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## Pulse oximetry in low-resource settings during the COVID-19 pandemic

Pulse oximetry is essential for assessing oxygen saturation during respiratory compromise and for monitoring patients undergoing anaesthesia, who are critically ill, or whose condition is rapidly evolving. More immediately, during the ongoing COVID-19 pandemic, silent hypoxia (ie, abnormally low oxygen saturation without symptoms of dyspnoea), is common in patients with COVID-19.<sup>1</sup> In low-resource settings where oxygen supplies and monitored beds are scarce, pulse oximetry is a crucial device for triaging patients and establishing the need for supplemental oxygen.<sup>2</sup> Early recognition of hypoxia and oxygen administration has been shown to reduce mortality,<sup>3</sup> and a triage tool developed in collaboration with WHO uses pulse oximetry to guide management of oxygen therapy.

In Ethiopia, pulse oximetry is not widely available.<sup>4</sup> The Federal Ministry of Health has developed a National Newborn and Child Survival Strategy to address these gaps, and efforts have been made between the Ministry and aid organisations to combat pneumonia and neonatal hypoxaemia and tackle shortfalls in perioperative care.<sup>5,6</sup>

As part of a long-term pulse oximeter training and distribution programme developed by the Lifebox Foundation, we surveyed Ethiopian hospitals for the presence and functionality of devices and capacity for oxygen saturation monitoring. In partnership with national anaesthesia professional societies, we approached anaesthesia providers in facilities capable of providing surgical care, because these providers and hospitals have been the focus of previous distribution efforts and they typically have access to a pulse oximeter if it is available. Hospitals were selected by purposive sampling, including

ten hospitals each in the five most populated regions, and at least two each in the remaining six regions.

From 90 candidate public hospitals nationwide, 60 were identified and one anaesthesia provider from each was contacted for participation; 58 public hospitals and one private hospital completed the survey. All surveyed hospitals reported at least one functioning operating room. They had a median of 3 (IQR 2–5) integrated pulse oximetry monitors (IPOs) and 0 (0–2) portable pulse oximetry monitors (PPOs; appendix). Most surveyed hospitals (49 [83%]) reported additional integrated monitors in their post-anaesthesia care unit (PACU) but few portable monitors (median 0 [IQR 0–1]). Of the 41 (70%) hospitals with an intensive care unit (ICU), there were a median of 4 (4–6) integrated monitors but 0 (0–1) portable devices. 54 (91%) hospitals had an emergency room with at least one bed for critically ill patients (median 4 [IQR 2–6]), but a median of only 1 (0–2) integrated and 0 (0–1) portable pulse oximetry monitors.

We calculated the monitoring gap (designated high-acuity beds–pulse oximetry monitors) for each clinical area. In operating rooms, the mean monitoring gap was –0.6 beds (SD 2.3), meaning that on average, every operating room bed was monitored. The mean gap in PACUs was 2.9 beds (SD 3.1), in ICUs it was 1.2 (SD 2.7), and in emergency rooms it was 2.9 (SD 3.1).

Although pulse oximetry monitoring capacity is well met in most of the Ethiopian operating rooms surveyed, four referral and two general hospitals reported at least one operating room without a patient monitor. Furthermore, large gaps remain in other critical units of the hospital, including PACUs, ICUs, and emergency rooms, where on average there were 1–3 unmonitored high-acuity beds per unit. Particularly in emergency rooms, about 75% of

critical beds were unmonitored in referral and general hospitals, and primary hospitals had essentially no access to pulse oximetry. Over the past 8 years, Lifebox has distributed 1108 devices in Ethiopia, typically directly to anaesthesia providers; nearly half of those surveyed had received one, and of 140 devices that were identified during the survey work, 123 were still in use up to 7 years later (nine were reported as missing and eight reported as malfunctioning). These were typically owned by the providers themselves and were thus not available for flexible clinical use. Despite its durability and usefulness in clinical care, there were very few generally available portable pulse oximeters that could move to areas of a hospital as needed, whether to recovery rooms, intensive care, emergency units, or even point-of-care screening and triage areas.

The pulse oximeter was a crucial monitoring device before the pandemic, and will be long after it subsides. Although oxygen saturation assessment and monitoring is a critical component of patient triage and clinical decision making during the COVID-19 pandemic, few pulse oximeters are available in low-resource settings. Ethiopia is no exception, and closing the monitoring gap in clinical environments, including emergency and critical care units, should be prioritised, as should availability of oxygen resources. Pulse oximeters enable clinicians to identify and rapidly treat hypoxia, monitor patients in respiratory distress or at risk of deterioration, and aid decision making and allocation of precious hospital beds and oxygen resources. Their scarcity is symptomatic of the insufficient investment in emergency and essential critical care<sup>7</sup> and the surgical, obstetric, and anaesthetic ecosystem.<sup>8</sup> Investing in these devices pays tremendous dividends because they are durable, highly valued, and can be rapidly used across clinical units.



Published Online  
July 3, 2020  
[https://doi.org/10.1016/S2214-109X\(20\)30287-4](https://doi.org/10.1016/S2214-109X(20)30287-4)

See Online for appendix

For the Lifebox triage tool see  
<https://www.lifebox.org/covid-19-decision-tool/>

NS and DR contributed to study design, data analysis, data interpretation, writing of the manuscript, and clinical revision. SB, IW, and MT contributed to study design and clinical revision. YMA, LA, HAM, MWM, and EM contributed to data collection, data interpretation, and clinical revision. TGW contributed to study design, data interpretation, writing of the manuscript, and clinical revision. MT and TGW provided study oversight. NS is a surgical safety fellow, SB is the programme manager, and TGW is the consulting medical officer for Lifebox. YMA is an employee of Jhpiego. YMA, LA, HAM, MWM, and EM were supported by Lifebox for contribution of their time in data collection. NS is supported by a National Institutes of Health T32 grant, DK007573. DR was supported by institutional funds from New York University School of Medicine. IW and MT declare no competing interests.

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**\*Nichole Starr†, Daniela Rebollo†,  
Yohannes Molla Asemu,  
Leulayehu Akalu,  
Hanan Ali Mohammed,  
Misrak Woldeyohannes Menchamo,  
Eyayelem Melese, Senait Bitew,  
Iain Wilson, Mahelet Tadesse‡,  
Thomas G Weiser‡  
nichole.starr@ucsf.edu**

†Joint first authors

‡Joint last authors

Department of Surgery, University of California San Francisco, San Francisco, CA 94143, USA (NS); Lifebox Foundation, London, UK (NS, SB, IW, TGW); Department of Surgery, New York University School of Medicine, New York, NY, USA (DR); Jhpiego Ethiopia Country Office, Addis Ababa, Ethiopia (YMA); Ethiopian Association of Anesthetists, Addis Ababa, Ethiopia (YMA, LA, HAM, MWM, EM); Addis Ababa University College of Health Sciences, School of Medicine, Addis Ababa, Ethiopia (LA, MWM, EM, MT); Royal Devon and Exeter NHS Foundation Trust, Exeter, UK (IW); Ethiopian Society of Anesthesiologists, Addis Ababa, Ethiopia (MT); and Department of Surgery, Stanford University, Stanford, CA, USA (TGW)

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