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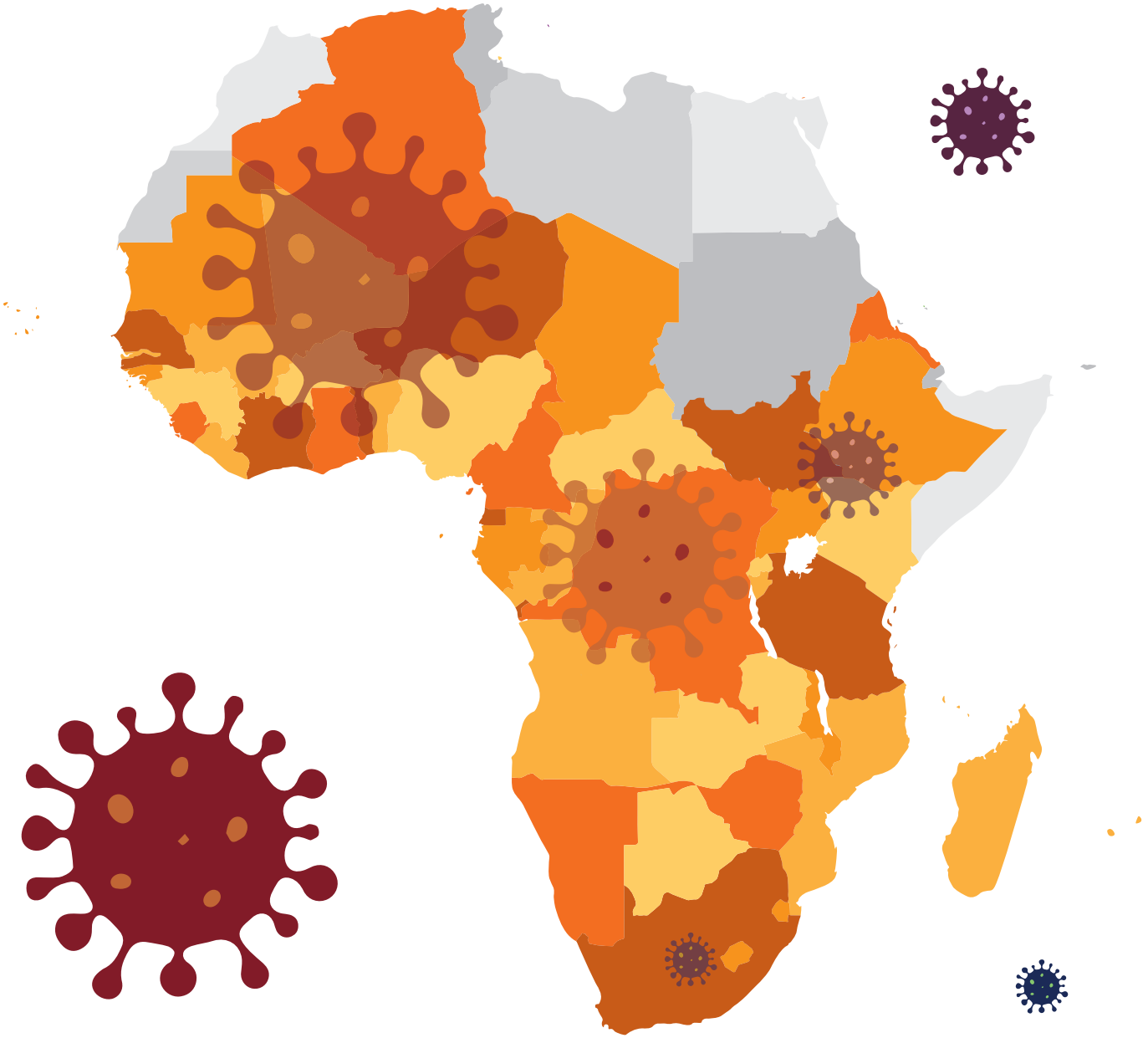

Oxygen provision in Sub-Saharan Africa to fight COVID-19

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Summary Box

1. The adequate provision of medical oxygen is going to make the difference between life and death for the majority of COVID19 patients in Africa.
2. Sub-Saharan African countries lack affordable and reliable oxygen supply.
3. There is evidence from Sub-Saharan Africa for why medical oxygen provision must be made a regional urgent priority.
4. Efforts being made in some African countries (e.g. Gambia, Kenya and Ethiopia) demonstrate how oxygen provision can be scaled up through innovative affordable technologies.

Introduction

Oxygen saves lives. Its provision is a critical component of emergency respiratory resuscitation around the world and it consequently features on the WHO's list of essential medicines.[1] Oxygen therapy is not just used for pneumonia and other lung diseases. It is also crucial for treating various non-respiratory conditions that result in hypoxaemia, such as sepsis, severe malaria, trauma and cardiovascular diseases. It is equally essential for surgical care and anaesthesia.

In western countries the reaction to the COVID-19 pandemic has been to increase hospital capacity, provide more intensive care units (ICUs) and more ventilators. There had been little discussion of the provision of oxygen as this is a standard clinical tool widely available in hospitals. This is not the case in Sub-Saharan Africa (SSA). There is a shortage of oxygen in health centres in SSA.[2] When it comes to prioritising the medical resources SSA needs to save the maximum number of lives, arguably two things should be atop of that list before ICUs and ventilators. These are personal protective equipment (PPE) for frontline health workers and oxygen for the patients. The need for PPE is a global issue and one whose importance has been highlighted in the different health systems as it is critical to ensure frontline health workers are protected from COVID-19 infection and that they are not infections conduits within hospitals.

Oxygen on the other hand, has received less attention and this is the second most important aspect of the COVID-19 response. Critically pneumonia is the main clinical feature of COVI19 and adequate ventilation support is essential for patient survival. It has been indicated that supplemental oxygen is a first essential step for the treatment of severe COVID-19 patients with hypoxemia and should be a primary focus in resource-limited settings.[3] In China a study of 1,099 hospitalised patients with the corona virus this year found that 41.3% needed supplemental oxygen and 2.3 per cent needed invasive mechanical ventilation.[4] Therefore, investing in supplementary oxygen would strengthen the response to COVID19 in Africa and save lives.

Prior to the COVID-19 pandemic several countries in SSA were already suffering from shortages of oxygen, shortages of equipment as well as lack of training to support correct and optimally use oxygen therapy[5] especially for the treatment of

paediatric pneumonia. For example, in 2018 one in 10 children with pneumonia in Nigeria received the oxygen they needed. [6] In Kenya, many rural hospitals lack supplementary oxygen equipment, adequate supply chains for oxygen cylinders, and reliable electrical power needed for oxygen delivery. The impact of such shortages during an epidemic were illustrated during the in the response to influenza.[6] Even when available, the cost of oxygen in SSA can be prohibitive and it fluctuates widely, often depending on whether or not production sites are nearby. For example, 6.8m^3 of oxygen (enough to sustain an adult for 24 hours) can reach up to $100 in Somalia.[7]

The need for oxygen to fight COVID-19 in SSA

By modelling the epidemic in each Sub-Saharan African country every week (see http://tiba-partnership.org/), we have been able to calculate doubling times for the COVID-19 epidemic, providing important evidence to inform planning and resource mobilisation. Given that we know how much supplementary oxygen a patient requires at various stages of COVI-19, and using the doubling times of disease spread, we can calculate the oxygen requirements for each country. For example, on the African continent the COVID-19 pandemic has doubled size in the 10 days up to April 16th.[8] With only two countries in Africa, Ethiopia[9] and Nigeria[10, 11] having oxygen policy roadmaps Africa and its global partners need to put together a rapid plan to supply oxygen to all countries in the region in order to save lives.

Although the majority of people with COVID-19 have uncomplicated or mild illness, WHO currently estimates that around 14% of cases may be severe and that an additional 5% will be critical and require treatment in intensive care units.[12] WHO recommends the immediate supply of oxygen therapy as part of clinically managing all patients with severe acute respiratory infection and respiratory distress, hypoxaemia or shock.[12] This is likely to apply to the majority of critical and severe patients hospitalized for COVID-19. Whether or not these patients receive oxygen will be decisive for their survival. It has been observed in the UK that for those hospitalised COVID-19 patients who require high levels of supplemental oxygen it is lifesaving in c.80%.[14] Due to the anticipated large number of people in SSA who will likely require oxygen, and the great impact this will likely have on their survival,

its provision - together with that of oximeters and oxygen-delivering interfaces - should be made a regional priority.

Context relevant solutions to Oxygen supply

Medical oxygen is a regulated commodity, that must be at least 82% pure, free from any contamination and generated by an oil-free compressor.[15] It can come from oxygen plants, liquid oxygen storage tanks and oxygen concentrators. In SSA there are two main sources of oxygen - concentrators and cylinders. While concentrators are the cheapest and most scalable way to supply oxygen, they require a functioning infrastructure with reliable power supply (although some countries have solved this problem by using solar powered concentrators as detailed below), as well as regular servicing. The more expensive cylinders require neither a power source nor costly maintenance. Clinicians in some SSA health systems have indicated that the priority list would include first pulse oximeters to measure oxygen levels, followed by oxygen concentrators that can be used in small healthcare settings, and finally higher-tech equipment like ventilators.

Comparison of oxygen cylinders and concentrators[16]

	Oxygen cylinders	Oxygen concentrators
Capital Cost	Low (higher if including regulators and flowmeter assemblies)	Moderate
Running cost	High: frequent refilling, transport and logistics	Low: power, maintenance
Power source	None required	Required, continuously
Reliability	Good, so long as supply lasts	Good, on selected models
Continuous supply	No, limited by volume (Large H-type cylinders last 2-4 days with continuous low-flow use)	Yes, limited by equipment or power failure
Maintenance	Minimal: check regulators, leakage	Essential: simple preventive and intermittent repairs

Training	Yes, clinical use of oxygen, care of cylinders and connections	Yes, clinical use of oxygen, care of concentrators and connections, technical maintenance

Some solutions from African countries for building oxygen supply

The problem is not insurmountable. A 42 bed hospital in the Gambia has managed to ensure uninterrupted oxygen supply for 8 years straight, using oxygen concentrators (rather than the more expensive cylinders).[17] In Kenya, a county government enabled the construction of an oxygen plant by a private company, while the hospital commissioning the plant committed in advanced to buying a fixed oxygen quota.[18] In Ethiopia a garment manufacturer that produces oxygen for bleaching purposes aims to provide it to a nearby hospital.[19] Solar-powered oxygen delivery for rural settings has equally been developed.[20] What matters today is that governments, the private sector and hospitals work together to urgently increase regional oxygen availability.

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