

Impact of Personal Protective Equipment on Health of Health Care Providers: A Review From the “Other Side”

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ABSTRACT

Background: In the last twenty years, the world has faced a series of epidemics such as the SARS-CoV, H1N1 influenza and MERS-CoV. Later in December 31 2019, unexplained respiratory infection cases were reported in the city Wuhan, Hubei, China, which was later concluded to be the novel Coronavirus (nCoV). Within a short period of time, numerous amounts of cases were reported from all over the world with time WHO issued a set of guidelines which included the mode of transmission of the infection and also the protocols to be followed to prevent the excessive progression of the infection. Safety of frontline health care workers is of greater concern as they come in direct contact with the patients of COVID-19. So as to ensure their utmost safety, certain protective measures were incorporated such as the N95 respirator, masks and PPE. Use of masks as a protection against the infection became a mandatory part of the preventive measures adopted by the public. This review article focuses on the difficulties faced by healthcare workers due to the prolonged use of masks and PPE.

Keywords: Severe Acute Respiratory Syndrome Corona virus (SARS-CoV), Middle East Respiratory Syndrome Coronavirus (MERS-CoV), Novel Coronavirus (nCoV), Personal Protective Equipment (PPE).

INTRODUCTION

According to WHO, viral infections pose an immediate threat to the healthy living of the public. The world has faced a series of viral epidemics in the last twenty years, such as the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) from 2002 to 2003 and H1N1 influenza in 2009. Most recently, the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) was first identified in Saudi Arabia in 2012. [1] In the present timeline, on December 31 2019, a cluster of unexplained lower respiratory infection cases were reported by the Wuhan Municipal Health Commission, China, which was eventually identified as novel Coronavirus. WHO officially published the

first disease outbreak news on the new virus on January 5 2020. Within a short amount of time; hundreds and thousands of cases were diagnosed around the world, causing the World Health Organization to announce it as an infectious disease pandemic on January 30 2020. India reported its first case of COVID on January 30 2020, in Kerala's Thrissur District in a student who came for vacation from Wuhan University, China. [2] After that period, India also shows a greater number of Covid 19 cases in a short time span.

As the initially reported cases were linked to the direct exposure to the Huanan Seafood Wholesale Market of Wuhan, animal to human transmission

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was initially suspected. [1] Cases reported later had no confirmation for the prior assessment. Hence it was concluded that the transmission occurs from human to human. The transmission was believed to occur through respiratory droplets as with other respiratory pathogens seen in flu and rhinovirus. Possibility of transmission of the virus was noted even when the individuals were asymptomatic. With elevated aerosol concentrations in closed spaces, aerosol transmission portrayed a possible way of transmitting the diseases. Hence healthcare professionals are mandated to wear PPE when caring for COVID-19 patients. PPE includes gloves, medical/surgical face masks, face shields, goggles and gowns. Aside from a major shortage of PPE across the United States, causing stress to hospital

administrators and healthcare professionals on the front lines, many expressed added stress from adverse effects of prolonged PPE usage.

DISCUSSION

The last incidence of prolonged use of PPE among healthcare professionals was during the SARS (severe acute respiratory syndrome) outbreak in 2003-2004, which originated in Guangdong, China. Studies focusing on the effects of prolonged use of PPE during the SARS outbreak were published in subsequent years. A study by Lim et al. focused on headaches related to mask use [3] and another study by Foo et al. discussed adverse skin reactions such as rashes, acne and itching from mask use [4].(Table - 1)

Table 1: Adverse effects following wearing of PPE.

Type of PPE	Symptoms		Symptoms(%) as per different study			
			E.C.H Lim et al.	Chris et al	Juan et al.	Faisal
N 95 mask	Scar at nose bridge			3.7%		
	Increased pore size			0.9%		
	Runny nose			0.9%		
	Worsened asthma			0.9%		
	Headache		37.3%	-----		
	Adverse reactions on skin			35.5%	97%	70-95%
	1	Itch		51.4%		
	2	Rash		35.8%		
	3	Pigmentation		7.3%		
	4	Peeling skin		0.9%		
	5	Redness nose bridge		0.9%		
	6	Dry skin		1.8%		
	7	Wheals		0.9%		
	8	Acne		59.6%		
Gloves	Adverse reactions on skin					
	1	Dry skin		75.4%		
	2	Itch		56.3%		
	3	Rash		37.5%		
	4	Wheals		6.3%		

The WHO COVID-19 IPC GDG considered all available evidence on the COVID-19 virus modes of transmission and on medical mask versus respirator use to protect health workers from infection, its level of certainty as well as the potential benefits and harms, such as the development of facial skin lesions, irritant dermatitis or worsening acne, or breathing

difficulties that are more frequent with respirators. [4, 5]

The CDC and WHO recommend wearing N95 masks during the care of patients with highly transmissible diseases such as Tuberculosis, SARS, and COVID-19. The N in N95 stands for NIOSH, the National Institute for Occupational Safety and Health of the United States and 95 indicates filter efficiency of

particles. Thus, an N95 mask is 95% effective at filtering airborne particles, including very small ones. In comparison, while surgical masks provide a barrier against large respiratory particles, they are ineffective at providing protection from smaller particles. Surgical masks also do not prevent leakage around the mask when the user inhales. Therefore, surgical masks are ineffective and do not provide enough protection when performing direct care of patients with COVID-19 [6].

To prevent the spread of COVID 19, hospitals required the employees and visitors to wear N95 masks for better protection. Generally, surgical masks were worn by the employees and visitors. While providing direct care to patients with or without COVID 19, the employees wore the N95 masks.

The protective measures taken to prevent the transmission of infection came with a set of limitation on the physiological and psychological performance of the healthcare workers. Wearing masks for a prolonged amount of time causes a host of physiologic and psychologic burdens and can decrease work efficiency. The activity cannot be performed as long or as efficiently while wearing masks as compared to when masks are not worn. Additionally, the timeframe that an activity can be sustained is decreased when wearing masks and PPE [7]. Due to prolonged use of N95 and surgical masks causes physical adverse effects such as headaches, difficulty in breathing, acne, skin breakdown, rashes and impaired cognition. It also interferes with vision, communication and thermal equilibrium. Use of PPE during emergency surgery throughout the pandemic revealed that PPE uses affected surgical performance, reduced comfort, communication difficulties and impaired visibility. Additionally, the double and even triple gloving, the use of face masks and goggles can hamper psychomotor skill and performance of manual tasks, especially in prolonged emergency settings.[8,9] In a study, factor analysis showed a set of strongly related variables consisting of hearing, understanding speech, and understanding the situation. This suggests that degradation in communication was strongly associated with degradation in situational awareness. A subsequent mediation analysis showed a direct effect of PPE discomfort on situational awareness ($P<.001$); this was also influenced (mediated) by difficulties in

communicating, namely in hearing and understanding speech. [10]

Headaches related to prolonged mask use can be attributed to mechanical factors, hypercapnia and hypoxemia. Tight straps and pressure on superficial facial and cervical nerves are mechanical features causing headaches [3]. There is evidence of a cross-sectional study to determine the risk factors associated with the development of de novo PPE-associated headaches as well as perceived impact of these headaches on their personal health and work performance along with the impact of COVID-19 on the pre-existing headache of 158 healthcare providers, which revealed that, among them, 29% respondents had pre-existing primary headache diagnosis and 81% of the respondents responded to have developed de novo PPE-associated headaches. Since COVID-19 outbreak, 91.3% of respondents with pre-existing headache diagnosis either "agreed" or "strongly agreed" that the increased PPE usage had affected the control of their background headaches, which affected their level of work performance [11,12]. Tight-fitting masks cause inadequate ventilation and increased levels of carbon dioxide (CO₂) known as hypercapnia. As CO₂ is a known respiratory stimulant, a buildup of exhaled CO₂ between the mask and face will cause increased lung ventilation and respiratory activity. Symptoms of hypoxemia, such as chest discomfort and tachypnea, are also noted in healthcare professionals with prolonged mask use. Exhaled CO₂ builds up between the mask and face and increased levels of CO₂ causes confusion, impaired cognition and disorientation [7].

A hot and humid environment found in the facial region covered by masks causes discomfort and hyperthermia. This may create a situation where the healthcare professional is unable to recognize dangers and perform manual tasks, and it also significantly affects motor skills [6]. The moist environment and pressure from tight-fitting masks also block facial ducts. This can explain the increase of acne with prolonged mask use [4]. When a controlled clinical trial was carried on pregnant healthcare workers, it showed breathing through N95 mask materials have been shown to impede gaseous exchange and impose an additional workload on the metabolic system.[13] Prospective crossover study quantitated the effects of wearing no mask, a surgical mask and an FFP2/N95 mask.

The cardiopulmonary and metabolic responses were monitored by ergo-spirometry and impedance cardiography. Ten domains of comfort/discomfort of wearing a mask were assessed by questionnaire. The results of that study indicated that ventilation, cardiopulmonary exercise capacity and comfort were reduced by surgical masks and highly impaired by FFP2/N95 face masks in healthy individuals.^[14]

Frequent PPE and mask changes may cause shearing and breakdown of the skin and breakdown on the bridge of the nose and cheekbones can be attributed to tight-fitting masks and goggles that put pressure on these specific areas ^[12, 15, 16]

Urticaria and contact dermatitis can occur from sensitivity to components of masks and PPE. Formaldehyde is a chemical used in PPE that some are sensitive and/or allergic to. Others may react to thiuram which is found in the ear loops of surgical masks.^[17, 18]

This review identified various adverse effects of prolonged mask use experienced by healthcare professionals during the COVID-19 pandemic. While healthcare professionals and the world at large wish this pandemic to end and never return, these adverse effects can be dealt with by proposal of modified preventive measures.

CONCLUSION

The number of cases of COVID-19 pandemic is increasing at an alarming rate. The health care workers, elderly and the immune compromised people are at greater risk of fatality. The rapid spread of disease calls for more intense and modified surveillance and preventive methods keeping into considerations the downsides of the presently followed preventive methods to improvise the overall psychological and physiological challenges faced by the health care workers.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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