

How to Cite:

Sargaiyan, V., Arya, J., Jain, S., Misurya, A., Swarnkar, S. K., & Yadav, D. (2022). A study to assess the difficulties encountered while using PPE kits among medical professionals. *International Journal of Health Sciences*, 6(S2), 1752–1758.
<https://doi.org/10.53730/ijhs.v6nS2.5306>

A study to assess the difficulties encountered while using PPE kits among medical professionals

Vinod Sargaiyan

Professor, Department of Oral pathology and Microbiology, Maharana Pratap College of Dentistry n Research Centre, Gwalior (M.P.)
Email: dr.vinodsargaiyan@yahoo.co.in

Jayendra Arya

MD, 3rd year resident, Department of Pediatrics, Shyam shah medical college, Rewa (M.P.)
Email: jafriend9@gmail.com

Sakshi Jain,

MD, 3rd year resident, Department of anesthesiology, Shyam shah medical college, Rewa (M.P.)
Email: jainsakshimbbs@gmail.com

Archana Misurya

BDS, MDS, Associate professor, Department of dentistry, MLB medical college, Kanpur road, Jhansi, Uttar Pradesh
Email: drarchanamisurya@gmail.com

Sandeep Kumar Swarnkar

Reader, Department of Pedodontics, Maharana pratap college of dentistry & research centre, Gwalior (M.P.)
Email: sandeepswarnkar98@gmail.com

Diksha Yadav

Masters in Dental surgery, 3rd yr. Postgraduate student, Department of Conservative Dentistry and Endodontics, Maharana Pratap college of Dentistry & research center, Gwalior (M.P.)
Email: diksha.004singh.ds@gmail.com

Abstract---The personal protective equipment (PPE) undoubtedly provides a shield of protection for the healthcare workers (HCWs) fighting the disease as a valuable asset to the nation. However, there have been various problems associated with the PPE, ranging from its

shortage to problems arising from heat, dehydration, etc while wearing them. There is a need to assess these problems faced by HCWs both qualitatively and quantitatively for their timely and effective redressal. An electronic questionnaire survey was conducted among a cohort of HCWs who had performed COVID-19 duties and used PPE kits in Madhya Pradesh. The cohort consisted of different categories of doctors, nursing personnel, and other paramedical staff. Results; The most common problems associated with using PPE kits was excessive sweating (100%), fogging of goggles, spectacles, or face shields (79 %), suffocation (61%), breathlessness (49 %), fatigue (82 %), headache due to prolonged use (34 %), and pressure marks on the skin at one or more areas on repeated use (56 %). Occasional problems reported were skin allergy/dermatitis caused by the synthetic material of the PPE kit, face shield impinging onto the neck during intubation, and nasal pain, pain at the root of the pinna, and slipperiness of shoe covers. Various ways and means have been employed by the HCWs to actively address and solve these problems. Conclusion: These plausible solutions will definitely help the HCWs to deal with and solve the problems arising out of the PPE use.

Keywords--COVID-19, sars-cov2, novel coronavirus, PPE, personal protective equipment, difficulties, challenges.

Introduction

Keeping the COVID-19 workforce safe has presented a daunting challenge. From being used by beekeepers as reported in ancient literature, to 16th-century plague doctors in Europe to modern times, PPE kits have come a long way. They form a very important part of the protective armour for the frontline warriors in this battle against the COVID-19 pandemic. It is important to carefully select the adequate PPE to protect the skin, eyes, face, nose, mouth, hands, feet, head, and other parts of the body, so as to provide protection and act as an effective barrier between the HCW and the contaminated materials like blood, body fluids, respiratory secretions, and aerosols. The PPE usually comprises protective clothing, helmets, goggles, shoe covers, and respiratory protective equipment (RPE). Proper instructions, training, and supervision are required to ensure that the PPE is properly used and adequate protection is gained. With the emergence of this unique challenge faced by modern medicine worldwide, the word PPE has been trending on Google Search engine (1-5). Globally, the users have often found wearing the PPE uncomfortable while working, more so in the summer season, when facilities for controlling the environmental temperature like centralised air conditioners are unavailable or are shut down for fear of spreading the infection. In addition to reduced tactile sensitivity and impaired visibility due to the deposition of water vapours on the eye goggles with their use, users have also found verbal communication difficult while wearing the PPE (6-10). Although the literature has started to address and highlight the problems and issues related to PPE use on a global scale, there is still a dearth of authentic literature pertaining to the issue from within India. Hence, we believe there is a need to evaluate and have a qualitative and quantitative assessment of the problems faced by HCWs in

their use of PPE in India. The outlined aim of the study was to identify the difficulties encountered by HCWs while using PPE kits and to propose ways and means to help them overcome these difficulties.

Methodology

A descriptive study was conducted by a team of researchers working in a Hospital in Madhya Pradesh, which was a designated for COVID-19 patients. An electronic questionnaire was prepared by the researchers for a multi-centre survey in urban India among HCWs who had used PPE kits during their COVID duties (Table 1). Internal consistency of the questionnaire was validated by keeping a spectrum of discrete options, eliminating the scoring system, and having a simple multiple-choice format. Content validation and construct validation of the questionnaire had been done by independent assessment by the two investigators in different time scales. Inter-rater reliability was ensured by allowing the respondents to fill in the questionnaires by themselves and keeping the questions simple. Test-retest validation of the questionnaire was ensured by allowing the respondent to edit the responses even after the first submission. During questionnaire validation, the average response time was also noted down.

Table 1: An overview of Questionnaire

Questionnaire
What have been your daily average of duty hours?
How many PPE kits do you normally use per duty?
Did you have free availability of PPE kits?
What is the approximate duration of wearing one PPE kit?
Do you face any size problem with the PPE kit or any of its components?
Did you ever have any problem with the PPE kit getting torn at one/more places?
Did you face any problem in patients recognizing you due to the PPE kit?
Did you have any communication problems with staff/colleagues/patients during the PPE kit use?
Which other issues did you face while using the PPE kit?
Were you ever forced to remove the PPE kit due to severe thirst or dehydration?
Were you ever forced to remove the PPE Kit due to the urge for voiding the bladder?
Were you given prior training in donning/doffing of the PPE kit?
Was someone available to help you in donning and doffing?
What steps did you take to overcome the problems you faced?

Outcome measures were recorded automatically upon submission to Google Drive (Alphabet Inc., Mountain View, CA) and downloadable in the form of Microsoft Excel (Microsoft Corporation, Redmond, WA) spreadsheet tabulation. During the first stage, de-duplication of data was done using the unique mobile number fields in the Excel sheet. In the next stage, the validation of data was done, followed by data categorisation, preliminary analysis, and graphical

representation. Subsequently, the result interpretation was done by the application of statistical analysis using SPSS Statistics software version 16.0 (IBM, Armonk, NY).

Results

We contacted 100 HCWs to be part of the survey. The respondents included 55 doctors, 31 nursing personnel and 13 technical staff, and ancillary staff from 26 different medical institutions, actively involved in COVID care. We found that 40% respondents had completed more than 28 days of COVID duty. The survey revealed that 41% had used a single PPE kit per shift. The proportional usage of the number of PPE kits per duty was highest among ancillary staff, followed by nursing personnel and doctors. This is probably reflective of the work profile of each category. Also, the nursing personnel wore PPE kits for a longer duration compared to other classes of HCWs, but this correlation did not come out to be significant with respect to various categories of HCWs (Table 2). The post-hoc comparison of problems of wearing PPE kits with respect to the approximate duration of use of each kit did not come out to be significant for any of the parameters.

Table 2: Comparison of duration of wearing of each PPE kit among various classes of HCWs

Each PPE duration	Doctors, n=55, n (%)	Nursing personnel, n=31, n (%)	Technical & Ancillary staff, n=13, n (%)	Total, n=100, n (%)	P-value
1 hour	1	0	0	2	0.002(s)
2 hours	9	5	14	8	
3 hours	13	7	26	14	
4 hours	42	29	40	32	
5 hours	8	32	6	11	
6 hours or more	27	27	14	33	
Correlation-p	0.019				-
Median (IQR)	4 (2)				-
Kruskal-Wallis test (mean ranks)	120.99	150.31	104.5	-	0.001(s)

The most common problems associated with using PPE kits was excessive sweating (100%), fogging of goggles, spectacles, or face shields (79 %), suffocation (61%), breathlessness (49 %), fatigue (82 %), headache due to prolonged use (34 %), and pressure marks on the skin at one or more areas on repeated use (56 %).

Discussion

The most common problems associated with using PPE kits was excessive sweating (100%), fogging of goggles, spectacles, or face shields (79 %), suffocation

(61%), breathlessness (49 %), fatigue (82 %), headache due to prolonged use (34 %), and pressure marks on the skin at one or more areas on repeated use (56 %). India is a tropical country with hot and, at times, both hot and humid conditions. Hence, this problem was even more daunting. Shutting down central air conditioning systems (with common air duct systems) in the hospitals to prevent the spread of droplets and droplet nuclei further aggravated this problem. Features of dehydration like muscle cramps, dizziness, vertigo, and nausea were also reported on continuous use. We had a report of one respondent actually collapsing due to symptoms similar to heatstroke and had to be hospitalised. Similar reports are not uncommon from other centres (8). Respondents reported drinking moderate quantities of cool water before donning (80%), frequent change of kits with intervals in between (59%), and using AC relaxation room (92%) to ameliorate dehydration. The health administration also got exhaust fans installed in each patient room and ICUs. This not only helped in heat reduction but also reduced the risk of suspended droplets in a closed space, by creating a negative pressure environment. In our study, 69% reported forced removal of PPE kit due to extreme heat or thirst on one or more occasions; 13 % reported forced removal of PPE kit due to the urge to void the bladder, and 52 % reported voiding bladders before donning to permit prolonged duration of PPE kit usage. In our survey, 61% did not report any size-related issues with PPE kits. In our study, 45% respondents said they used N95 masks only, while 55% reported using both N95 masks and surgical masks simultaneously. The usage of simple three-ply surgical masks over the N95 mask was done possibly for two reasons. One reason was to make the N95 mask secure a tight fit on the face leaving no gaps between the rims of the mask and areas around the nose and mouth, while the other reason was to increase the life span and re-usability of the N95 mask. Of note, 48.3% reported using single pairs of gloves while 110 respondents (43.5%) used double pairs of gloves, which reportedly helped in various stages of doffing. Also, 93% respondents reported using sanitizer on gloved hands while doffing at each stage. Double gloves have been reported to result in reduced dexterity in fine manual work. 64% respondents reported getting formal training in donning, doffing, and other aspects of the usage of PPE kits. Knowledge augmentation and shortcomings in formal training were overcome by watching online videos, 49%, and taking part in online webinars (37%). Active training in donning and doffing PPE has been shown to definitely boost the confidence level and reduce the risk of contamination and infection of HCWs. Of note, 44% reported PPE kits getting torn at one or more places on at least one occasion during doffing or donning. This is potentially a very serious problem associated with the use of PPE kit. Contact dermatitis/eczema caused by the material of the PPE components has also been reported from elsewhere, especially in high-friction and perspiration areas such as the chin, jaw, ears, eyelids, and arm-pits (11-24). There are certain problems reported in the literature from other countries that none of our respondents have enumerated. For example, studies have reported dissatisfaction with work, a statistically significant drop in oxygen saturation, and an increase in pulse rate after wearing PPE for four hours as compared to baseline. Another finding has been that most of the participants tended to adjust their N95 masks intermittently due to breathing issues, which raises the risk of self-contamination (25). There has been an interesting report of a child getting frightened at seeing someone in a PPE kit, and tweaking the surface of the kit with cartoon stickers worked wonders, making the PPE suit more child-friendly (26-27). The strengths

of our study include surveying all strata of HCWs who had used PPE kits. Disclosing the shorter average response time of three minutes for the questionnaire, assurance of the confidentiality of data, and making subject/institution name submission optional helped in increasing the acceptability of the survey questionnaire towards this sensitive topic, which has been under much media glare.

Conclusion

We believe that this first-of-its-kind, non-funded survey among HCWs, conducted in a country that has experienced some of the biggest burdens due to the COVID-19 pandemic, should serve as a guide to health administrators as well as other HCWs in adopting ways and means to ameliorate the problems encountered in the use of PPE kits.

References

1. World Health Organisation: coronavirus disease dashboard. [Dec;2021];<https://covid19.who.int/table> 2021
2. Personal protective equipment (PPE) guidelines, adaptations and lessons during the COVID-19 pandemic. Woolley K, Smith R, Arumugam S. *Ethics Med Public Health*. 2020;14:100546.
3. Healthworld. 87k health staff infected with Covid, 573 dead; 74% cases from six states. [Dec;2021];<https://health.economicstimes.indiatimes.com/news/industry/87k-health-staff-infected-with-covid-573-dead-74-cases-from-six-states/77814807> 2021
4. Wikipedia: personal protective equipment. [Dec 2021;2020];https://en.wikipedia.org/w/index.php?title=Personal_protective_equipment&oldid=971886294 Dec;2021
5. Covid-19: appropriate PPE prevents infections in doctors in frontline roles, study shows. Torjesen I. *BMJ*. 2021;369:0.
6. Strategies for rational use of personal protective equipment (PPE) among healthcare providers during the COVID-19 crisis. Mahmood SU, Crimbly F, Khan S, Choudry E, Mehwish S. *Cureus*. 2021;12:0.
7. Google Trends; explore search term PPE. [Dec;2021];<https://trends.google.com/trends/explore?q=ppe> 2021
8. Problems arising from PPE when worn for long periods. Vidua RK, Chouksey VK, Bhargava DC, Kumar J. *Med Leg J*. 2021;88:47–49.
9. Infographic. Cooling strategies to attenuate PPE-induced heat strain during the COVID-19 pandemic (Epub ahead of print) Bongers CC, de Korte JQ, Catoire M, Greefhorst J, Hopman MTE, Kingma B, Eijsvogels TMH. *Br J Sports Med*. 2020;10
10. Limiting factors for wearing personal protective equipment (PPE) in a health care environment evaluated in a randomised study. Loibner M, Hagauer S, Schwantzer G, Berghold A, Zatloukal K. *PLoS One*. 2019;14:0.
11. cases rise in Russia as health workers pay the price for PPE shortage. Dyer O. *BMJ*. 2020;369:0.
12. Challenges and solutions for addressing critical shortage of supply chain for personal and protective equipment (PPE) arising from Coronavirus disease

- (COVID19) pandemic - case study from the Republic of Ireland. Rowan NJ, Laffey JG. *Sci Total Environ.* 2020;725:138532.
13. Availability of personal protective equipment (PPE) among US and Pakistani doctors in COVID-19 pandemic. Ahmed J, Malik F, Bin Arif T, et al. *Cureus.* 2020;12:0.
 14. PPE guidance for covid-19: be honest about resource shortages. O'Sullivan ED. *BMJ.* 2020;369:0.
 15. Human rights protections are needed alongside PPE for health-care workers responding to COVID-19. Amon JJ. *Lancet Glob Health.* 2020;8:0.
 16. Personal protective equipment and intensive care unit healthcare worker safety in the COVID-19 era (PPE-SAFE): an international survey. Tabah A, Ramanan M, Laupland KB, et al. *J Crit Care.* 2020;59:70–75.
 17. Personal protective equipment (PPE) for surgeons during COVID-19 pandemic: a systematic review of availability, usage, and rationing (Epub ahead of print) Jessop ZM, Dobbs TD, Ali SR, et al. *Br J Surg.* 2020;10.
 18. Commentary on: a novel solution to the PPE crisis during the coronavirus pandemic (COVID-19) Syed DS, Malik MS, Ominu-Evbota K. *Int J Surg.* 2020;79:192–193.
 19. Review of sterilization techniques for medical and personal protective equipment contaminated with SARS-CoV-2. Jinia AJ, Sunbul NB, Meert CA, et al. *IEEE Access.* 2020;PP:1.
 20. Beyond the PPE shortage: improperly fitting personal protective equipment and COVID-19 transmission among health care professionals (Epub ahead of print) Ming X, Ray C, Bandari M. *Hosp Pract (1995)* 2020.
 21. Cognitive load and performance of health care professionals in donning and doffing PPE before and after a simulation-based educational intervention and its implications during the COVID-19 pandemic for biosafety. Díaz-Guio DA, Ricardo-Zapata A, Ospina-Velez J, Gómez-Candamil G, Mora-Martinez S, Rodríguez-Morales AJ. <https://pubmed.ncbi.nlm.nih.gov/32532947/> *Infez Med.* 2020;28:111–117.
 22. Personal protective equipment (PPE) and its use in COVID-19: important facts (Epub ahead of print) Das S, Rajalingham S. *Indian J Surg.* 2020
 23. Human factor considerations in using personal protective equipment in the COVID-19 pandemic context: binational survey study. Parush A, Wacht O, Gomes R, Frenkel A. *J Med Internet Res.* 2020;22:0.
 24. Therapeutic approach to skin reactions caused by personal protective equipment (PPE) during COVID-19 pandemic: an experience from a tertiary hospital in Granada, Spain (Epub ahead of print) Navarro-Triviño FJ, Ruiz-Villaverde R. *Dermatol Ther.* 2020:0.
 25. Impact of personal protective equipment on surgical performance during the COVID-19 pandemic. Yáñez Benítez C, Güemes A, Aranda J, et al. *World J Surg.* 2020;44:2842–2847.
 26. COVID-19 pandemic: the 3R's (reduce, refine, and replace) of personal protective equipment (PPE) sustainability. Ip V, Özelsel TJP, Sondekoppam RV, Tsui BCH. *Can J Anaesth.* 2020;67:1070–1071.
 27. Child-friendly PPE. Naga Sailaja DSV. *Br Dent J.* 2020;228:901–902.