An assessment of “Double-Masking” to reduce airborne spread of the SARS CoV-2 virus

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Summary

The world-wide prevalence of the virus has led to many mutations that have been identified by genetic sequencing. Recently evidence suggest that some of these spread more readily than the original strains. As such the question arises if more intense strategies to reduce the spread are warranted.

One possible action that has emerged is to encourage people to wear two masks, instead of just one.

Our recommendation is that this may be of limited utility. Further, if done improperly double masking could actually lead to an increased level of exposure as explained below.

The procedures already in place at the University include surveillance tests and contact tracing to keep prevalence low, distancing and reduced density of people (hence possible sources), carefully monitored ventilation, and properly worn masks that greatly reduce emissions. This should be sufficient to protect the general Notre Dame community from any of the new variants.

Individuals at high risk for complications from Covid-19 may wish to consider using properly fitted N95 masks or elastomeric respirators.

Risks

New variants of the SARS-CoV-2 virus are believed to be somewhat more contagious and possibly exhibit a higher resistance to antibodies produced by previous infection or vaccination. This is not surprising, as mutations and selection pressure naturally result in such an outcome (https://science.sciencemag.org/content/371/6526/284.full). The mechanism for transmission of these variants is unchanged, however, and mitigation efforts still devolve to a three-pronged approach: 1) reduction of viral load in the community by reduced levels of infection, 2) reduction of viral load by emission control and mitigation, and 3) reduction of infection by reducing uptake of the virus. The reduction of viral load in the Notre Dame environment is accomplished by aggressive surveillance testing and contact tracing (reducing the numbers of individuals who could potentially spread the virus), by maintaining a low classroom density with proper ventilation and filtration, and by universal masking requirements to control emissions from individuals that surveillance testing has not yet identified. The masking requirement also reduces uptake of any virus which may be present in the environment.

To understand the risks it is useful to separate the exhalation and inhalation (the “out” and the “in”). This is because emitted droplets are hydrated, and thus are approximately five times the diameter of dehydrated droplet nuclei. Thus, it is far easier to catch emitted droplets at the source (control the “out”) rather than prevent inhalation of the much smaller nuclei (control the “in”).

Exhalation

A mask is a filter intended to allow the passage of air and to capture the liquid droplets that could be carrying the SARS virus. This is done by forcing the air between the weave of the fibers through flow passages that are small enough to capture a very large fraction of the droplets. However, to accomplish this, a large fraction of the area across which the breath could pass through is blocked and hence the wearer will feel some amount of "resistance".

Filtration only occurs for breath that passes through the porous fabric. For the portion of breath that is filtered, two layer cloth or disposable masks are actually quite effective in blocking hydrated droplets. These include the large droplets that would settle within a few feet and the somewhat smaller droplets which evaporate to form droplet nuclei and aerosols that remain suspended in the air.

For properly fitted N95 masks or fitted elastomeric respirators essentially all of the air is filtered. For ordinary masks, however, the fit of the mask is *not* perfect and hence some *bypass* will occur, typically around the cheeks or the bridge of the nose. Air bypassing the mask is not filtered and would carry hydrated droplets of O(25μm) diameter or smaller which would dry out to form aerosols. In general, provided the mask is at least two layers of sufficiently dense weave to catch hydrated droplets, further emission mitigation can only be achieved by reducing bypass.

Disposable masks or cloth masks with wires can reduce the gaps at the nose bridge, however they often have gaps at the cheek during exhalation. Simply adding a second mask would increase the resistance to air flow through the (now less) porous material. Since flow *through* the mask is in parallel with flow through any unfiltered gaps, this greater resistance can actually lead to an *increase* in the emission of viral containing droplets and potentially increase the viral load in the classroom. This would be particularly true for masks without nose wires where the bypass around the nose bridge is substantial. Only if the second mask "closes the gaps" would it reduce overall emissions.

Inhalation

The issue here is the inhalation of the smaller dehydrated droplet nuclei. The filtration effectiveness of mask material, excepting N95's, falls off quickly for for particles smaller than ~5 μm. This is why ordinary masks are less effective at controlling the "in" rather than the "out". Because the direction of flow is reversed for inhalation, bypass is somewhat less of a problem (the mask tends to collapse to the face during inhalation and "puff out" during exhalation). Thus, adding a second mask may reduce the intake of the largest aerosol particles. <u>For this strategy to be effective it is essential that the outside mask cover any bypass areas of the inside mask</u>. However, it has to be noted that even if the inhalation protection is increased, it is hard to be sure that the exhalation efficiency is not degraded.

In order to reliably remove the smallest aerosol particles of O(1μm) or less it is necessary to use a properly fitted N95 mask or an elastomeric respirator with aerosol filter. With proper adherence to source control it is not clear that this level of protection is warranted in most cases.

Conclusion

The transmission mechanism of the new variants is exactly the same as the original virus with just somewhat smaller amounts of active virus needed to cause infection. Thus the protocols already in place, if carefully followed, should prevent transmission. Adding a cloth mask over a carefully fitted disposable mask might provide some reduction in the intake of potentially infectious particles. However, even if this is done with careful fitting, it is possible the emissions from a person will increase. Further, any increase in filtering efficiency will be accompanied by an increase in the resistance to airflow which hence requires a greater breathing workload by the wearer.