

Protective Armour Against the Invisible Enemy

The effectiveness of Personal Protective Equipment (PPE) in the COVID-19 Pandemic

Seoyoon Kim

Secondary School Pupil

King George V School

Word Count: 1492 words (excluding title page & references)

The Unofficial Guide to Medicine Essay Competition

INTRODUCTION

The uproar over the COVID-19 pandemic in recent years has reached an international crisis. As a result, the healthcare workforce is struggling under physical and mental exhaustion. Evidently, it is crucial for the medical staff to protect themselves from getting an infection. Although protective equipment such as face masks and gloves provide sanitation to a certain extent, any exposure from the infectant may lead to infection. Therefore, a more accurate and stricter method of applying protective equipment is needed in order to reduce the number of infected individuals from growing day by day.

In this essay, I aim to elaborate on the effectiveness of Personal Protective Equipment (PPE) on COVID-19 which can minimize the spread of the current pandemic. Ultimately, it can help alleviate the outgoing pressure on the healthcare and medical systems and any doubt people have on its use.

DEFINING PPE (Personal Protective Equipment)

The Occupational Safety and Health Administration Organisation (OSHA) defines PPE as "all equipment which is intended to be worn or otherwise used by a person at work and which protects the person against one or more hazards to his/her safety or health".¹

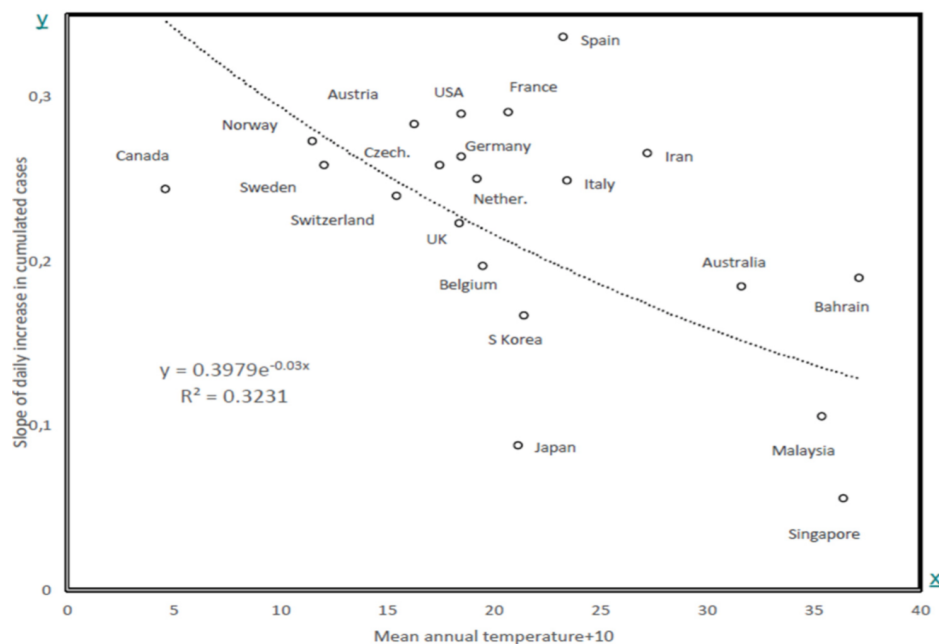
TYPES OF PPE



All forms of equipment have different purposes and methods of protection. The common ones are gloves, masks, face shields, goggles, and gowns³. Among the different types of masks, the N95 mask is the strongest of them all, which is a type of respirator that filters out 95% of microscopic molecules in the air⁴. This prevents the intrusion of harmful microorganisms. Protective eyewear is mandatory for healthcare workers given the information that SARS-CoV-2 viruses can spread through eyes. Safety

goggles protect the medical staff from aerosol transmission³. They must be designed so that they can prevent the transmission of particles at all angles. Face shields are a direct covering from the spume of infectious viruses. While the safety goggles and masks protect parts of a human's vital organs, a face shield allows protection of skin, as it is the most detrimental way of spreading the virus to others. Latex, Nitrile, PVC medical gloves⁵ are worn depending on the type of contact the healthcare worker is going to have with the patient⁶. Gloves provide a blockage of direct contact with the patient and the virus is located at the surface. The picture² above illustrates the features of medical gowns (or, PPE suits). They are usually made of polyesters, which predominantly offer splash protection, allowing the whole body to avoid contamination. These medical equipment all combine to allow for the user to have a higher level of protection from viruses.

STRENGTH OF PPE



PPE is designed to protect oneself from getting infected from COVID-19 in various ways. First, PPE limits the amount of exposure to the SARS-CoV-2 virus by inhalation, absorption, or contact⁷. The clothing forbids any contact to the outside atmosphere, reducing the risk of getting the virus. Second, PPE reduces the severity of injuries⁸; hence, when there is a skin tear, the contact between the bloodstream and the air will be minimized, limiting the chance for viruses to enter the wound. Third, proper usage of PPE minimizes heat loss from one's body which reduces the risk of being vulnerable to such contagious diseases. From an article, the data⁹ shows the negative correlation between the mean annual temperature and the number of infected cases around the world. Lower body temperatures decrease the level of activity in immunity systems, making the body susceptible to illnesses. Therefore, sustaining a safe level of body temperature helps drive down the possibility of catching diseases.

PROPER USE AND TRAINING



The picture¹⁹ above displays an example of healthcare workers donning PPE. Proper training for the use of PPE¹¹ should be compulsory in order to avoid cross contamination. Cross contamination can happen through donning and removing the kit¹², and there are several steps the wearer should take to make use of PPE's effectiveness. Small mistakes and errors in donning or removing the kit makes the equipment futile.

With adequate usage and training, all exposure and leakages can be blocked by the PPE during and after the contact with a COVID-19 diagnosed patient.

CASE STUDY 1: Level of PPE need for protection against Ebola

Personal Protective Equipment has been used in certain medical sectors for some time, in particularly, for contagious diseases such as Ebola. The level of PPE needed to prevent oneself from getting an infection from exposure to diagnosed patients has not yet been certified. The experiment Dunn et al. conducted illustrates the correlation of the level of PPE equipped with the efficiency of preventing oneself from getting exposed to the virus.

Sixty-four healthcare workers who have been exposed to patients infected with Ebola have been studied by segregating them into smaller groups in accordance with the level of PPE worn (no PPE to high level of PPE). Through precise measurements, the relative risks and the 95% confidence intervals have been calculated and arranged in a table shown below.

Table 1 Relative risk of infection with Ebola for health care staff while wearing at least gloves and gowns, at least gloves, or gloves only compared with no PPE and for wearing at least gloves and gowns compared with no PPE or gloves only (N = 64)

Type of PPE used	No. infected	Exposure person-episodes	RR and (95% confidence interval)
At least gloves and gown	0.5	29	
No PPE	3	5	0.03 (0.00-0.57)
At least gloves	4	71	
No PPE	3	5	0.09 (0.02-0.42)
At least gloves and gown	0.5	29	
No PPE or gloves only	7	47	0.12 (0.01-2.04)
Gloves only	4	42	
No PPE	3	5	0.16 (0.04-0.71)

PPE, personal protective equipment; RR, relative risk.

The results¹³ significantly show that there is a positive relationship between the level of PPE with the efficiency of PPE. Higher levels of protective equipment (gloves and gown) has significantly shown a low number of infectants compared to lower levels of protective equipment (gloves only). This highlights the importance of the level of PPE along with proper training and usage of the equipment. Therefore, PPE can be effective for other viruses like Ebola and may be equally applied to COVID-19.

CASE STUDY 2: COVID-19 Infection Among Healthcare Professionals in Wuhan, China

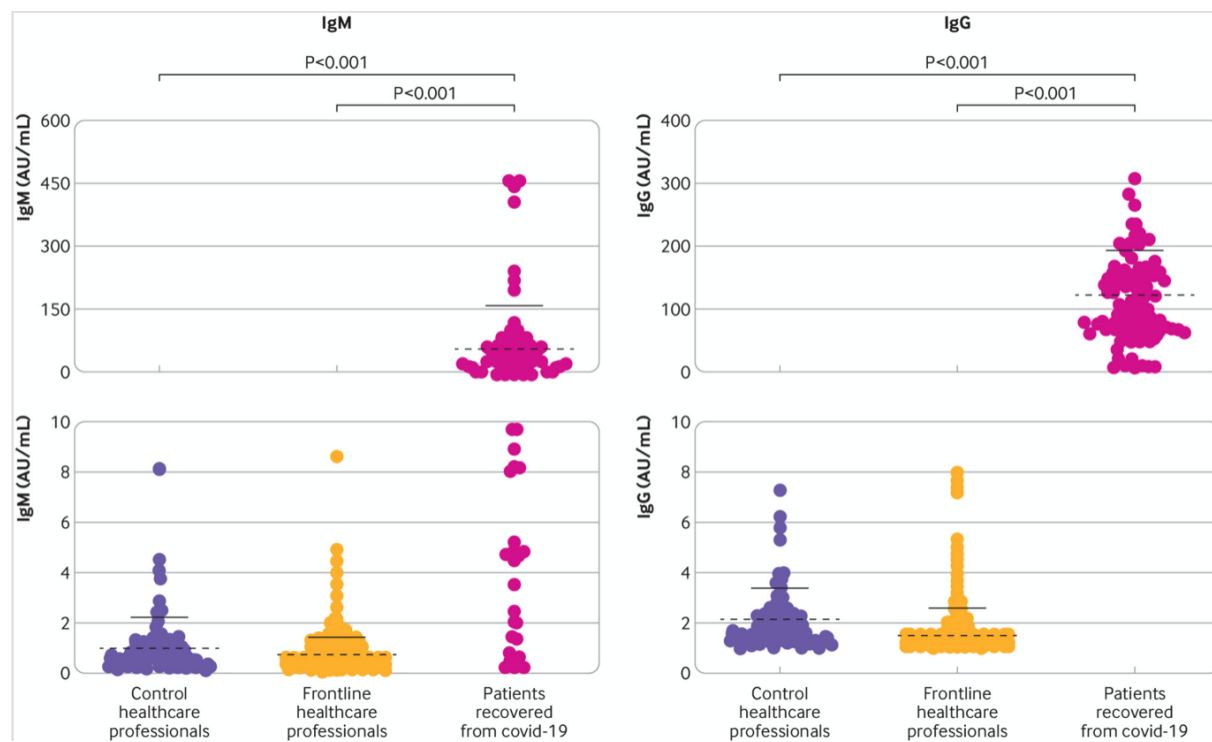
Here is an example of direct evidence that may demonstrate that PPE is effective for protecting ourselves from a COVID-19 infection. The birth of COVID-19 originated in Wuhan, China, indicating that the healthcare systems located nearby were overwhelmed with millions of infectants streaming in day by day. The experiment was carried out through examining the effectiveness of wearing PPE on healthcare professionals who provided care for patients diagnosed with COVID-19.

A total of 420 healthcare professionals took part from four hospitals in Wuhan, China (West Division of Union Hospital, GuangGu Division of Tongji Hospital, HanKou Hospital, and HongHu Hospital) where they cared for patients with COVID-19 symptoms (fever, dyspnoea, cough, etc). Their temperatures were checked twice a day using a digital infrared thermometer along with reports of any COVID-19 symptoms. The participants wore standardised PPE (protective suits, masks, gloves, goggles, face shields, and gowns) after being trained in their correct use.

Online questionnaires were sent to the participants in regard to daily clinical practice. Careful diagnostics have been made through the collection of nucleic acids in nasopharyngeal swabs three times in two weeks of quarantine after they returned home from Wuhan (day 1, day 7, day 14) and serum samples for detection of IgM (class of antibodies that appear early after an infection) or IgG¹⁴ (class of antibodies that gradually replaces IgM antibodies) antibodies. A negative control of 77

healthy healthcare professionals with no COVID-19 symptoms were also tested to increase the validity of this serological testing.

Data analysis¹⁵ was performed with the usage of Prism 8.0 software. Comparisons were assessed by using the Kruskal-Wallis test measurements and multiple comparisons. 95% confidence intervals of infection rates were analysed by Wilson score interval. Two-sided P value less than 0.05 was considered as statistically significant.



Although there were high risks of exposure, no evidence was found of infection in any of the 420 participants as their test results were shown to be negative for nucleic acids and specific IgM or IgG antibodies. Evidently, with proper training and usage of PPE, the level of infection among healthcare professionals can be significantly reduced.

POSSIBLE HEALTH RISKS/CONCERNS

However, there are other concerns the medical staff should take into consideration before wearing PPE. The dense covering of the material without any leakage causes an overheating of the user's body, resulting in heat-related illnesses such as exhaustion, dehydration, rashes, and fainting in worst cases. To prevent all of this heat-related stress, Public Health England¹⁶ advises the healthcare system to assess the risks of overheating in the environment and cut off the sources of heat as much as possible. Healthcare workers should stay hydrated by drinking plenty of water during break time intervals and rest when feeling unwell.

All equipment is intended for single use¹⁷.

CONCLUSION

This essay suggested several reasons and cases why PPE is useful and how it brings benefits to the healthcare system given the right conditions.

In conclusion, the fastest way to reduce the spread of the COVID-19 pandemic is to take sanitation into consideration by wearing the full PPE kit, which is a top priority for medical staff. Different types of equipment stand for different purposes, which are crucial in protection of the healthcare staff and others. With proper use and training, PPE is robust enough to withstand the invasion of microorganisms. This essay has outlined the benefits of bringing PPE mandatorily into the healthcare system to avoid the spread of COVID-19 among healthcare workers.

REFERENCES

1. "Personal Protective Equipment (PPE)" *OSHC*, Occupational Safety & Health Council, <http://www.oshc.org.hk/eng/main/hot/ppe/index.html>
2. "PPE protective clothing" *Derekduck*, <https://www.derekduck.com/page/238>
3. Lawes, Rhonda, "COVID-19: Personal Protective Equipment Function and Usage" *Lecturio*, Lecturio Medical, 08, April. 2020, <https://www.youtube.com/watch?v=49gKSsPCIG8>
4. "Understanding the Difference, Surgical Mask. N95 Respirator." *CDC*, Centers for Disease Control and Prevention, , <https://www.cdc.gov/niosh/npptl/pdfs/understanddifferenceinfographic-508.pdf>
5. "Technical specifications of personal protective equipment for COVID-19 | COVID-19: Infection prevention and control / WASH" *WHO*, World Health Organization, 13, November. 2020, https://www.who.int/publications/i/item/WHO-2019-nCoV-PPE_specifications-2020.1
6. "Types of PPE" *Environmental Health and Safety*, University of California Merced, <https://ehs.ucmerced.edu/researchers-labs/ppe/selection>
7. Baxter, Christina M., & Stull, Jeffrey O., "Minimum Recommended Guidance on Protection and Decontamination for First Responders involved in COVID-19 cases", The Interagency Board For Emergency Preparedness and Response, 10, April. 2020, https://www.ems.gov/pdf/Federal_Guidance_and_Resources/PPE_and_Infection_Control/Minimum_Guidance_on_Protection_Decontamination_for_First_Responders_Detailed.pdf
8. Ilesanmi, Olayinka, & Omotoso, B. & Amenkhenan, I., "Accidents, injuries and the use of personal protective equipment, among hospital cleaners in a tertiary hospital in South West Nigeria", *ResearchGate*, 01, January. 2015, https://www.researchgate.net/publication/294581262_Accidents_injuries_and_the_use_of

[personal protective equipment among hospital cleaners in a tertiary hospital in South West Nigeria](#)

9. Demongeot, Jacques, & Flet-Berliac, Yannie, & Seligmann, Hervé, “Temperature Decreases Spread Parameters of the New Covid-19 Case Dynamics” *Biology*, MPDI, 03, May. 2020, <https://www.mdpi.com/2079-7737/9/5/94/htm>
10. Watts, Ianor, & Leck, Astrid, & Hu, Victor, “Personal protective equipment for COVID-19 in eye care” *CEH Journal*, Community Eye Health Journal, 01, September. 2020, <https://www.cehjournal.org/article/ppe/>
11. “Personal Protective Equipment for Infection Control”, U.S. Food & Drug Administration, 10, February. 2020, <https://www.fda.gov/medical-devices/general-hospital-devices-and-supplies/personal-protective-equipment-infection-control>
12. Larry, M., & Baddour, MD, “Personnel Contamination During PPE Removal”, *NEJM Journal Watch*, 28, October. 2015, <https://www.jwatch.org/na39461/2015/10/28/personnel-contamination-during-ppe-removal>
13. Verbeek, Jos. H., & Mihalache, Raluca Cecilia, “More PPE protects better against Ebola” *AJIC*, American Journal of Infection Control, 01, June. 2016, [https://www.ajicjournal.org/article/S0196-6553\(16\)00002-X/fulltext](https://www.ajicjournal.org/article/S0196-6553(16)00002-X/fulltext)
14. “General information and FAQs for Covid-19 IgM and IgG Antibodies”, Strong Health & Wellness, <https://sa1s3.patientpop.com/assets/docs/163150.pdf>
15. Liu Min, Cheng Shou-Zhen, Xu Ke-Wei, Yang Yang, Zhu Qing-Tang, Zhang Hui et al., “Use of personal protective equipment against coronavirus disease 2019 by healthcare professionals in Wuhan, China: cross sectional study”, *the BMJ*, 10, June. 2020, <https://www.bmj.com/content/369/bmj.m2195>
16. “Personal protective equipment and heat: risk of heat stress” *HSE*, Public Health England, https://www.dentistry.co.uk/wp-content/uploads/2020/06/CEM_CMO_2020_027-1.pdf
17. “Personal Protective Equipment” *The Northern Ireland Regional Infection Prevention and Control Manual*, Public Health Agency, <https://www.niinfectioncontrolmanual.net/personal-protective-equipment>