

Perioperative provider safety in low-and middle-income countries during the COVID-19 pandemic: A call for renewed investments in resources and training

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Abbreviations

Low- and lower-middle income countries	LIC/L-MICs
Low- and middle-income country	LMIC
Personal protective equipment	PPE
Upper-middle income countries	UMICs

Mini-Abstract:

During the COVID-19 pandemic, protection of the surgical workforce with proper PPE and safety practices is essential. We surveyed 230 surgical facilities and 507 perioperative clinicians in 52 low- and middle-income countries in October 2020 to understand ongoing resource and training limitations. Facilities and clinicians in the lowest income countries had severe shortages in PPE, viral anesthesia filters, and the least COVID-19 related training and protocol implementation, all of which were associated with low perceived workplace safety. Understanding these gaps can help to direct local and international responses to improve surgical provider safety until the pandemic comes to an end.

The protection of healthcare workers is vitally important during the coronavirus pandemic¹. In addition to delays in availability of vaccines for low- and middle-income country (LMIC) providers², there are ongoing deficits in COVID-19 mitigation and provider protection efforts, particularly with respect to personal protective equipment (PPE)³. Pandemic-related supply chain disruptions have resulted in severe shortages of PPE, including gloves, masks, and eye protection used routinely in patient care by surgical and anesthetic providers. Furthermore, continued development and implementation of policies and procedures for the safe donning, doffing, and use of PPE is essential. This includes protocols for managing COVID-19+ patients on the wards and in the operating theatre. We conducted a global survey of surgical facilities and perioperative providers to assess the availability of materials and

safety processes, including provider training, for preventing transmission of SARS-CoV-2 in the perioperative setting.

An online facility-level survey was distributed to contacts of Lifebox, Smile Train, and Jhpiego who work at partner hospitals. A second online survey aimed at individual providers was disseminated widely through our networks and via social media. Both surveys were translated into nine languages (English, Bahasa, French, Spanish, Khmer, Mandarin, Portuguese, Vietnamese), to align with common organization partner languages. Responses were collected in October, 2020 and all data were anonymized. Participation was voluntary, ethical approval was obtained, and data were analyzed using Stata v.15.1. Primary outcomes of interest were provider reported PPE availability and self-purchasing, COVID-19 related training and protocol usage, and surgical facility COVID-19 testing, viral filter and pulse oximeter availability as reported by a senior level single facility respondent.

A total of 230 facility and 507 provider surveys, representing 52 LMICs, were included in the analysis. Provider and facility surveys were similar in regional, hospital type, and hospital level distribution. We stratified data by income classification, grouping low- and lower-middle income countries (LIC/L-MICs) as compared to upper-middle income countries (UMICs) to better elucidate where the largest gaps in training and material resources were located.

Providers LIC/L-MICs reported less training in COVID-19 protocols for the operating room (51.2% vs 81.8%), PPE donning and doffing (67.2% vs 86.4%), and COVID-19 surgical patient checklist (40.0% vs 59.8%) than those in UMICs (Table 1). Actual use of protocols followed the same pattern, with LIC/L-MIC providers reporting less COVID-19 protocol implementation (48.5% vs 78.8%).

In LIC/L-MICs, providers did not have routine access to N95s (37.1%), surgical masks (29.1%), gloves (21.6%) or eye protection (30.9%). Shortages were present but less severe in UMICs. Clinicians also reported reusing PPE; some were reusing PPE without decontamination (7.7% in LIC/L-MICs vs. 6.8% in UMICs). Other providers (8.8% in LIC/L-MICs vs. 6.1% in UMICs) reported using decontamination methods known to damage N95s and surgical masks such as soap and water, alcohol, and bleach. More providers in LIC/L-MICs felt unsafe performing their clinical duties than in UMIC (35.5% vs. 6.8%, $p<0.001$). In a multivariate logistic regression analysis, completion of training, use of protocols, and availability of N95s and eye protection were all associated with higher perceived safety.

Surgical facilities in LIC/L-MICs had less access to SARS-CoV-2 testing (75.3%) compared to UMIC (92.3%, $p=0.008$) and were performing less testing for surgical patients (37.1% vs. 50.0%, $p=0.012$), and fewer facilities had designated an operating room for COVID-19+ or suspected patients, although the difference was not significant (32.6% vs. 46.2%, $p=0.078$). Pulse oximetry was lacking in LIC/L-MIC surgical suites with only 84.8% having a pulse oximeter for each OR and 57.9% for each recovery room bed. Viral filters for the anesthesia

machine and ventilator circuit were also critically scarce in LIC/L-MICs: 25.8% of facilities reported having none, and 28.1% reported severe to moderate shortages.

At the time of the survey, the seven-day rolling average of new confirmed COVID-19 cases per million people in LIC/L-MICs respondent countries was <30 cases per million people and the majority of UMIC case rates <50 cases per million. Outliers to the LIC/L-MIC average were Nepal (~100 cases per million) and Honduras (~60) while outliers to the UMIC average were Argentina (~300) and Colombia (~150)⁴. This is contrasted sharply with rolling seven-day averages in the US at 200 and UK at 300 cases per million during the same time period, although lower testing in LMIC environments may contribute to falsely low numbers of confirmed cases. In May 2021, as seven-day rolling average cases fell in the US, UK, Canada, Germany and other HICs to <100, new cases in LIC/L-MIC were rising rapidly to around 50 per million on average, and notably in India and Nepal were around 200 per million. UMIC respondent country cases also continue to rise with Argentina and Colombia holding at 300 and 150 and many others >100 cases per million. Furthermore, while vaccination rates are approaching 50% in many HICs, the majority of LIC/L-MICs have rates <5% and UMICs <15%⁵. Even relatively high vaccination performers such as India (12%), Brazil (22%) and Argentina (21%) still have high case burdens and lower percentages of the population vaccinated in comparison with HICs.

As we enter the second year of the COVID-19 pandemic, a renewed commitment including investments are needed to protect the health and safety of health care workers, including those providing essential and emergency surgery^{6,7}. In May 2020, an assessment of 13 hospitals in Malawi found that supplies of N95 respirators and eye protection were inadequate and identified insufficient availability of handwashing facilities⁸. Months later, our survey reveals persistent shortages, pervasive throughout low- and middle- income settings globally. Gaps in training and implementation of COVID-19 related safety processes, poor access to PPE, and absence of viral filters continue in many settings. Our survey demonstrates that insufficient safety practices and lack of material resources are associated with perceived low safety. These shortages not only lead to perceived shortages, but there is probable real danger to providers. Our survey suggests that the lowest income environments continue to experience the greatest need for access to PPE and training as compared to their upper-middle income counterparts, and urgent support for resources to these areas is needed in the short-term.

Methods such as UV-C irradiation, humid heat, and the wait and reuse method can be used in crisis shortages to safely decontaminate and reuse N95s to expand the PPE supply. More sustainable solutions such as the procurement of elastomeric respirators for long-term reuse should be considered. Additionally, local surgical mask, N95 and other PPE manufacturing can help to ameliorate these shortages, and reduce reliance on supply chains that may be overwhelmed and prioritize delivery of contracts to high-income countries. Many training materials around PPE donning and doffing, OR safety protocols and checklists have been created by the international response community, including the World Health Organization COVID app⁹ and others such as Emory University and Médecins Sans Frontières, that could

be adapted and delivered to surgical teams, if local protocols do not exist. Ministries of Health and national or regional professional societies are integral to contextualizing and implementing any training or donation program and must be included as well.

Perioperative providers are experienced in infection prevention and sanitation and well positioned to strengthen these practices during the COVID-19 pandemic¹⁰. With coordination and improved access to training and materials, providers will be able to more safely provide essential surgical services. The providers included in this study may not represent all clinical practice settings in LMICs, with variable resources available by country and facility type. However, current severe resource and training shortages, affecting providers with some of the highest exposure risks and routine involvement in aerosol-generating procedures, are likely the tip of the iceberg - indicating widespread, fundamental gaps in provider safety.

This study has some limitations. Survey dissemination methodology may have resulted in more responses from providers at particular facility types, e.g., partner facilities or those working in urban areas with improved connectivity. Responses from both providers and facilities were predominantly referral and teaching level, potentially better resourced than primary/secondary or rural facilities, and the facility survey had a response rate of approximately 20%. Providers with greater concerns or resource deficits may have been more likely to participate; alternatively, the worst affected providers may have had limited capacity to do so. A targeted survey to follow up on particular equipment shortages or to address newer issues such as vaccine access could be distributed using cluster sampling, designed to proportionally represent regions based on overall population or COVID-19 prevalence.

The global health community and leading policy organizations, including the United Nations, are calling for solidarity worldwide to emerge from the pandemic, particularly around vaccine distribution⁹. Any vaccination campaign, however equitable, will take months, at a minimum, to reach herd immunity levels that allow for relaxation of PPE and safety protocol use in hospitals. The ongoing, severe shortage of protective equipment and training gaps should be immediately remediated to prevent the loss of healthcare workers in lower-income environments, both from the virus and from the burnout resulting from chronically unsafe working conditions. As resource shortages subside and vaccines become widely available in wealthier countries, the ethical distribution of diagnostic, treatment, and protection resources to low-income nations and essential healthcare workers must not be ignored¹¹. We urge local and international organizations, professional societies and donors to redouble efforts to ensure providers in the lowest-income environments have consistent access to PPE, viral filters, pulse oximeters and the training and protocols to appropriately utilize protective and clinical resources. With solidarity, creativity, and persistence, we can improve workplace safety as we fight to emerge from the COVID-19 pandemic, and improve our global preparedness for the future without leaving providers in the lowest-income environments behind.

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Table 1: COVID-19 related resources, training and safety reported by LMIC surgical providers and facilities

Perioperative Clinical Provider Survey (N = 507)	LIC/L-MIC n=375	UMIC n=132	p-value	Multivariate Predictors of Perceived Safety at work during COVID-19*	
				O R	p-value
Demographics					
<i>Region</i>			<0.001		
East Asia & Pacific	31 (8.3%)	33 (25.0%)			
Latin America & Caribbean	29 (7.7%)	92 (69.7%)			
South Asia	141 (37.6%)	0 (0.0%)			
Sub-Saharan Africa	172 (45.9%)	5 (3.8%)			
Designated COVID-19 Care Center	62 (16.5%)	39 (29.5%)	0.001		
Personally cared for COVID-19 Patients	171 (45.6%)	73 (55.3%)	0.16		
Feel unsafe at work	133 (35.5%)	9 (6.8%)	<0.001		
Training					
COVID-19 OR Protocols	192 (51.2%)	108 (81.8%)	<0.001	3.05	0.001
PPE Donning & Doffing	252 (67.2%)	114 (86.4%)	<0.001	4.45	0.001
COVID-19 Surgical Patient Checklist	150 (40.0%)	79 (59.8%)	<0.001	3.17	0.001

Protocol Use					
Use of COVID-19 OR Protocol	182 (48.5%)	104 (78.8%)	<0.00 1	3.7 7	<0.00 1
WHO Surgical Safety Checklist Use	226 (60.3%)	85 (64.4%)	0.94	2.4 7	0.008
COVID-19 Surgical Patient Checklist	122 (32.5%)	55 (41.7%)	0.14	4.4 7	<0.00 1
PPE Shortages: Item not routinely available to providers					
N95	139 (37.1%)	23 (17.4%)	<0.00 1	4.8 2	<0.00 1
Surgical Mask	109 (29.1%)	43 (32.6%)	0.45		
Gloves	81 (21.6%)	14 (10.6%)	0.005		
Eye Protection	116 (30.9%)	26 (19.7%)	0.013	2.8 0	0.027
PPE Purchasing: Provider reports purchasing item					
Purchase N95s	150 (40.0%)	60 (45.5%)	0.27		
Purchase surgical masks	90 (24.0%)	20 (15.2%)	0.034	0.7 0	0.049
Purchase gloves	57 (15.2%)	9 (6.8%)	0.014		
Purchase Eye Protection	115 (30.7%)	70 (53.0%)	<0.00 1	0.9 3	0.261
PPE Reuse & Decontamination					
<i>N95 Decontamination</i>					
Reuse without decontamination	29 (7.7%)	9 (6.8%)	0.73		
Appropriate method (Wait & reuse, UVC, H2O2, heat)	81 (21.6%)	34 (25.8%)	0.33		
Inappropriate method (Alcohol, bleach, soap and water)	33 (8.8%)	8 (6.1%)	0.32		
Surgical Facility Survey (N=230)	LMIC n=178	UMIC n=52	p- value		

Third Level/Referral Hospital	80 (44.9%)	20 (38.5%)	0.16		
Teaching Institution	60 (33.7%)	16 (30.8%)	0.69		
Stopped or delayed surgery due to COVID-19	124 (69.7%)	32 (61.5%)	0.25		
Laboratory testing available for SARS-CoV-2	134 (75.3%)	48 (92.3%)	0.008		
COVID-19 Preoperative testing for all surgical patients	66 (37.1%)	26 (50.0%)	0.012		
Operations performed on COVID-19+ patients	66 (37.1%)	25 (48.1%)	0.15		
Designated OR for COVID-19+ patients	58 (32.6%)	24 (46.2%)	0.078		
Pulse oximeter available for each OR	151 (84.8%)	50 (96.2%)	0.013		
Pulse oximeter available for each recovery bed	103 (57.9%)	45 (86.5%)	<0.001		
HEPA/Viral Filter Availability			0.01		
None	46 (25.8%)	5 (9.6%)			
Severe or moderate shortage	50 (28.1%)	11 (21.1%)			

*Multivariate regression analysis controlled for income level, hospital level, type and location and experience caring for COVID-19. Only statistically significant predictors of safety in univariate analysis were included in the multivariate regression model and reported here.