Effect of Personal Protective Equipment (PPE) on oxygen saturation and dehydration status in COVID-19 nurses in Gorontalo Province

Yusrin Aswad¹, Suwarni Loleh²

¹²Politeknik Kesehatan Kemenkes Gorontalo, Indonesia

*Yusrinaswad@gmail.com

Abstract. The Executive Board of the Indonesian Doctors Association (PB IDI) confirmed that no less than 228 health workers including nurses, died from the corona virus. Lack of oxygen can result in hypoxia, coupled with the use of Hazmat and a longer number of shift hours, this results in increased body heat. Body heat is closely related to fluid balance, the higher the body heat, the more sweat that comes out, if not balanced with fluid replacement it will cause dehydration. The sampling technique used was purposive sampling. This type of research is a quasi-experimental design with a "group pre and post-test design". Based on the results of the study, it was found that the average decrease in oxygen saturation was 4% and examination of Dehydration Status through urine color with an average increase of 1.1. Results of Oxygen Saturation Based on the statistical analysis Wilcoxon test p value <0.05 and Dehydration Status Assessment Based on the Wilcoxon test statistical analysis, the value of p <0.05, so from these results it could be concluded that there was an effect on the use of personal protective equipment (PPE) Against Oxygen Concentration in the Body and Dehydration Status of Covid-19 Nurses in Gorontalo Province.

1. Introduction
A total of 150 health-care workers in DKI are confirmed to have contracted this Covid-19 disease on Thursday (9/4/2020). "So far, 24 doctors and a dentist are dead due to this virus. (Public Relations IDI) The Managing Board of the Indonesian Doctors’ Association (IDI) confirmed that no less than 24 doctors are dead due to this coronavirus. Meanwhile, the Chairman of the Indonesian Nurses Association (PPNI), Harif Fadillah, confirmed that at least 16 nurses are dead due to this virus. Based on this data, at least 40 health-workers are dead while providing care for other Covid-19 patients (Kompas). One of the reasons for this health-workers to be infected with this virus is due to the lack of Personal Protective Equipment (PPE).

Even more, health-workers often uses PPE that does not meet WHO standard (IDI, 2020). Some of the required PPEs are N95 Respirator masks and surgical masks. N95 respirator mask itself consists of 4-5 layers (the outer layer polypropylene, mid-layer electret (charged polypropylene), and 95% efficient to filter small particles (0.3 microns). In comparison, the surgical mask is composed of 3-4 layers made from spun-bound melt-blown spun-bond (sms) and spun-bound melt-blown spun-bound (smms). Standard care for Covid-19 patients demands that the healthcare provider wear 2 types of masks simultaneously, N95 mask as the first layer, and the outer layer is the surgical mask. This means that the total layer of masks worn by the healthcare workers are nine layers, five layers of N95, and four layers of surgical mask.
On the one hand, this is effective to prevent the nurses and doctors from contracting the Covid-19 disease, but still, this creates a new problem, such as breathing difficulty for doctors and nurses. Interview results from the initial study with several nurses stationed at the isolation chamber of Ainun Habibie Hospital of Gorontalo province on the 30th of June 2020 revealed that there are differences between wearing Covid-19 standard PPE and normal PPE. Even though this Covid-19 standard PPE protects them from virus exposure, the PPE is uncomfortable. The nurses should maintain neither to eat or drink nor pee when wearing this Coverall Hazmat PPE. In addition, they mostly complained about breathing difficulty and excessive sweating, even dizziness.

2. Methodology
The present study is a quasi-experiment study with one group pre and post-test design. This study only uses one group, where oxygen saturation and dehydration status are measured before and after the nurses wear the PPE of N95 mask and coverall hazmat. A saturated sampling technique is employed in this study based on the criteria listed below.

2.1 Inclusive Criteria
a. Volunteer to be respondent
b. Age 18 – 40 years’ old
c. Assigned as a nurse in Covid-19 patients ward for more than one month.

2.2 Exclusive criteria
a. Refuse to participate
b. Has a history of lungs diseases?
c. Has co-morbid diseases

3. Result and Discussion
3.1 Respondents’ Characteristics

| Characteristics | Number | %  |
|-----------------|--------|----|
| Sex             |        |    |
| Female          | 18     | 60 |
| Male            | 12     | 40 |
| Age             |        |    |
| 17 – 25         | 11     | 36 |
| 26 – 34         | 16     | 53 |
| 35 – 40         | 3      | 10 |

Based on the table above, it is shown that male nurses are 12 respondents or 40%, whereas female nurses are 18 respondents or 60%. the age of the nurses is within three large groups with 26 – 34 years old group as the largest age group by 53%, followed by 17-25 years old group by 37%, and 35-40 years old age group by 10%. It can be inferred that all respondents are young nurses.

3.2 The influence of wearing Personal Protective Equipment (PPE): N95 mask and Coverall hazmat on oxygen concentration of Covid-19 Nurse Team

| Characteristics | POST_SPO2 | PRE_SPO2 | Z     | Asymp. Sig. (2-tailed) |
|-----------------|-----------|----------|-------|-----------------------|
|                 |           |          | -4.793a | .000                  |

a. Based on negative ranks.
b. Wilcoxon Signed Ranks Test
Based on the Wilcoxon test, it was revealed that α: 0.00, which means that there is a significant difference in oxygen saturation before and after wearing the PPE level 3 on Covid-19 nurses. This result indicated an influence of utilization of Personal Protective Equipment, N95 Mask and Coverall hazmat on oxygen saturation in the Covid-19 nurse team. A large proportion of nurses and doctors who wear the coverall hazmat complained about breathing difficulty, excessive sweating, unable to drink, eat or pee during the duration they wear this coverall hazmat. There were even nurses who pass out at the nurse station during their shift within 2.5 hours’ duration of wearing hazmat [1].

Pass out or syncope is a natural body defense mechanism. This condition is caused by a lack of blood and oxygen supply to the brain. Hence, brain function slows down and can influence all bodily functions [2]. In addition, short and quick breath, limp body, excessive sweating, loss of consciousness, and syncope, are hypoxia indicators or lack of oxygen within the body [3]. This present study affirms the previous studies where it shows a different oxygen saturation before and after wearing the Coverall Hazmat. Oxygen saturation after wearing coverall hazmat on average, reduced by 2%. This situation should be taken into account considering 3% or more of SPO2 is considered clinically important [4].

Based on the result above, it is assumed that utilization of Personal Protective Equipment (PPE), N95 mask, and Coverall hazmat can influence air circulation or ventilation process, thus causes hypoxia. Apart from air circulation, available literature shows that the reduction of oxygen saturation is partly influenced by nurse’s activities with longer hour shifts. Berman et al. (2016), as cited in [5], found that factors that influence the saturation reading are hemoglobin, air circulation, and activity.

A study by [5], activity or exercise can influence body temperature, where body temperature will rise along with the increase of activity or exercise. Ganong (2003), as cited in [5] posed that each increase in body temperature will cause the bonds between hemoglobin and oxygen to reduce. Body temperature is one factor that influences metabolism speed and the determinant factor within metabolism is muscle activity. Guyton and Hall (1997) found that working muscles will release carbon dioxide (CO2). The released carbon dioxide acid increases the hydrogen ion (reduce PH) within the muscle capillaries. In addition, the muscle’s temperature increases by 2-30c, which can increase the PO2 to release the O2 within the muscle.

All of these factors work to reduce hemoglobin affinity, whereas according to [6], oxygen saturation is the percentage of oxygen that can be carried by hemoglobin. Thus, the reduction of hemoglobin affinity resulted in the reduction of oxygen saturation. Therefore, physical activity can cause a decrease in oxygen saturation. In several articles, it is described that once the nurse entered the isolation chamber for Covid-19 patients, the medical staff should wear the coverall hazmat for 2 -3 hours. This is for patients with clinically mild to medium conditions.

3.3 The influence of utilization of Personal Protective Equipment (PPE), N95 Mask and Coverall Hazmat, on Dehydration Status of Covid-19 Nurse Team

| Test Statistics | URINE_POST | URINE_PRE |
|-----------------|------------|-----------|
| Z               | -5.057<sup>a</sup> | .000<sup>b</sup> |

<sup>a</sup> Based on negative ranks.
<sup>b</sup> Wilcoxon Signed Ranks Test

The result of the Wilcoxon statistical test above shows that α 0.00; thus, it can be inferred that there is a significant influence on dehydration status by urine measurement indicator. This result confirmed that there is an influence of using personal protective equipment, N95 mask and coverall hazmat, on the dehydration status of the Covid-19 nurse team. [8] found that workers in a heated environment who experience heat pressure will result in their body to adapt to the environment. When the
temperature in the environment increases, the body temperature will also increase. The hypothalamus gland will activate a heat regulatory mechanism of the body to react by maintaining constant body heat, balancing the received heat from the environment with heat loss from within the body through the evaporation process of breathing and sweating. The largest evaporation happens through sweating. Excessive sweating can cause dehydration when it is not balanced with a sufficient intake of fluids.

This result is supported by [9], who reported that workers' dehydration was due to an increase in fluid needs as a result of environmental temperature factors and insufficient fluid intake. Dehydration can be caused by an increase in activities with imbalanced fluid intake. Physical activity is working or leisure activities that need energy from the body. The gastric can store fluid replacement slower than the fluid released through sweating during an increase in activities (Diyani, 2012 as cited in [10]. This shows that it is easier for sweat to be released compared to the fluid to be stored by the gastric. Suma’mur (2009), as cited in [8] found that shift length determined one’s exposure toward risk factor of heat pressure. The heat pressure effect happens due to body system’s failure to maintain body heat. The effect of heat pressure can manifest partly in subject complaints such as heat complaint, excessive sweat, thirstiness, unwell feeling, and loss of appetite due to loss of body fluid through sweat evaporation.

Andayani (2013), as cited in [8] found that dehydration on workers can decrease cognitive abilities, such as temporary decreased concentration and memory, influence mood and work spirit, and decrease physical work capacity due to fatigue, drowsiness, or dizziness. This could lead to declined work productivity and even lead to an increase in work-related accidents. Based on the result of this present study on dehydration status and supported by findings of the previous studies described above, it can be concluded that dehydration can happen to medical staffs who wear Personal Protective Equipment (PPE), N95 mask and coverall hazmat, due to excessive sweating that is not balanced by sufficient fluid intake during long-hour work-shift. The longer the work shift of the medical staff that treated the Covid-19 patients, the higher the hypoxia and dehydration risk these medical staffs are exposed to.

4. Conclusion
4.1 Conclusion

Based on the results and findings of this study, it can be concluded that there are influences of the use of Level 3 Personal Protective Equipment (PPE) on oxygen saturation and dehydration status of Nurse Team that treated the Covid-19 patients. In detail, the results of this study are:

a. There is a significant reduction of oxygen saturation on patients who treated Covid-19 patients by 4%

b. There is an increase of dehydration status on nurses who treated Covid-19 patients by 1.1 point.

c. There is a significant influence on oxygen saturation and dehydration status of nurses who treated Covid-19 patients before and after wearing the level 3 PPE.

4.2 Recommendation

a. Length of time Usage of level 3 PPE should be shortened

b. The work-hour/shift of nurses who treat Covid-19 patients should be shortened to a maximum of 4 hours/day.

c. The isolation chamber/ward should use an air conditioner that is suitable for the size of the chamber/ward

d. Nurses who treat Covid-19 patients should be facilitated with portable oxygen.

References

[1] B. M. Abdi, “Berjam-jam Gunakan Baju Hazmat seperti Terjebak di Kamar Sauna,” Jawa Post Web Page, 2020. https://www.jawapos.com/surabaya/09/04/2020/berjam-jam-gunakan-baju-hazmat-seperti-terjebak-di-kamar-sauna/.

[2] Rizal Fadli, “Inilah 6 Penyebab Orang Bisa Pingsan,” halodoc web page, 2020. https://www.halodoc.com/artikel/inilah-6-penyebab-seseorang-bisa-pingsan.
[3] G. Florencia, “Mengganggu fungsi otak kenali gejala dan penyebab Hipoksia,” halodoc web page, 2019. https://www.halodoc.com/artikel/mengganggu-fungsi-otak-kenali-gejala-dan-penyebab-hipoksia.

[4] N. C. Chan, K. Li, and J. Hirsh, “Peripheral Oxygen Saturation in Older Persons Wearing Nonmedical Face Masks in Community Settings,” JAMA Netw., 2020, [Online]. Available: https://jamanetwork.com/journals/jama/fullarticle/2772655.

[5] A. Andriani and Rodhi Hartono, “Saturasi Oksigen dengan Pulse Oximetry dalam 24 jam pada pasien dewasa terpasang Ventilator di Ruang ICU Rumah Sakit Panti Wilasa Citarum Semarang,” Jendela Nurs. J., vol. 2, 2013.

[6] S. Fadlilah, N. Hamdani Rahil, and F. Lanni, “Analisis Faktor Yang Mempengaruhi Tekanan Darah Dan Saturasi Oksigen Perifer (SpO2),” J. Kesehat. Kusuma Husada, no. Spo 2, pp. 21–30, 2020, doi: 10.34035/jk.v111i1.408.

[7] C. Wijaya, “Virus corona: Perawat yang meninggal akibat Covid-19,” BBC News Indonesia, 2020. https://www.bbc.com/indonesia/indonesia-52074437.

[8] M. P. Sari, “Iklim Kerja Panas dan Konsumsi Air Minum Saat Kerja Terhadap Dehidrasi,” HIGEIA (Journal Public Heal. Res. Dev., vol. 1, no. 2, pp. 108–118, 2017.

[9] K. Andayani and F. F. Dieny, “Hubungan Konsumsi Cairan Dengan Status Hidrasi Pada Pekerja Industri Laki-Laki,” J. Nutr. Coll., vol. 2, no. 4, pp. 547–556, 2013, doi: 10.14710/jnc.v2i4.3738.

[10] F. Pusisari, L. Sitoayu, R. Nuzrina, D. Angkasa, and N. Gifari, “Hubungan Aktivitas Fisik , Konsumsi Cairan , Status Gizi Dan Status Hidrasi Pada Pekerja Proyek,” J. Gizi Unimus, vol. 9, no. 2, pp. 215–223, 2020.