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## Why so many healthcare workers and their contacts contracted Covid-19 infection despite personal protective equipment?



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Although mandated in many countries, the impact of universal face-masking for preventing COVID-19 (size 60–140 nm) [1] spread is debatable. Healthcare workers are vulnerable to contract the infection due to prolonged and closer contact with Covid-19 patients as well as during certain medical procedures. Accordingly, despite using personal protective equipment (PPE), considerable number of healthcare workers contracted Covid-19 infection themselves while looking after their patients as well as transmitted the infection to their family members [2]. Accordingly, compared to the general community, front-line health-care workers were reported to be at about threefold increased risk of developing COVID-19 infection during the early period of the current pandemic. The proposed reasons for this observation were lack of information about the nature of disease spread, inadequate supply of PPE, poor quality of PPE as well as reusing the same mask for many times. Specifically, the reuse of PPE was believed to be associated with self-contamination and breakdown of materials from extended wear [3–5]. Interestingly, a joint mission of the World Health Organization reported that by February 2020, about 2055 healthcare workers were infected with COVID-19 and contributed to 22 (1.1%) deaths in China [6].

Current information suggests that the two main routes of transmission of the COVID-19 virus are respiratory droplets and contact. Respiratory droplets are generated when an infected person coughs or sneezes. Any person who is in close contact (within 1 m) with someone who has respiratory symptoms (coughing, sneezing) is at risk of being exposed to potentially infective respiratory droplets. Droplets may also land on surfaces where the virus could remain

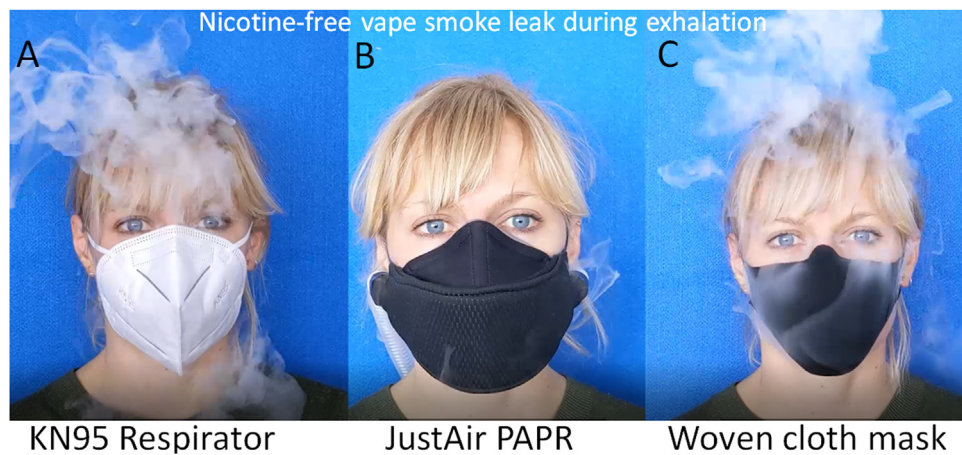
viable; thus, the immediate environment of an infected individual can serve as a source of transmission (contact transmission) [7].

Which type of face-mask protects the close contacts of Covid-19 patients, especially of frontline healthcare workers remains debatable. N95 respirator mask, certified by the National Institute for Occupational Safety and Health, filter out 95% of particles greater than 0.3 microns in size. Thus, at least some Covid-19 viral particles may pass through these respirators (Fig. 1).

We present the transmission of nicotine-free vape smoke (with particle size 250–450 nm range) [8] through KN95-respirator (Emercate-GMBH), powered-air-purifying-respirator (PAPR, JustAir-Theranova-US) and woven cloth-mask (Knit Engine-US) in real-time. While, large amount of vape-smoke leaked through KN95 and woven cloth-mask during normal exhalation, the leak was relatively minimal through the JustAir PAPR (Figure 1 and video), due to the continuous flow of purified air. We reiterate that this is just an observational study, which provides one possible reason for large number of Covid-19 infection among healthcare workers. However, it needs to be verified in a larger prospective study.

Powered air purifying respirators (PAPR) are multi-use devices validated by international standards. The quality of filtration of many models of PAPR is equivalent to or greater than that of N95 respirators, while preventing the increase in end-tidal carbon-dioxide concentration and its related cerebral hemodynamic effects [9]. While generalised use of PAPR by Covid-19 patients or their close household contacts may not be feasible, donning such equipment may be considered better for healthcare workers managing patients with active Covid-19 infection, especially in view of the recent speculation that Covid-19 infection transmission could be airborne [10]. Furthermore, vaccinating all healthcare professionals still appears as the best way to reduce the number of workers who become infected.

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**Fig. 1.** With first normal exhalation, large amount of nicotine-free vape smoke leaked through KN95-respirator (A) and woven cloth-mask (C). However, the leak was relatively minimal through the JustAir-PAPR (B).

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### Competing interests

None declared.

### Ethical approval

The study was approved by the Institutional ethics committee. Voluntary consent was obtained from the healthy volunteer, including about video-filming, prior to the test.

### Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at <https://doi.org/10.1016/j.jiph.2021.04.004>.

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