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# FALL IN OXYGEN SATURATION AND NOTICEABLE TACHYCARDIA IN HEALTH CARE WORKERS POSTED IN COVID-19 INTENSIVE CARE UNIT: AN OBSERVATIONAL STUDY

Anaesthesiology

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## ABSTRACT

**OBJECTIVES:** Health care workers are at the frontline of any outbreak and as such are exposed to hazards that put them at risk of infection, that happen the outbreak of COVID-19. Use of Personal protective kit (PPE) and prolong stay in wards and intensive care unit (ICU) has a physiological impact among heath care workers, thereby exaggerating their pre-existing psychological stress. This study aimed to evaluate physiological impact among health care worker with PPE in COVID-19 intensive care unit.

**MATERIAL AND METHODS:** Fifty HCWs, aged 18–50 years were enrolled in this observational cross-sectional study. The physiological variables (heart rate, blood pressure, oxygen saturation, and respiratory rate) were recorded 5 minutes prior to donning with personal protective kit (PPE) and just after doffing, along with duration of stay in ICU. The physiological variables were represented as the mean ± standard deviation and a *p* value of <0.05 was considered significant.

**RESULTS:** There is a statistically significant difference in the post-doffing physiological parameters of HCWs compared with baseline: Heart rate ($p < 0.000$); oxygen saturation ($p < 0.000$); Blood pressure ($p < 0.000$); Respiratory Rate ($p < 0.000$) was observed where duration of ICU stay with PPE was more than 2 hours. The major adverse effects noted were sweating, fogging, headache, tiredness, difficulty in breathing.

**CONCLUSION:** The use of PPE results in noticeable physiological changes in HCWs during their prolong ICU stay. Increase in duration of stay in ICU wearing PPE can also lead to exhaustion, breathlessness and tiredness affecting their health.

## KEYWORDS

COVID-19, Health care worker, Oxygen saturation, Intensive care unit

## INTRODUCTION:

The COVID 19 pandemic in India is a part of worldwide pandemic of coronavirus disease 2019 caused by Severe Acute Respiratory Syndrome Coronavirus or SARS-CoV-2. It spreads through fomites, aerosols droplets and contact from human to human with an incubation period of 5-6 days (ranges from 1 to 14 days).[1-3] Respiratory signs and symptoms include fever, cough, and shortness of breath. In more severe cases infection can cause pneumonia, severe acute respiratory syndrome and sometimes death.[4] On 19 April 2020, China had reported 84,223 confirmed cases and 4,642 deaths and also reported that more than 3,000 healthcare workers (HCWs) have suffered from this infection, prompting a lockdown for more than 10 weeks.[5]

India reported the first case of COVID-19 in Kerala on 30 January 2020, and within a couple of weeks, COVID-19 spread to 27 states and 7 union territories [6] India adopted the disease containment strategies as per the WHO guidelines to fight against COVID-19 and implemented an early lockdown for 21 days on 25 March 2020, when the total confirmed cases were 550 only.[5] Health care workers are at the frontline of any outbreak and as such are exposed to hazards that put them at risk of infection with this outbreak pathogen (COVID-19). They are vulnerable population in this scenario because of enhanced risk of exposure and contracting the infection (roughly 33 times) and chances of transmitting the infection to their loved ones.[7] Long working hours, psychological stress, fatigue, occupational burnout, physical and psychological violence are among some hazards seen in health care workers.[8] All these factors can make health care professionals more prone for anger, anxiety, insomnia and stress.[9]

Based on experience with other respiratory viruses, consistent use of personal protective kit (PPE) is important to reduce nosocomial transmission of COVID-19. Use of PPE and prolonged stay in wards and ICU has a physiological impact among heath care workers, thereby exaggerating their pre-existing psychological stress.[10] Thus, we carried out a study to evaluate physiological impact among health care worker with PPE in dedicated COVID-19 intensive care unit at tertiary care level with primary aim to evaluate changes in vital parameters.

## MATERIAL AND METHODS:

After approval from institutional ethical committee ( RNT/STAT/ IEC / 2020 / SPL-1, dated 05/07/2020) and taking informed written consent from healthcare workers, this observational cross-sectional study was carried out in intensive care unit (ICU) in dedicated COVID hospital (ESIC) under tertiary care hospital for an one-month duration (Sept2020).

**We studied physiological impact in terms of:**

1) Heart rate and oxygen saturation in blood ($SpO_2$) by fingertip pulse oximeter Ver 1.0.
2) Noninvasive Blood pressure by Sphygmomanometer.
3) Duration of ICU stay (use of N95 mask with PPE kit).
4) Various adverse effects.

We recruited health care workers posted in COVID ICU including doctors, nursing staff and fourth class of more than 18 years of age, either sex. Exclusion criteria included participants with history of smoking, any comorbidity or any anxious personality/ health care workers not willing to participate in the study. Health care workers were monitored for basic vitals: heart rate (HR), respiratory rate (RR) , oxygen saturation in blood ($SpO_2$) and blood pressure (BP), 5 minutes prior to donning with personal protective kit (PPE) and just after doffing, along with duration of stay in ICU. Adverse effects like discomfort, anxiety, dehydration, nausea, vomiting etc were also noted.

We observed a total sample of 50 HCWs who were posted in COVID-19 ICU at dedicated COVID hospital (ESIC) in one month duration and informed consent to participate in the study was taken. The analysis was performed using IBM SPSS 20 Statistics software. Descriptive statistical analysis (n%) were performed on pearson chi-square test. Categorical data or quantitative data analysis were performed by paired t test. A p-value <0.05 was considered statistically significant.

## RESULTS:

Table 1 shows age and gender distribution of health care workers enrolled in study. There were 50 participants in the study, 12 (24%) were females and 38 (76%) were males. 20 participants were in age group 18-30 years (8 females and 12 males), 12 in age group 31-35 years (3 females and 9 males), 13 in age group 36-40 years (1 female and 12 males), 5 in age group more than 40 years (5 males). Same is represented in figure 1. Data was comparable and there was no significant difference (p>0.05).

**Table 1: Age and Gender Distribution of health care workers**

| Age Group | Female | Male | Total | P value |
|---|---|---|---|---|
| 18≤30 | 8 (40%) | 12 (60%) | 20 | >0.05* |
| 31-35 | 3 (25%) | 9 (75%) | 12 | |
| 36-40 | 1 (7.7%) | 12 (92.3%) | 13 | |
| >40 | 0 | 5 (100%) | 5 | |
| Grand Total | 12 (24%) | 38 (76%) | 50 | |

Data represented as n%
*Test used- Pearson chi-square test

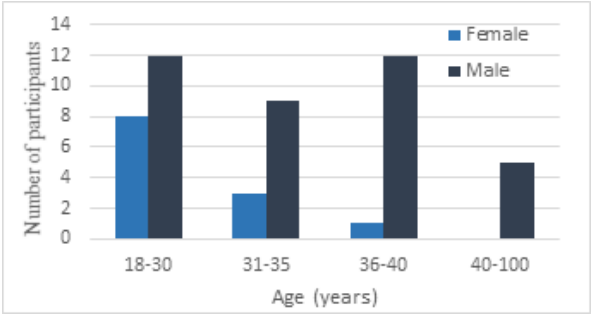


**Figure 1: Age and Gender Distribution of health care workers**

**Table 2: Distribution of health care workers according to duration of ICU stay**

| DESIGNATION | < 2 Hrs | >2 Hrs | Grand Total |
|---|---|---|---|
| Doctor | 15 (37.5%) | 25 (62.5%) | 40 |
| Fourth Class | 1 (33.3%) | 2 (66.7%) | 3 |
| Nursing Staff | 1 (14.3%) | 6 (85.7%) | 7 |
| Grand Total | 17 (34%) | 33 (66%) | 50 |

Data represented as n%
*Test used- Pearson chi-square test

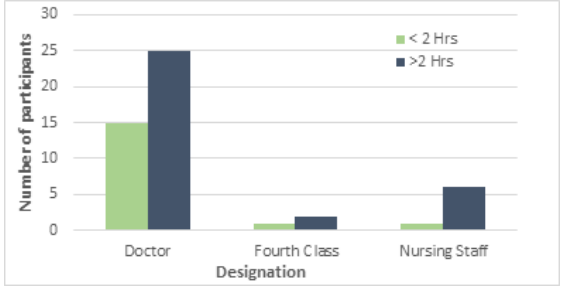


**Figure 2: Distribution of health care workers according to duration of ICU stay**

**Table 3: Comparison of haemodynamic parameters of health care workers before donning and after doffing, according to stay in ICU**

| | HEALTH CARE WORKERS (N= 50) | | |
|---|---|---|---|
| | < 2 hrs (N=17) Mean±SD | > 2 hrs (N=33) Mean±SD | Intergroup p value |
| | Systolic Blood Pressure | | |
| DONNING | 128.12±12.8 | 128.36±11.13 | 0.945# |
| DOFFING | 127.65±11.86 | 115.58±10.47 | |
| p value | 0.298 | 0.000* | |
| | Diastolic Blood Pressure | | |
| DONNING | 82.82±8.25 | 80.79±9 | 0.441# |
| DOFFING | 81.29±7.31 | 72.36±7.27 | |
| p value | 0.438 | 0.000* | |
| | Mean Arterial Pressure | | |
| DONNING | 97.92±9 | 96.64±9.23 | 0.468# |
| DOFFING | 96.74±7.84 | 86.76±7.72 | |
| p value | 0.0503 | 0.000* | |
| | Heart Rate | | |
| DONNING | 79.12±9.78 | 82.42±10.51 | 0.283# |
| DOFFING | 80.35±8.54 | 97.12±12.74 | |
| p value | 0.037* | 0.000* | |
| | SPO2 | | |
| DONNING | 97.88±0.93 | 98.09±0.88 | 0.436# |
| DOFFING | 97.53±1.07 | 95.09±1.96 | |
| p value | 0.110 | 0.000* | |
| | Respiratory Rate | | |
| DONNING | 16.12±1.50 | 16.39±2.15 | 0.646# |
| DOFFING | 16.41±1.37 | 20.36±2.26 | |
| p value | 0.096 | 0.000* | |

Data represented as Mean±SD, * Paired 't' test, # Unpaired 't' test

**Table 4: Adverse effects among Health Care Workers post doffing PPE**

| Adverse Effects | Participants (n=50) |
|---|---|
| Sweating | 50 (100%) |
| Fogging | 50 (100%) |
| Headache | 47 (94%) |
| Tiredness | 41 (82%) |
| Breathlessness | 38 (76%) |
| PPE Breach | 2 (4%) |
| Palpitations | 1 (2%) |
| Nausea and Vomiting | 1 (2%) |

Table 2 shows distribution of health care workers according to designation and ICU stay. Total 40 doctors were there, 25 (62.5%) remain in ICU for > 2 hours while 15 (37.5%) for < 2 hours. There were 7 nursing staff, out of which 6 (85.7%) were in ICU for > 2 hours while 1 (14.3%) for < 2 hours. Total 3 were fourth class health workers, 2 (66.7%) were in ICU for > 2 hours while 1 (33.3%) for < 2 hours. As total, 33 (66%) participants were in ICU for > 2 hours while 17 (34%) were in ICU for < 2 hours, out of 50 participants. Following distribution is represented in figure 2.

Table 3 shows mean vital parameters before 5 minutes of donning with PPE and just after doffing was compared using paired 't' test. In health care workers with <2 hours of stay in ICU, there was no significant difference in mean systolic blood pressure, mean diastolic blood pressure, mean arterial pressure, mean oxygen saturation and mean respiratory rate, ($p>0.05$). Difference in mean heart rate was statistically significant 5 minutes before donning with PPE and just after doffing ($p=0.037$). In health care workers with >2 hours of stay in ICU, there was statistically significant difference in mean systolic blood pressure, mean diastolic blood pressure, mean arterial pressure, mean heart rate, mean oxygen saturation and mean respiratory rate, 5 minute before donning with PPE and just after doffing ($p<0.05$).

Comparison between baseline haemodynamic parameters of health care workers who stayed in ICU for < 2 hours and those who stayed > 2 hours was done using unpaired 't' test. Difference between mean systolic blood pressure, mean diastolic blood pressure, mean arterial pressure, mean heart rate, mean oxygen saturation and mean respiratory rate, 5 minutes before donning was comparable and was statistically insignificant ($p>0.05$).

## DISCUSSION:

The novel coronavirus pandemic mandates the use of PPE to reduce exposure in health care workers during their ICU stay. However, this protection is not without certain adverse physiological consequences.[11] Present study evaluated the physiological changes associated with the use of PPE among frontline HCWs during their stay in ICU. A significant increase in heart rate from the baseline was noted in our study with the prolonged use of PPE (post doffing) in HCWs that remained in ICU for >2 hours as compared to stay of <2 hours. These findings may signify the physiological responses to hypoxia and hypercarbia caused by the dead space of the N95 mask (with PPE) which might have led to the accumulation of carbon dioxide.[11-13] The reduced availability of oxygen in PPE and increased levels of carbondioxide leads to increase in heart rate. This physiological alteration may increase aortic and left ventricular pressures, leading to an upsurge of cardiac overload and coronary demand.[14] Therefore, increase in heart rate after prolonged periods of wearing PPE (with N95) correlates to breathing resistance and increased retention of CO2.

A study on the impact of the surgical mask on SpO2 in surgeons during surgery revealed that a significant decrease in SpO2 occurs only in procedures longer than 60 minutes.[15] This was corresponding to our study where significant difference in oxygen saturation was observed from baseline (post doffing from PPE) in HCWs with ICU stay of >2 hours. These findings were similar to those seen during qualitative respirator-fit testing done for N95 FFR among controls and

subjects.[16] The decrease in SpO2 from baseline to post-doffing can be explained by the increase in work rendered by HCW after donning PPE. A similar finding was noted by ***Spurling et al***. [17] wherein they found poor saturation of hemoglobin secondary to the increased partial pressure of CO2 at higher exercise intensity.

Moreover, the effect of microenvironments like the high temperatures and humidity levels prevailing in our work environment might have led to a high microenvironment temperature and humidity inside the the PPE. [12,18] This results in a higher resistance offered while breathing through the filtering facepiece respirators (FFRs) and consequently drop-in oxygen saturation seen post doffing, which though statistically significant, does not seem to be clinically significant.

The significant fall in blood pressure (systolic, diastolic and mean arterial) after PPE use in ICU was observed in HCW with duration of stay of >2hrs in ICU which was not significant in ICU stay of <2hrs. The most likely cause is the redistribution of body fluids, as HCWs were involved in heavy work post-donning. So, muscle cells consumed more energy and oxygen leading to a decrease in nutrients and an increase in molecules, such as carbon dioxide resulting in vasodilation.[19] In addition, the vasodilatation secondary to the extreme heat due toprolonged wearing of PPE can lead to profuse sweating causing dehydration and redistribution of body fluids as observed by ***Vegforse M et al.***[20]

In present study, we observed that respiratory rate (RR) was significantly higher among HCW after doffing as compared to baseline with duration of ICU stay >2 hrs ($p<0.000$), due to sweating and dehydration increasing work of breathing, raising respiratory rate.

During long duration of ICU stay, sweating and fogging was the most common adverse effect among HCWs, followed by headache, tiredness, breathing difficulty and nausea-vomiting. If the mask is not well fitted, it may result in a leak from the nasal bridge causing fogging of the protective eye gear leading to poor visibility, thus hampering work. The face mask forms a closed circuit for the inspired and expired air. Rebreathing of the expired air increases arterial CO2 concentrations thereby increasing the intensity of acidity in the acidic environment.[21] Thus, individuals working with a mask would have physiological effects similar to a chronic obstructive pulmonary disease (COPD) person exercising, such as: discomfort, fatigue, dizziness, headache, shortness of breath, muscular weakness, and drowsiness.[22]

Another study by ***Agarwal et al*** [23] reported most common problems associated with using PPE kits was excessive sweating (100%), fogging of goggles, spectacles, or face shields (88%), suffocation (83%), breathlessness (61%), fatigue (75%), headache due to prolonged use (28%), and pressure marks on the skin at one or more areas on repeated use (19%). Though PPE is must for protecting the HCWs in a physically demanding environment of increased risk of infection with COVID-19, its negative impact cannot be ignored. Research on designing more comfortable protective gear should be encouraged along with better engineering modifications to work environments.[24]

## CONCLUSION:

We conclude that hemodynamic perturbations in HCWs coupled with the additional stress of wearing PPE for a long duration in COVID-19 ICU adds to their discomfort with a resultant reduction in their working efficiency. So, institutional policies should be framed to ensure schedule of frequent breaks during long shifts along with adequate hydration and nutrition.

## Ethical Clearance:

By institutional ethical committee {RNT/STAT/IEC/2020/SPL-1, Dated 05/07/2020}

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