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Occupational Health

EFFECT OF PPE ON THE VITAL SIGNS OF HEALTHCARE WORKERS IN THE COVID 19 ERA

KEY WORDS: Covid-19, pandemic, thermal stress

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ABSTRACT Covid 19 , the most recent pandemic faced by our world has been one of the most toughest challenges faced by the healthcare system worldwide. It made the whole healthcare system worldwide crippled and put an excessive burden on the healthcare workers . The HCW's were faced with an unimaginable task of managing the ever increasing Covid 19 patients , their health , their well being as well as hospital management all the while being donned in an air and water droplet impervious suit known as PPE(Personal Protective Equipment) in the scorching heat of Indian summer. This article aims at studying the effects of wearing long hours of PPE on the vital signs of Healthcare workers because of the thermal stress it puts on their body and certain pointers to manage the excessive heat build up while in the PPE.

INTRODUCTION

On 11 March 2020, the entire world was gripped by a pandemic known as COVID-19 due to the viral infection spread by SARS-COV-2 Virus. The progress of the COVID-19 pandemic was on a rapid scale in India. From the time it was declared a pandemic until the end of August 2020, the number of cases in India increased from 60 to 3,542,733[1,2]. In India, this represented a rise from less than 0.001% to 0.26% of the population which considering the vast population of India is a big leap. Pandemics place an abundant amount of pressure on the country's healthcare system causing resource-depletion[3]. Certain adverse physical and mental effects have been experienced by frontline healthcare workers (HCWs) due to the use of the personal protective gear. HCWs face a rising demand for patient care, managing logistics, and long working hours. This puts unwarranted burden on the body due to the need to wear enhanced personal protective equipment (PPE) which is necessary to reduce the risk of disease transmission [4].

The norms of social distancing , work from home which are usually applied to the general population couldn't be applied to the frontline health care workers as they have to be in direct contact with the patients whether Covid positive or suspected of having a respiratory infection. Hence the use of PPE comes into play for such frontline HCW for their safety . The PPE provided usually includes a gown, gloves, and N95 respirator with face shield or goggles. While it offers protection to the wearer from biological hazards it also subjects the wearers body to excessive heat [5]. The human body generates heat[6] which has to be dissipated from the body in the form of sweat evaporation, convection and conduction. However the PPE wore by HCW prevents the vapour molecule from escaping to the environment increasing the risk of body overheating, thermal strain leading to a change in their vital signs [7,8]. India being a tropical country with temperatures in the summer season going upwards of 45C further exacerbates this problem[9].

This article aims to relate the excessive burden put on the body of frontline HCWs after wearing PPE kits for long hours which translated to changes in their vital signs for the worse and suggests certain pointers to prevent it or decrease the intensity of it from happening in future.

MATERIALS AND METHODS

This study was conducted in our institute, King George Medical University, Lucknow, UP. A dedicated Covid hospital was established just outside the campus of the university. The study included the frontline HCWs who were posted in this covid hospital during the pandemic. They included doctors, nurses, ward boys, sweepers, all of whom had to wear PPE kit for varying duration of times to dispose their designated duties. This accounted to 60 subjects. The participation was voluntary. Since the start of the pandemic in India which coincided with the start of summer season in our country , all air conditioning units whether centralised or not were instructed to stop operating for the fear of the dreaded viruses transmission. This put up an increased thermal load on the bodies of the HCWS wearing PPE kits.

The vital signs of all the PPE kit wearers were taken before their donning of the PPE and immediately after the doffing of their PPE kits. To minimise the chance of error, the same machine was used after proper sanitisation to measure the vital stats i.e. heart rate, body temperature, blood pressure, respiratory rate and oxygen saturation.

The procedure which was done was as follows: The HCW who was supposed to go inside the covid red zone or covid ward first reported to the vital room which was a separate room allotted for the purpose of taking the vitals of that HCW. A nursing staff would measure the said vitals of the concerned HCW by using a wall mounted measuring instrument which was capable of recording the BP, Heart rate, Temperature, SPO2. The respiratory rate was measured manually by the nursing staff. After the vitals were recorded for the said HCW , he/she would proceed to the donning area where the PPE kit was donned by him/her.

Following completion of duties in the covid ward/ red zone area, the HCW would doff his used PPE kit in the designated doffing area, sanitise himself properly and then immediately report back to the vital room for the measurement of his vitals post doffing. The same procedure of recording of vitals was followed again by the same machine and same nursing staff to minimise error and bias.

Following measurements were made in a tabulated way and studied:

Table 1 shows the pre donning and post doffing heart rates in subjects

Pre Donning Heart rate	Post Doffing Heart rate	Pre Donning Heart rate	Post Doffing Heart rate
106	108	99	98
98	84	80	82
74	78	83	89
80	98	110	112
90	102	82	84
77	80	110	98
79	102	80	102
79	81	62	76
112	98	82	93
80	81	80	84
80	89	79	80
96	108	80	82
78	82	81	80
79	90	84	86
85	98	79	80
77	86	102	112
104	118	89	92
82	87	80	84
68	79	86	90
88	89	76	88
110	114	80	96
76	75	96	100
82	90	100	110
86	97	80	96
104	109	78	80
102	112	80	96
100	107	96	100
88	89	100	110
86	90	80	96
76	88	78	80

Table 2 shows the pre donning and post doffing body temperature

Pre Donning Temperature	Post Doffing Temperature	Pre Donning Temperature	Post Doffing Temperature
97.6	97.9	96.7	96.9
98.1	98.9	97.5	97.9
97.3	99.1	96.6	96.2
97.5	98.4	96.8	97.6
98.2	99.0	96.5	97.8
97.2	98.7	97.4	97.9
97.9	99.2	97.6	99.4
99.0	99.9	96.8	96.9
98.2	98.9	96.8	98.2
97.4	97.8	97.2	97.7
98.2	98.7	97.2	97.3
99.2	99.4	97.6	99.8
97.4	99.2	98.2	98.8
98.2	99.1	98.4	100.2
96.8	97.3	97.2	98.4
96.8	97.8	98.2	98.7
97.7	98.6	98.4	99.3
98.0	98.4	96.9	97.6
97.6	97.0	98.1	99.7
96.8	97.0	97.3	98.2
98.6	97.2	99.0	99.3
97.2	97.9	98.3	98.9
97.6	97.8	97.4	98.8
98.4	99.6	98.1	98.7
98.2	99.8	99.1	100.2
98.1	100.2	99.8	100.9
97.4	99.2	98.2	98.6
99.0	99.8	98.9	99.8
98.8	99.7	97.3	97.8
98.3	98.7	97.1	99.1

Table 3 shows the pre donning and post doffing changes in blood pressure

Pre Donning Blood pressure	Post Doffing Blood pressure	Pre Donning Blood pressure	Post Doffing Blood pressure
118/68	122/70	124/84	126/88
116/70	118/64	118/72	118/74
112/66	122/68	108/60	110/68
102/80	106/76	112/74	116/80
116/78	126/86	120/82	116/80
112/70	118/78	128/78	134/76
110/72	120/84	122/70	116/78
130/80	126/88	112/80	116/84
120/76	124/82	116/88	114/84
126/78	124/86	122/76	118/84
120/70	114/74	120/88	128/86
118/80	118/68	118/82	118/84
110/70	114/88	112/70	116/76
100/84	106/88	110/70	114/74
112/80	118/78	108/68	108/70
110/80	114/82	122/84	126/80
128/84	122/90	134/88	138/94
136/86	130/88	128/86	126/90
120/76	124/80	118/84	122/88
110/70	112/74	108/54	112/66
118/90	112/78	116/90	118/86
118/80	122/86	128/90	134/96
110/82	114/82	120/76	124/82
110/80	106/78	122/74	126/80
122/90	112/94	116/78	118/82
114/78	116/82	112/80	118/86
128/90	124/92	118/90	116/94
114/76	118/84	108/60	110/72
120/78	122/86	112/80	110/76
112/68	116/74	124/86	128/84

Table 4 shows pre donning and post doffing respiration rate

Pre Donning Respiration rate	Post Doffing Respiration rate	Pre Donning Respiration rate	Post Doffing Respiration rate
18	20	16	16
18	21	16	20
16	19	14	16
16	21	18	19
18	22	16	18
18	23	16	19
16	21	18	22
18	24	20	19
20	26	20	25
20	21	18	19
18	25	18	23
20	23	16	19
18	19	18	22
16	21	20	25
18	25	18	23
18	24	20	27
16	26	16	20
20	25	18	19
18	1	16	19
18	26	18	27
18	19	20	25
18	22	16	21
16	20	18	22
18	19	16	19
20	24	18	28
19	21	21	22
17	22	22	25
22	27	25	30
24	28	20	24

21	26	16	21
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Table 5 shows pre donning and post doffing SpO2 levels

Pre Donning SpO2	Post Doffing SpO2	Pre Donning SpO2	Post Doffing SpO2
99	98	99	96
97	99	98	92
98	95	100	98
96	94	97	94
96	93	97	93
96	92	96	92
96	97	94	90
95	92	100	96
96	94	96	93
98	92	95	95
100	98	97	93
95	97	99	96
98	96	98	92
95	91	98	96
95	89	96	91
97	94	100	96
95	92	99	93
95	92	100	95
99	96	99	89
95	91	98	93
99	94	100	90
96	92	99	95
100	97	99	93
98	94	96	91
99	98	94	90
96	93	98	97
94	91	99	96
95	88	96	90
99	93	92	87
100	97	94	88

DISCUSSION

The primary objective of this study was to determine the change in vital stats of HCWs after PPE usage and performing their duties during the COVID-19 pandemic.

We observed that HCWs wearing PPE while working in hot and humid environments displayed significant changes in their vital statistics especially when it came to their body core temperature, heart rate and spO2 levels [Table 1,2,3,4,5]. These stats are related critically to the work capacity, productiveness and judgement of the HCW's during their time in the wards donned in PPE. Various studies have been done which show that thermal stress is related to reduced work capacity[10], increase in the amount of errors occurring during the work[11], accidents [12], and an overall deterioration of personsal well being [13,14]. The altered vitals of the subjects which are an indirect sign showing body thermal stress negatively impact their roles as HCWs, which requires undivided attention and commitment. With the ever increasing rise of the Covid 19 patient numbers, the HCW's who continue to work in such hot and humid conditions not only put their body's on stake but also the patients under their care are affected due to their poor judgement calls.This is of grave concern as the pandemic itself puts an immense burden on the healthcare system.

Working in such hot and humid conditions laden with PPE suits, the signs of thermal stress are reflected in the vital signs of the HCW's as well as other general actions like excessive thirst, excessive sweating, exhaustion and wanting to leave the shift early to reach to a more comfortable environment. Such stress also puts undue pressure on the cardiovascular system putting them at a disadvantage of contracting heart related ailments.

The blunt was borne more by Indian HCW's because of 3

factors-

1. India is a tropical country with extremes of weather, especially summer which let the temperatures soar to as high as 49-50 celsius along with extreme humidity which makes wearing and working in air and water impermeable PPE suits a ginormous task.
2. India is a developing nation , so the facilities and resources are not upto the mark; like there is lack of dedicated rest areas for all HCW's, lack of surplus amount of PPE kits for regular change during breaks and lack of air conditioned work sites.
3. India is a country with the second highest population in the world making it a nightmare for the meager amount of health care workers and health care facilities to cope up with the enormous numbers of patients who turned up with the Covid-19 infection requiring health care.

Certain strategies can be thought of which can help lower this thermal stress and asphyxiating environment of PPE like a balance between work and rest cycle while wearing PPE and removal of it during breaks. While it is a great concept to moderate the effects of PPE on HCW'S health and vital status, some HCW's avoid taking it off to because of lack of it or due to fear of getting infected.

Some other pointers which can be given are pre cooling the HCW before he dons on his PPE and enters the covid wards. This can be done by keeping the worker in an air-conditioned room prior to his donning and making him eat Ice slurry which helps lower down his core temperature to some extent affecting all other vital stats too[15].Ice slurry has a dual effect on body that it not only cools but also hydrates the drinkers body. This helps in tolerating the stuffy environment of PPE suit a little longer for the HCW. If ice slurry isn't readily available, cold water can be used as replacement. [16].

One more way to keep core temperature in check is by aerobic fitness, although overlooked in our country, aerobic fitness can help lower body core temperature, step up the heat dissipation mechanisms of body[17,18].

RESULTS

As its obvious that after donning PPE the body goes in a stressful environment and the fight, fright , flight response is triggered. This leads to all the vitals of the wearer become more than normal to counter the stress it faces. In PPE, this stress is in the form of thermal stress which translates to a change in the wearer's vitals.

The mean Heart rate of the PPE wearer pre donning was found to be 87 and post doffing it had elevated to 93 signifying the stress which was put on the cardiovascular system.

The mean body core temperature pre donning was 97.7F which post doffing had increased to 98.6F, translating as an almost increase in 1 degree of body core temperature which has debilitating effect on the body.

The mean blood pressure pre donning was 124/82 which had increased to 128/87 which again shows the effects of PPE on the cardiovascular system of the wearer .

The mean Respiration rate cycle pre donning was 18 which had increased to 22 cycles per minute because of the air hunger in the air tight PPE suit.

The mean SPO2 of the wearer pre donning was 97% which dropped down to 93% post doffing due to the extremely asphyxiating environment inside the PPE suit.

CONCLUSION

Covid 19 tested the healthcare structure of the entire world which nearly crippled at its feet. It is the steel nerves of all the Health care workers that we were able to handle it and

emerge victorious although with great casualties. The PPE suit although a complete necessity to prevent infection also has debilitating effects on the wearer's body. The wearer of this suit should be made to take appropriate breaks and his vitals should be monitored to prevent any life threatening change in them. Heat lowering strategies should be implemented to make the working of HCW's in PPE more bearable.

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