



REPUBLIC OF KENYA
MINISTRY OF HEALTH

TECHNICAL REVIEW ON OXYGEN SUPPLY

**MOH TECHNICAL ASSISTANCE TO THE COUNTY GOVERNMENTS
FOR MITIGATION OF COVID-19 PANDEMIC AND STRENGTHENING OF
HEALTH SYSTEMS FOR UHC IN THE COUNTIES**

AUGUST 6, 2020

Version 1.0

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1. BACKGROUND

1.1 Team Mandate

To assist the Counties to meet set irreducible minimum standards, and to enhance attainment of the overriding National Universal Health Coverage Agenda, a team of **154** officers were commissioned to the exercise by the Cabinet Secretary for Health on **7th July 2020**, and commenced ground work on Phase I of the Technical Assistance exercise from 14th July 2020, for a period of 30 days. This would be followed by Phase II UHC Technical Assistance thereafter. The irreducible minimums were organized into terms of reference across **nine** thematic areas as follows.

1.1.1 County Capacity

- i). County infrastructure including bed count to support pandemic and essential services delivery.
- ii). Human Resources for Health capacity in the County

iii). Availability of essential equipment and health commodities.

1.1.2 Quality of service,

i). Laboratory testing, contact tracing, case management, quarantine and isolation.

ii). Functionality of the supply chain in the County.

1.1.3 County Administration, Operations and Safety

i). Communication/information sharing - national, inter county, public channels.

ii). County Emergency Rapid Response team (RRT's) and Multiagency teams (MAT's).

iii). County financing mechanisms and cost management for pandemic cases

iv). County Risk Management Systems, risk identification and mitigation strategies.

1.2 Technical Reporting

This report is a high level summary to highlight the key findings and conclusions of the Technical assistance teams efforts from July 14th to August 6th 2020. The findings will be discussed with the team leaders from the Technical Experts and the County Executive. A detailed report will thereafter, be prepared for onward transmission to the Ministry.

1.3 Methodology

The Technical teams in collaboration with the CHMT's, and Health Systems Inspectors utilized a combined check list to objectively score the following health facility areas:

Section 1: Facility Preparedness	Marks
1. Infrastructure	20
2. Equipment	20
3. IPC & Wash	10
4. Human Resources	15
5. Case Management	10
6. Capacity Building	10
7. Patient Information Management	5
8. Support Structures & Services	5
9. Support Structures & Services For Health Workers	5
10. Disinfection	5

2. EXECUTIVE SUMMARY

This report documents the findings as collaboratively assessed by the Technical Assistance Teams and the County Representatives as at August 6th, 2020

2.1 Team Execution

2.1.1 The teams have visited and uploaded reports for **45** of the 47 counties (**96%**). The data for Trans Nzoia, and Elgeyo Marakwet will be included in the subsequent report as received.

2.1.2 To date, nearly **300 reports** have been received from the ground since 16th July 2020.

2.1.3 Out of **290** reference facilities provided by the Counties, **263 facilities (91%)** have been collaboratively assessed with County representatives and reports uploaded.

2.2 Summary of key findings

2.2.1 Assessed Bed Capacity from Health Facilities

- a) Based on the data collected the total number of functional beds assessed is **7,723 beds**, comprising of **7,411 isolation beds** and **312 ICU beds**.
- b) Out of 45 counties so far assessed **28%** have a bed capacity over 200, and only **15%** currently meet the minimum 300 bed capacity. Refer to Table 2.
- c) Several counties have ongoing construction works to increase their health infrastructure to meet the minimum requirements within the short term (30 days) and medium to long term (90 days).

2.2.2 Additional Isolation Bed Capacity from Non Health Facilities

- a) An additional bed capacity of **4, 015 isolation beds** have been identified to supplement the Health Facility isolation beds.
- b) Together with the Health Facility isolation and ICU beds, this would cumulatively **avail 11, 738 bed capacity** for the Pandemic.
- c) The additional capacity comprises of beds from Kenya Medical Training College (KMTC) and Educational facilities in Nairobi County as follows:
 - i). From **KMTC, 44** Campus sites nationally have been identified for isolation of mild cases which will add **3, 247** isolation beds to the national capacity.
 - ii). In Nairobi County, Moi Girls High School and Upper Hill High School will add **768** isolation beds to the county capacity.

2.2.3 Facility Infrastructure and capacity

- a) Out of **263** facilities visited, **64%** were level 4 and above (Refer to Section 3.2), which comprise of specialized facilities selected to handle COVID isolation cases.
- b) All the facilities were assessed for adherence to MOH guidelines; **45%** fell in the ‘Good – High’ category, reflecting high levels of functional infrastructure, service capacity and capabilities in line with MOH standards. In contrast, **47%** fell in the ‘Low – Fair’ category, revealing gaps and challenges in standards.

2.2.4 Human Resources for Health Capacity

- a) Based on the HRH protocols for Staff to patient Ratios, all counties in general, have **inadequate HRH** (Section 3.4). This will affect the level of health care services.

2.2.5 Quality of Services

- a) For Oxygen services, the most common supply method is **oxygen tank/cylinder** (See Figure 6).
- b) For laboratory testing services, **65%** of the facilities assessed had general lab services; however, **54%** did not have adequate lab supplies for the pandemic (See Section 7.1).
- c) The lack of fully equipped lab services, timely testing and reliable transportation, including long turnaround times for sample collection and results is seen as a **weak link** in management of the pandemic (see Section 7.2).

2.2.6 County Administrative Support

- a) The data so far gathered reveals that **59%** of the counties scored strongly, to reflect adequate support, structures, count administration and set up to handle pandemic situations. Notably, there

- is an **intrinsic link** between the strength of the county administrative support, and the technical facility findings. For counties demonstrating strong county management coordination, structures and visible **hands on leadership** led by the Governor at the front, then the facility standards were also high and overall county readiness was visibly strong.
- b) The areas of County **administrative strengths** were found to be in the **structures and mechanisms** for Multi Agency and Emergency Response teams, supplies of essential medicines and communication and publicity. The roles strongly involved in the Emergency teams include the Governor, County Commissioner, Police, CEC's, sub county and county directors who hold regular meetings. All Counties had activated Rapid Response Teams at County, Sub County and Ward levels. For communication, the Health Promotion Officers are leveraging a **vast array of channels** to inform the public about COVID. These include Radio talk shows by HCW's, radio jingles, social and mobile media, and in Coast, the use of town criers, Youth and Art (Graffiti) were particularly innovative.
 - c) The areas of **weakness** in County Administration include **coordination, case management, lab testing, and finance** mechanisms and **risk management**. In spite of a lot of activity, the outcomes are being diluted by **lack of adequate planning**, execution and follow up. None of the counties exhibited any risk management activities, while effective case management is being affected by weak capacity building and **adoption** of MOH developed protocols, guidelines, SOP's and job aids. Lack of **lab supplies, access to labs, long turnaround times are challenges to achieving effective testing, surveillance and response**.

2.3 Summary of Recommendations

- 2.3.1 The **persistent** technical challenges for the Counties are in **health infrastructure and facility standards**, support for **human resources** for health, **laboratory testing** and **capacity building**. The Counties need more technical support to expand their physical health infrastructures and to raise the standards of the facilities in line with MOH Standards.
- 2.3.2 To support COVID treatment through adequate **availability and reliable supply of oxygen**, medical supplies and testing services, MOH will need to initiate policy and guidelines for Oxygen, facilitate enhanced support for supplies and establish clear mapping and access to labs for all counties.
- 2.3.3 MOH should also consider assigning **County Liaisons** to strengthen coordination between MOH and the Counties, to assist in capacity building, and adoption of MOH guidelines and protocols.
- 2.3.4 Similarly, to be more effective the Counties should consider separate committees responsible to enhance **planning, risk management and monitoring and evaluation**; optimize use of public signage to enhance communications; Counties should **automate and integrate** their supply chain for medical supplies and inventory management with KEMSA.
- 2.3.5 As part of the national and county financial management, it is necessary for **NHIF** to provide clarity on the guidelines pertaining to their role in the COVID pandemic, even for the benefit of public

knowledge. Although financially, at least 99% of the counties have waived COVID related treatment fees, several counties have set up COVID emergency committees to mobilize funding, and are leveraging health budgets, disaster and contingency funds to handle the cost of COVID. These measures are not enough, and need to be backed by all possible resources from the Government, and private and public partnerships.

3. KEY TECHNICAL FINDINGS

3.1 Oxygen Supply

- 3.1.1** Ensuring adequate availability and supply of medical services, devices and equipment to support COVID-19 prevention and treatment included an assessment of the availability and reliable supply of high-quality oxygen whether by **gas cylinders**, liquid **oxygen tanks** through central oxygen piping system, concentrators or liquid **oxygen plants**.
- 3.1.2** County findings on the oxygen status are included in section 5 of this report.
- 3.1.3** In general, the most common oxygen supply method is oxygen **gas cylinder/tank** (See Table 8):

TABLE 1: OXYGEN PLANTS BY COUNTY

Cluster	County & Facility Oxygen Plant
Cluster 1	Moi Teaching and Referral Hospital, Uasin Gishu Transmara County Referral Hospital, Narok Nandi Hills County Referral Hospital, Nandi Lodwar County And Referral Hospital, Turkana Kapsabet referral hospital, Nandi Kapenguria Teaching hospital, West Pokot Baringo Referral Hospital: 6 tonnes of liquid oxygen, Baringo Trans Nzoia Teaching Hospital (1000 liters), Trans Nzoia
Cluster 2	Kericho (2) Kericho County Referral Hospital Nakuru (1), Nakuru Provincial General Hospital Bomet (2); Longisa County Referral Hospital
Cluster 3	Kisii Teaching and Referral Hospital; Kisii Level 5 Hospital Busia County Referral Hospital Siaya District Hospital & Siaya County Referral Hospital Migori County Referral Hospital
Cluster 4	Kenyatta National Hospital, Nairobi Pumwani Maternity Hospital, Nairobi
Cluster 5	Thika Level 5 Hospital Muranga County Referral Hospital Nyandarua County Referral Hospital, Nyandarua
Cluster 6	Meru Level 5 Hospital Embu Provincial General Hospital Level Five
Cluster 9	Kakamega Provincial County Hospitals; Bungoma County Referral Hospital Jaramogi Oginga Odinda Teaching and Referral Hospital Homa Bay County Referral Hospital Nyamira County Referral Hospital Vihiga County Referral Hospital, Vihiga

Cluster	County & Facility Oxygen Plant
Cluster 7	Kitui General Hospital. Machakos Level 5 Hospital Makueni County Referral Hospital
Cluster 8	Kilifi County Referral Hospital, Kilifi Coast Provincial General Hospital, Mombasa Kinango Hospital, Kwale Mpeketoni District Hospital, Lamu
Cluster 10	Mandera County Referral Hospital Garissa Provincial General Hospital, Garissa
Cluster 11	Isiolo District Hospital, Isiolo Nanyuki District Hospital

- 3.1.4 The primary supplier for medical oxygen cylinders is BOC (British Oxygen Company Gases); other private-sector suppliers include Crown Gases, Noble Gases (supplying KNH), and Oxyplus;
- 3.1.5 Although the Government Managed Equipment Services (MES) Program provided for oxygen plants in 11 level 5 hospitals across Kenya through a leasing mechanism
- 3.1.6 There is a mild focus on oxygen in the smaller facilities who leverage the specialized facilities (level 4+) with stable supply to handle the severe cases. There is generally a diluted focus on supply and utilization of Oxygen, with low quality oxygen in use. It will be important to realistically quantify total oxygen needs per facility, per county and streamline oxygen utilization and delivery per patient. Proper maintenance and appropriate purity levels of Oxygen needs to be guaranteed by Pharmacy and Poisons board and the suppliers.

4. RECOMMENDATIONS

4.1 Oxygen Services

- 4.1.1 The Technical Teams should assist in implementing a strategy and road map to scale oxygen, and policy and guidelines for Oxygen supply and utilization. To mitigate high rate of referrals/strain on the high level hospitals with stable oxygen supply all facilities should also be required to review, improve and expand their oxygen capabilities. The minimum capacities per facility should be guided at a national level.
- 4.1.2 The Ministry of Health, should support the installation of oxygen plants in all the counties; in more remote counties where distribution network for cylinders is complicated by supply chain logistics and infrastructure, oxygen concentrators may be considered as a positive alternative to oxygen cylinders. This will require Strategic planning and appropriate needs analysis and plant sizing.
- 4.1.3 The importance of reliable and quality oxygen supply needs to be **prioritized** in capacity building to enable facilities to handle escalating cases, and to limit congesting the specialized facilities. Scale-up

efforts for oxygen will require allocation of financing, prioritization of procurement and training of clinicians/health care workers on use of devices at the county level.

4.1.4 The findings of the MOH Technical Assistance Team have been shared with the Oxygen Committee which was constituted in July 2020 at MOH to review the status of oxygen supply in the country particularly in designated COVID19 national and county facilities, and was tasked to identify suitable solutions to improve and secure supply of medical oxygen. Resource mobilization subcommittee, covid taskforce. Their report is separately attached; a summary of their recommendations are below

4.1.4.1 Recommendation 1. Set up efficient onsite oxygen distribution and delivery systems and supply oxygen to identified facilities

4.1.4.2 Recommendation 2: Undertake a comprehensive technical evaluation of existing PSA plants and support the rehabilitation of these plants to ensure they produce >95% medical grade oxygen

4.1.4.3 Recommendation 3: Strengthen the regulation of oxygen as a drug and enforcement quality of medical grade oxygen:

4.1.4.4 The estimated budget to cover for the recommended support to the 76 facilities is

5. COUNTY OXYGEN REPORTS

5.1 Oxygen status – Cluster 5; Meru & Embu

- 5.1.1 Below is the current status in the oxygen supply to the isolation /treatment facilities.
- 5.1.2 MERU-Oxygen Capacity is 480 per Minute and its Piped. They also have cylinders to supply the oxygen to Nyambene District Hospital and Mboronga Health Centre. Its Sufficient for The Covid Unit in the County.
- 5.1.3 EMBU-Current Oxygen Capacity is 80 per/Min, the county intends to improve it to 400 per/Min. The sub counties of Runyenges District Hospital, Mbeere Siakago Level 4,Ishiara Hospital & Kiritiri Hospital have Cylinder to supply Oxygen to.

5.2 Oxygen status – Cluster 9 Western

- 5.2.1 Below is the report of facilities oxygen cylinders.
- 5.2.2 Mumias w. Hosp_2 concentrators
- 5.2.3 Manuals hospital_2 concentrators
- 5.2.4 Kakamega cgh_ has oxygen plant and 30 oxygen cylinders
- 5.2.5 Mautuma hospital_4 concentrators
- 5.2.6 Likuyani hospital_2 oxygen cylinders and 2 concentrators
- 5.2.7 Oxygen plant at Webuye producing 81.5% Oxygen.

5.3 Oxygen Status – Cluster 7 Lower Eastern Counties

County	Facility	Supply Type	Remarks / comments
Kajiado	Kajiado County Referral Hospital	Cylinders from BOC	Setting up of manufacturing plant in an advanced stage. 10 cylinders of 11.5kg reported as inadequate for the 10 bed ICU
	Kitengela Sub county Hospital	Cylinders from BOC	6 cylinders of 11.5Kg. Reported as adequate for the isolation unit. For the main hospital piped from a manifold with 12 eces of 11.5Kg Cylinders
	Ngong Subcounty Hospital	Cylinders from BOC	None
	Ngátataek Health Centre	Cylinders from BOC	To be verified
	Ole Kesasi Health Centre	Cylinders from BOC	To be verified
	Oloitokitok County Hospital	Cylinders from BOC	To be verified

Kitui	Kitui Level 4 Hospital		To be verified
	Kauwi Subcounty Hospital		To be verified
	Mwingi Level 4 Hospital		To be verified
	Ikutha Subcounty Hospital		To be verified
	Katulani Subcounty Hospital		To be verified
Makueni	Makueni County Referral Hospital	Oxygen manufacturing plant Piped to unit	To be verified
	Makindu KMTC	Cylinders Special oxygen beds	To be verified

5.4 Oxygen Status – Nandi County

ITEM	QUANTITY
Oxygen Concentrators	100
Oxygen Cylinders	200
Oxygen Flowmeters	200
Nasal Cannula	26,600
Laryngoscope	10 Sets
Nebulizing machines	300
Re breather Masks	200
Oxygen Plants	1 Functional at County Referral Hospital

5.5 Oxygen Status – Trans Nzoia County

The county has an Oxygen plant at Trans Nzoia Teaching and Referral hospital with a capacity of 1000 liters. There are also 8 cylinders.

5.6 Oxygen Status – West Pokot County

The county has an oxygen plant at Kapenguria Teaching and referral.

5.7 Oxygen Status – Turkana County

The county and referral hospital has an oxygen plant installed in 2015 and piped to the wards.

There are also 10 cylinders producing 25 liters per day

5.8 Oxygen Status -Baringo County

ITEM	QUANTITY
Oxygen Concentrators	50
Oxygen Cylinders	30
Oxygen Flowmeters	30
Nasal Cannula	500
Laryngoscope	10 Sets
Nebulizing machines	60
Re breather Masks	100
Oxygen Plants	1 In progress at Mogotio SC Hospital Need for piped oxygen in the Isolation wards at the County

5.9 Oxygen Status –Nairobi County

INSPECTOR	CLUSTER	COUNTY	SUB-COUNTY	FACILITY NAME	FACILITY TYPE	OXYGEN
Team A	4	Nairobi	Langata	Mbagathi District Hospital	NMS	9 cylinders
Team A	4	Nairobi	Kamkunji	Pumwani Nursing School	NMS	6 Oxygen concentrators
Team A	4	Nairobi	Makadara	Bahati Health Center	NMS	No Oxygen provision
Team A	4	Nairobi	Starehe	Nairobi South Plainsview Health Center	NMS	No Oxygen provision
Team A	4	Nairobi	Langata	Nairobi South Hospital	PRIVATE	12 cylinders
Team A	4	Nairobi	Langata	The Karen Hospital	PRIVATE	10 cylinders
Team A	4	Nairobi	Westlands	MP Shah	PRIVATE	PIPED
Team A	4	Nairobi	Dagoretti North	The Nairobi Hospital	PRIVATE	PIPED + 9 Cylinders at silver springs

Team A	4	Nairobi	Kibra	Kenyatta National Hospital	National	PIPED
Team A	4	Nairobi	Starehe	Mater Hospital	PRIVATE	PIPED

5.10 Oxygen Status –Kericho County

S/N O	FACILITY	REGULAR BEDS	ICU BEDS	OXYGEN SOURCE	ESTMATED REQUIREMENT S IN LITRES/DAY	ESTIMATED NO. OF CYLINDERS	AVAILABLE	GAP	Remarks
1	Kericho Hospital	33	2	Oxygen plant	47,520 + 86,400=133,920	98	Oxygen plant in place	None	Piping done to the isolation unit
2	Ainamoi Level 3A Hospital	55	0	Cylinders	86,4000	64	1	63	County to consider an oxygen plant
3	Unilever Tea Central Hospital	17	4	Oxygen cylinders	24,480+172,800=197,280	145	Oxygen plant in place	None	Piping done to the isolation unit
4	Kipketer Hospital	29	0	Cylinders	41,760	31	10	15	6 cylinders and 4 oxygen concentrators

5.10.1 10% of patients with mild to moderate disease will need oxygen

5.10.2 Cylinder F size- medium of 1360L

5.10.3 Oxygen requirement per patient

5.10.4 Regular bed- 10L/min

5.10.5 Critical care- 30L/min

5.10.6 Ref: D Lutman and A J Petros (2006); How many oxygen cylinders do you need to take on transport? A nomogram for cylinder size and duration; Emergency Medicine Journal; <https://www.ncbi.nlm.nih.gov>

5.10.7 NB: Southrift Cluster team recommends that Ministry of Health develops/determines a Standard Oxygen

5.10.8 Requirement Protocols for the Isolation and Treatment Centers and general Hospital use

5.11 Oxygen Status –Narok County

S/N O	FACILITY	REGULAR BEDS	ICU BEDS	OXYGEN SOURCE	ESTMATED REQUIREMENTS IN LITRES/DAY	ESTIMATED NO. OF CYLINDERS	Available	Gap	Remarks
1	Narok County Referral Hospital	11	0	Oxygen cylinders	14,400	11	1	10	County to consider establishing an oxygen plant
2	Nairregia Enkarre Level 3A	10	0	None	14,400	11	0	11	Facility not recommended to be an Isolation Centre
3	Emurua Dikirr Level 3A	36	0	None	57,600	42	0	42	County to urgently provide oxygen
4	Baraka Hospital	11	0	Cylinders	15,840	12	4	8	2 cylinders and 2 oxygen concentrators
5	Lolgorian Level 4 Hospital	61	3	Cylinders	87,840+129,600 = 217,440	160	1	159	1 oxygen concentrator available
6	Olulunga Sub County Hospital	310	15	None	432,000+ 648,000= 1,080,000	795	0	795	County to consider establishing an oxygen plant
7	Transmara Sub County Hospital	9	0	Oxygen Concentrators	12,960	10			10 Oxygen Concentrators

5.11.1 10% of patients with mild to moderate disease will need oxygen

- 5.11.2 Cylinder F size- medium of 1360L
- 5.11.3 Oxygen requirement per patient
- 5.11.4 Regular bed- 10L/min
- 5.11.5 Critical care- 30L/min
- 5.11.6 Ref: D Lutman and A J Petros (2006); How many oxygen cylinders do you need to take on transport? A nomogram for cylinder size and duration; Emergency Medicine Journal;
<https://www.ncbi.nlm.nih.gov>
- 5.11.7 NB: Southrift Cluster team recommends that Ministry of Health develops/determines a Standard Oxygen
- 5.11.8 Requirement Protocols for the Isolation and Treatment Centers and general Hospital use

5.12 Oxygen Status –Nakuru County

S/N O	FACILITY	REGULAR BEDS	ICU BEDS	OXYGEN SOURCE	ESTMATED REQUIREMENTS IN LITRES/DAY	ESTIMATED NO. OF CYLINDERS	AVAILAB LE	GA P	Remar ks
1	Nakuru Level 5 Hospital	20	4	Oxygen plant	28,400 + 172,800=201,20 0	148	Oxygen Plant in place	Non e	Piping done to the isolatio n unit
2	Gilgil Sub County Hospital	55	0	Cylinder s	72,000	53	0	53	0 cylinde rs availabl e
3	Langa Langa Sub County	32	0	None	43,200	32	0	32	County to urgently provide oxygen
4	Bondeni Level 4 Hospital	60	0	Cylinder s	86,400	64	3	61	3 cylinde rs
5	Naivasha Sub County Hospital	10	2	Cylinder s	14,400+86,400= 100,800	74	6	55	County to urgently provide oxygen

6	PGH Annex Level 4 Hospital	60	4	Cylinders	86,000+ 172,800= 259,200	191	4	187	Refilling done at the Nakuru Level 5 Hospital
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- 5.12.1 10% of patients with mild to moderate disease will need oxygen
- 5.12.2 Cylinder F size- medium of 1360L
- 5.12.3 Oxygen requirement per patient
- 5.12.4 Regular bed- 10L/min
- 5.12.5 Critical care- 30L/min
- 5.12.6 Ref: D Lutman and A J Petros (2006); How many oxygen cylinders do you need to take on transport? A nomogram for cylinder size and duration; Emergency Medicine Journal; <https://www.ncbi.nlm.nih.gov>
- 5.12.7 NB: Southrift Cluster team recommends that Ministry of Health develops/determines a Standard Oxygen Requirement Protocols for the Isolation and Treatment Centers and general Hospital use

5.13 Oxygen Status –Bomet County

S/N	FACILITY	REGULAR BEDS	ICU BEDS	OXYGEN SOURCE	ESTMATED REQUIREMENTS IN LITRES/DAY	ESTMATED NO. OF CYLINDERS	AVAILAB LE	GA P	Remarks
1	Longisa County Referral Hospital	22	2	Oxygen Plant	28,200 + 86400= 115,200L	85	Oxygen plant in place	Non e	Piping to be done to isolation unit
2	Koiwa Sub County Hospital	24	0	Cylinders Concentrators	43,200	32	25	7	Explore having an oxygen plant
		200	10	None	144,000	106	0	106	
	Tenwek Hospital	24	3	Oxygen plant	43,200 +129,600=172,800	127	Oxygen plant in place	Non e	Oxygen piping done from the plant to individual beds
	St Clare Kaplong	6	0	Cylinders	14,400	11	1	5	Consider increasi

	Mission Hospital								ng the oxygen supply
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5.13.1 10% of patients with mild to moderate disease will need oxygen

5.13.2 Cylinder F size- medium of 1360L

5.13.3 Oxygen requirement per patient

5.13.4 Regular bed- 10L/min

5.13.5 Critical care- 30L/min

5.13.6 Ref: D Lutman and A J Petros (2006); How many oxygen cylinders do you need to take on transport?

A nomogram for cylinder size and duration; Emergency Medicine Journal;

<https://www.ncbi.nlm.nih.gov>