Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

COVID-19 preparedness in Malawi: a national facility-based critical care assessment

COVID-19 has emerged in 46 countries in the WHO African region as of May 6, 2020.[1] To treat patients with the disease, facilities require oxygen, intensive care unit (ICU) beds, ventilators, isolation space, and personal protective equipment (PPE) among other resources.[2] Even in well-resourced countries, COVID-19 has strained or overwhelmed health systems, necessitating surges in ICU capacity to accommodate the increased number of patients who are critically ill.[3]

Assessing readiness of health facilities is a key element of outbreak preparedness, and initial capacity assessments are central to WHO guidelines for country-level response to COVID-19.[4] Although concerns about the vulnerability of low-income countries' health systems are widespread,[5] few facility-level assessments of critical care capacity exist in these settings.[6] This lack of data is a substantial barrier to COVID-19 preparedness.

Malawi, is a low-income country of over 17 million people[7] with 41 reported cases of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and three deaths as of May 6, 2020.[1] In January and February, 2020, the Malawi Emergency and Critical Care (MECC) Survey assessed public hospital capacity at all four central (tertiary) hospitals in Malawi and a simple random sample of nine of the country's 23 district (secondary) hospitals. Here, we present data from the MECC Survey relevant to COVID-19 preparedness.

The MECC Survey combined the WHO Hospital Emergency Unit Assessment Tool[8] with additional questions on emergency and critical care capacity in hospitals in low-income countries. Newly developed questions were piloted and refined with expert review before inclusion (appendix p 1). The final instrument included questions for hospital administrators; clinicians in the emergency department or, if there was no emergency department, the outpatient department; clinicians in the internal medicine ward; and clinicians in the ICU or high-dependency unit, if present. Clinician surveys for each ward were similar but were adjusted on the basis of the anticipated care activities at each location. At hospitals without an emergency department, the outpatient department was substituted as the most likely site to receive new patients. The sample size of nine district hospitals was determined as part of the broader MECC Survey, using methods recommended by the WHO Service Availability and Readiness Assessment.[9] Eligible participants had to be aged 18 years or older, a staff member who had been working at the selected hospital for at least 1 month, and self-reported spending at least part of their time working in the hospital area corresponding to the survey section (ie, emergency department or outpatient department, general

Published Online
May 25, 2020
https://doi.org/10.1016/S2214-109X(20)30250-3

See Online for appendix

	District hospitals			Central hospitals			All hospitals		
	Outpatient or emergency department (n=9)	General ward (n=9)	Intensive care or high dependency unit (n=3)	Outpatient or emergency department (n=4)	General ward (n=4)	Intensive care or high dependency unit (n=5)	Outpatient or emergency department (n=13)	General ward (n=13)	Intensive care or high dependency unit (n=8)
Infection control and PPE									
Isolation room	0	6 (67%)*	0	1 (25%)	1 (25%)	0	1 (8%)	7 (54%)	0
Handwashing facilities	2 (22%)	0*	2 (67%)	4 (100%)	3 (75%)	4 (80%)	6 (46%)	3 (23%)	6 (75%)
Eye protection	1 (11%)	0	0	1 (25%)	1 (25%)	1 (20%)	2 (15%)	1 (8%)	1 (13%)
N95 masks	4 (44·4%)	7 (78%)	0	3 (75%)	3 (75%)	4 (80%)	7 (54%)	10 (77%)	4 (50%)
Gowns	2 (22%)	8 (89%)	2 (67%)	2 (50%)	2 (50%)	5 (100%)	4 (31%)	10 (77%)	7 (88%)
Gloves	9 (100%)	9 (100%)	3 (100%)	4 (100%)	4 (100%)	5 (100%)	13 (100%)	13 (100%)	8 (100%)
Diagnostics									
Pulse oximetry (continuous or intermittent)	2 (22%)	7 (78%)	3 (100%)	4 (100%)	4 (100%)	5 (100%)	6 (46%)	11 (85%)	8 (100%)
Arterial blood gas	0	0	0	1 (25%)	0	1 (20%)	1 (8%)	0	1 (13%)
Chest x-ray (portable or stationary)	8 (89%)	8 (89%)*	3 (100%)	4 (100%)	3 (75%)	4 (80%)	12 (92%)	11 (85%)	7 (88%)
Ultrasound	0	2 (22%)	1 (33%)	1 (25%)	2 (50%)	4 (80%)	1 (8%)	4 (31%)	5 (63%)
Treatment									
Oxygen	1 (11%)	7 (78%)	2 (67%)	4 (100%)	3 (75%)	5 (100%)	5 (38%)	10 (77%)	7 (88%)

Data are n (%). Number of facilities reporting adequate access to each item needed for the SARS-CoV-2 response. Facility-level data reflect average responses from individual respondents within each unit. Questions were not asked about access to SARS-CoV-2 testing because the survey was developed before the start of the pandemic. For oxygen, invasive mechanical ventilation, handwashing facilities, and isolations rooms, there was "adequately availability" at an area of the hospital if the average score was more than 2·5 (out of 3). For the remaining yes or no questions, a unit was considered to have access to an individual item if at least two staff members reported availability. PPE=personal protective equipment. SARS-CoV-2=severe acute respiratory syndrome coronavirus 2. *Data missing for this question from one respondent at one hospital.

Table: **Number of wards with adequate access to resources relevant to SARS-CoV-2 response**

medical ward, high-dependency unit or ICU, or administration). Answers were recorded from three staff members at each targeted area in the hospital to allow for addressing discrepancies between participants' responses by averaging answers. All participants provided written informed consent. Ethics approval was obtained from the Partners Institutional Review Board (2019P003457) and Malawi's National Health Science Research Committee (protocol #19/05/2346, approval number: 2346). The Malawi Ministry of Health also approved the study. All hospitals were contacted by study staff in advance of the study team visit and granted approval for study participation through district-level research committees.

For the current analysis, we examined questions relevant to treatment of patients with SARS-CoV-2. For questions on oxygen, non-invasive and invasive mechanical ventilation, handwashing facilities, arterial blood gas capabilities, chest x-ray, ultrasound, and isolation rooms, participants ranked availability on a scale of 1 to 3, with 1 indicating generally unavailable, 2 indicating some availability, and 3 indicating adequate availability, using definitions established by the WHO Hospital Emergency Unit Assessment Tool. The responses from the three participants from each hospital area were averaged to create a final ward score at a given facility. Study data were collected using REDCap electronic data capture tools[10] then analysed in Stata (version 16).

We interviewed 101 clinical staff (appendix p 2) and 13 administrators to develop capacity estimates for 34 units across 13 hospitals. The median population in a hospital catchment area was 681 375 (IQR 478 347–2 289 780). Among the 12 hospitals with available data, the median number of inpatient beds was 340 (271–602). Of the 13 hospitals surveyed, three had an ICU, three had a high-dependency unit, and one had both a high-dependency unit and an ICU (table), with a mean of 4·3 (SD 1·7) beds per unit. All four central hospitals, but none of the nine district hospitals, could give non-invasive ventilation and mechanical ventilation. There were 16 working ventilators across all four central hospitals.

Oxygen was reported as adequately available in five (38%) of 13 outpatient or emergency departments, ten (77%) of 13 general medical wards, and seven (88%) of eight ICU or high-dependency units (table). Regarding PPE, all units reported adequate availability of gloves but not eye protection or N95 masks. Isolation rooms were available in seven (54%) medical wards but only one (8%) outpatient or emergency department, and none of the ICUs or high-dependency units. Three (23%) medical wards, six (46%) outpatient or emergency departments, and six (75%) ICUs or high-dependency units had adequate access to handwashing facilities.

Using data collected during the first months of the COVID-19 pandemic, this analysis shows crucial gaps in resources needed to treat patients with SARS-CoV-2 infection in Malawi. Expanding and strengthening health system capacity must be prioritised to address this need. The restricted availability of oxygen in medical wards is a particular cause for concern and will result in avoidable mortality in the event of a widespread outbreak.

The lack of PPE poses a substantial risk to health-care workers and must also be addressed. Globally, thousands of health-care workers have already been infected with SARS-CoV-2 and many have died.[11]

Finally, our findings highlight the crucial importance of early containment in Malawi and other low-income countries through widespread testing, outpatient treatment, contact tracing, isolation, and physical distancing. These efforts must be multisectoral and tailored to the local context. Effective isolation and quarantine will probably require additional social supports, such as food and water distribution.

These results should be interpreted in the context of the study design. As a single-country analysis, the generalisability of our findings to other low-income countries is unknown, but similar gaps probably exist in other countries with substantial resource-constraints. Furthermore, our sample size was determined as part of a larger study; however, even if not generalisable across the entire health system, the reported gaps are still of importance. Our instrument was not specifically designed to assess COVID-19 preparedness because the pandemic had not begun when the study was designed, but survey administration coincided with the beginning of the outbreak. Finally, although we interviewed multiple participants on each ward to improve the accuracy of our estimates, some reporting bias might exist (eg, social desirability), which could result in overestimation of resource availability.

These findings provide unique facility-based data characterising of available resources necessary for COVID-19 preparedness in an low-income countries. Our results highlight the urgent need for short-term interventions against the current outbreak in Malawi. In the long-term, health system strengthening is needed to ensure the capacity of low-income countries to mitigate the effects of future pandemics.

We declare no competing interests. PDS and JM are joint first authors. MN and SAR are joint senior authors. PDS received funding support for this study from the Division of Pulmonary and Critical, Care Medicine at Brigham and Women's Hospital. SAR received an Esther B Kahn Seed Grant from the Department of Emergency Medicine at Brigham and Women's Hospital. The funders had no role in study design, data collection, data analysis, data interpretation, or writing of the report. We thank Joia Mukherjee for her advice and support, Neill Adhikari and the CERTAIN study group for permitting us to use their survey validation tool during the piloting our instrument, Tim Baker for his feedback during the development of our survey instrument, and the Ministry of Health and Population of the Republic of Malawi for their support and dedication to these important topics. We thank the staff at Abwenzi Pa Za Umoyo/Partners In Health for their support of survey implementation.

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