plants will require running costs and skilled personnel to ensure longevity of equipment. Moreover, for effective delivery of oxygen therapy and resuscitation high-end equipment like, CPAP/BiPAP, High Flow Nasal Cannula (HFNC) and mechanical ventilators are required. All these equipment require specialized maintenance

[8] Calculation of the PSA operational costs include electricity costs (estimates sourced from Electricite du Cambodge), staff costs (hospital technical staff and plant operator), repair and maintenance (spare parts + fees, vendor engineer time)
[9] Calculation of the PSA operational costs include electricity costs (estimates sourced from Electricite du Cambodge), staff costs (hospital technical staff and plant operator), repair and maintenance (spare parts + fees, vendor engineer time)

support, but all the repair and maintenance services are majorly dependent on import of spare parts which make it time consuming and expensive. To discuss a potential solution Provincial Health Departments were consulted and there were two possible actionable that can pave way for more effective equipment maintenance:

1. During procurement of equipment, the supplier may be contracted to provide extended warranty services for 5 years or near to the expected life cycle of the equipment. However, the supplier may only be paid on annual basis based on the evaluation of the services and response time. Moreover, other key deliverables like logistics and transportation cost and penalty for non-performance should be clearly spelled out in such contracts.
2. There is a possibility to hire a service provider or recruit a central workforce to repair equipment in all provinces as and when needed. During the consultation, 14 provinces expressed their willingness to contribute towards such an arrangement along with Calmette national hospital Phnom Penh. Therefore, it can be concluded that there is enough interest from provinces for MOH to start deliberating the modalities for a service contract perhaps in PPP (Public-Private Partnership) mode for repair work across these 14 provinces and Calmette Hospital.
   List of provinces is as follows:
   i. Kandal PHD
   ii. Takeo
   iii. Kampong Cham
   iv. Kampong Chhnang PHD
   v. Kep
   vi. Kampot
   vii. Koh Kong
   viii. Preah Sihanouk
   ix. Pursat
   x. Oddar Meanchey
   xi. Tboung Khmom
   xii. Mondulkiri
   xiii. Ratanakiri
   xiv. Svay Rieng

Staff: While some BME staff exist at national level, most hospitals do not have any biomedical engineer or technician to effectively manage the different medical devices, including pulse oximeters, vital signs monitors, oxygen cylinders, central pipelines, or oxygen plants. There is a lack of specialized technical training for (1) installation of oxygen cylinders and regulators, (2) oxygen plant maintenance (preventative and curative), (3) production, (4) distribution, (5) oxygen piping, and (6) oxygen concentrators (preventative and curative).

Financing: Hospitals have responsibility to maintain their equipment, but most hospitals do not set aside sufficient budget to do so adequately.

Since COVID-19 pandemic hit Cambodia, donations of new equipment increased, however the training of staff on equipment maintenance at provincial level stopped. This has caused health care staff to struggle maintaining the new and existing medical equipment.

3.4. Healthcare Worker Capacity to detect hypoxemia and provide oxygen therapy for COVID-19 and other respiratory diseases

Many health care practitioners in Cambodia, especially at the lowest levels, still have limited clinical skills and confidence in diagnosing hypoxemia and providing oxygen therapy. Oxygen therapy requires trained healthcare workers at all levels for safe and effective delivery, which is currently lacking.

Moreover, there is an opportunity for improvements in human resources capacity to provide oxygen treatment services for severe and critical COVID-19 patients (who require continuous monitoring) . The oxygen baseline capacity assessment identified 472 staff, mainly located in Phnom Penh, to have experience in invasive mechanical ventilation or intubation.

In quarter 4 of 2021, clinical staff across all provinces in Cambodia received oxygen therapy training. This activity was led by DHS with support from WHO, FHI360 and CHAI. Refresher training and onsite coaching are being planned.

3.5 Data systems

The success of containment measures needs to be closely monitored via key data such as number of mild, moderate, severe and critical COVID-19 cases, provision of oxygen therapy and equipment by facility.

Data management systems need to be strengthened to

(1) capture important case management data points,
(2) put in place a maintenance/repair reporting system to ensure optimal use of equipment, materials and
(3) provide visibility on stock of oxygen consumables to avoid stock out at facility level.

Case management

The MoH currently collects general data on patients tested and on positive COVID-19 cases on a daily basis through Go Data; however, further details are needed, especially for the management of COVID-19 cases, if patients are either treated at home or in treatment centers or public or private hospitals and on the disease severity.

The existing HMIS, in which data are collected monthly, cannot cope with the required daily frequency monitoring required for COVID-19.

Medical equipment asset tracking and maintenance reporting system

Today, the largely paper-based equipment management system is owned by hospitals with little provincial to central communication, which means Cambodia is missing oversight into reliability of devices procured, needs for spare parts, human resource support needed etc.

The medical equipment maintenance (MEDEM) system is an online tool that was developed in 2011. All provincial hospitals can access and update the status of their medical equipment. The system has been used to report to the medical equipment maintenance working group at national level any equipment that requires maintenance. Previously, with support from Japan International Cooperation Agency (JICA), the NMCHC members of the medical equipment maintenance working group would travel to the province and repair the equipment. There is an opportunity to support teams at the subnational level to use the online system more frequently, and for the medical equipment list to be updated on the MEDEM system.

Moreover, the MEDEM system does not alert timely for broken equipment to be fixed and preventative maintenance to prolong its lifespan. This has been replaced by Telegram, an instant messaging platform, where staff report to the medical equipment maintenance working group any equipment that requires maintenance. Although Telegram is a useful tool to ensure immediate action is taken, there is an opportunity to improve a routine mechanism of reporting from subnational level to central level to provide visibility of oxygen related equipment/accessories/supplies purchased by subnational level.

A standard operating procedure (SOP) for equipment guidelines was developed in 2012 with support from JICA, which reached a draft stage. However, the central level administration did not have resources to continue validating and operationalizing the procedure and there currently are no strong incentives/mechanisms to ensure communication between facilities and central level. For example, facilities do not receive support from central level for repair and maintenance when equipment is broken due to limited staff and capacity of the Biomedical Engineering Unit (4 staff) at the Department of Hospital Services at MoH, therefore there is little incentive to report any information.

Visibility on stock of oxygen consumables

The current LMIS system (Drug Information Database) does not capture data on oxygen consumables and supplies and therefore there is less visibility to identify which hospitals are, for example, stocked out of oxygen delivery interfaces like nasal cannulas.

The MoH needs to consider which oxygen indicators should be monitored and should be included into LMIS for stock management by CMS.

3.6 Financing for oxygen

There is a lack of dedicated domestic funding in combination with fragmented and uncoordinated external funding. Funding for equipment, consumables, delivery interfaces has been insufficient to date, although resource mobilization efforts outlined in the previous sections are helping to fill this gap.

Though MOH is securing the investments required for oxygen equipment, hospitals will need to secure the funding for operating expenses every year. To date, there is insufficient funding for the maintenance of biomedical equipment, including oxygen-related devices and plants. As a result devices and equipment are not fully utilized as highlighted in the oxygen baseline capacity assessment, where, for example, some hospitals do not run PSA plants at full capacity due to the high cost of electricity.

In addition, it is evident from the situational analysis that almost all of the oxygen supplies depend on imports to meet the demand of all oxygen commodities in Cambodia. However, there is a stark inconsistency in tax structure for medical devices, oxygen and consumables when compared to other essential medicines, as only pharmaceutical products starting with an HS Code 30 are exempted from customs duty and a VAT is also levied which further accentuates the end costing for medical devices and oxygen[10].

[10] http://www.cambodiainvestment.gov.kh/investors-information/trade-and-custom.html (Accessed December 2021)

4. Key priorities under Oxygen Preparedness Plan

Given the challenges identified under section 3, the Oxygen Preparedness Plan foresees the following seven priority areas of intervention to be led by the DHS of the MoH:

1. **Oxygen supply**: efficiently increase supply sources of oxygen by operationalizing immediately implementable solutions
2. **Equipment**: Accelerate procurement and roll-out of new biomedical equipment for diagnosing hypoxemia and oxygen delivery
3. **Maintenance**: Increase output of existing plants and lifespan of oxygen equipment through enhanced maintenance and operations
4. **Training:** Training of healthcare workers to detect hypoxemia and provide Oxygen therapy for COVID-19 and other respiratory diseases
5. **Data systems**: Develop and strengthen data management systems
6. **Sustainable Financing**: Ensure sustainable funding for oxygen supply and availability at hospitals
7. **Long-term plan**: Develop a long-term national strategy for oxygen scale-up and adequate use

Cambodia already experienced a peak in number of COVID-19 cases and the Omicron variant could lead to surge. Therefore, Cambodia needs to be prepared for the 'High' COVID-19 scenario (more information in section 1.1 Methodology) in the context of this Oxygen Preparedness Plan. This scenario was also selected as the primary basis for resource mobilization (e.g. Global Fund C19 RM application).

4.1 Oxygen Supply

Cambodia can efficiently increase supply sources of oxygen by operationalizing implementable solutions in the near term in both the public and private sector.

- **Optimizing domestic supply solutions** to reduce cost.
- **Increasing access for domestic suppliers** by identifying and supporting efficient ways for domestic suppliers to increase access to existing oxygen sources internationally.

These strategies can be approached in parallel and should be carefully costed and modelled to determine the optimal price for health facilities to access all oxygen required to meet patient needs while allowing private suppliers to operate sustainably.

Sustainable investments and support to develop the private sector to import oxygen can offer the public health sector the following benefits:

1. Fill the existing gap in oxygen supply more quickly than building public sector infrastructure from the ground up
2. Fill the existing gap in oxygen supply while investments in oxygen supply are being operationalized at a relatively low cost
3. Offers additional human resources to be leveraged by public sector plants for support, repair and maintenance in a cost-effective way

4. Offers a competitive alternative to oxygen produced by PSA plants which encourage lower costs overall

***Objective 1**: efficiently increase supply sources of oxygen by optimising existing domestic supply solutions*

Recommended Interventions

Public Sector

- Ensure that all the requirements for the oxygen storage and production plants are met including. For example, for PSA plant installations:
  - Conduct needs assessment and evaluate the absorption capacity
  - Budget for human resources, training, power supply, ancillary equipment, and maintenance
  - Plan for security of supply, such as redundancy, secondary source, backup manifold or high-pressure gas cylinders
  - Ensure product suitability and long-term service agreement with (local) suppliers
- To help with the cost-efficiency of PSA investments, discuss appropriateness of a "hub and spoke" model whereby smaller hospitals can come to procure oxygen from hospitals where PSA plants or liquid oxygen tanks are being installed,
  - Determine which hospitals will get a cylinder filling station (booster compressor, filling ramp, cylinders) along with the PSA plant. And if they have any plans to distribute the O2 to surrounding health facilities and how.
  - Develop a refilling system of oxygen cylinders from the various PSA plants already available or to be set up in the coming months to supply in priority health facilities managing COVID-19 patients.
  - If deemed appropriate, help put in place SOPs for such a model

Private Sector

- Identify domestic suppliers who are supplying high quality and purity medical oxygen at lower than market average prices. Pending further information from suppliers, support these suppliers to scale up their distribution network and provide greater access to oxygen at lower cost by, for example, increasing hours, scaling distribution and/or filling capacity etc.
- Use pooled procurement and negotiate cost effective rates for refilling of oxygen cylinder and the purchase of oxygen cylinders with suppliers through transparent bidding processes. Currently, the purchase mechanism for Oxygen refill is largely fragmented and even there is a lack of formal tendering process in majority of the provinces, perhaps because of the limited choice of suppliers at the provincial and hospital level. However, there is an overwhelming interest from all the provinces to participate in pooled procurement which can be a way forward to formalize purchase at every level and ensure better value for money because of the increased volume and assured business. It is suggested that MOH may explore ways to enter into pooled procurement with Long Term Agreements (LTA) that would in turn support continuum of supply as well.

Public & Private Sector

- Identify challenges with a disproportionate effect on oxygen cylinder cost from private suppliers and engage with appropriate stakeholders to provide a solution

- Electricity – Identify if another sector of the government could provide a subsidy on electricity for oxygen production that is sold to public health facilities and whether a special rate be designated for hospitals
- Transportation – Determine whether funds could be used to subsidize transportation to remote facilities. Can businesses with similar transportation routes and appropriate vehicles leverage volume to levy a more efficient rate?

***Objective 2**: Identify and support efficient ways for domestic suppliers to increase access to existing oxygen sources internationally*

Recommended Interventions

- Determine capacity of domestic suppliers to scale oxygen supply in the short term. First, understand willingness to scale import.
  - If capacity to scale exists aggregate volumes & develop a volume guarantee deal to support suppliers to more accurately forecast demand and incentivize them to import more liquid oxygen. Also, facilitate suppliers to approach higher volume, lower margin oxygen suppliers regionally.
  - If they do not have capacity, identify key constraints for government intervention for example tanks required to store additional oxygen, problems with leakage/storage, nor insufficient means to transport liquid oxygen, insufficient cylinders etc.
- Identify international suppliers capable of supplying products or services to help private suppliers scale (transport, tanks, vaporizers, technical assistance)
  - Determine viability of strategy & supply chain for importation of liquid oxygen from regional suppliers (e.g. in Vietnam) to meet surge demand shortage.

4.2 Equipment

From the baseline capacity assessment, it is clear that health facilities lack oxygen equipment, even with the procurement and investments secured by the RGC and donors since the baseline assessment. Therefore, the procurement and distribution of oxygen equipment and materials is needed.

***Objective 3:** Accelerate procurement and roll-out of new biomedical equipment for diagnosing hypoxemia and oxygen delivery*

Recommended Interventions

- Prioritize (as much as possible given supplier timelines) the procurement of requested oxygen equipment and materials and mobilize additional funding as needed.
- Specifically for PSA, map out detailed requirements for PSA plants and find appropriate contractors for installation. The PSA plants consume a lot of electricity and often end up not being used for the lack of the power capacity of the hospital transformer. Therefore, it is essential that a power survey is conducted at all the sites where PSA plants are planned to understand the need for augmentation of power/ electricity capacity. The tranfor upgrade for the PSA plant may range up to US$ 30,000 and the survey from a specialized service provider may cost around US$ 1,000-2,000. Moreover, if skid mounted configuration of the PSA plant is chosen the housing/ room for installation need to be provisioned in the budget requirements. From experience at some sites, it can be estimated that such a room may cost in the range of

US$ 15,000. All this to conclude that PSA installation require a lot of investment in site preparation and must be accounted for in the financial outlay at the time of planning.

- Execute installation of additional PSA plants for prioritized health facilities and ensure continued availability of oxygen from these plants, by meeting the following requirements:
  - Health facilities with PSA plants to have assurance of continued power for oxygen production from the plant.
  - Key wards in the host facilities piped directly from the plant (Emergency Room (ER), ICU, maternity, paediatric ward) and have emergency back-up distribution manifolds
  - Oxygen back-up supply to be kept in stock
  - To account for the annual operating costs which amount to between 14-46% of the PSA procurement cost.

Objective 4: *Strengthen the supply chain & equipment management for oxygen therapy (diagnostic devices, oxygen equipment, consumables, etc.).*

- Implement use of procurement tracker tool to ensure full visibility on procurement status and next steps
- Conduct an updated forecasting and quantification exercise to inform oxygen needs and identify gaps for Covid-19 and non-Covid-19 for equipment planning and reallocation purposes.
- Create detailed allocation plan for equipment and consumables to be allocated to each hospital based on need.
- Updates to data systems to provide more visibility on stock of available consumables (through LMIS) and strengthen the asset-tracking maintenance system (see section 4.5 Data Systems).

4.3 Maintenance

Objective 5: *Increase output of existing plants and lifespan of oxygen equipment through enhanced maintenance and operations systems*

Recommended Interventions

- Update and operationalize the existing maintenance/repair system (MEDEM) to be used by biomedical engineers at national and CPA3 level hospitals and lower-level hospitals to monitor oxygen equipment status (repeated in 4.5 Data Systems)
- Mobilize funding for required maintenance/repair of oxygen equipment such as:
  - Fix existing equipment that need refurbishment and repair through a Blitz Campaign
  - Explore maintenance contract and warranty options for biomedical and oxygen equipment from private sector suppliers.
- Put in place a system to anticipate restocking needs for spares and consumables to operate existing and planned oxygen supply at full capacity
- Procure spare parts and consumables to maintain oxygen supply at full capacity
- Maintenance visits by staff of Biomedical Engineering Unit from DHS (central level) to sub-national hospitals to troubleshoot the broken equipment, on-the-job training, and strengthening maintenance management system
- Maintenance/Repairing visits by bio-medical staff at provincial level to support referral hospitals in their assigned catchment area to troubleshoot the broken equipment, provide on-the-job training, and strengthening maintenance management system

4.4 Capacity building

Objective 6: *Improved clinical skills & practices of healthcare workers for management of hypoxemia and referral of patients*

Priority should be given to regularly train healthcare workers on oxygen therapy to patients, including COVID-19 patients, and BME/Ts on operating and maintaining oxygen equipment. This also entails updating the training guidance on the management of COVID-19.

Recommended Interventions

- Conducting pre- and post-test analysis from 2021 clinical training (including on oxygen therapy) to identify areas/modules for improvement in the 2022 clinical training
- Design of selected training model (e.g., in person, virtual, training of trainers, coaching etc.) on hypoxemia diagnosis and management / referral of patients for healthcare workers at lowest levels
- Training preparations (e.g. training materials/job aids development/planning and procurement) to implement clinical care training for healthcare workers including emergency medical technician cadre for the ambulatory care support of patients transferring from one point of care to another
- Implementation of the selected training model for clinicians and ambulatory care staff

Objective 7: *Expand network of BME/Ts and improve technical skills & practices of BME/Ts and operators to maintain oxygen equipment*

Recommended Interventions

- Design of selected training model (e.g., in person, virtual, training of trainers (ToT), coaching etc.) for BME/Ts on oxygen equipment maintenance.
- Training of BME/Ts and/or staff at health facilities on basic preventative maintenance and repair to troubleshoot issues for oxygen therapy and other medical equipment
- The expansion and strengthening of the BME/T network (2-3 BME/Ts or operators in each facility with PSA plant, 1-2 in each referral hospital (CPA2) without a PSA plant)
- Continued support post-training for clinician & BME:
    - Integrating onsite coaching of clinicians with monitoring and supervision visits with BME/Ts.
    - Identifying clinical and BME/T 'champions' at national or sub-national level to provide support to peers on oxygen therapy or preventive maintenance and repair activities

4.5 Data systems

Objective 8: *Improve and/or develop data systems to incorporate oxygen related indicators for interventions planning on clinical uses of oxygen, assets, and consumables*

Recommended Interventions

- Case management: Strengthen the use of the MoH reporting system (Health Information System) to include data on oxygen diagnosis, therapy and availability. Different options should

be considered with Pros & Cons for using a separate or integrated system with the existing MoH structure.

- Medical equipment asset tracking and maintenance: Develop a system for medical equipment asset tracking & maintenance by agreeing with all stakeholders (DHS, DPHI, MOH, hospitals) required functionalities to signal broken equipment and decrease equipment downtime through accelerated repair. Identify best system/platform to be used and pilot system and trouble shoot with user feedback before implementing nationwide.
- Logistic Management information system (LMIS): Integrate into existing LMIS to include oxygen materials and consumables for regular supply and stock management and to create visibility of consumable stocks at health facility
- For all new reporting tools, training to data entry staff will be necessary and monitoring and supervision visits to identify required adjustments to system or process as needed.

4.6 Sustainable Financing

***Objective 9**: Mobilize resources and put in place systems to support oxygen investment for sustainable financing of oxygen with a focus on operational cost recovery at hospital level*

Recommended Interventions

- Secure existing donor funding to continue financing the Oxygen Preparedness Plan through reprogramming or new funding application submission
- Mobilize funding resources by highlighting gap required to execute Oxygen Preparedness Plan (eg. Equipment, programmatic activities).

***Objective 10**: Secure consistent domestic financing for oxygen services by advocating for inclusion into funding schemes such as national insurance system*

Recommended Interventions

- Advocate for the addition of oxygen therapy provision as an indicator for evaluating health facility performance to be eligible for receiving additional funding from the World Bank H-EQIP 2 project.
- Ensure a one-off package given to facility upon their transition from primary care to secondary to tertiary care facility (health center to CPA 1 hospital, CPA 1 to CPA 2, CPA 2 to CPA 3 hospital) has oxygen equipment as their start-up infrastructure

***Objective 11**: Ensure oxygen is affordable to patients with a focus on women and children under 5*

Recommended Interventions

- Establish oxygen cost recovery mechanism to deliver oxygen to patients through appropriate oxygen charge / income for hospitals
- Develop a strategy to advocate for a price cap on oxygen charge to ensure a consistent charge across facilities from the same catchment geography

- Advocate for annual hospital budget to be defined for oxygen related expenses usage (e.g., for purchase of oxygen consumables) instead of current practice (oxygen-related expenses being undefined under an umbrella of hospital budget for operational cost budget line)

Objective 12: Advocate for improvements in the regulatory and taxing approval system of oxygen related commodities through cross sector collaboration

Recommended Interventions

- Initiate a joint working group with the General Department of Customs and Excise Cambodia/ Ministry of Economy and Finance to work towards inclusion of oxygen related commodities into the customs duty exempt list.

4.7 Long-term plan

Objective 13: *Post-COVID-19 planning established for oxygen including developing a long-term national strategy for oxygen scale-up and adequate use*

Recommended Interventions

- Develop new or update policy, guideline, or protocol to include hypoxemia management at all point of cares, including any SOPs needed for an integration of policy, guideline, protocol between central MoH department and national program that focus on women and children
- Initiate the development process of drafting the 3–5-year Oxygen Strategic Plan which will include further consideration of strategies to reduce the cost of oxygen (e.g. through Private-Public partnerships), and strategies to assist private sector to scale oxygen supply (policy, investment, marketing shaping). It will guide hospitals in their budgeting for oxygen. The Oxygen Strategic plan will establish 3-5 year training targets and strengthen oxygen as part of pre-service training of clinical staff. It will track impact of oxygen systems improvement through a decentralized performance management strategy and it will seek to cost and mobilize resources for activities beyond Year 1.

5. Implementation plan

To implement the oxygen preparedness plan it is essential that detailed work activities are listed out with a time reference so that clear and objective work scheduling can be coordinated among MOH, partners, and hospitals. Moreover, there are activities that are interlinked and dependent on each other and therefore an implementation plan that is acceptable to all stakeholders is developed, please refer to Annex C for details of the interventions and timelines.

Number	Objectives & Interventions	Institution in charge	Supported by	Status	Timeline (2022)				Timeline (2023)				Timeline (2024)				Timeline (2025)				Budge
					Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Fundi
	Oxygen Supply																				
1	*Objective 1: Efficiently increase supply sources of oxygen by optimising domestic supply solutions*																				
1.1	Public Sector																				
1.1.1	Procurement of 12 PSA plants (RGC)	RGC MoH		Completed		x															No
1.1.2	Installation of PSA plants in Ratanakiri PH, Tbong Khmum PH (3 PSA plants), Siem Reap PH (3 PSA plants), Battambang PH (3 PSA plants), Kampong Cham PH, Koh Kong PH	RGC MoH		Completed	x	x	x	x	x	x											Yes
1.1.3	Procurement of PSA plant for CENAT National Hospital		WHO/UNOPS	Completed	x	x	x	x	x	x	x										Yes
1.1.4	Installation of PSA plant in CENAT National Hospital		WHO/UNOPS	In Progress					x	x	x	x	x								No
1.1.5	Procurement of 11 PSA plants (UNOPS/Japan MoFA)		UNOPS	In Progress	x	x	x	x	x	x	x										No
1.1.6	Installation of PSA plants (with piping and/or cylinder filling statios) in Siem reap Provincial, Battambang Provincial, Khmer Soviet Friendship hospitals, Kampong Cham Provincial, Sihanoukville Provincial, NMCHC hospitals, Phnom Penh Municipal, Mongkul Borey, Svay Rieng, Chak ANgre Krom hospital (UNOPS)		UNOPS	In Progress			x	x	x	x	x	x									Yes
1.1.7	Procurement of 14 PSA plants (ADB)		ADB	In Progress			x	x	x	x	x	x	x	x	x	x	x	x	x	x	No
1.1.8	Installation of PSA plants (with piping and/or cylinder filling statios) in Kampong Thom PH, Kratie PH, Pursat PH, Oddor Meanchaey PH, Ratanakiri PH, Prey Veng PH, Koh Kong PH, Cheychumnash PH, Kampot PH, Pailin PH, Mondulkiri PH, Kep RH, Tbong Khmum, Stung Treng PH (UNOPS)	MoH-PMU	ADB	Not Started																	Yes
1.1.9	Procurement of three PSA plants (GF)	DHS	CHAI	In Progress	x	x	x	x	x	x	x										No
1.1.10	Installation of PSA plants (with piping and/or cylinder filling stations) in Takeo PH, Kampong Chhnang PH, Peareang RH	DHS	CHAI	Not Started							x	x	x	x	x		x	x	x		Yes
1.1.11	Procurement of PSA plant for P Vihear 16 Makara PH (UNICEF)	Preah Vihear PHD	UNICEF	In Progress	x	x	x	x	x	x											No
1.1.12	Installation of PSA plant in P Vihear 16 Makara PH	Preah Vihear PHD	UNICEF	Not Started					x												Yes
1.1.13	Installation of oxygen 10 liquid tanks (210 liters) and systems at COVID-19 IPD ward of Khmer Soviet Friendship Hospital	Khmer Soviet Friendship Hospital	GIZ	Completed	x																No
1.1.14	Setup of GF funded liquid oxygen system	DHS	CHAI	Not Started																	No
1.1.15	Determine appropriateness of a "hub and spoke" model & if deemed appropriate, put in place SOPs for such a model	DHS	Oxygen TWG	In Progress			x	x	x	x	x	x	x	x	x		x	x	x		No associ

Figure7: Oxygen Preparedness Plan Logframe – Link to Excel Sheet

6. Monitoring and Evaluation Plan

The specific outcomes DHS expects to reach from this Preparedness plan investment include:

- Ensure uninterrupted oxygen supply to COVID-19 patients and non-COVID-19 patients
- Improved management of oxygen therapy with patients, including COVID-19 patients.
- Improved maintenance system to ensure the longevity of equipment

To achieve these goals, specific outputs include (but are not limited to):

- PSA plants are procured and set up in high oxygen consumption hospitals using hub and spoke model to distribute excess oxygen production to lower CPA 2 and CPA 1 level hospitals
- The supply base of empty cylinders is built for health facilities to refill oxygen from sellers and share the cost of refilling
- Liquid oxygen infrastructure is built with liquid oxygen tanks, piping, and vaporization for converting liquid oxygen to gas oxygen for consumption at more cost-effective prices and lesser operational burden on electricity to health facility
- Piping system to upgrade ICU units are built to ensure uninterrupted oxygen therapy for severe and critical patients
- Capacity of healthcare workers on delivering oxygen therapy and COVID-19 case management are built
- HMIS to capture case management data points are developed and integrated for action points
- LMIS system to track stock on hand status of oxygen consumable is operationalized

The workplan which list out all interventions highlighted in the Implementation Plan (see Annex C), along with the M&E Indicators, will be regularly tracked, timelines updated and reviewed during monthly review meetings led by DHS, to ensure that DHS, other MoH Institutions, and development partners are on track.

Annex A – Quantification Scenarios

This section describes the methodology which was used to generate the four quantification scenarios and discusses how they map to the current pandemic context.

Methodology

The baseline assessment collected data on the number of beds allocated to severe and critical COVID patients. Table 7 below summarizes the data collected.

Proportions of beds allocated to severe COVID-19 patients by facility level
(Data from the oxygen rapid assessment in September 2020)

Health Facility Level	# of health facilities assessed	Total beds		ICU beds	
		Total beds	Allocated for COVID Severe patients (% of total beds)	ICU beds	Allocated for COVID Critical patients (% of all ICU beds)
National	5	1625	114 (7%)	174	14 (8%)
CPA 3	19	3729	248 (7%)	355	35 (9%)
CPA 2	33	2627	207 (8%)	248	33 (13%)
CPA 1	64	3385	228 (7%)	285	30 (11%)
Chak_Angrae	1	87	87 (100%)	0	0
Total	**122**	**11,253**	**888 (7.8%)**	**1062**	**112(10.5%)**

Source: Oxygen rapid assessment conducted in September 2020 in Cambodia (Missing hospitals in the assessment: Calmette, Ang Duong, Kuntha Bophea, Jaya 7)

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Table 7: Proportion of beds allocated to severe COVID-19 patients by facility level

Taking this information, we can create four scenarios based on the expected occupancy of these beds. Table 8 below outlines the assumptions in each scenario.

II. Defining case scenarios to estimate oxygen demand in the cases of COVID-19 surge

Scenarios: Prepare health facilities for COVID by adding beds to existing bed capacity		Severe beds	Critical (ICU) beds
Base case (No COVID)	During normal operating time (no COVID-19)	0 bed added	0 bed added
Scenario 1 (Low caseload):	Adding • 10% of allocated beds (meaning preparing 100 beds extra) for severe COVID patients • 5% of allocated ICU beds (meaning preparing 5 ICU beds extra) for critical COVID patients	**+ 10% of COVID severe beds** (+100 beds)	**+ 5% of COVID critical ICU beds** (+5 ICU beds)
Scenario 2 (Medium)	Adding • 50% of allocated beds (meaning preparing 444 beds extra) for severe COVID patients • 25% of allocated ICU beds (meaning preparing 28 ICU beds extra) for critical COVID patients	**+ 50% of COVID severe beds** (+ 444 beds)	**+ 25% of COVID critical ICU beds** (28 ICU beds)
Scenario 3 (High caseload)	Adding • 100% of allocated beds (meaning preparing 888 beds extra) for severe COVID patients • 50% of allocated ICU beds (meaning preparing 56 ICU beds extra) for critical COVID patients	**+ 100% of COVID beds** (+888 beds)	**+ 50% of COVID ICU beds** (+56 ICU beds)

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Table 8: Covid-19 case scenario definitions to estimate oxygen demand

By using the bed turnover rate and the expected incidence of hypoxemia for each type of patient (severe and critical), we can estimate the number of hypoxemic patients that each scenario assumes. Table 9 below outlines these estimates.

Scenario	COVID Severe Hypoxemic Patients	COVID Critical Hypoxemic Patients
Base	0	0
Low	**823**	**56**
Med	**14,373**	**290**
High	**50,281**	**1,742**

Table 9: Estimate number of hypoxemic patients under each Covid-19 scenario.

Limitations

There are many limitations to this methodology, and it is strongly recommended that the data be used directionally only for quantification. The amount of equipment identified in the gap analysis remains identical in each scenario. The high scenario was used for the preparation of the Global Fund Proposal and this document.

The following limitations should be considered:

1. Testing prevalence and the implications on the accuracy of the case count, and therefore, oxygen need
2. Scenarios have a fixed assumption for beds dedicated to severe and critical patients. This does not account for any changes in this data since October 2020.
3. Scenarios are fixed to the number of beds, which means that the four scenarios do not map exactly to the estimated breakdown of severe and critical cases (i.e. the Low case undershoots the number of critical patients for the current context and the medium case overshoot the number of severe patients).

Annex B – Procurement tracker (Link to view the worksheet)

No	Item Description	Unit	Gap (Baseline)	Total donation (2020)	Global Fund C19RM	Global Fund Spare Parts	GF: Status of items procured	UNICEF	UNICEF Spare Parts	UNICEF: Status of items procured	World Bank	World Bank spare parts	World Bank: Status of items procured	Total donation (2021) (excluding spare parts)	Total Procured (2021)	Total Received (Donated + Procured)	Remaining gaps and needs (Low COVID)	Remaining gaps and needs (Med COVID)	Remaining gaps and needs (High COVID)	Remaining gaps and needs (Base)	Estimated price per unit ($USD)	Total price per remaining gaps and needs (Base, $USD)
1	2	3	7	11	30	31	32							39	49	50	51	52	53	54	55	56
I	**Oxygen Equipment**		**(771)**	**0**	**21,587**	**6175**	**0**							**34929.96**	**0**	**34904.96**	**35,313**	**38,821**	**43,215**	**34,134**	**$ 1,719,110.04**	**$ 4,052,051.37**
1	Patient Monitor (Tabletop)	Unit	(544)	-	259	370	Funds Approved				370		Installed	289	-	289	(311)	(313)	(322)	(255)	$ 1,500.00	$ -
2	Handheld Pulse Oximeter	Unit	(770)	-	1,165		Purchase Order Placed							2,365	-	2,365	1,539	1,537	1,528	1,595	$ 290.00	$ 462,550.00
3	Fingertip Pulse Oximeter	Unit	90	-	-									10,338	-	10,338	10,403	10,355	10,321	10,428	$ 25.00	$ 260,700.00
4	10 LPM Concentrators	Unit		-	-									-	-	-	-	-	-	-	$ 1,000.00	$ -
5	8 LPM Concentrators	Unit		-	-									-	-	-	-	-	-	-		$ -
6	5 LPM Concentrators	Unit		-	-									-	-	-	-	-	-	-		$ -
7	Oxygen Concentrators (Capacity not mentioned)	Unit	(59)		-	300	Funds Approved							440		440	406	384	352	381		
8	Flowsplitters	Unit	28	-	21		Purchase Order Placed							21	-	21	60	60	60	49	$ 119.00	$ 5,831.00
9	Number of (size TBD) L cylinders	Cylinder			9,988	2212	Procurement in Progress							9,988		9,988	9,988	9,988	9,988	9,988	$ 200.00	$ -
10	Number of 15 L cylinders	Cylinder			-			150		Funds Approved				-		-	-	-	-	-		
11	Number of 40 L cylinders	Cylinder	4,857		-			50		Funds Approved				650		650	7,455	12,189	18,132	5,507		
12	Number of 680 L cylinders	Cylinder			-									-		-	-	-	-	-		
13	Number of 1360 L cylinders	Cylinder		-	-									-	-	-	-	-	-	-		$ -
14	Number of 3400 L cylinders	Cylinder		-	-									-	-	-	-	-	-	-		
15	Number of 6800 L cylinders	Cylinder			-									-		-	-	-	-	-		
16	Number of 7080 L cylinders	Cylinder	-	-	-									-	-	-	-	-	-	-		$ -
17	Regulators	Pcs	(1,173)	-	4,323	1531	Funds Approved	80		Funds Approved				4,323	-	4,323	2,935	2,555	2,071	3,150	$ 50.00	$ 157,500.00
18	Flowmeters	Pcs	(1,531)	-	1,071		Purchase Order Placed	80		Funds Approved				1,721	-	1,721	(25)	(405)	(889)	190	$ 20.00	$ 3,800.00
19	Humidifier	Pcs	(1,219)	-	4,323	1531	Purchase Order Placed	80		Funds Approved				4,323	-	4,323	2,889	2,509	2,025	3,104	$ 8.00	$ 24,832.00
20	Adult BiPAP/CPAP	Unit	(50)	-	172	143	Funds Approved							172	-	172	122	117	115	122	$ 5,298.04	$ 647,738.37
21	Pediatric BiPAP/CPAP	Unit		-	-									-	-	-	-	-	-	-		$ -
22	Neonatal BiPAP/CPAP	Unit		-	-									-	-	-	-	-	-	-		$ -
23	HFNC	Unit	(84)	-	116	88	Purchase Order Placed							116	-	116	32	27	25	32	$ 5,003.00	$ 160,096.00
24	Adult ventilator	Unit	(316)	-	-						185		Installed	-	-	-	(339)	(341)	(350)	(316)		$ -
25	9.5 - 13m3 PSA plant	Per Plant			-									4			-	-	-	-	$ 200,000.00	
26	12m3 PSA Plant	Per Plant			-									-			-	-	-	-		
27	15m3 PSA Plant	Per Plant		-	1		Funds Approved	1	SUPPLIED WITH	Funds Approved				1	-	1	1	1	1	1	$ 360,000.00	$ 360,000.00
28	22 - 25m3 PSA plant	Per Plant			-									3			-	-	-	-	$ 240,000.00	
29	30m3 PSA Plant	Per Plant		-	2		Funds Approved							2	-	2	2	2	2	2	$ 600,000.00	$ 1,200,000.00
30	30 - 35m3 PSA plant	Per Plant			-									4			-	-	-	-	$ 250,000.00	
31	50m3 PSA Plant	Per Plant			-									-			-	-	-	-		
32	69m3 PSA plant	Per Plant															-	-	-	-		
33	Unknown size PSA plant	Per Plant			-			1		Funds Approved				14			-	-	-	-		
34	Liquid Oxygen Bulk Storage Tank	Unit		-	2		Funds Approved							12	-	12	12	12	12	12	$ 50,000.00	$ 600,000.00
35	Vaporizer	Unit		-	2		Funds Approved							2	-	2	2	2	2	2	$ 3,000.00	$ 6,000.00
36	Piping	Per Bed		-	82		Funds Approved							82	-	82	82	82	82	82	$ 1,872.00	$ 153,504.00
37	Oyxgen Cylinder Trolleys	Unit		-	52		Funds Approved							52	-	52	52	52	52	52	$ 150.00	$ 7,800.00
38	Oxygen Analyser - Electrochemical, battery-powered, handheld	Unit		-	4		Purchase Order Placed							4	-	4	4	4	4	4	$ 275.00	$ 1,100.00
39	Oxygen Analyser - Ultrasonic, battery-powered, handheld	Unit		-	4		Purchase Order Placed							4	-	4	4	4	4	4	$ 150.00	$ 600.00
40	Tools for Repairing Concentrators	Unit		-	-									-			-	-	-	-	$ 150.00	$ -
II	**Oxygen Consumables**		**947**	**0**	**276,729**	**0**	**0**	**0**	**0**	**0**	**234**	**0**	**0**	**276729.4**	**0**	**276729.4**	**277,630**	**277,586**	**277,520**	**277,676**	**$ 105.77**	**$ 250,406.97**
41	Adult Nasal Cannula	Pcs		-	160,365		Purchase Order Placed							160,365	-	160,365	160,365	160,365	160,365	160,365	$ 0.45	$ 72,164.25
42	Pediatric Nasal Cannula	Pcs		-	-		Purchase Order Placed							-	-	-	-	-	-	-	$ 0.45	$ -
43	Neonatal Nasal Cannula	Pcs		-	-									-	-	-	-	-	-	-	$ 0.20	$ -
44	Nasal Prongs	Pcs		-	-									-	-	-	-	-	-	-	$ 0.26	$ -
45	Mask with resevoir bag	Pcs		-	-									-	-	-	-	-	-	-	$ 0.80	$ -
46	Venturi Masks	Pcs		-	16,977		Purchase Order Placed							16,977	-	16,977	16,977	16,977	16,977	16,977	$ 0.80	$ 13,581.60
47	Endotracheal tube	Pcs		-	43,578		Funds Approved							43,578	-	43,578	43,578	43,578	43,578	43,578	$ 1.09	$ 47,500.02
48	Laryngoscope	Pcs	340	-	60		Funds Approved				49		Installed	60	-	60	395	395	391	400	$ 80.00	$ 32,000.00
49	Laryngeal mask airway (LMA)	Pcs		-	1,795		Funds Approved							1,795	-	1,795	1,795	1,795	1,795	1,795	$ 2.98	$ 5,349.10
50	Oro/nasopharyngeal airway guedel	Pcs		-	20,000		Funds Approved							20,000	-	20,000	20,000	20,000	20,000	20,000	$ 0.75	$ 15,000.00
51	Suction device	Pcs	607	-	-						185		Installed	-	-	-	566	522	460	607	$ 0.49	$ 298.64
52	Colorimetric end tidal Co2 detector	Pcs		-	-									-	-	-	-	-	-	-	$ 15.60	$ -
53	Simple Oxygen Masks	Pcs		-	33,954		Funds Approved							33,954	-	33,954	33,954	33,954	33,954	33,954	$ 1.90	$ 64,513.36
III	**Drugs**		**-**	**0**	**199445**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**199445**	**0**	**104**	**-**	**-**	**-**	**-**	**$ 5,010.12**	**$ 260,000.00**
54	Dexamethasone (1 amp 5 mg)	Pack		-	26,811		Purchase Order Placed							26,811			-	-	-	-	$ 0.12	$ -
55	Enoxaparin sodium severe cases (0.4 ml)	Pack		-	172,530		Purchase Order Placed							172,530			-	-	-	-	$ 5.00	$ -
56	Enoxaparin sodium critical cases (0.4 ml/d)	Pack		-										-			-	-	-	-	$ 5.00	$ -
IV	**Other**		**-**	**0**	**52**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**52**	**-**	**52**	**52**	**52**	**52**	**52**	**$ 2,500.00**	**$ 130,000.00**
57	Triage Tents	Per Setup		-	52									52	-	52	52	52	52	52	$ 2,500.00	$ 130,000.00

Annex C – 1-year Implementation Plan **Link to Excel Sheet**

Number	Objectives & Interventions	Institution in charge	Supported by	Status	Timeline (2022)				Timeline (2023)				Timeline (2024)				Timeline (2025)				Budget/ Funding
					Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
	Oxygen Supply																				
1	*Objective 1: Efficiently increase supply sources of oxygen by optimising domestic supply solutions*																				
1.1	Public Sector																				
1.1.1	Procurement of 12 PSA plants (RGC)	RGC MoH		Completed	x																No
1.1.2	Installation of PSA plants in Ratanakiri PH, Tbong Khmum PH (3 PSA plants), Siem Reap PH (3 PSA plants), Battambang PH (3 PSA plants), Kampong Cham PH, Koh Kong PH	RGC MoH		Completed	x	x	x														Yes
1.1.3	Procurement of PSA plant for CENAT National Hospital		WHO/UNOPS	Completed	x	x	x	x													Yes
1.1.4	Installation of PSA plant in CENAT National Hospital		WHO/UNOPS	In Progress				x	x	x	x	x									No
1.1.5	Procurement of 11 PSA plants (UNOPS/Japan MoFA)		UNOPS	In Progress	x	x	x	x													No
1.1.6	Installation of PSA plants (with piping and/or cylinder filling statios) in Siem reap Provincial, Battambang Provincial, Khmer Soviet Friendship hospitals, Kampong Cham Provincial, Sihanoukville Provincial, NMCHC hospitals, Phnom Penh Municipal, Mongkul Borey, Svay Rieng, Chak ANgre Krom hospitals) (UNOPS)		UNOPS	In Progress			x	x	x	x	x	x									Yes
1.1.7	Procurement of 14 PSA plants (ADB)		ADB	In Progress			x	x	x	x	x	x	x	x	x	x	x	x	x	x	No
1.1.8	Installation of PSA plants (with piping and/or cylinder filling statios) in Kampong Thom PH, Kratie PH, Pursat PH, Oddor Meanchaey PH, Ratanakiri PH, Prey Veng PH, Koh Kong PH, Cheychumnash PH, Kampot PH, Pailin PH, Mondulkiri PH, Kep RH, Tbong Khmum, Stung Treng PH (UNOPS)	MoH-PMU	ADB	Not Started																	Yes
1.1.9	Procurement of three PSA plants (GF)	DHS	CHAI	In Progress	x	x	x	x	x	x											No
1.1.10	Installation of PSA plants (with piping and/or cylinder filling stations) in Takeo PH, Kampong Chhnang PH, Peareang RH	DHS	CHAI	Not Started				x	x	x	x		x	x	x		x	x	x		Yes
1.1.11	Procurement of PSA plant for P Vihear 16 Makara PH (UNICEF)	Preah Vihear PHD	UNICEF	In Progress	x	x	x	x													No
1.1.12	Installation of PSA plant in P Vihear 16 Makara PH	Preah Vihear PHD	UNICEF	Not Started			x														Yes
1.1.13	Installation of oxygen 10 liquid tanks (210 liters) and systems at COVID-19 IPD ward of Khmer Soviet Friendship Hospital	Khmer Soviet Friendship Hospital	GIZ	Completed	x																No
1.1.14	Setup of GF funded liquid oxygen system	DHS	CHAI	Not Started																	No
1.1.15	Determine appropriateness of a "hub and spoke" model & if deemed appropriate, put in place SOPs for such a model	DHS	Oxygen TWG	In Progress		x	x	x	x	x	x	x	x	x	x		x	x	x		No associat

					Timeline (2022)				Timeline (2023)				Timeline (2024)				Timeline (2025)				Budget/
Number	Objectives & Interventions	Institution in charge	Supported by	Status	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Funding
1.2	Private Sector																				
1.2.1	Identify domestic suppliers who are supplying high quality and purity medical oxygen at lower than market average prices.	DHS	TBD	Not Started		x x															No
1.2.2	Pending further information from suppliers, support these suppliers to scale up their distribution network and provide greater access to oxygen at lower cost.		TBD	Not Started																	
1.2.3	Use pooled procurement and negotiate cost effective rates for refilling of oxygen cylinder with suppliers through transparent bidding processes.	DHS	Oxygen TWG	In Progress	x x																No
1.3	Public and Private Sector																				
1.3.1	Identify challenges with a disproportionate effect on oxygen cylinder cost from private suppliers and engage with appropriate stakeholders to provide a solution (see below)	DHS	TBD	Not Started			x x x														No associat
1.3.2	Electricity – Identify if another sector of the government could provide a subsidy on electricity for oxygen production that is sold to public health facilities and whether a special rate be designated for hospitals	DHS	TBD	Not Started		x x x															No associat
1.3.3	Transportation – Determine whether funds could be used to subsidize transportation to remote facilities. Can businesses with similar transportation routes and appropriate vehicles leverage volume to levy a more efficient rate?	DHS	TBD	Not Started		x x x															No associat
2	***Objective 2: Identify and support efficient ways for domestic suppliers to increase access to existing oxygen sources internationally***																				
2.1	Determine capacity of domestic suppliers to scale oxygen supply in the short term.	DHS	TBD	Not Started				x x													No associat
2.2	If domestic suppliers do not have capacity, identify key constraints for possible government intervention	DHS	TBD	Not Started				x x													No associat
2.3	If capacity to scale exists aggregate volumes & develop a volume guarantee deal	DHS	TBD	Not Started			x x x														No associat

Number	Objectives & Interventions	Institution in charge	Supported by	Status	Timeline (2022)												Timeline (2023)				Timeline (2024)				Timeline (2025)				Budget/ Funding
					Q1				Q2				Q3				Q4				Q1				Q2				Q3				Q4				
2.4	Determine viability of strategy & supply chain for importation of liquid oxygen from regional suppliers to meet surge demand shortage.	DHS	Oxygen TWG	Not Started											x	x	x	x															No associat
	Equipment																																
3	***Objective 3: Accelerate procurement and roll-out of new biomedical equipment for diagnosing hypoxemia and oxygen delivery***																																
3.1	Prioritize the procurement of requested oxygen equipment and materials from GF C19RM	DHS	Oxygen TWG	In Progress	x	x	x	x																									No associat
4	***Objective 4: Strengthen the supply chain & equipment management for oxygen therapy (diagnostic devices, oxygen equipment, consumables, etc.).***																																
4.1	Implement the procurement tracker of oxygen equipment to track progress of procurement from government and donors	DHS	Oxygen TWG	In Progress	x	x	x	x	x	x	x	x	x	x	x	x	x	x															No associat
4.1	Conduct an updated forecasting and quantification exercise to inform oxygen needs and identify gaps for Covid-19 and non-Covid-19 for equipment planning and reallocation purposes	DHS	Oxygen TWG	In Progress	x	x																											No associat
4.1	Develop an allocation/distribution plan for oxygen equipment and consumables to be allocated to each hospital based on need (identified in 3.1)	DHS	Oxygen TWG	In Progress	x	x	x																										No associat
4.1	Allocation plan updated every month and reviewed	DHS	Oxygen TWG	Not Started			x	x	x	x	x	x	x	x	x	x	x	x															No associat
	Maintenance																																
5	***Objective 5: Increase output of existing plants and lifespan of oxygen equipment through enhanced maintenance and operations systems***																																
5.1	Mobilize GF C19RM funding for required maintenance/repair of oxygen equipment: Fix existing equipment that need refurbishment and repair	DHS	Oxygen TWG	In Progress	x	x																											No associat
5.2	Mobilize GF C19RM funding for required maintenance/repair of oxygen equipment: Procure spare parts and consumables to maintain oxygen supply at full capacity	MoH-LIT/DHS	Oxygen TWG	In Progress	x	x	x																										No associat
5.3	Explore maintenance contract and warranty options for existing biomedical and oxygen equipment from private sector suppliers for repair/maintenance	DHS	Oxygen TWG	Not Started																													No associat
5.4	Put in place a system to anticipate restocking needs for spares and consumables to operate existing and planned oxygen supply at full capacity	DHS	Oxygen TWG	Not Started																													No associat
5.5	Maintenance visits by staff of Biomedical Engineering Unit from DHS (central level) to sub-national hospitals to troubleshoot the broken equipment, on-the-job training, and strengthening maintenance management system	DHS	Oxygen TWG	Not Started	x				x						x																		Yes

Number	Objectives & Interventions	Institution in charge	Supported by	Status	Timeline (2022)				Timeline (2023)				Timeline (2024)				Timeline (2025)				Budget/ Funding
					Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
5.6	Maintenance/Repairing visits by bio-medical staff at provincial level to support referral hospitals in their assigned catchment area to troubleshoot the broken equipment, provide on-the-job training, and strengthening maintenance management system	DHS	Oxygen TWG	Not Started	x	x	x														Yes
	Capacity Building																				
6	*Objective 6: Improved clinical skills & practices of healthcare workers for management of hypoxemia and referral of patients*																				
6.1	Conducting pre- and post-test analysis from 2021 clinical training to identify areas/modules for improvement in the 2022 clinical training	DHS	Oxygen TWG	Completed	x																No associat
6.2	Design of selected training model (e.g., in person, virtual, training of trainers, coaching etc.) on hypoxemia diagnosis and management / referral of patients for healthcare workers at lowest levels	DHS	Oxygen TWG	Completed	x																Yes
6.3	Training preparations (i.e., training materials/job aids development/planning and procurement) to implement clinical care training for healthcare workers including emergency medical technician cadre for the ambulatory care support of patients transferring from one point of care to another	DHS	Oxygen TWG	Not Started			x x x														Yes
6.4	Implementation of a selected training model for clinicians and ambulatory care staff	DHS	Oxygen TWG	Not Started				x x x													Yes
7	*Objective 7: Expand network of BME/Ts and improve technical skills & practices of BME/Ts and operators to maintain oxygen equipment*																				
7.1.1	The expansion and strengthening of the BME/T network (2-3 BME/T or operator in each facility with PSA plant, 1-2 in each RH facility (CPA2) without PSA plant)	DHS/NMCHC	Oxygen TWG	Not Started		x x x x															No associat
7.1.2	Design of selected training model on BME	DHS/NMCHC	Oxygen TWG	In Progress			x x x														No associat
7.1.3	Training preparations (i.e., training materials/job aids development/planning and procurement) to implement training for BME/Ts	DHS/NMCHC	Oxygen TWG	Not Started			x x x														Yes
7.1.4	Implementation of the training model: Training of BMET/Ts and/or staff at health facilities on basic preventative maintenance and repairment to troubleshoot issues for oxygen therapy and other medical equipment	DHS/NMCHC	Oxygen TWG	Not Started			x x x		x x x x												Yes
7.2	Clinicans & BME/Ts (continued support post-training)																				
7.2.1	Integrating onsite coaching of clinicians with monitoring and supervision visits of BME/Ts.	DHS	Oxygen TWG	Not Started	x x																No associat
7.2.2	Identifying 'champions' at natioanl or sub-national level to provide support to peers on oxygen therapy or preventive maintenance and repair activities	DHS	Oxygen TWG	Not Started		x x x		x x x x													No associat

Number	Objectives & Interventions	Institution in charge	Supported by	Status	Timeline (2022)				Timeline (2023)				Timeline (2024)				Timeline (2025)				Budget/
					Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Funding
	Data systems																				
8	***Objective 8: Improve and/or develop data systems to incorporate oxygen related indicators for interventions planning on clinical uses of oxygen, assets, and consumables***																				
8.1	Case management																				
8.1.1	Develop indicators for tracking oxygen diagnosis, therapy and availability in an appropriate health information system	DHS	TBD	Not Started			x x x														No associat
8.1.2	Incorporate the developed indicators into an appropriate health information system	DHS	TBD	Not Started			x x x														No associat
8.1.3	Rollout of the updated indicators a health information system through training of healthcare workers to manage and analyze data	DHS	TBD	Not Started			x x x														No associat
8.2	Medical equipment asset tracking and maintenance																				
8.2.1	Update and operationalize the existing medical equipment maintenance (MEDEM) system	DHS	TBD	Not Started			x x x	x x x													No
8.2.2	Field testing of the system and then launching of the system nationwide	DHS	TBD	Not Started				x x x													No
8.2.3	Training of BME/Ts or operators to update status of equipment on the updated system	DHS/NMCHC	TBD	Not Started				x x	x												Yes
8.2.4	Routinely troubleshooting the system through analyzing completeness and utilization of the system to ensure broken equipment and asset are first reported into the system and then get fixed timely	DHS	TBD	Not Started				x x x													Yes
8.3	Logistic Management Information System																				
8.3.1	Update oxygen supplies and consumables in the Essential Medicine List (EML) for oxygen to be essential commodities at all public health facilities	DHS/DDF	TBD	Not Started			x x x	x x													No associat
8.3.2	Ensure oxygen supplies and consumables are updated into existing LMIS	DHS, CMS, DDF	TBD	Not Started				x x	x												No associat
8.3.3	Training of store managers on the oxygen consumables and supplies	DHS, CMS, DDF	TBD	Not Started				x	x	x											Yes
8.4	All systems																				
8.4.1	Conduct monitoring and supervision on the use of new reporting tools for hospital	DHS	TBD	Not Started				x x x													No associat
	Sustainable Financing																				
9	***Objective 9: Mobilize funding resources and put in place systems to support sustainable oxygen investment with a focus on operational cost recovery at hospital level***																				
9.1	Secure existing donor funding to continue financing the oxygen preparedness plan through reprogramming or new funding application submission	DHS	Oxygen TWG	Not Started			x x x	x x x													No associat
9.2	Mobilize funding resources by highlighting gap required to execute 1 year oxygen preparedness plan (eg. Equipment, programmatic activities).	DHS	Oxygen TWG	Not Started			x x x	x x x													No associat

Number	Objectives & Interventions	Institution in charge	Supported by	Status	Timeline (2022)												Timeline (2023)				Timeline (2024)				Timeline (2025)				Budget/ Funding
					Q1			Q2			Q3			Q4			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
10	***Objective 10: Secure consistent domestic financing for oxygen services by advocating for inclusion into funding schemes such as national insurance system***																												
10.1	Advocate for the addition of oxygen therapy provision as an indicator for evaluating health facility performance to be eligible for receiving additional funding from World Bank H-EQIP 2 project.	DHS	Oxygen TWG	Not Started									x	x	x	x	x												No associat
10.2	Ensure a one-off package given to facility upon their transition from primary care to secondary to tertiary care facility (health center to CPA 1 hospital, CPA 1 to CPA 2, CPA 2 to CPA 3 hospital) has oxygen equipment as their startup infrastructure	DHS	Oxygen TWG	Not Started									x	x	x	x	x												No associat
11	***Objective 11: Ensure oxygen is affordable to patients with a focus on women and children under 5***																												
11.1	Establish oxygen cost recovery mechanism to deliver oxygen to patients through appropriate oxygen charge / income for hospitals	DHS	Oxygen TWG	Not Started						x	x	x	x	x	x														No associat
11.2	Develop a strategy to advocate for a price cap on oxygen charge to ensure a consistent charge across facilities from the same catchment geography	DHS	Oxygen TWG	Not Started							x	x	x	x															No associat
11.3	Advocate for annual hospital budget to be defined for oxygen related expenses usage (e.g., for purchase of oxygen consumables) instead of oxygen related expenses being undefined under an umbrella of hospital budget for operational cost budget line	DHS	Oxygen TWG	Not Started				x	x	x	x	x																	No associat
12	***Objective 12: Advocate for improvements in the regulatory and taxing approval system of oxygen related commodities through cross sector collaboration***																												
12.1	Initiate a joint working group with the General Department of Customs and Excise Cambodia/ Ministry of Economy and Finance to work towards inclusion of oxygen related commodities into the customs duty exempt list.	DHS	Oxygen TWG	Not Started								x	x	x															No associat
13.1	Develop new or update policy, guideline, or protocol to include hypoxemia management at all point of cares, including any SOPs needed to be developed for an integration of policy, guideline, protocol between central MoH department and national program that focus on women and children	DHS	Oxygen TWG	Not Started							x	x	x	x	x	x	x		x										No associat