



INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACEUTICAL SCIENCES

Published by JK Welfare & Pharmascope Foundation

Journal Home Page: www.pharmascope.org/ijrps

A Review on Methods of Face Masks Sterilization for Reuse Owing To Crisis During COVID-19

Pradyuman Singh Rajput¹, Asish Kumar Saha^{*2}, Insiya Gangardiwala¹,
Anand Vijayakumar Palur Ramakrishnan³

¹Department of Pharmacy Practice, Shree Dhanvantary Pharmacy College, Kim, Surat, Gujarat, India

²Department of Clinical Pharmacology, Bhagwan Mahavir Medica Superspecialty Hospital, Ranchi, Jharkhand, India

³Department of Pharmacology, (A DST FIST sponsored department) JSS College of Pharmacy (JSS Academy of Higher Education and Research) Ootacamund, Tamil Nadu, India



Article History:

Received on: 06 Aug 2020

Revised on: 19 Sep 2020

Accepted on: 21 Sep 2020

Keywords:

COVID19,
Pandemic,
face masks,
PPE,
Sterilization methods

ABSTRACT

The COVID-19 pandemic initially started from the Wuhan capital city of Hubei Province in the People's Republic of China had now led to a severe public health hazard across the globe, the recorded death is approximately 958 thousand globally and counting. With the enormous amount of spread of the disease, a severe crisis for Personal Protective Equipment (PPE) is being noticed across the globe. Face masks being the first line of defence for all the health-care workers as well for the common public. It became mandatory to wear face masks before entering the patient care area. The countries who are not manufacturing it locally had to depend on other countries for the procurement. As there is a severe supply chain disruption due to the lockdown measures taken by all the countries to contain the disease, so it had become difficult to procure the face masks from the manufacturing countries. The price for these PPEs is also rising at an alarming rate with the increase in the COVID-19 cases and the huge rate of consumption by the healthcare and other sectors. Therefore, with limited resources, the hospital has to run its services. The CDC, WHO and ICMR have released several guidelines from time to time for sterilization and reuse of face masks. This article will discuss the various methods that can be utilized to sterilize the face masks and reuse of it.

*Corresponding Author

Name: Asish Kumar Saha

Phone: +91-7278285133

Email: drasishksaha@gmail.com

ISSN: 0975-7538

DOI: <https://doi.org/10.26452/ijrps.v11iSPL1.3604>

Production and Hosted by

Pharmascope.org

© 2020 | All rights reserved.

Health care workers, COVID-19 has been deadly so far. (COVID-19, 2020) After WHO declared COVID-19 as an emergency on 28 January 2020, the virus is known to have spread from the Wuhan city, Province of Hubei, China to over more than 184 countries affecting over 2.5 Million positives worldwide. (23 April 2020) (Lu *et al.*, 2020; WHO, 2020) Death rates have been a whopping 6% with a large proportion of individuals being aged more than 50. (Wang *et al.*, 2020) The highly exposed group of individuals are generally the frontline health forces, including physicians and nurses.

INTRODUCTION

With over 172 thousand deaths in the last few months around the world, including a larger ratio of

The only known method to avoid the virus is the effective use of preventive measures as it spreads through airborne transmission and contact transmission route, the spread can be generally avoided

with the use of Personal Protective Equipment.

Personal Protective Equipment (PPE) as defined by the Occupational Safety and Health Administration is “specialized clothing or equipment, worn by an employee for protection against infectious materials”. It comprises of gloves, masks, respirators, aprons or gown, goggles and face shields. Respirators have been designed to protect the respiratory tract from the infectious airborne transmission. (CDC, 2020) The most frequently utilized respirators in healthcare settings are the N95, N99, or N100 particulate respirators. These devices have a sub-micron filter capable of excluding particles that are less than 5 microns in diameter.

WHO has recommended the use of N95 masks to prevent the airborne transmission of the pathogenic material. (W.H.O., 2020) UK Health Guidelines promoted the use of type FFP3 masks equivalent to N99 masks a higher alternative to WHO preferred N95 with filtering efficiency of at least 99% airborne particles. (Public Health England, 2020) Based on the clinical experiences in China, Hospitals have recommended the use of N95 for any contact with concurrent use of plasma air sterilizers with intermediary use of UV Lamps for one hour thrice a day in areas with human activity including the disinfection of faecal matter and sewage with chlorine-containing disinfectant. (Skorzewska, 2020)

WHO evaluates that about 89 million FFRs are required each month to withstand the COVID-19 pandemic with such estimates surging upwards. Due to unmet demands and limited access to supplies of N95 FFRs in the global market has led to a shortage in the available resources which can pose harm to the healthcare workers. (World Health Organization, 2020) Various health institutions and organizations around the world have produced guidelines on the rationale and effective use of PPE and prevent the exhaustion of resources. (Coronavirus disease (COVID-19), 2020; ECDC, 2020) Guidelines have generally classified the HCWs into different risk categories from low risk to high risk, allocating N95s to the HCWs engaged in the moderate to high risk of transmission. (MHFW, 2019)

The reuse of single-use medical devices up to 5 times is permissible unless labelled by the manufacture in times of crisis. (NIOSH, 2018) Various strategies and experiments have been conducted on reusing and testing the efficacies of the single-use medical devices post sterilization.

This review article enlists strategies and methods leading to the reuse of the face masks to cater to the services even during the crisis with uncompromised safety and efficacy.

METHODS

NIOSH and CDC have published guidelines and recommendations for reuse of mask towards improving practice in sensitive settings. Decontamination of masks was required to be done before carrying out the reuse of masks considering the availability of the resources, space, and manpower to carry out under controlled measures without impacting the filtering performances and safety of HCWs. (NIOSH, 2018; Lin et al., 2018)

Various researches have been conducted in the past to access the efficacy and sterility of PPE post sterilization for reuse. (Schöpe and Klopotek, 2020) Among the literature survey, the most accurate and effective methods to sterilize PPE were found out to be:

1. UV Light Decontamination
2. Autoclave
3. Vaporized Hydrogen Peroxide

Other methods included 70% alcohol, dry and wet heat methods, bleach, ethylene oxide gas treatment, and hydrogen peroxide in plasma and liquid forms. These methods failed to maintain the structural and functional requirements of the masks and thereby, were excluded. Ethylene oxide and Ionized Hydrogen Peroxide gas treatment were not recommended due to their potential toxicity. (Kumar et al., 2020)

UV Light Decontamination

The high energy of the UV-C rays is known to damage the nucleic acid formation leading to the prevention of the microbial replication of bacteria and viruses. (Card et al., 2020) Lowe et al. incorporated the use of dedicated rooms for the decontamination process of the masks using specialized ultraviolet germicidal irradiation towers. This UVGI setup sterilized the masks from both sides producing sterilization in less time than one-sided irradiation. At the same time, a group of authors proposed the use of biosafety cabinets readily available at all the facilities. These BSC were able to sterilize N95 masks with the intensity of 100 μ W to make the mask safe for reuse after 15-20 minutes of exposure per side. (Lowe et al., 2020)

A method where Samples were placed into a UV sterilizer cabinet with a 254 nm, 8 W lamp, and 475 internal area (17 mW) was irradiated for 30 minutes and let to stand under ambient conditions for 10 minutes per cycle. Limitation of this process was the inability of the light to penetrate through the layers of respirator inducing only the topical layer to be

sterilized and also lead to structural deformations on further repetitions. (Liao *et al.*, 2020)

Autoclave

Autoclave remains the most widely used sterilization method across health care settings all over the world. The standard autoclave was performed at 121 C for 15 minutes, with a total cycle time of 40 minutes. Standard use of the method was linked to no loss of structural or functional integrity to a minimum of 10 cycles in the 3 pleated mask models. In contrast, the moulded N95 mask tolerated only 1 cycle of the following treatment. Its benefits were limited due to reduced reuse cycles. (Kumar *et al.*, 2020)

Vaporized Hydrogen Peroxide

Hydrogen peroxide is known to be virucidal on most of the hard surfaces without impairing respirator's performance. (Goyal *et al.*, 2014; Viscusi *et al.*, 2009) This method provides an advantage over the other methods by good material compatibility, low temperature, rapid cycle time, environmentally safe by-products with ease of operation, installation, and monitoring. Penetration is low in terms of EtO, making it less toxic comparatively.

A method incorporated cycle consisting of 10 minutes dehumidification, 3 minutes conditioning (5 gram/minute), 30 minutes decontamination (2.2 gram/minute), and 30 minutes aeration while peak concentration being >750 ppm. (Kumar *et al.*, 2020) While an alternative method sterilized masks using a 10-minute conditioning phase, 30-40 minute gassing phase (varies with humidity and room size) at 16 g/min, 25 minutes dwell phase, and a 150-minute aeration phase (varies with the number of respirators and room size), with this long-duration intended to reduce HP vapours. (Viscusi *et al.*, 2009) An FDA undertaking exhibited no change in performance requirements, collection of aerosol, or air-flow resistance in N95 respirator even after decontamination with Hydrogen Peroxide Vapor in the laboratory for over 50 times. (N95 FFR, 2016) Elastic straps showed degradation in the maximum attempts of the test, thereby reuse of N95s was lowered down to 30 cycles to maintain the qualitative properties. (Schwartz *et al.*, 2020)

CONCLUSION

In this review, we included several methods for most accurate, less time consuming, and inexpensive sterilization methods of face masks for the reuse to lower down the demands by at least 50%. The most effective method was the use of vaporized hydrogen peroxide. It provided maximum sterilization

with uncompromised degradation up to 50 cycles. The recommended use is at least five times to overcome demands by 500%. Rest of the methods provided sterilization for the least period but could be beneficial in the setups where the certain facility is not available. These methods should be adopted to continue health services and are capable enough to lower down the strain in a healthcare setting. It provides an uncompromised safety for HCWs even in the time of crisis and helps them fight the pandemic effectively. These methods should be checked and verified at one's facility before implementing it as a norm for reuse. In the near future, it would be beneficial in overcoming the shortage crisis across the globe. A proper guideline for the reuse and reallocation would help us in fighting pandemics without lives at stake.

Funding Support

The authors declare that they have no funding support for this study.

Conflict of Interest

The authors declare that they have no conflict of interest for this study.

REFERENCES

- Card, K. J., Crozier, D., Dinh, M., Dolson, E., Dhawan, A., *et al.* 2020. UV Sterilization of Personal Protective Equipment with Idle Laboratory Biosafety Cabinets During the COVID-19 Pandemic. Accessed on 14 April 2020.
- CDC 2020. Guidance for the Selection and Use of Personal Protective Equipment (PPE) in Healthcare Settings. Centers for Disease Control and Prevention. Accessed on 23 April 2020.
- Coronavirus disease (COVID-19) 2020. Interim recommendations for the use of personal protective equipment (PPE) during hospital care of people with Coronavirus disease (COVID-19). Accessed on 23 April 2020.
- COVID-19 2020. WHO Coronavirus Disease (COVID-19) Dashboard. World Health Organization. Accessed on 23 April 2020.
- ECDC 2020. Guidance for wearing and removing personal protective equipment in healthcare settings for the care of patients with suspected or confirmed COVID-19. European Centre for Disease Prevention and Control. .
- Goyal, S. M., Chander, Y., Yezli, S., Otter, J. A. 2014. Evaluating the virucidal efficacy of hydrogen peroxide vapour. *Journal of Hospital Infection*, 86(4):255-259.
- Kumar, A., Kasloff, S. B., Leung, A., Cutts, T., Strong,

- J. E., Hills, K. 2020. N95 Mask Decontamination using Standard Hospital Sterilization Technologies. medRxiv. The Preprint Server for Health Sciences. Accessed on 23 April 2020.
- Liao, L., Xiao, W., Zhao, M., Yu, X., Wang, H., Wang, Q. 2020. Can N95 respirators be reused after disinfection? And for how many times? medRxiv. The Preprint Server for Health Sciences. Accessed on 14 April 2020.
- Lin, T. H., Tang, F. C., Hung, P. C., Hua, Z. C., Lai, C. Y. 2018. Relative survival of *Bacillus subtilis* spores loaded on filtering facepiece respirators after five decontamination methods. *Indoor Air*, 28(5):754–762.
- Lowe, J. J., et al. 2020. N95 filtering facemask respirator ultraviolet germicidal irradiation (uvgi) process for decontamination and reuse. *Tech. Rep*, pages 1–19. Accessed on 23 April 2020.
- Lu, H., Stratton, C. W., Tang, Y.-W. 2020. Outbreak of pneumonia of unknown etiology in Wuhan, China: The mystery and the miracle. *Journal of Medical Virology*, 92(4):401–402.
- MHFW 2019. Novel Coronavirus Disease 2019 (COVID-19): Guidelines on the rational use of Personal Protective Equipment. Ministry of Health and Family Welfare Directorate General of Health Services; pg. 1-11.
- N95 FFR 2016. Final Report for the Bioquell Hydrogen Peroxide Vapor (HPV) Decontamination for Reuse of N95 Respirators. pages 1–46. N95 FFR Decontamination for Reuse Final Report .
- NIOSH 2018. Pandemic planning - recommended guidance for extended use and limited reuse of N95 filtering facepiece respirators in healthcare settings. The National Institute for Occupational Safety and Health. Accessed on 23 April 2020.
- Public Health England 2020. Guidance COVID-19 personal protective equipment (PPE). Accessed on 23 April 2020.
- Schöpe, H. J., Klopotek, M. 2020. Strategies for the reuse of N95 and N99 respiratory masks during the COVID-19 pandemic. *Medical Physics*. Accessed on 24 April 2020.
- Schwartz, A., Stiegel, M., Greeson, N., Vogel, A., Thomann, W., Brown, M., Sempowski, G. D., Alderman, T. S., Condreay, J. P., Burch, J., Wolfe, C., Smith, B., Lewis, S. 2020. Decontamination and Reuse of N95 Respirators with Hydrogen Peroxide Vapor to Address Worldwide Personal Protective Equipment Shortages During the SARS-CoV-2 (COVID-19) Pandemic. *Applied Biosafety*, 25(2):67–70.
- Skorzewska, N. 2020. A clinician's view from the frontline: UV light and other strategies to reduce aerosol transmission of COVID-19 and protect health workers. *Global Biosecurity*, 1(3).
- Viscusi, D. J., Bergman, M. S., Eimer, B. C., Shaffer, R. E. 2009. Evaluation of Five Decontamination Methods for Filtering Facepiece Respirators. *The Annals of Occupational Hygiene*, 53(8):815–827.
- Wang, D., Hu, B., Hu, C., Zhu, F., Liu, X., Zhang, J., Zhao, Y. 2020. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *Jama*, 323(11):1061–1069.
- WHO 2020. Novel Coronavirus (2019-nCoV) Situation Report - 12. World Health Organization. Accessed on 23 April 2020.
- W.H.O. 2020. Rational use of personal protective equipment for coronavirus disease (COVID-19): interim guidance. World Health Organization. Accessed on 23 April 2020.
- World Health Organization 2020. Shortage of personal protective equipment endangering health workers worldwide. Accessed on 23 April 2020.