OPEN

COVID-19 Preparedness Within the Surgical, Obstetric, and Anesthetic Ecosystem in Sub-Saharan Africa

Community transmission of COVID-19 is already being reported in Africa.[1] Most countries on the continent will have +10,000 confirmed cases within the month.[2] The population, while generally younger than in Europe and North America, has much higher rates of poverty, malnutrition, HIV, and TB, which could shift the demographics of lethality. For surgeons, obstetricians, and anesthesiologists, the major challenge will be maintaining provision of emergency and essential surgery and obstetric care while preserving precious resources, minimizing exposure of health care workers, and preventing onward transmission (Table 1).[3] The human skill sets, resources, and supply chains supporting surgical services are also those needed for responding to the crisis.[4,5]

DEVELOP A CLEAR PLAN FOR PROVIDING ESSENTIAL OPERATIONS DURING THE PANDEMIC

The capacity to care for surgical and obstetric emergencies must be preserved. Many facilities have already postponed elective operations to conserve vital resources, but this approach is not as applicable as in high-income countries. Operations in the region are frequently for high-risk cancers or highly symptomatic patients, for which current guidance is not to postpone. The surgical burden is already high, and limitations on services will exacerbate waiting lists and sacrifice essential care.

Truly elective operations should, however, be postponed immediately to preserve the health and wellbeing of surgical, anesthetic, nursing, and cleaning staff. These providers will be important resources during a surge response. Many providers rely on elective and private work for their financial well-being, thus postponing elective surgery may work against their financial incentives. However, improved health worker and patient safety through reduced transmission is a compelling enough argument. To facilitate decision making and avoid conflicts, a triage algorithm needs to be established and enforced, such as that proposed by the American College of Surgeons: https://www.facs.org/about-acs/covid-19/information- for-surgeons/triage.

Patients should be kept geographically separate from COVID+ patients and discharged expeditiously to minimize nosocomial transmission.[6–8] If case burden is high, consider dedicating one OR to COVID+ operations only (ideally with neutral or negative pressure).[9] This should be emptied of all nonessential materials and equipment. No unnecessary items should be brought into the operating room, including personal items such as mobile phones and pens. Personal linens and coverings such as cloth masks and bonnets should be laundered at least daily, and probably more often when treating COVID+ patients.

DECREASE EXPOSURE OF HEALTH CARE STAFF AS MUCH AS PRACTICABLE AND PREVENT NOSOCOMIAL TRANSMISSION TO OTHER PATIENTS AND PERSONNEL

While few staff are adequately trained in the appropriate use and application of personal protective equipment (PPE), perioperative personnel are at an advantage given their familiarity with maintaining sterility. Staff should receive training in appropriate donning and doffing techniques through simulation and videos (without using precious resources). Clear instructional posters for PPE donning/doffing should be prominently displayed, and the use of 2 providers should be encouraged to allow 1 person to observe and coach the other through the steps of the routine: www. cdc.gov/hai/pdfs/ppe/ppe-sequence.pdf.[10–15] Hand hygiene is critical, and 70% alcohol-based hand rub should be made widely available: https://www.who.int/gpsc/5may/Guide_to_Local_Production.pdf. Symptomatic workers should not provide patient care but rather self-isolate, and testing of these workers should be prioritized.

Limiting unnecessary patient, family, and health worker movement through the hospital decreases the introduction and transmission of disease. When not essential, keep surgical and anesthetic staff out of hospital to preserve human resources. Trainees and students, in particular, should not be involved with known COVID+ cases unnecessarily. For usual care routines, including patient encounters, plain surgical masks can lower rates of health care worker infections and are recommended.[16–18] Ancillary staff such as OR cleaners, instrument reprocessing staff, and laundry personnel should take appropriate precautions and wear full PPE (goggles or face shield, surgical mask, heavy duty gloves, and long sleeved gown).[5] No special decontamination methods other than machine laundering with detergent are required for laundering linens; all surface areas should be disinfected with 0.5% chlorine or 70% alcohol solutions.

Patients with known or suspected COVID-19 should wear surgical masks when being transported through hospital spaces or in rooms without negative pressure isolation.[19–21] Intubation is an aerosolizing procedure and should be performed by the most skilled provider available wearing an N95 or KN95 mask. *Only absolutely essential staff* should be present during intubation, and IV rapid sequence induction without bag mask ventilation is preferred.[22] When appropriate and safe, consider regional anesthesia with IV sedation to reduce aerosols. Whenever practicable, decrease case duration and limit aerosol-generating maneuvers (such as the free release of pneumoperitoneum during laparoscopy). Patients should be recovered in the OR, and prior to transport an advance runner sent to clear the path. Consider using a checklist to ensure appropriate precautions are taken for operations with suspected or known COVID-19 patients (Fig. 1).[7]

Viral filters and appropriate circuit cleaning measures are essential and should be reviewed,[6,23] otherwise ventilation mechanics may disseminate aerosols throughout an intensive care unit (ICU). If single-use plastic anesthesia or surgical equipment (endotracheal tubes, ventilator circuit tubing, plastic suction tubing, electrocautery handpieces) must be reused, ensure that disinfection aiming for "high-level disinfection" or "sterility" is employed, including immersion in appropriate concentration glutaraldehyde, phenol, or hydrogen peroxide solution.[7,20,24]

Surfaces in the OR should be thoroughly cleaned between cases, including pulse oximeter probes, thermometers, blood pressure cuffs, and other reusable materials; SARS-CoV-2 is rapidly killed with 70% alcohol solution or 0.5% chlorine solution.[5,25] Using clear plastic sheets (cleaned or changed in between patients) to cover the anesthesia machine, the monitors, and the patient's face during aerosol-producing maneuvers like intubation and extubation, could provide additional protection.

CONSERVE PPE AND CONSUMABLES

Manufacturers are already filling backorders from high-income countries; this will additionally stress supply chains to Africa. Familiarity with severe resource shortages may guide creative and innovative strategies to

The authors report no conflicts of interest. NS is supported by NIH grant T32 DK007573.

ISSN: 0003-4932/20/27201-00e9
DOI: 10.1097/SLA.0000000000003964

TABLE 1. Recommendations for COVID-19 Preparedness Within the Surgical, Obstetric, and Anesthetic Ecosystem in Sub-Saharan Africa

Develop a clear plan for essential operations during pandemic	Preserve hospital capacity to care for surgical and obstetric emergencies
	Postpone truly elective operations to preserve PPE, staff and facility capacity
	Adapt algorithms to categorize cases as elective, urgent, or emergent, and enforce them
	Trial nonoperative management of patient conditions when safe for patients
	Keep COVID+ patients geographically separate from other surgical patients
	Consider dedicating one OR cleared of all nonessential equipment for COVID+ patient use if case burden is high
	Operating rooms used for COVID+ patients should be kept at neutral or negative pressure
Limit exposure of health care staff and prevent hospital transmission of SARS-CoV-2	Train staff on appropriate donning and doffing of PPE
	Encourage simulation and use of providers for donning/doffing procedures
	Limit unnecessary patient and physician movement through the hospital, limit visitors
	Avoid involving students and trainees in patient care of COVID+ patients when possible
	Minimize the staff required in the hospital to preserve human resources
	All staff including cleaners, laundry personnel, and others should be provided with appropriate PPE
	Use surgical masks when caring for COVID-19 suspected or infected patients
	Launder all contaminated linens with detergent regularly
	Disinfect all hard surface areas regularly with 0.5% chlorine or 70% alcohol solution
	Enforce frequent and proper handwashing practices—Alcohol-based hand rub can be locally manufactured easily and inexpensively
	Develop care protocols and teams specifically for COVID response
	Minimize aerosols during anesthesia: use regional anesthesia when possible, most senior provider should attempt intubation, only absolutely essential personnel in OR during intubation, recover patients in OR
	Limit case duration, limit aerosolization during laparoscopy
	Consider use of COVID checklist for suspected/known COVID patients undergoing surgery
	If reprocessing single use plastic materials, achieve high-level disinfection, or sterilization
Conserve PPE and consumables	Develop a clear understanding of current stocks and supply chains
	Airborne precautions (N95 or PAPR) only required during aerosolizing procedures (intubation, bronchoscopy, NIPPV, high flow nasal cannula oxygen, nebulized medication administration)
	Use droplet and contact precautions (surgical mask, eye protection, gown, gloves) for other patient encounters with suspected or known COVID patient.
	Extended use of N95 masks is preferred to reuse of the same mask
	N95 mask contamination may be reduced by covering with plastic face shield or surgical mask
	Do not decontaminate N95 respirators with chlorine or alcohol solution
	If severe shortage, consider reprocessing N95 masks (see www.n95decon.org for up-to-date information)
	Launder reusable PPE (cloth hats, gowns, etc) between each use
	Cloth masks should be used as a last option only as they provide less protection against droplet or airborne particles
Plan to expand critical care and repurpose staff	Carefully consider if/how many ORs or PACUs could be repurposed for critical care needs
	Prepare providers to work outside their usual scope of practice
	Provide refresher trainings on ventilator management, critical care, and COVID-specific care guidelines to providers who may be asked to work in different areas
Support staff wellness while assisting with difficult ethical considerations	Provide material and psychological resources to staff during this time of crisis
	Consider how needs such as HCW home isolation, child care, meal preparation, or general stress management can be supported by hospital leadership
	Develop a plan in advance for managing resource shortages and determining scarce resource allocation
	Frontline healthcare workers should not have to make resource allocation decisions alone
	Provide compassion, empathy and respect for patients, family members, and healthcare workers in this time of crisis

conserve and extend resources. Extended use of N95 masks (continuous wearing while seeing multiple patients) is preferred to limited reuse of N95 masks (doffing and redonning between patients).[26] N95 mask life may be lengthened by wearing a plastic face shield or a surgical mask over it. Use of chlorine or alcohol solution to sanitize N95 masks damages mask integrity; however heating to 70°C (160°F) in a dry oven for 60 minutes seems a promising solution to disrupt viral particles and maintain mask integrity for reuse, as have other methods that may be less readily available such as hydrogen peroxide vapor and high-dose ultraviolet-C exposure.[27,28] Other innovative solutions are being proposed, as in this example from Boston Children's Hospital: https://www.youtube.com/watch?v=E-s_iY5WJdmI. While N95 masks are superior to surgical masks in protecting against aerosolized viral particles, surgical masks still afford significant protection over no mask.[29–31]

Cloth attire in the form of scrub hats or bonnets should be laundered between each use if possible, and no less than daily. If gowns are repurposed for isolation units, they should be laundered after each prolonged care routine; consider wearing rubber aprons under such gowns. The protection afforded by cloth masks is not well studied but may be significantly less than surgical masks and is not protective to the same extent as N95 respirators; it should be used as a last option only.[5,29,32–36]

PLAN FOR STRATEGIC REPURPOSING OF ORs, RECOVERY AREAS, AND STAFF FOR MANAGING COVID-19 CASES

The commandeering of ORs for use as ICUs, which has been proposed in many high-resource settings, must be done with extreme caution. Emergency surgery capacities should not be compromised by taking up all available OR space and anesthetic machines with COVID+ patients. As the average reported time spent on mechanical ventilation has been up to 13 days,[37,38] critical resources and space will be occupied for

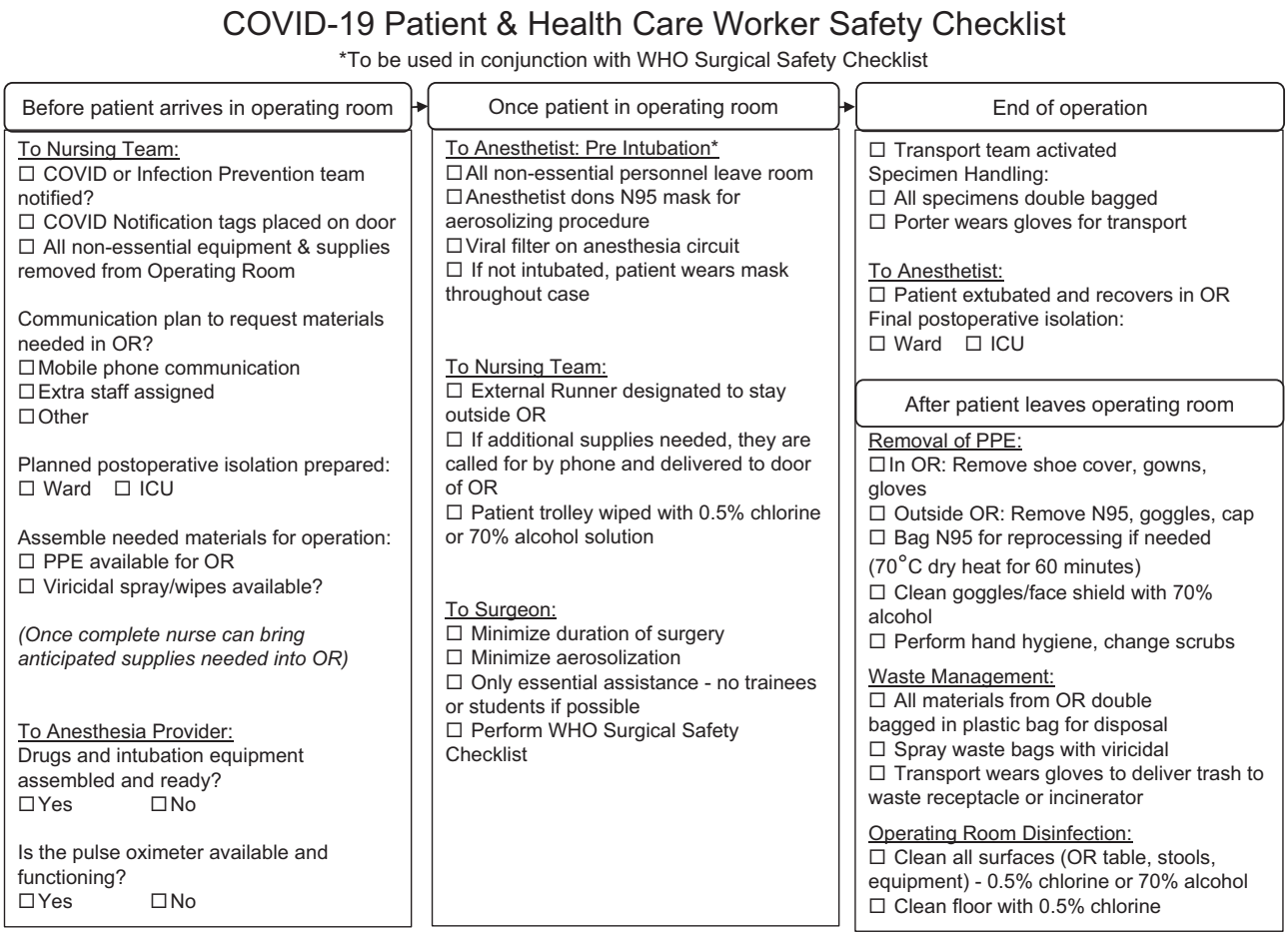

FIGURE 1. Perioperative checklist for operations on confirmed or suspected patients with COVID-19.

weeks to months and will be difficult to reclaim once repurposed.

Guidance and training should be provided *immediately* to make best use of the technical and clinical skills of all perioperative personnel—waiting until caseloads increase will unduly delay preparations. Hospitals, professional societies, and ministries of health should provide physician and nursing staff with basic ICU and ventilator management refresher education to improve their skill sets; SAGES and the Faculty of Intensive Care Medicine have recently provided such resources: https://www.sages.org/basics-of-mechanical-ventilation-for-non-critical-care-mds/ and https://icmanaesthesiacovid-19.org/clinical-guidance.

MAINTAIN AND SUPPORT STAFF WELLNESS WHILE ASSISTING WITH DIFFICULT ETHICAL CONSIDERATIONS IN RESOURCE MANAGEMENT

Doctors, nurses, cleaners, and other hospital support staff have significant anxieties that must be acknowledged and managed. The fears of transmitting to family or becoming infected oneself, the increase in work hours, and the need for childcare coverage are real. Furthermore, providers may be understandably nervous about providing care outside of their normal scope of practice or working beyond their area of competence. Leadership can help by providing information in a transparent way, expressing gratitude for the commitment to patients and colleagues, and offering reassurance that the system will help protect them and support them and their family.

As ventilators will be critically inadequate, there will be additional emotional distress when allocating resources and denying care to patients. Facilities should create a committee and utilize standardized risk assessments to determine allocation decisions in advance. The burden of decision making should not be placed on the frontline health care workers, nor made ad hoc at the bedside. There are multiple resources for guiding the complex decision making in resource allocation and rationing in pandemic situations.[39–44] A recent ethical framework made the following priority recommendations,[45,46] amongst others: 1) Aim to both save the most lives and most years of life, giving priority to maximizing the number of patients that survive treatment (maximizing benefit); 2) Critical testing, PPE, ICU beds, therapeutics, and vaccines should go first to front line health care workers and others who keep critical infrastructure functioning due to their instrumental value in the pandemic response and difficulty of replacing (instrumental value); and 3) Avoid first-come first serve approaches and use random allocation such as a lottery instead (equality). The Hastings Center has provided a freely available online resource that is helpful to guide an ethics process: https://www.thehastingscenter.org/ethicalframeworkcovid19/.

Communication will be critical, and an effective communication plan within and between facilities, as well as between providers across the health system and even between countries, is essential and should be established immediately. A task force that can oversee this dynamic situation and provide additional guidance and interpretation of

directives (from ministries or multinational organizations such as the World Health Organization) can be extremely valuable. A useful tool for health system organization is the Incident Command System, a standardized hierarchical structure that enables a cooperative response and organizes and coordinates activities; online Incident Command System training is available for free: https://emilms.fema.gov/IS0700b/curriculum/1.html.

Much will be asked of us all in the coming weeks and months, and we may well find ourselves stretched and beyond our comfort zones. We will be remembered for our actions, and how we comported ourselves in the midst of this pandemic. Our most valuable talents—our compassion, our empathy, and our words of comfort—must be dispensed liberally, as they are both free and priceless.

Adesoji O. Ademuyiwa, MBBS
University of Lagos and Lagos University Teaching Hospital, Lagos, Nigeria

National Institute of Health Research Global Surgery Unit, Lagos Hub, Lagos, Nigeria

Pan Africa Paediatric Surgery Association

Abebe Bekele, MD
University of Global Health Equity, Kigali, Rwanda

Chair of Examinations, College of Surgeons of Eastern, Central, and Southern Africa

Ataklitie Baraki Berhea, MD
Addis Ababa University, Addis Ababa, Ethiopia

President, Surgical Society of Ethiopia

Eric Borgstein, MD
College of Medicine, University of Malawi, Blantyre, Malawi

Secretary General, College of Surgeons of Eastern, Central, and Southern Africa

Nina Capo-Chichi, MBBS
Smile Train, Francophone West Africa (Benin, Togo, Burkina Faso)

Lifebox Foundation

Miliard Derbew, MD
Past President, College of Surgeons of Eastern, Central, and Southern Africa

Addis Ababa University, Addis Ababa, Ethiopia

Lifebox Foundation

Faye M. Evans, MD
Boston Children's Hospital / Harvard Medical School, Boston, MA

Lifebox Foundation

Medical Advisory Board Member, Smile Train

Mekdes Daba Feyssa, MD, MPH
St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia

President, Ethiopian Society of Obstetricians and Gynaecologists

Moses Galukande, MBChB, MSc, MMED, PhD
Makerere University, Kampala College of Health Sciences, Uganda

Governing Council, Association of Surgeons of Uganda

Atul A. Gawande, MD, MPH
Lifebox Foundation

Ariadne Labs at Brigham Health and Harvard TH Chan School of Public Health

Haven, LCC

Boston, MA

Serigne M. Gueye, MD
University Cheikh Anta DIOP, Dakar, Senegal

President, West African College of Surgeons

Ewen Harrison, MBChB, MSc, PhD
NIHR Global Health Research Unit on Global Surgery, Centre for Medical Informatics, Usher Institute, University of Edinburgh, Edinburgh, UK

Pankaj Jani, MBChB, MMED
Past President, College of Surgeons of Eastern, Central, and Southern Africa
Department of Surgery, University of Nairobi, Nairobi, Kenya,

Neema Kaseje, MD, MPH
World Health Organization Emergency and Essential Surgical Care Program

Medecins Sans Frontieres, Geneva, Switzerland

Global Initiative for Children's Surgery

Louis Litswa, MBChB, MMED
Gertrude's Hospital Division of Anesthesia, Nairobi, Kenya

President, Kenya Society of Anaesthesiologists

Tihitena Negussie Mammo, MD
Addis Ababa University, Addis Ababa, Ethiopia

Lifebox Foundation

Jannicke Mellin-Olsen, MD, DPH
Department of Anesthesiology, Baerum Hospital, Oslo, Norway

President, World Federation of Societies of Anaesthesiologists

Godfrey Muguti, MBChB, MS
University of Zimbabwe, Harare, Zimbabwe

President, College of Surgeons of Eastern, Central, and Southern Africa

Mary T. Nabukenya, MBChB, MMED
Makerere University College of Health Sciences, Kampala, Uganda

Education Committee, Association of Anesthesiologists of Uganda

Lifebox Pulse Oximeter Clinical Advisory Group, Lifebox Foundation

Eugene Ngoga, MD, MMED
Department of Obstetrics and Gynecology, Rwanda Military Hospital (affiliated with University of Rwanda), Kigali, Rwanda

President, Rwanda Society of Obstetricians and Gynecologists

President, East, Central, and Southern Africa College of Obstetrics & Gynecology

Faustin Ntirenganya, MD, MMED
University of Rwanda, Kigali, Rwanda

National Institute of Health Research Global Surgery Unit, Rwanda Hub

Stephen Rulisa, MD, PhD
University of Rwanda, Kigali, Rwanda

Finance Committee, East, Central, and Southern Africa College of Obstetrics & Gynecology

Nichole Starr, MD, MPH
University of California San Francisco, San Francisco, CA,
Lifebox Foundation

Stephen Tabiri, MD, PhD
University for Development Studies-School of Medicine and Health Sciences, Tamale, Ghana

National Institute of Health Research Global Surgery Unit, Ghana Hub

Mahelet Tadesse, MD
Addis Ababa University, Addis Ababa, Ethiopia

President, Ethiopian Society of Anesthesiologists

Isabeau Walker, MB, BChir, BSc
Lifebox Foundation, London, UK

Association of Anaesthetists of Great Britain and Ireland Foundation

Thomas G. Weiser, MD, MPH✉
Stanford University, Stanford, CA.
✉tweiser@stanford.edu

Lifebox Foundation

Sherry M. Wren, MD
Stanford University, Stanford, CA

REFERENCES

1. World Health Organization: Coronavirus disease 2019 (COVID-19) Situation Report - 71 [Internet]. [Accessed Apr 1, 2020]. Available at: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200331-sitrep-71-covid-19.pdf?sfvrsn=4360e92b_6.
2. Pearson CAB, Schalkwyk CV, Foss A, O'Reilly K, SACEMA Modelling and Analysis Response Team, CMMID nCov working group, Pulliam JRC. Projection of early spread of COVID-19 in Africa as of 25 March 2020. Centre for Mathematical Modelling of Infectious Diseases; [Accessed Apr 1, 2020] Available at: https://cmmid.github.io/topics/covid19/current-patterns-transmission/reports/COVID10k_Africa.pdf.
3. Spinelli A, Pellino G. COVID-19 pandemic: perspectives on an unfolding crisis. BJS [Accessed Mar 24, 2020]. Available at: http://bjssjournals.onlinelibrary.wiley.com/doi/abs/10.1002/bjs. 11627.
4. Brindle M, Gawande A. Managing COVID-19 in surgical systems. *Ann Surg*. 2020 [Epub ahead of print.
5. Partners In Health: COVID-19 Clinical Response [Accessed Mar 21, 2020]. Available at: https://www.pih.org/covid-response.
6. Wen X, Li Y. Anesthesia procedure of emergency operation for patients with suspected or confirmed COVID-19. *Surg Infect (Larchmt)*. 2020;21:299.
7. Ti LK, Ang LS, Foong TW, et al. What we do when a COVID-19 patient needs an operation: operating room preparation and guidance. *Can J Anesth*. 2020 [Epub ahead of print].
8. Wong J, Goh QY, Tan Z, et al. Preparing for a COVID-19 pandemic: a review of operating room outbreak response measures in a large tertiary hospital in Singapore. *Can J Anesth*. 2020 [Epub ahead of print].
9. Alhazzani W, Møller MH, Arabi YM, et al. Surviving sepsis campaign: guidelines on the management of critically ill adults with coronavirus disease 2019 (COVID-19). Intensive Care Med. 2020 [Epub ahead of print].
10. Personal protective equipment: Our process if COVID-19 is suspected | The Loop [Internet]. [Accessed Mar 21, 2020]. Available at: https://medcom.uiowa.edu/theloop/news/personal-protective-equipment-our-process-if-covid-19-is-suspected.
11. Hon C-Y, Gamage B, Bryce EA, et al. Personal protective equipment in health care: can online infection control courses transfer knowledge and improve proper selection and use? *Am J Infect Control*. 2008;36:e33–e37.
12. Lim SM, Cha WC, Chae MK, et al. Contamination during doffing of personal protective equipment by healthcare providers. *Clin Exp Emerg Med*. 2015;2:162–167.
13. Chughtai AA, Chen X, Macintyre CR. Risk of self-contamination during doffing of personal protective equipment. *Am J Infect Control*. 2018;46:1329–1334.
14. Otter JA, Donskey C, Yezli S, et al. Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination. *J Hosp Infect*. 2016;92:235–250.
15. Centers for Disease Control and Prevention: PPE Donning and Doffing Sequence [Internet]. [Accessed Mar 21, 2020]. Available at: https://www.cdc.gov/hai/pdfs/ppe/ppe-sequence.pdf.
16. Poston JT, Patel BK, Davis AM. Management of critically ill adults with COVID-19. *JAMA*. 2020 [Epub ahead of print].
17. Ng K, Poon BH, Kiat Puar TH, et al. COVID-19 and the risk to health care workers: a case report. *Ann Intern Med*. 2020 [Epub ahead of print].
18. Smith JD, MacDougall CC, Johnstone J, et al. Effectiveness of N95 respirators versus surgical masks in protecting health care workers from acute respiratory infection: a systematic review and meta-analysis. *CMAJ*. 2016;188:567–574.
19. Chen C-C, Willeke K. Aerosol penetration through surgical masks. *Am J Infect Control*. 1992;20:177–184.
20. Rowley E, Dingwall R. The use of single-use devices in anaesthesia: balancing the risks to patient safety. *Anaesthesia*. 2007;62:569–574.
21. Milton DK, Fabian MP, Cowling BJ, et al. Influenza virus aerosols in human exhaled breath: particle size, culturability, and effect of surgical masks. *PLoS Pathog*. 2013;9:e1003205.
22. World Federation Of Societies of Anaesthesiologists - Coronavirus [Internet]. [Accessed Mar 23, 2020]. Available at: https://www.wfsahq.org/resources/coronavirus.
23. Anesthesia Patient Safety Foundation. FAQ on Anesthesia Machine Use, Protection, and Decontamination During the COVID-19 Pandemic [Internet]. [Accessed Mar 20, 2020]. Available at: https://www.apsf.org/faq-on-anesthesia-machine-use-protection-and-decontamination-during-the-covid-19-pandemic/.
24. Rutala WA, Weber DJ. Disinfection, sterilization, and antisepsis: an overview. *Am J Infect Control*. 2019;47S:A3–A9.
25. World Health Organization. Water, sanitation, hygiene and waste management for the COVID-19 virus [Internet]. 2020 [Accessed Mar 21, 2020]. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/infection-prevention-and-control.
26. Fisher EM, Shaffer RE. Considerations for recommending extended use and limited reuse of filtering facepiece respirators in health care settings. *J Occup Environ Hyg*. 2014;11:D115–D128.
27. N95decon: https://www.n95decon.org/publications, accessed 24 April 2020.
28. University of Tennessee Research Foundation. Information and FAQs on Performance, Protection, and Sterilization of Masks Against COVID-19 [Internet]. 2020 [Accessed Mar 26, 2020]. Available at: https://utrf.tennessee.edu/information-faqs-performance-protection-sterilization-of-masks-against-covid-19/.
29. Centers for Disease Control and Prevention. Strategies for Optimizing the Supply of N95 Respirators [Internet]. 2020 [Accessed Mar 21, 2020]. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirators-strategy/index.html.
30. Makison Booth C, Clayton M, Crook B, et al. Effectiveness of surgical masks against influenza bioaerosols. *J Hosp Infect*. 2013;84:22–26.
31. Centers for Disease Control and Prevention. Coronavirus Disease 2019 (COVID-19) [Internet]. 2020 [Accessed Mar 23, 2020]. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/face-masks.html.
32. MacIntyre CR, Seale H, Dung TC, et al. A cluster randomised trial of cloth masks compared with medical masks in healthcare workers. *BMJ Open*. 2015;5:e006577.
33. Rengasamy S, Eimer B, Shaffer RE. Simple respiratory protection—evaluation of the filtration performance of cloth masks and common fabric materials against 20-1000 nm size particles. *Ann Occup Hyg*. 2010;54:789–798.
34. Davies A, Thompson K-A, Giri K, et al. Testing the efficacy of homemade masks: would they protect in an influenza pandemic? *Disaster Med Public Health Prep*. 2013;7:413–418.
35. Dato VM, Hostler D, Hahn ME. Simple respiratory mask. *Emerg Infect Dis*. 2006;12:1033–1034.
36. van der Sande M, Teunis P, Sabel R. Professional and home-made face masks reduce exposure to respiratory infections among the general population. *PLoS One*. 2008;3:e2618.
37. Arentz M, Yim E, Klaff L, et al. Characteristics and outcomes of 21 critically ill patients with COVID-19 in Washington State. *JAMA*. 2020 [Epub ahead of print].
38. Wujtewicz M, Dylczyk-Sommer A, Aszkiełowicz A, et al. COVID-19—what should anaethesiologists and intensivists know about it? *Anaesthesiol Intensive Ther*. 2020;52:34–41.
39. Powell T, Christ KC, Birkhead GS. Allocation of ventilators in a public health disaster. *Disaster Med Public Health Prep*. 2008;2:20–26.
40. Fink SL. Worst case: rethinking tertiary triage protocols in pandemics and other health emergencies. *Crit Care*. 2010;14:103.
41. Patrone D, Resnik D. Pandemic ventilator rationing and appeals processes. *Health Care Anal*. 2011;19:165–179.
42. Vawter DE, Garrett JE, Prehn AW, et al. Health care workers' willingness to work in a pandemic. *Am J Bioeth*. 2008;8:21–23.
43. Lin JY, Anderson-Shaw L. Rationing of resources: ethical issues in disasters and epidemic situations. *Prehospital Disaster Med*. 2009;24:215–221.
44. Howes D, Tsai E. Ventilator allocation in a pandemic: discussion and a model for rationing restricted resources. *WebMed Central*. 2010. Dec 3 [Accessed Mar 20, 2020]; Available at: http://www.webmedcentral.com/article_view/1258.
45. Vawter D, Garrett J, Gervais K, et al. For the good of us all: Ethically rationing health resources in Minnesota in a severe influenza pandemic. *Minnesota Pandemic Ethics Project Report*. 2010 [Accessed Apr 1, 2020]; Available at: https://www.health.state.mn.us/communities/ep/surge/crisis/ethics.pdf.
46. 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 [Epub ahead of print]