Commentary

Combating the COVID-19 battle with personal protective equipment (PPE) armamentarium

Healthcare workers (HCWs) are dynamic and precious assets of a nation who can handle the burden of any disease meticulously with clinical precision. HCWs should be provided with a complete armamentarium in the form of personal protective equipment (PPE), medicines, investigation set-ups, social and financial support during health emergencies and crisis hours as we all have been seeing during this COVID-19 pandemic. Safeguarding the health and well-being of HCWs in the workplace is the combined responsibility of policy-makers, employers, and concerned health administrators.[1]

"*Health thrives if I live.and it cries if Ileave*"

During this pandemic, this is what can be truly said about every HCW.The preferable primary approach to protect HCWs includes a combination of engineering methods and use of appropriate type of PPE. PPE, the protective gear designed to minimize the exposure of HCWs to a biological agent is a critical component in the hierarchy of control used to protect HCWs from infectious hazards.[2,3]Setlur *et al*. in their article being published in this issue of the Journal of Anesthesiology Clinical Pharmacology (JOACP) have elaborately described the various ways of preventing exposure to COVID-19 in the OTs and Intensive Care Units (ICUs) and have mentioned that effective and rational provisioning of PPEs is of paramount importance in preventing the spread of COVID-19 in the hospital setting.[4]

The sample specifications for a sterile PPE kit related to COVID-19 includes a single piece coverall with head hood cap (jacket/nun type), a N-95 respirator mask, a pair of shoe covers, a pair of goggles, a face shield, two pairs of sterile gloves, and a waste collection bag which are mentioned in the ISA national OT advisory.[5]

The appropriate selection of PPE for preventing transmission of infection from patient to the HCWs while ensuring satisfactory working conditions is important. The use of PPE has to be rational to suit the group the HCW belongs to, the risk profile of the HCW and the setting he or she works in. According to the Occupation Safety and Health Administration (OSHA) rule, the required PPE type depends on the condition, type,

duration, and amount of exposure to the hazardous agents.[2] As the evidence is emerging, different levels of precautions and protection mechanisms are being scaled as per the settings of patient care. Scaled protection in the form of three levels for HCWs amid COVID-19 pandemic has been recommended by Chinese authors, based on regulations established in a hospital in Wuhan. Level l protection includes medical mask, hand hygiene, gloves, scrubs, isolation gown, and disposable hair cover. This was recommended for personnel working in fever clinics and floors for infectious diseases. Level II protection includes respiratory protection, hand hygiene, gloves, scrubs, disposable hair cover, and shoe cover. Protective clothing, isolation gown, and eye protection are optional and it is indicated for those rendering non-contact care for patients with confirmed or suspected COVID-19. Level III protection is indicated for direct contact with patients with confirmed or suspected COVID-19. This includes respiratory and eye protection, hand hygiene, gloves, scrubs, protective clothing, disposable hair cover, head and shoe covering. Intubation and ventilation management includes direct patient contact and hence level III precaution is mandatory for these.[6]

The use of PPEs in different settings (settings approach) including the recommended PPE at the point of entry into hospital, different areas of the outpatient department, in-hospital setting, in-patient services, emergency department, pre-hospital services, ancillary services, health workers in community setting and quarantine facility is also described in the Ministry of Health and Family Welfare (MoHFW) COVID-19 guidelines and World Health Organisation (WHO) guidelines on the rational use of PPE.[3,7,8]

COVID times have exposed many shortcomings and limitations in infrastructure and health care delivery management systems globally. Simply making guidelines and recommendations regarding PPE to prevent virus exposure among HCWs is not enough; rather the successful implementation of these recommendations is important. This includes complying with technical specifications for quality of PPE kits as per published guidelines,[3,5] providing training and refresher training in the use of PPE for HCWs and having in place written protocols for the management of used PPE items. Most important is that the recommended PPE should be available and accessible to all HCWs. For this assured availability, it is important to ensure effective resource management for PPE items including stock management at national, state, district and facility level, having items easily accessible, controlling the quality of items purchased and setting up of a system to prevent or ensure early reporting of shortages.[1] Nevertheless, the path for provision of PPE is not very straightforward yet and problems like shortage of PPEs and questionable quality of PPE kits have risen all over the globe. Strategies that can facilitate optimum PPE availability including minimizing the need for PPE in health care settings, ensuring rational and appropriate use of PPEs as per the "settings approach" as mentioned above and coordinating the PPE supply chain management system have to be used.[8] In case of severe PPE shortage despite these strategies, measures to be undertaken include urgent increased production of PPE through advanced market commitments, public sector mandated scale-up of production by the private sector and perceiving donation options.[8] India has ramped up its domestic production capacity of PPE and N-95 masks. At present, approximately 3 lakh PPE kits and N-95 masks are produced per day in our nation.[9]

Temporary measures like extended use of PPE and reprocessing followed by reuse of either reusable or disposable PPEs can be used in case of failure of all PPE shortage strategies.[8] Methods for reprocessing masks or respirators are not well established and should be considered only when there is a critical PPE shortage. The extended and prolonged use of respirators and isolation gowns may increase the risk of contamination with COVID-19 virus and other pathogens, facial dermatitis, acne, respiratory fatigue, increased breathing resistance, and easy exhaustion.[8] It is said that micro perforations can occur in PPE.[10] The MoHFW in its recent advisory mentions that goggles dedicated to each HCW can be reprocessed and reused after proper disinfection. Goggles can be reused at least five times each and can be used rationally till their transparency decreases or they get damaged.[11]

All components of PPE like goggles, coveralls, gloves, N-95 masks, and face shields have to be quality compliant with the recommended standards.[3,7] An isolation gown too has several important characteristics which must be looked into. These include barrier effectiveness, functionality/mobility, comfort, cost, strength, fit, time to doff and don, biocompatibility, flammability, odour and quality of maintenance. Several studies have identified that fabric property like repellence, pore size, fabric thickness, and wicking have an impact over the barrier effectiveness of the gowns. Interfaces like the glove–gown interface are very important because leakages more often occur in the glove–gown interface.[2]

The HCW has a wide choice in the design of PPE kits; however, one must remember the important requisite characteristics of a PPE kit while making a choice. The PPE should protect the mucous membranes, have minimum number of PPE element junctions, provide an unobstructed range of vision and enable easy communication. It should provide adequate barrier protection from front and behind throughout the entire working period, allow standardized donning and doffing protocol with minimum steps and one should be able to dispose it in an environment friendly manner.[10] Several

problems with PPE use have been reported by HCWs from hot and humid climatic regions. These problems include significant fog and sweat interference while performing clinical and heavy duty tasks leading to visual obstruction. Also, when masks/respirators become wet due to sweat, they become less effective.[10] In a survey, heat stress was reported by 64% of those who use hoods and none of those who used covers.[1] Having cooling and rehydrating facilities available for HCWs taking off PPE, informing HCWs about the mitigating effects of PPE when used consistently and correctly and the consideration of issues like climatic conditions by policy makers and health administrators can ensure that protection measures are maximally adopted. An interesting literature review of values and preferences of HCWs in the use of PPEs in the context of infectious disease revealed that face shields were preferred by HCWs compared to goggles as they were comfortable, fogged less and the perceived protection was higher. Respirators were associated with problems like warmth and wetness around the face, while masks were found to be more reusable and to cause less discomfort, fatigue, and odour than respirators. The main identified problems with double gloving were discomfort, reduced dexterity, and reduced tactile sensation. Impermeable gowns and coveralls caused increased heat stress. Most HCWs expressed the need to have correct size gowns/rubber boots.[1]A Cochrane systematic review of controlled studies found very low quality evidence that more breathable types of PPE may not lead to more contamination, but may have greater user satisfaction; also, double gloving, following CDC doffing guidance, and spoken instructions during doffing may reduce contamination and increase compliance.[12]

Currently, several knowledge gaps related to PPEexist.PPE has entered into an evolving area of research. Research is needed on the development of new materials/manufacturing techniques to improve barrier function of PPE, the appropriate order of doffing the PPE elements, methods to reduce the impact of heat strain on the HCW wearing the PPE and innovative packaging methods to protect PPE. Randomized controlled trials on the training of HCWs in PPE use, simulation studies to find out the best combinations of PPE, literature reviews and surveys on HCWs' preferences for PPEs for COVID-19 are currently needed. Real-life evidence in the form of case series and reports on the transmission of COVID-19 to the HCWs would be certainly useful.

As the old saying goes "*Save for a rainy day*".The graded, rational, and correct use of PPEs can definitely sustain us in the battle against COVID-19. We must remember that though wearing PPE is important, wearing the right grade of PPE is even more important to protect us in the battle against COVID-19.

Sukhminder Jit Singh Bajwa, Madhuri Kurdi[1], Naveen Malhotra[2]

Department of Anaesthesiology and Intensive Care, Gian Sagar Medical College and Hospital, Banur, Patiala, Punjab, [1]Department of Anaesthesiology, Karnataka Institute of Medical Sciences, Hubli, Karnataka, [2]Anaesthesiology and In Charge Pain Management Centre, Pt BDS PGIMS Rohtak, Haryana, India

Address for correspondence: Dr. Sukhminder Jit Singh Bajwa, Department of Anaesthesiology and Intensive Care, MD, FACEE (Emergency Medicine), Gian Sagar Medical College and Hospital, Banur, Patiala, Punjab, India.
E-mail: sukhminder_bajwa2001@yahoo.com

References

1. World Health Organisation (WHO).Personal protective equipment for use in a filovirus disease outbreak.Rapid advice guideline. Geneva: WHO; 2016.Available from: www.who.int>csr>resources>publications>ebola. [Last accessed on 2020 Jul 05].
2. Kilinc FS. A review of isolation gowns in healthcare: Fabric and gown properties. J EngFabr 2015;10:180-90.
3. Ministry of Health and Family Welfare. Directorate General of Health Services (Emergency Medical Relief).Novel Coronavirus Disease 2019 (COVID 19): Guidelines on rational use of Personal Protective Equipment.Available from: www.mohfw.gov.in/pdf/GuidelinesonrationaluseofPersonalProtectiveEquipment.pdf. [Last accessed on 2020 Jul 05].
4. Setlur R, Jaiswal A, Jahan N. Preventing exposure to COVID-19 in the operation theatre and intensive care unit. J Anaesthesiol Clin Pharmacol [Epub ahead of print]. Available from: http://www.joacp.org/preprintarticle.asp?id=290615. [Last cited on 2020 Jul 28].
5. Malhotra N, Bajwa SJ, Joshi M, MehdirattaL, Trikha A. COVID operation theatre –advisory and position statement of Indian Society of Anaesthesiologists (ISA National). Indian J Anaesth 2020;64:355-62.
6. Meng J, Qui H, Ai Y, Xue Z, Guo Q, Deshpande R, *et al*. Intubation and ventilation amid the COVID -19 outbreak: Wuhan's experience. Anesthesiology 2020;132.doi: 10.1097/ALN. 0000000000003296.
7. Ministry of Health and Family Welfare. Directorate General of Health Services (Emergency Medical Relief).Novel Coronavirus Disease 2019 (COVID 19): Additional guidelines-on rational use of Personal Protective Equipment (setting approach for Health functionaries working in non-COVID areas) (Updated on 2020 May 15). [Available from: www.mohfw.gov.in/pdf/UpdatedAdditionalguidelinesonrationaluseofPersonalProtectiveEquipmentsettingapproachforHealthfunctionariesworkinginnonCOVID19areas.pdf].[Last accessed on 2020 Jul 05].
8. World Health Organisation (WHO). Rational use of Personal protective equipment for coronavirus disease (COVID-19) and consideration during severe shortages.Interim guidance 2020. April 6. [Available from: www.who.int/publications/i/item/ratio

nal-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages]. [Last accessed on 2020 Jul 05].
9. Coronavirus: More than 3lakh PPE Kits being manufactured every day. Punekar News 2020 May20. Available from: www.punekarnews.in. [Last accessed on 2020 Jun 04].
10. World Health Organisation (WHO). Preferred Product Characteristics for Personal Protective Equipment for the Health Workeron the Frontline responding to viral hemorrhagic fevers in tropical climates. Geneva: WHO; 2018.[Available from: www.who.int>Personal_Protective_Equipment _tpp].[Last accessed on 2020 Jul 05].
11. Ministry of Health and Family Welfare. Advisory on re-processing and re-use of eye-protection –Goggles. (Updated on 2020 May 27). [Available from: www.mohfw.gov.in/pdf/Advisoryonreprocessingandreuseofeyeprotectiongoggles.pdf]. [Last accessed on 2020 Jul 05].
12. Verbeek JH, RajamakiB, Izaz S, Tikka C, Routsalainen JH, Edmond MB, *et al*. Personal protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in healthcare staff. Cochrane Database Syst Rev 2019;17:CD01162/.doi: 10.10002/14651858.CD011621.pub3.

Access this article online

Quick Response Code:

Website: www.joacp.org

DOI: 10.4103/joacp.JOACP_324_20

How to cite this article: Bajwa SJ, Kurdi M, Malhotra N. Combating the COVID-19 battle with personal protective equipment (PPE) armamentarium. J Anaesthesiol Clin Pharmacol 2020;36:S133-6.

Submited: 06-Jun-2020 **Revised:** 04-Jul-2020
Accepted: 06-Jul-2020 **Published:** 17-Aug-2020