

CASE STUDY

**Increasing access to  
medical oxygen in Somalia:**  
fostering a resilient health system  
in fragile context

August 2023





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# Highlights

## Need:

Medical oxygen particularly in remote and peripheral health centres with no access to electricity.

## WHO's solution:

Six solar-powered oxygen delivery systems for small-to-medium-sized health care facilities and three containerized pressure swing adsorption (PSA) plants for large specialized hospitals installed between 2021 and 2023.

## Impact:

Many patients have received oxygen at the health care facilities where solar-powered oxygen delivery systems have been installed. Although this system was initially developed to support COVID-19 patients, most patients treated have been children with neonatal asphyxia, pneumonia and other acute respiratory diseases. Without this system, most, if not all, of these patients would have died due to lack of medical oxygen. At least 1800 40-litre oxygen cylinders are being refilled every month from the PSA plants serving more than 1000 patients a month in need of medical oxygen.

## Moving forward:

Evidence shows that this innovation is efficient and cost-effective for use in a fragile setting. Thus, extending the availability of medical oxygen in Somalia can save many more lives. The WHO country office intends to deliver more solar-powered medical oxygen systems to small health care facilities and establish more PSA plants in large hospitals to ensure that this essential therapy is available in every health care facility in the country.



A child with pneumonia receiving oxygen from a solar-powered oxygen concentrator at a peripheral health facility in Galmudug

*Photo credit: WHO/Fouzia Bano*

## Health services in Somalia before COVID-19: fragility and underinvestment

Somalia has suffered from decades of conflict, political instability and climatic shocks such as recurrent droughts and floods. The result of this longstanding hardship has been underinvestment in health and social services and hence weakened and fragmented health systems. The universal health coverage index for Somalia was 27 out of 100 in 2019 – one of the lowest in the world where the global average is 60.3.<sup>1</sup> The emergence of the coronavirus disease 2019 (COVID-19) pandemic and the resultant disruption of essential health services in this fragile setting have created an environment where many determinants of poor health outcomes among Somali people have been exacerbated. Even before COVID-19, maternal and infant deaths in Somalia were among the highest in the world. Furthermore, decades of war, insecurity and protracted crises had led to the migration of skilled health workers from the country. Today, for every 1000 people in Somalia, fewer than one doctor/nurse/midwife is available.<sup>2</sup> With so few health workers, the current health system struggles to deliver even basic life-saving health interventions.



Zahra's baby, born in February 2021 at Hanaano General Hospital in Dusamareb, had birth asphyxia. She was saved by the oxygen delivered through the solar-powered medical oxygen concentrators which increased her oxygen level from less than 40% to 94% in a few hours.

*Photo credit: WHO/Fouzia Bano*

<sup>1</sup> The Global Health Observatory. UHC service coverage index (SDG 3.8.1) [Internet]. Geneva: World Health Organization; 2021 (<https://www.who.int/data/gho/data/indicators/indicator-details/GHO/uhc-index-of-service-coverage>).

<sup>2</sup> Abdi A, Ahmed AY, Abdulmunim M, Karanja MJ, Solomon A, Muhammad F, et al. Preliminary findings of COVID-19 infection in health workers in Somalia: a reason for concern. *Int J Infect Dis.* 2021;104:734–6.

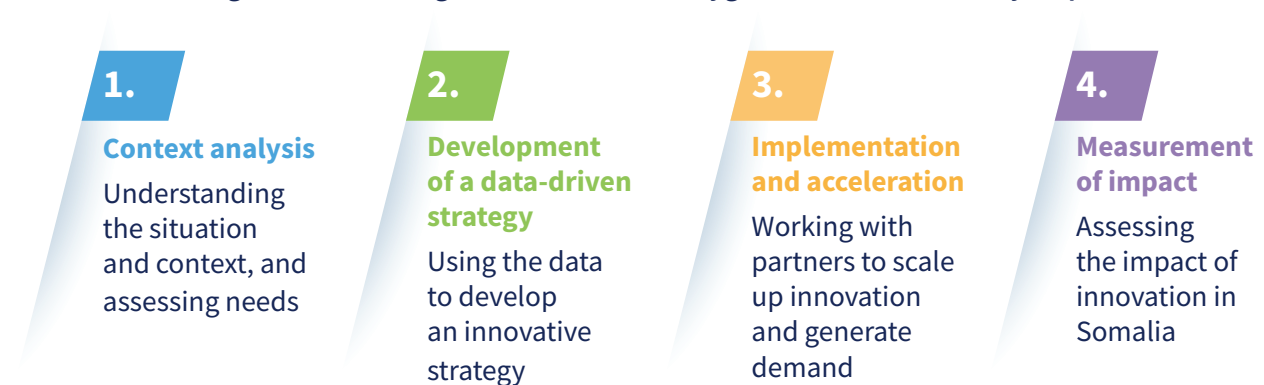
# COVID-19 and the surge in oxygen demand: search for innovative solutions

During May–June of 2020, when the first wave of the COVID-19 pandemic hit Somalia, the fragility of the health system was clearly exposed: it struggled to manage patients with severe symptoms of COVID-19. People were needlessly dying because of the lack of available medical oxygen. The WHO Somalia country office assessed the availability of oxygen in the country and planned for the increased demand as COVID-19 cases spiked. Even so, a survey

conducted by WHO in 2022 showed that still only 26% of health facilities surveyed had at least one oxygen source, while 4% had oxygen concentrators and 22% had access to oxygen cylinders.

This situation led the WHO Somalia country office to develop a data-driven strategy for scaling up oxygen availability in Somalia using a phased approach (Figure 1).

Figure 1. Increasing access to medical oxygen in Somalia: four key steps



**The availability of medical oxygen in health facilities is critical to saving people’s lives. I would like to congratulate WHO for dreaming big and inspiring us to think that lives can be saved and deaths prevented even in fragile settings with good investment and harnessing the power of innovation. The investment that WHO is making today on medical oxygen in one of the most fragile countries will inspire other countries to follow the same path. Whether it is in primary care or at higher levels of care, no patient should die from lack of medical oxygen. Many lives have already been saved and countless more will be saved through WHO’s leadership and visionary role in this country.**

**Mr Adam Abdelmoula**

Deputy Special Representative of the Secretary-General,  
United Nations Resident and Humanitarian Coordinator for Somalia (2019-May 2023)

# Scale-up of medical oxygen availability: three-pronged approach

Based on the data, the WHO Somalia country office implemented a three-pronged strategy to scale up the availability of high-grade medical oxygen throughout the country from 2021 to 2023.

**1. Equipping primary care with oxygen.** The WHO country office provided 376 peripheral primary health care centres with oxygen concentrators and distributed pulse oximeters to more than 3000 community health workers.

**2. Installing solar-powered oxygen delivery systems (concentrators).** As only one in four health facilities in Somalia had access to the power grid or an uninterrupted supply of electricity, WHO, with support from Grand Challenges Canada, installed the first solar-powered oxygen equipment in Hanano hospital in Galmudug, one of the most insecure areas of Somalia. Since then, WHO has set up five more such systems in other locations of the country.

**3. Procuring pressure swing adsorption (PSA) plants.** WHO has installed containerized PSA plants in three large specialized hospitals. Each has the capacity to refill 100 40-litre oxygen cylinders every day and simultaneously provide high-grade medical oxygen to 25 intensive care beds.



Somalia has turned to solar power in rebuilding a health system recovering from protracted conflict that has taken a significant toll on its public health infrastructures.

*Photo credit: WHO/Fouzia Bano*



## Achievements so far

After the solar-powered medical oxygen systems were installed between 2021 and 2023, 1059 care seekers with less than 70% oxygen saturation levels received medical oxygen (Table 1). Most (94%) of these patients were discharged without any disability. Children younger than 5 years made up 64% of those receiving oxygen. Although this oxygen system was installed initially to support COVID-19 patients, 70% of the patients treated were children with neonatal asphyxia, pneumonia and other acute respiratory diseases. The knowledge gained so far from this innovation shows that solar-powered oxygen systems are efficient and cost-effective for use in a fragile setting.

**Table 1: Characteristics and outcomes of 1059 patients treated with oxygen produced by solar-powered systems provided by the World Health Organization at six health facilities in Somalia, 2023**

Characteristic of patients	No. (%)
<b>Age group</b>	
< 1 week	355 (33.5)
1 week to < 1 year	164 (15.5)
1–4 years	274 (25.9)
5–19 years	77 (7.3)
20–49 years	101 (9.5)
50–69 years	66 (6.2)
≥ 70 years	22 (2.1)
<b>Sex</b>	
Female	523 (49.4)
Male	536 (50.6)
<b>Diagnosis on admission</b>	
COVID-19	27 (2.5)
Birth asphyxia	339 (32.0)
Pneumonia	408 (38.5)
Other acute respiratory diseases	42 (4.0)
Trauma	71 (6.7)
Other	172 (16.2)
<b>Duration of oxygen therapy in days</b>	
1	526 (49.7)
2	223 (21.1)
3	142 (13.5)
4	104 (9.8)
5	19 (1.8)
6	12 (1.1)
7	12 (1.1)
≥ 9	20 (1.8)
<b>Outcome</b>	
Death	50 (4.7)
Discharge without disability	992 (93.6)
Transfer to another facility	17 (1.6)
<b>SpO<sub>2</sub> %</b>	<b>Median (IQR)</b>
At initiation of oxygen	70 (19)
On discharge	99 (32)

COVID-19: coronavirus disease 2019; SpO<sub>2</sub>: peripheral oxygen saturation; IQR: interquartile range.

# The power of innovation: increasing access to medical oxygen and reducing health inequality

Unlike most other medicines, medical oxygen does not have a substitute.

Oxygen is an essential requirement in all health care facilities. It is one of WHO's 30 essential life-saving medicines needed for a wide range of conditions including: severe pneumonia, severe malaria, complications of childbirth and pregnancy, other newborn conditions, surgery and trauma. The COVID-19 pandemic highlighted the importance of medical oxygen as a lifesaving therapy for patients struggling to breathe. The demand for oxygen rose across the world as COVID-19 cases rose. As a result, affordable and sustainable access to oxygen became a challenge globally. During the peak of the COVID-19 pandemic in Somalia, between 8000 and 9000 cubic metres of oxygen a day (about 1000 to 1200 oxygen cylinders)

were needed to meet the country's demand. Only 5–12% of this need was met.

Capitalizing on the COVID-19 response, the WHO country office intends to increase access to medical oxygen using solar power in small health care settings and establish more PSA plants in large hospitals to ensure this essential therapy is available in every health care facility in the country.

Improving access to medical oxygen in Somalia is a smart investment for Somalia and WHO. The country has one of the highest under 5 mortality rates in the world. About 21% of child deaths in Somalia are attributed to pneumonia, which is the leading cause of death in children younger



WHO has procured and installed three containerized pressure swing adsorption oxygen plants as part of its work to scale up oxygen availability in health centres providing critical care; for example, the one in De Martino hospital has produced 128 000 cubic metres of high-grade medical oxygen since it went into operation.

Photo credit: WHO/Fouzia Bano

than 5 years – about two children die in Somalia every hour. Global evidence shows that up to 35% of childhood deaths from pneumonia are preventable with the use of medical oxygen<sup>3</sup>. Thus, increasing the availability of medical oxygen in Somalia can save many more lives and help the country move closer to attaining WHO's Triple Billion targets and the health-related Sustainable Development Goals (SDGs). This solar power innovation has the potential to reduce the substantial health inequality that exist in this disadvantaged country.

The global target is to reduce pneumonia-related deaths in children younger than 5 years to 3 per 1000 live births. In Somalia, the current rate is 24 pneumonia deaths per 1000 live births, very far from the global target. The WHO Somalia country office anticipates that by building strategic partnerships with innovators, funders, SDG3 Global Action Plan agencies and the private sector, the solar power innovation can be scaled up, thus accelerating its impact and helping to reduce deaths from childhood pneumonia in the country in the long run.

Using innovation and affordable solutions to make oxygen available at all levels of health care will also contribute to building a resilient health system as the country recovers from the COVID-19 pandemic.

A focused effort by all to accelerate innovations in oxygen provision and track progress with

transparency and accountability can protect the most vulnerable children and fulfil the promise – every breath counts.



**When the first laboratory-confirmed case of COVID-19 was reported on 16 March 2020 in Somalia and the outbreak was raging across the country, none of the public sector hospitals in Somalia had medical oxygen available. Driven by the urgent need for high-grade medical oxygen, we realized we had to act fast to save lives and, with the support of our partners, we delivered the solar-powered oxygen system. This unique life-changing innovation has reached at least 1 million vulnerable people in the country and now we want to scale it up to reach all peripheral health centres so these facilities are better prepared to deliver critical services for children and women. Using clean, renewable energy to electrify these health care facilities could be a game changer for Somalia as having medical oxygen available around the clock in these centres can save the lives of thousands of children.**

**Dr Sk Md Mamunur Rahman Malik**

WHO Representative and Head of Mission,  
Somalia

**WHO envisions that no child or mother should die needlessly in Somalia because of lack of oxygen and that solar-powered oxygen systems can help build an inclusive and equitable health system serving the needs of all people, not just a few.**

<sup>3</sup> Duke T, Wandt F, Jonathan M, Matai S, Kaupa M, Saavu M, et al. Improved oxygen systems for childhood pneumonia: a multihospital effectiveness study in Papua New Guinea. *Lancet*. 2008;372(9646):1328–33.

## Lessons learnt



The power of innovation can be harnessed to save lives even in challenging circumstances. Challenging times can bring opportunities. Innovation can drive progress and accelerate improvements in health even in fragile settings.



Unique life-saving interventions can be scaled up to benefit millions of people and address health inequities in humanitarian crisis settings, if these are implemented with tangible outcomes in mind.



Use of solar power will help the country to move closer to clean and renewable energy and reduce its carbon emissions.



By procuring and installing oxygen concentrators, and training health workers on the use of medical oxygen, measurement of oxygen saturation levels using pulse oximeters and the the indications for using oxygen, WHO has helped the country improve access to medical oxygen at the point of care.

*Photo credit: WHO/Fouzia Bano*

**In focus. Solar-powered oxygen saving the lives of Somali children**

The solar-powered oxygen system has come to symbolize life for Somali children in a country where pneumonia accounts for at least one fifth of deaths in children younger than 5 years. For example, Abdiaziz Omar Abdi, a 2-year-old child in severe distress, was admitted to Hanano hospital in 2021 with alarmingly low oxygen levels of 60% – the minimum level required is 90%. Doctors immediately administered oxygen, and ampicillin and dexamethasone. Abdiaziz would probably have died had he come in 3 months earlier when no oxygen was available in the hospital. Three days after admission, his oxygen level was at 90% and he was discharged alive and well. “I came because my child was unwell, he was not breathing properly, he was not breastfeeding,” says relieved mother, Zahra. “Now he is breastfeeding. He is feeling well.” Abdiaziz received this treatment at no cost to the family.

Abdiaziz is one of the many people who have accessed life-saving oxygen in Hanano hospital and recovered from life-threatening medical conditions such as asphyxia, pneumonia, injuries and trauma. The oxygen system has also significantly shortened hospital stay, with inpatient hospitalization averaging 1 day down from 5 days pre-installation. Furthermore, the solar-powered system overcame the frequent power interruptions and allowed the vaccine cold chain to be maintained. Importantly, demand for health care among catchment communities is increasing. “Now, we bring our children to Hanano hospital to live and no longer die,” said Zahra, Abdiaziz’s mother.

Dr Mohamed Abdi, the Hospital Director, could not hide his gratitude to the Government, WHO and all partners who supported this intervention. Zahra’s baby was special to him because she was the first person to receive the solar-powered oxygen since it had been installed. “I was responsible for laying the first brick in the Hanano Hospital,” said Dr Mohamed Abdi. “This is the first time I have seen how one timely investment can save lives. Last year, sadly, more than 180 patients died in the hospital due to the lack of oxygen. Many of them were children. This system will save many lives. This innovation has brought life back to this hospital; we now have people coming from as far as 100 km away,” says Dr Mohamed Abdi, Director of Hanano hospital.

## **In focus. Added benefits of the solar-powered oxygen system**

Fuelled by an ambition to help medical practitioners in developing countries find solutions to children's needs, Dr Michael Hawkes, Associate Professor in the Department of Pediatrics at the University of Alberta, had set up solar-powered oxygen systems successfully in Uganda in 2013. He installed the oxygen system in Somalia as a pilot project to measure its impact in a conflict-affected country, with support from a nurse and project manager, John Kanyonyozi, and an electrician who oversaw the installation, Steven Ngaciki.

Surprised at how in the past few months, the system in Somalia had gone beyond his expectations, Dr Hawkes remarked, "When the hospital asked us to install solar-powered oxygen in the operating theatre, I was hesitant. We had focused on children in paediatric wards. But when violent conflict erupted and patients with gunshot injuries flooded the hospital, solar-powered oxygen was crucial for anaesthesia for trauma surgeries – an unexpected use for solar-powered oxygen in Somalia!"

Dr Hawkes explains that in resource-constrained settings such as Somalia where power outages are frequent, the supply of medical oxygen from other sources, such as oxygen cylinders and concentrators which require electricity, would be interrupted, adversely affecting patients. With a solar-powered system, however, with the continued promise of uninterrupted sunshine, it will keep running and producing oxygen for patients in need.



**Saving lives by using freely available resources – the sun and air – how ingenious. We take it for granted but oxygen is an essential medicine used to care for patients at all levels of the health care system, including in pneumonia, surgery, heart failure and emergency obstetric care. We are excited to participate in this global partnership that focuses on local ownership and the needs of remote, rural health facilities in Somalia, and has a tangible impact.** ”

**Ms Karlee Silver**

Co-Chief Executive Officer, Grand Challenges Canada

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“

Whatever we do, we want to do, there has to be a measurable impact of the work of WHO at the country level. The heart of our transformation should be to deliver public good through our country offices to achieve health for all. ”

**Dr Tedros Adhanom Ghebreyesus**  
WHO Director-General





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