

Difficulties Faced by the Healthcare Workers Wearing Personal Protective Equipments in COVID-19 Pandemic during Summers of Mumbai City

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ABSTRACT

Introduction: The coronavirus pandemic poses a massive challenge for the healthcare system and overburdens the Healthcare Workers (HCWs) in a developing country like India. The coronavirus may survive on various surfaces and/or aerosols for hours to days, making it a necessity to use Personal Protective Equipment (PPE) while treating infected patients. Wearing the PPE is often uncomfortable while working, more so in the summer season, when the temperatures in a tropical country like India are soaring.

Aim: To identify, quantify and highlight the difficulties faced by the HCWs while wearing PPEs.

Materials and Methods: This descriptive cross-sectional study was conducted in June 2020, by a team of researchers working in a government owned designated Coronavirus Disease-2019 (COVID-19) hospital in metropolitan city, West India. The questionnaire was prepared for a multicentre survey for 230 HCWs who had used PPE kits during their COVID-19 duties. The online questionnaire responses were recorded in an Microsoft Excel sheet and the results were analysed using Statistical Package for the Social Sciences (SPSS) software version 19.0.

Results: Total 230 responses were received out of which 74% were doctors, 21.7% nurses and 4.3% paramedical staff. The mean duration of work was 6.24 hours and per duty one, PPE was used by almost all of the respondents. The most common difficulty faced by the responders while on duty was excessive sweating (96%/n-221), itching of the nose (56%/n-129) and face (50.9%/n-117). While after the duty 61.7% of respondents reported being dehydrated and 68.2% complained of de novo headache. In a subset with a history of migraine, almost all reported worsening of migraine with increased frequency and severity of attacks. Many (40%) reported occasionally lowering the masks or face shield due to unbearable heat, risking self-contamination.

Conclusion: The PPEs in current use and in the hot and humid conditions of summer months in tropical countries poses a unique challenge for the HCWs. Customisation of PPEs and working conditions is essential in the mitigation of the problems faced by the HCWs.

Keywords: Coronavirus disease-2019, Dehydration, Health administration, Migraine, Public health

INTRODUCTION

The coronavirus pandemic poses a massive challenge for healthcare systems around the world. With over 19 million cumulative COVID-19 positive cases, India is one of the worst-hit countries, second only to the Americans [1]. Treating such patients may demand close patient contact sometimes in enclosed spaces for hours together, which makes the HCWs especially vulnerable to disease transmission. Official reports in India released to the media claim that as of April 2020, more than 700 doctors in the country have sacrificed their lives in their line of duty. Around 17,975 doctors have been infected in the state of Maharashtra alone [1].

The coronavirus may survive on various surfaces and/or aerosols for hours to days, making it a necessity to use PPE while treating infected patients. PPE reduces exposure to risk in addition to enabling HCWs to provide effective care to patients [2-4]. Wearing the PPE is often uncomfortable while working, more so in the summer season, when the temperatures in a tropical country like India are soaring and facilities like centralised air conditioners are unavailable or are shut down for the fear of spreading the infection. In addition to reduced manual dexterity and impaired visibility, users have also found verbal communication difficult while wearing the PPE [5].

There are very few studies on this topic from within India. On literature search, authors could find only one such study, conducted in New Delhi [6]. Hence, it is important to highlight the myriad of

issues faced by HCWs while using PPE and quantify them to find acceptable solutions to combat them and bring about changes to make the work atmosphere healthy and pleasant.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted in June 2020, by a team of researchers working in a Government Hospital in Western India. The hospital was a designated Coronavirus Disease-2019 (COVID-19) treatment centre. The Institutional Ethics Committee permission was obtained to recruit a maximum of 300 subjects for the survey (IEC number: 2022/49).

Inclusion criteria: HCWs who had completed at least 15 days of COVID duty in total in the city of Mumbai, having worn the PPE kit during each duty at least once. Written informed consent was obtained from the participants prior to the study were included.

Exclusion criteria: Those participants who were pregnant, those who had not worked in COVID-19 wards and those who had not worn PPE were excluded from the study.

Sample size calculation: The respondent-to-item ratio principle was applied to estimate the effective sample size. Twenty compulsory responses were kept in the questionnaire. By applying the 5:1 ratio rule for sampling size, a minimum of 100 respondents were required.

The researchers prepared an electronic questionnaire for a multicentre survey in urban India among HCWs who had used PPE kits during their COVID-19 duties [Table/Fig-1]. The simple multiple-choice

questionnaire was validated for internal consistency with the help of discrete options and by eliminating the scoring system. Two investigators independently assessed the questionnaire. The validation was done in different time scales. Respondents were allowed to fill in the questionnaire by themselves and hence inter-rater reliability was ensured. By allowing the respondents to edit the responses even after the first submission, the test-retest validation of the questionnaire was ensured. The reliability of the test was calculated using the Cronbach's alpha test was 0.78. The validity score assessed by calculating the average congruency percentage was 90% (expert 1-100% and expert 2-80%).

Questionnaire
<ul style="list-style-type: none"> Which hospital area have you done your COVID-19 duty in?
<ul style="list-style-type: none"> How many days of COVID-19 duty have you done consecutively? A) Less than 7 days; B) 7 to 14 days; C) More than 14 days
<ul style="list-style-type: none"> What was the duration of the duty hours?
<ul style="list-style-type: none"> What is the approximate duration of wearing one PPE kit?
<ul style="list-style-type: none"> What components of PPE kits/protective gear did you normally use? A) Gown/ plastic apron, double gloves, face shield, face mask, foot and leg coverings (Full Hazmat Suite) B) Face shield, face mask and double gloves C) Only face mask and gloves
<ul style="list-style-type: none"> During your duty in PPE what was the most difficult urge to control? A) Scratching itching body parts B) Thirst C) Urination D) Defecation
<ul style="list-style-type: none"> Which procedure did you find the most difficult to do in PPE? A) Endotracheal intubation B) IV line access C) Central line access D) Cardiopulmonary resuscitation (CPCR) E) Per-urethral catheterisation F) Nasogastric tube insertion G) Nasopharyngeal swab collection H) Not performed any of these procedure
<ul style="list-style-type: none"> Which procedure according to you is the riskiest of self-contamination? A) Nasopharyngeal swab collection B) Endotracheal intubation C) Cardiopulmonary resuscitation D) Per-urethral catheterisation E) Nasogastric tube insertion F) IV line access G) Central line access H) Not performed any of these procedures
<ul style="list-style-type: none"> Do you feel the centralised air conditioning increases the spread of COVID-19? A) Yes B) No
<ul style="list-style-type: none"> Do you want the centralised air conditioning to be working during your duty hours? A) Yes B) No
<ul style="list-style-type: none"> Have you given your nasopharyngeal swab for RT-PCR for COVID-19 testing? A) Yes B) No
<ul style="list-style-type: none"> Have you been tested positive for COVID-19 in the last 2 months? A) Yes B) No
<ul style="list-style-type: none"> If yes, did you test positive during your duty days of your duty? A) Yes B) No

[Table/Fig-1]: Questionnaire tabulated-the questionnaire was closed-ended.
PPE: Personal protective equipment; RT-PCR: Reverse transcription polymerase chain reaction

The invitation to participate in the study was sent through e-mail to HCWs who had done COVID-19 duties and worn PPE kits at various government-designated COVID-19 hospitals in the Mumbai city.

Those accepted to be part of the survey were sent a link to the questionnaire through e-mail. The submission form was kept open for 30 days. Anonymity was maintained in recording and analysing the data.

Definitions

PPE- Use of protective apron or gown covering the body (upper limbs, lower limbs, the feet, the torso and double hand gloves), a hood for the head, face shield and face mask (N-95) [7].

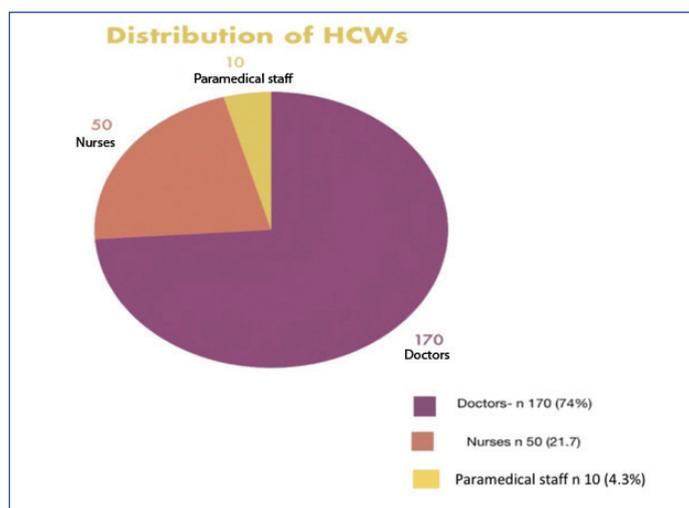
COVID-19 ward- both wards and ICUs where the patients including the suspected patients of COVID-19 and diagnosed patients of COVID-19 were kept [7].

STATISTICAL ANALYSIS

Outcome measures were recorded automatically upon submission to Google Drive and downloadable in the form of Microsoft Excel spread sheet tabulation. Subsequently, the validation of data was done and then preliminary analysis was done by data categorisation and graphical representation. Chi-square test was used to calculate p-value. A p-value <0.05 considered statistically significant. The results were analysed using Statistical Package for the Social Sciences (SPSS) software version 19.0.

RESULTS

A total of 250 HCWs were contacted to be part of the study, out of which 20 declined to participate. In total, 230 responses were received at the close of the study from 5 different government institutions across the city. In total, 141 (61.3%) HCWs were from BYL Nair Charitable Hospital, 20 (8.7) from TN medical college, 25 (10.9%) From KEM Hospital, 23 (10%) from Sion Hospital, 21 (9.1%) from Cooper Hospital. The detailed distribution of HCWs is depicted in [Table/Fig-2]. All the participants (100%) reported wearing all the components of PPE (Gown/plastic apron, double gloves, Face shield, Face mask, foot and leg coverings (Full Hazmat Suite) while working in the COVID-19 wards.



[Table/Fig-2]: Pie diagram depicting the distribution of professions of HCWs.

The median completed duty period was 14 days {IQR (Inter Quartile Range)=7-14 days}. The mean duration of the duty hours per day was 6.24 hours (IQR=5.8 to 6.8). The duration of the duty hours per day was maximum with the nursing staff, the mean duration being 6.7 hours. The mean duration of wearing PPE was 6.6 hours.

There were various difficulties faced by the HCWs both during and after the duty hours. They have been tabulated in [Table/Fig-3].

Total 142 HCWs (61.7%) [Table/Fig-3] felt they were dehydrated at the end of the six hours shift. Although only one of the 142 HCWs needed medical attention to deal with dehydration. While 5 respondents reported the need to doff the PPE before the duty hours due to dehydration. Many of the participants (40%) adjusted their N95 masks and lowered their face shields intermittently due to breathing issues or due to excessive heat while being aware of the risk of self-contamination.

Total 157 (68.2%) HCWs [Table/Fig-3] faced a de novo headache after the use of PPE. The headache was reported 2 to 6 hours after the duty by 97% of the HCWs complaining of a headache. Of the HCWs experiencing headaches, 15 (9.5%) had a history of migraine and they complained of worsening of the migraine. They complained of increased frequency and severity of migraine attacks after the duty hours.

Urges difficult to control during duty hours	Difficulties most challenging and bothersome during duty hours	Difficulties faced after the duty hours
Scratching itching body parts (57%)	Excessive Sweating (96%)	De novo headache (68.2%) (and worsening of migraine) (9.5% of them had history of migraine)
Thirst (46.1%)	Itching of body parts • Nose (56%) • Face (apart from nose) (50.9%) • Groin (17%) • Hands (6.7%) • Genitals (7.1%)	Dehydration (61.7%)
Urination (21.7%)	Headache (7%)	Contact dermatitis and eczema (10%) • Feet (7%) • Axilla (1%) • Wrist (1%) • Torso (1%)
Defecation (2.1%)		

[Table/Fig-3]: List of difficulties faced by the HCWs with PPE.

The PPE made it difficult to do routine ward procedures more challenging. The most difficult procedure to perform in PPE was reported to be endotracheal intubation by 55%. HCWs followed by central venous catheter insertion 30% [Table/Fig-4].

Procedure performed manually	Perceived to be most difficult in PPE by percentage of HCW	Perceived as the most risky in terms of self-contamination of COVID-19 doing the procedure by percentage HCWs
Endotracheal intubation	55	57
Central venous catheter insertion	30	7
Intravenous access	9	1
Nasogastric tube insertion	6	4
Perurethral catheterisation	2	1
Taking a Nasopharyngeal swab	3	11
CPCR	10	21

[Table/Fig-4]: Routine ward procedures and the perceived difficulty and the perceived risk of acquiring COVID-19 infection as reported by the HCWs.

All of the HCWs (100%) thought that there is an increased risk of spread of COVID-19 through centralised air conditioning systems. Hundred and six HCWs (46.1%) were apprehensive of the use of these air conditioners. The majority of HCWs 124 (53.9%) despite being aware of the increased risk, wanted the air conditioning to be used.

The HCWs reported the procedure of emergency intubation (57%) to be associated with the maximum risk of infection followed by Cardiopulmonary Resuscitation (CPCR) (21%) and nasopharyngeal swab [Table/Fig-4].

Fifty percent of the HCWs had given an oropharyngeal or nasal swab for COVID-19 testings (RT-PCR for COVID-19). Eleven HCWs (4.78%) reported having had a positive swab report for COVID-19 during the duty period. There was no statistical significance amongst those reported to have compromised their safety and those having been reported as COVID-19 positive (Chi-square test p-value=0.23).

DISCUSSION

The HCWs in Mumbai faced a unique challenge in working with PPE and adjusting to the hot and humid conditions. Cases of Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) infections increased over 375 times within 50 days around the duration of the study [8]. The difficulties faced by the HCWs in

working with PPE are very important as they might be significant barriers in the delivery of healthcare services to the patients.

In our study, the most common problem associated with using PPE kits were excessive sweating (96%). The HCWs also reported itching of the body parts to be a bothersome difficulty during their duty. De novo headaches and worsening of migraine were the other difficulties faced by the HCWs. India is a tropical country and Mumbai city with its hot and humid conditions during the peak summer months made the difficulties even more pronounced. There was a lot of apprehension with hospitals to prevent the spread through droplets and hence central air conditioning was kept shut in most of the hospitals [9]. This added to the problems faced by the HCWs working with PPE. The majority of HCWs 124(53.9%) wanted the air conditioner to be functional accepting the risk of infection.

Although the dehydration experienced by the HCWs rarely required any medical attention, one respondent reported to have had severe dehydration needing overnight hospitalisation. There have been similar incidences in the literature [10]. Fluid loss with heat stress has been perceived to be restrictive when working temperatures are beyond 28°C [11]. Double gloves have been reported to result in reduced dexterity in fine manual work [11,12]. Many of the participants (40%) adjusted their N95 masks and lowered their faces shields intermittently due to breathing issues or due to excessive heat while being aware of the risk of self-contamination. There was no statistical significance amongst those reported to have compromised their safety and those having been reported as COVID-19 positive (Chi-square test p-value=0.23).

There is a need for modifications of the working environment and customising PPEs. Solutions offered by certain studies include reducing elective surgical procedures, the use of PPEs from disposable to re-usable ones, and preferring regional anaesthesia over general anaesthesia wherever possible [13]. Another possible modification can be cost-effective, reusable customised PPE made of water-impervious polyester fabric 190 threads, which can be disinfected in 1% hypochlorite solution for 20 minutes [14]. The analysed results can be used by the PPE designers to make any possible changes in the design of PPE, the administrators can use this data to educate the HCWs and make the new HCWs aware of the probable challenges that one may face.

There was one similar study done a month after the inception of this study, the study has been compared with the current study in [Table/Fig-5] [6].

Parameters	Current study	Agarwal A et al., (2020) [6]
Number of participants	230	253
Online survey	Yes	Yes
Site of study	India	India
Distribution of HCWs	Doctors 74% Nurses 21.7% Paramedical 4.3%	Doctors- 55% Nurses 28% Paramedical staff- 17%
Average number of PPE used per duty	1	2
Mean duration of wearing PPE	6.6 Hours	4 hours
Most common difficulties faced by HCWs	Excessive sweating (96%) Itching (57%) Headache (7%)	Excessive sweating (100%) Fogging (88%) Suffocation (83%)

[Table/Fig-5]: Comparison of the current study with study done by Agrawal A et al., 2020 in New Delhi [6].

The strengths of our study include surveying all types of HCWs who had used PPE kits. Anonymity and confidentiality were maintained concerning the institution and the personnel. The study covers all the important issues faced by workers faced by the HCWs.

Limitation(s)

A relatively small sample size and no randomisation limit the analysis and interpretation of the study.

CONCLUSION(S)

De novo headaches, dehydration, excessive sweating and itching are the most common challenges faces by the HCWs after wearing PPE. Decreased dexterity and compromised vision with PPE leads to increased difficulty in performing ward procedure more difficult even to experienced HCWs. Heat and humidity significantly increased the challenges faced by HCWs working in PPE in the city of Mumbai during the peak of the pandemic.

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