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Editorial

COVID-19 treatment in sub-Saharan Africa: If the best is not available, the available becomes the best

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Community transmission of COVID-19 is ongoing in the majority of countries in sub-Saharan Africa (SSA), threatening, as elsewhere, the capacity of national healthcare systems (HCS) in low- and middle-income countries (LMIC) [1,2]. While the epidemic started slowly and late in SSA, currently - subject to often rapid changes - around 20,000 cases per day are reported [3], despite limited testing [1]. Shortages of personal protective equipment (PPE), as well as sophisticated and expensive molecular diagnostic tests are of concern. However, the biggest worry is the lack of health care workers (HCW) and health care infrastructure as a few figures compellingly illustrate. SSA has only 0.2 physicians per 1000 inhabitants (Europe 3.7, North America 2.6), while 10,000 HCW across the continent were infected by the 23rd of July [4]. In April, the WHO reported less than 2000 ventilators in 43, and only 5000 intensive care unit (ICU) beds in 41 African countries, respectively [1]. Worst though, their distribution is highly skewed. While many countries in SSA having just a few, if any [5]; in countries which govern such resources, like South Africa, they are mainly located in the private sector, creating corresponding access problems [1]. Non-profit organisations help with the procurement of materials at lower prices, like the African Medical Supply Platform; yet, a single N95 mask still costs 2 USD a piece on this platform [1].

COVID-19 combines all the aspects of a pandemic threat, which even pushed the HCS of some of the wealthiest countries to their limits, such as Italy's Lombardy region or New York City. Although molecular methods are used for diagnosis, false negative result rates make repeated re-testing necessary [6], further limiting the overall availability of tests. Severe and critical cases need constant intensive monitoring, oxygen treatment, if not extremely resource-intensive and costly mechanical ventilation [6]. Not only direct COVID-19-related morbidity and mortality, but the indirect impact on non-COVID-19 related healthcare in overwhelmed HCS were of great concern already at the beginning of the epidemic [7]. If the richest countries struggle, what can be done if LMIC, such as Sierra Leone, which serves as an example in the following, are hit hard by the current exponential increase in cases?

The population of Sierra Leone (~6.5 million) is very young, with a small number of those in the age group showing the highest risk of severe disease in wealthy countries (only 4% are >65 years old) [8]. However, this possible advantage may be offset by frequent concomitant diseases, malnourishment, or lack of access to HCS. Health expenditure increased during the Ebola outbreak and stood at 18% in 2015; translating into $270 per person, based on the GDP per capita of $1500 [8]. The physician density was only 0.03 per 1000 population in 2011; ten-fold below the African average; while the WHO reported only four hospital beds per 10,000 population for 2006, and 0.33 computed tomography units per million population in 2013 [9]. The number of nurses and midwives per 10,000 population is only 2.2 in Sierra Leone [9]. Regarding the COVID-19 response, there is a specific lack of intensive care nurses [10].

As of 25th of July, 1.768 COVID-19 cases were reported with 66 deaths [3], while 122 (11%) of cases were among HCW by June, 12th [11]. The Ministry of Information and Communication provides updates through a Facebook® site [12], while a short timeline is available at a Wikipedia site [13]. A recent study estimates the need of beds, ICU beds and ventilators for Africa at 40 or 131; 2 or 6.5; and 1.0 or 3.2 per 100, 000 population, respectively; assuming that 30% or 100% of infected patients with severe symptoms seek care [5]. This would translate into 2600 or 8515 hospital beds, as well as 130 or 423 ICU beds, respectively, required to meet either of these scenarios for Sierra Leone.

As an example, Masanga Hospital in central Sierra Leone was requested by the government to create a COVID-19 treatment center for severe cases. It is a 120-bed, secondary level of care hospital with internal medicine, gynecology/obstetrics, pediatrics, and surgery/orthopedic inpatient and outpatient services, in Tonkolili District (around 230 km from the Capitol, Freetown), with a population of 67,705 and a total

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catchment area of around 200,000 [14].

Infrastructure for screening and treatment of COVID-19 should be separated from non-COVID-19 healthcare to minimize spread. Important guidance in setting up a Severe Acute Respiratory Infection (SARI) Treatment Center in LMICs is given in a practical manual by the WHO [15], a 120-page document which extensively addresses details of layout, room-ventilation, water/sanitation and electrical supply. It even provides several budget estimates, such as for construction (310,303 USD), set-up of electrical supply (89,493 USD), furniture and general consumables for SARI treatment center set-up (34,815 USD), or PPE based on 100 patients (15,957 USD). While these cost estimates may serve as a crude orientation, they seem highly unlikely to be affordable in most remote settings in SSA. For example, the unit price for a FFP2/N95 mask is estimated at 0.66 USD [15], while real market prices reached 30 USD, and are still 2 USD on the African Medical Supply Platform [1].

While the manual is a resourceful compilation of highly useful and practical information [15], several passages seem distinctly out of touch with the realities lived in remote areas in LMIC, often near impossible to implement: "Use designated portable X-ray equipment and other important diagnostic equipment" (p.4); "Community facilities (e.g. stadiums, gymnasiums, hotels) with access to rapid health advice (i.e. adjacent COVID-19 designated health post/EMT-type 1, telemedicine)" (p. 8); "Mass critical care (e.g. open ICU for cohorted patients)" p.10; "Categorization of patients with severe acute respiratory infection (Chest imaging (radiograph, CT scan, lung ultrasound)"; or any significant "Surge capacity" p52. Even aspects like "Testing the ventilation/exhausted air systems" p. 23, or "SARI treatment centers should be able to test and monitor the quality and safety of their treated water" p. 64, may proof very difficult to implement.

The construction-based solutions suggested in the manual [15], either new buildings but even adaptations of existing ones, can often last a significant amount of time in remote SSA, with weeks or even months not being a surprise. Of course, this could miss the important time window when these services would be necessary, but due to the proximity to normal hospital services, construction might even interfere with usual provision of health care services.

Certainly, the use of tents could be an alternative [15]. However, it is necessary to consider the population's beliefs, their previous medical knowledge and their sensibilities. Here, in Sierra Leone, people are still very aware of the recent Ebola epidemic and in times of an outbreak, fewer people seek medical care [14]. If a medical institution starts using chlorine and/or building tents, the people of various communities are less likely to visit the institution. Already, the establishment of COVID-19 treatment centers seem to have this effect as HCS experienced a decrease in the number of in- and outpatients. Out of fear of potential stigmatisation associated with a diagnosis of COVID-19, people shun medical care when they fall ill. Unfortunately, guidelines rarely reflect on the disconcerting possibility that the proposed containment strategies carry these detrimental effects [16,17]. The lessons learnt from the Ebola epidemic in Sierra Leone seem clear: all institutions, NGOs and community leaders, all need to collaborate and emphasize the importance of maintaining basic (trust in) healthcare in addition to any technical approach to an epidemic [18].

In non-pandemic times, institutions in low-resource settings already struggle to provide regular medical care to their patients. Resources considered abundant, granted and necessary for the COVID-19 response in high income countries (HIC) are often scarce in LMIC (see Table 1). With the addition of taking care of COVID-19 patients in LMIC, whole health systems are on the verge of collapse [16,19–21].

Following the governmental proposal to adapt existing infrastructure into COVID-19 treatment centers; at Masanga Hospital, this translated into the re-modelling of a pre-existing eye care building to receive COVID-19 cases with severe disease based on several key characteristics: large building size; location distant from the main hospital; proximity to a separate hospital gate; as well as the number of windows allowing for

Table 1
Situation-adapted COVID-19 in-hospital containment strategies in LMIC.

Recommended	Details	Likely to be available	Alternatives
Ventilation principles WHO	Ventilation Rate[a] Airflow Direction[a] Air distribution/ airflow pattern[a]	+ - -	Use of natural ventilation (open windows and doors) and simple interior-to-exterior fans situated at poorly ventilated sections Outdoor area for (mild) cases if possible Cohorting patients with similar complaints/disease
Ventilation methods WHO	Natural ventilation (natural forces/winds) Mechanical ventilation (fans) Hybrid ventilation (mixed-mode)	++ + -	
Ventilation on wards WHO	Mild cases – natural ventilation Severe cases – 160L/s Critical cases – 160L/s Staff working area 60L/s	++ - - -	
Accessible water source	Reliable source of clean water	+	Use of proper wells, cisterns and reservoir systems Water-saving practices
Location and Ground conditions	Easy access, good soil condition. Environment manipulation to meet desired criteria	-	Use of existing facilities Gravel if cement not available
Waste management	Cleaning and disinfection point, temporary waste storage, organic pit, sharp pit and incinerator with ash pit, toilets (private) and proper plumbing	+	Burn pit Locally made incinerators that use charcoal Cohorting patients Latrines
Laboratory services	Hematological studies Biochemical studies Microbiology	+ - -	Proper history-taking Thorough physical examination Empirical treatment Lab studies just for documentation is not done Where possible stepping-up rapid test kit use (including HIV and Malaria)
Imaging services	Using various imaging modalities (e.g. CT scan, chest radiography, bedside USS) to orient case management	+	Some simple modalities may be available. However, most of the time clinicians have to perform a proper physical examination Imaging just for documentation is not done
Case management	Drugs	+	Use available options, often off-label use If no drugs available, use supportive or palliative care Treat other common (endemic) infections like malaria if no laboratory services to confirm disease.
	Oxygen Therapy and Artificial Ventilation	-	Use available options, many times using just the respiratory rate as monitoring Oxygen concentrators and oxygen cylinders can be used where available.

(continued on next page)

Table 1 (*continued*)

Recommended	Details	Likely to be available	Alternatives
			Due to limited skills set and lack of drugs for sedation the risks associated with mechanical ventilation are increased. Exercises to increase breathing efficacy Prone-positioning If no response, use palliative care
	Rehabilitation Therapy	-	Family/Community engagement
	Isolation in single rooms	-	Cohorting patients
Infection Prevention Control	Liquid soap	+	Grating solid soap in water
	Chlorine	++	Use it if available and locally accepted
	Alcohol base Solution	+	Soap
	Personal Protective Equipment	+	Cohorting patients and using the same equipment Strict use of equipment
Healthcare Workers	High qualified with multiple specialties	-	Teaching people important skills (empowerment) *Accept that sometimes you will have to use/apply not 'the best', but the best possible*
	Staff to be replaced if quarantined	-	As there is a limited amount of HCW; strict quarantine policies Use of PPE protects patients and staff; HCW using adequate PPE are not contacts Staff that are primary contacts could be tested and if negative allowed to work
	Psychosocial support (psychotherapy, government policies)	-	Empathic, positive team working environment Peer support
	Financial Support	-	Raise problem awareness

Note.

[a] According to WHO definitions, ventilation rate is defined as amount of outdoor air that is provided into the space, and the quality of the outdoor air, airflow direction as the overall airflow direction in a building which should be from clean zones to dirty zones, and air distribution/airflow pattern as the external air should be delivered to each part of the space in an efficient manner, and the airborne pollutants generated in each part of the space should also be removed in an efficient manner. Score for HIC and LMIC: ++ feasible, + potentially feasible, - not feasible.

ample natural ventilation. However, the building had significant limitations, such as insufficient running water, few beds, inappropriate ventilation, and no appropriate waste management.

Proper ventilation in facilities is a key aspect when treating patients with a viral respiratory infection [22], and, not surprisingly, constitutes a major part of the WHO practical manual [15]. Different sections in SARI treatment centers may require different types of ventilation: natural ventilation, hybrid or mechanical ventilation, HEPA (high-efficiency particulate air) filters. Whereas natural ventilation and dilution are sufficient for staff area and morgue; a room to obtain swabs, and the wards for moderately-ill and severe and critical cases might benefit from hybrid or mechanical ventilation and HEPA filters [15]. Unfortunately, any measure other than natural ventilation becomes extremely challenging for low-income settings. Although simpler devices might be used, air extractors, let alone exhaust air treatment and a certain amount of liters/minute turnaround air volume might be near impossible to install and maintain [15]. In many LMIC settings, as in our case, natural ventilation is the only feasible option.

Apart from issues concerning the building, SARI treatment facilities require the necessary tools and HCWs the necessary knowledge to manage respiratory failure, oxygen therapy and artificial ventilation (invasive and non-invasive). Just considering the oxygen, many LMIC lack a stable, reliable and affordable oxygen supply and transport chain. The few available mechanical ventilators in LMICs are matched by even fewer healthcare workers capable of delivering such modalities of treatment [15,23]. Obtaining relevant information or training is often difficult in remote, rural areas, where one struggles to get electrical power, let alone a stable internet connection. In essence, HCW in low-resource settings might be disadvantaged in many settings with regard to training how to deal optimally in their setting with COVID-19 cases [24].

In LMICs, very often the minimum requirements for healthcare are not, or barely, met; and even then mainly in urban areas. Local decision-makers have to think about their community well-being, try not to harm, and to make optimal use of the resources available.

Unfortunately, despite the fact that LMIC could be hit hard by the pandemic; to the best of our knowledge, no guidance has been made available for low-resource settings to implement a treatment facility, nor is there a list with second or third alternative (down-scaled) options. Interestingly, this is in stark contrast to a situation in HICs, where the lack of ventilators spawned a series of publications/recommendations on whom to select for mechanical ventilation, arguably a 2nd choice treatment, as standard of care would be to ventilate all [25].

At Masanga Hospital, with the same probably happening in many other locations elsewhere, we tried to establish a standard SARI treatment center [15], in light of the common challenge in LMIC: "If the best is not available, the available becomes the best" and as in our setting; in many other places, it might as well be necessary to modify guidelines to adjust to local realities in a low-income setting.

In conclusion, LMICs are usually confronted with compromised health infrastructures; pre-existing overcrowded hospitals which exceed their capacity; quantitative and qualitative deficiencies in human resources, materials or knowledge; unstable power supplies; unsafe water sources; or hazardous waste management. As healthcare systems are obviously very different in LMIC compared to HIC, a one-size-fits-all approach does not work in the global fight against this pandemic. Similar challenges in different HCS warrant different strategies and recommendations, especially in LMIC, and there, in particular, in remote areas. For the next pandemic, we need to be better prepared [26].

What to do if best medical care is not available? We should consider how locally accessible resources could be adapted and best used to deliver a more tailored and realistic, even if less favourable solution, that in the end will be better than the (likely) unrealistic implementation of high, but not attainable standards. Because the highest-possible, yet realistic level of care is better than no care at all.

Potential conflicts of interest

None of the authors has any conflict of interest to declare.

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Author contributions

JHD, TBM, MPG conceived the paper. JHD, with input from TBM, MPG, and TH, wrote the first draft. All authors discussed the ideas, contributed to the writing of, and endorsed the final version of the paper.

References

[1] Wadvalla BA. How Africa has tackled covid-19. Br Med J 2020;370:m2830. https://doi.org/10.1136/bmj.m2830.
[2] El-Sadr WM, Justman J. Africa in the path of covid-19. N Engl J Med 2020;383(3):e11. https://doi.org/10.1056/NEJMp2008193.
[3] Worldometer. Coronavirus. https://www.worldometers.info/coronavirus/. accessed 26th of July 2020.
[4] WHO. https://www.afro.who.int/news/over-10-000-health-workers-africa-infected-covid-19. accessed 26th of July 2020.
[5] Craig Jessica, Kalanxhi Erta, Gilbert Osena. Isabel Frost Estimating critical care capacity needs and gaps in Africa during the COVID-19 pandemic medRxiv. 2020.06.02.20120147, https://doi.org/10.1101/2020.06.02.20120147; 2020. accessed 26th of July 2020.
[6] Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, Prescott HC. Pathophysiology, transmission, diagnosis, and treatment of coronavirus disease 2019 (COVID-19): a review [published online ahead of print, 2020 jul 10]. JAMA 2020. https://doi.org/10.1001/jama.2020.12839.
[7] Hanscheid T, Valadas E, Grobusch MP. Coronavirus 2019-nCoV: is the genie already out of the bottle? Trav Med Infect Dis 2020;35:101577. https://doi.org/10.1016/j.tmaid.2020.101577.
[8] Index mundi. https://www.indexmundi.com/sierra_leone/age_structure.html. accessed 26th of July 2020.
[9] Global health observatory country view. Sierra Leone. https://apps.who.int/gho/data/node.country.country-SLE. accessed 26th of July 2020.
[10] Nuwagira E, Muzoora C. Is sub-saharan Africa prepared for COVID-19? Trop Med Health 2020;48:18.
[11] World Health Organization Africa. Publications, https://www.afro.who.int/publications/covid-19-related-materials-including-situation-reports. accessed 26th of July 2020.
[12] Government of Sierra Leone. Ministry of information & communications. https://www.facebook.com/mic.gov.sl/. accessed 26th of July 2020.
[13] COVID-19 pandemic in Sierra Leone. https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Sierra_Leone#cite_note-7. accessed 26th of July 2020.
[14] Huizenga E, van der Ende J, Zwinkels N, et al. A modified case definition to facilitate essential hospital care during EbolaOutbreaks. Clin Infect Dis 2019;68:1763–8.
[15] World Health Organization. Severe acute respiratory infections treatment center: practical manual to set up and manage a SARI treatment center and SARI screening facility in health care facilities. Geneva: World Health Organization; 2020. Available at: https://apps.who.int/iris/handle/10665/331603. accessed on: 10 July 2020.
[16] Wehrens E, Bangura J, Falama A, et al. Primum non nocere: potential indirect adverse effects of COVID-19 containment strategies in the African region. Trav Med Infect Dis 2020;35:101727.
[17] Buonsenso D, Iodice F, Biala J, et al. COVID-19 effects on Tuberculosis care in Sierra Leone. Pulmon 2020;S2531–0437(20):30130–6.
[18] Bolkan HA, Bash-Taqi DA, Samai M, et al. Ebola and indirect effects on health service function in Sierra Leone. PLoS Curr 2014;6. ecurrents.outbreaks.0307d588df619f9c9447f 8ead5b72b2d.
[19] Durski K, Osterholm M, Majumdar S, et al. Shifting the paradigm: using disease outbreaks to build resilient health systems. BMJ Glob Health 2020;5:e002499.
[20] Ayebare R, Flick R, Okware S, et al. Adoption of COVID-19 triage strategies for low-income settings. The Lancet Respir Med 2020;8:e22.
[21] Blanton R, Mock N, Hiruy H, et al. African resources and the promise of resilience against COVID-19. Am J Trop Med Hyg 2020. https://doi.org/10.4269/ajtmh.20-0470.
[22] Somsen GA, van Rijn C, Kooij S, et al. Small droplet aerosols in poorly ventilated spaces and SARS-CoV-2 transmission. Lancet Respir Med 2020;8:658–9.
[23] Stein F, Perry M, Banda G, et al. Oxygen provision to fight COVID-19 in sub-Saharan Africa. BMJ Glob Health 2020;5:e002786.
[24] Elhadi M, Msherghi A, Alkeelani M, et al. Assessment of healthcare workers' levels of preparedness and awareness regarding COVID-19 infection in low-resource settings. Am J Trop Med Hyg 2020 Aug;103(2):828–33. https://doi.org/10.4269/ajtmh.20-0330.
[25] Emanuel EJ, Persad G, Upshur R, et al. Fair allocation of scarce medical resources in the time of covid-19. N Engl J Med 2020;382(21):2049–55. https://doi.org/10.1056/NEJMsb2005114.
[26] Coalition for Epidemic Preparedness Innovations. Creating a world in which epidemics are no longer a threat to humanity. 2019. https://www.who.int/immunization/sage/meetings/2019/april/1_CEPI_Summary_WHO_SAGE_Meeting_April.pdf?ua=1. Accessed on: 11 July 2020. Available at:.

Jan H Dubbink

Masanga Hospital, Masanga, Tonkolili District, Sierra Leone
Masanga Medical Research Unit (MMRU), Masanga, Tonkolili District, Sierra Leone
Center of Tropical Medicine and Travel Medicine, Department of Infectious Diseases, Amsterdam University Medical Centers, Amsterdam Infection & Immunity, Amsterdam Public Health, University of Amsterdam, Location AMC, Meibergdreef 9, 1100 DD Amsterdam, Amsterdam, the Netherlands

Tiago Martins Branco

Masanga Hospital, Masanga, Tonkolili District, Sierra Leone
Masanga Medical Research Unit (MMRU), Masanga, Tonkolili District, Sierra Leone

Kelfala BB Kamara

Masanga Hospital, Masanga, Tonkolili District, Sierra Leone
Masanga Medical Research Unit (MMRU), Masanga, Tonkolili District, Sierra Leone

James S Bangura

Masanga Hospital, Masanga, Tonkolili District, Sierra Leone
Masanga Medical Research Unit (MMRU), Masanga, Tonkolili District, Sierra Leone

Erik Wehrens

Masanga Hospital, Masanga, Tonkolili District, Sierra Leone
Masanga Medical Research Unit (MMRU), Masanga, Tonkolili District, Sierra Leone
Center of Tropical Medicine and Travel Medicine, Department of Infectious Diseases, Amsterdam University Medical Centers, Amsterdam Infection & Immunity, Amsterdam Public Health, University of Amsterdam, Location AMC, Meibergdreef 9, 1100 DD Amsterdam, Amsterdam, the Netherlands
Capacare, Trondheim, Norway, and Freetown, Sierra Leone

Abdul M Falama

District Health Medical Team, District Medical Office, Magburaka, Tonkolili District, Sierra Leone

Abraham Goorhuis

Masanga Medical Research Unit (MMRU), Masanga, Tonkolili District, Sierra Leone
Center of Tropical Medicine and Travel Medicine, Department of Infectious Diseases, Amsterdam University Medical Centers, Amsterdam Infection & Immunity, Amsterdam Public Health, University of Amsterdam, Location AMC, Meibergdreef 9, 1100 DD Amsterdam, Amsterdam, the Netherlands

Peter B Jørgensen

Masanga Hospital, Masanga, Tonkolili District, Sierra Leone
Masanga Medical Research Unit (MMRU), Masanga, Tonkolili District, Sierra Leone

Stephen S. Sevalie

Joint Medical Unit, 34 Military Hospital, Republic of Sierra Leone Armed Forces, Free Town, Sierra Leone
National COVID-19 Emergency Response Team, National Emergency Operations Centre, Free Town, Sierra Leone

Thomas Hanscheid

Faculdade de Medicina, Universidade de Lisboa, Lisboa, Portugal

Martin Peter Grobusch*

Masanga Medical Research Unit (MMRU), Masanga, Tonkolili District, Sierra Leone
Center of Tropical Medicine and Travel Medicine, Department of Infectious Diseases, Amsterdam University Medical Centers, Amsterdam Infection & Immunity, Amsterdam Public Health, University of Amsterdam, Location AMC, Meibergdreef 9, 1100 DD Amsterdam, Amsterdam, the Netherlands

* Corresponding author. Masanga Medical Research Unit (MMRU), Masanga, Tonkolili District, Sierra Leone.
E-mail address: m.p.grobusch@amsterdamumc.nl (M.P. Grobusch).