EDITORIAL

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EDITORIAL

The scientific rationale for the use of simple masks or improvised facial coverings to trap exhaled aerosols and possibly reduce the breathborne spread of COVID-19

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1. The concept

- Wearing simple medical masks or improvised facial coverings reduces community exposures from asymptomatic, but unknowingly infectious, individuals.

The medical community agrees that breathborne infectious materials can be spread with exhaled aerosols and that asymptomatic people, i.e. those showing no symptoms, could be unknowingly infectious. With the current worldwide pandemic of the respiratory coronavirus disease 2019 (COVID-19), various health bodies and governments are recommending or imposing that the population wear some form of mask or improvised facial covers while out in public in an effort to reduce the spread of disease.[4] The general concept is that more accessible masks or mask-like materials (scarves, bandanas, etc) could serve to reduce the amount of infectious aerosol from infected people, and reduce the viral load in the environment. The prevailing consensus at present is '*…it could not hurt…*'.

2. The problem

- Simple medical masks or improvised facial coverings are perceived as ineffective, burdensome, and unattractive.

Medical grade masks, such as the N95 respirator, are designed for a snug fit on the face to force inhaled and exhaled breath through the mesh materials and thereby effectively filter aerosols in both directions. Such masks are generally only available to medical personnel for protection against airborne infection. The standard disposable 'hospital' or 'surgical' masks are more loosely fitting; they are designed to reduce exhaled particles and aerosols, and to protect the wearer from sprays, splashes and dust. These and homemade cloth masks are inexpensive and broadly available to the public.

The perceived problem is that basic, inexpensive or improvised masks do not protect the wearer from airborne disease, specifically the small virions of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that cause COVID-19, and so represent an unnecessary burden to the wearer. The general public may not recognize that there is a scientific justification for these simple masks in reducing exhaled aerosols from asymptomatic, but infectious, individuals within their community.

3. The scientific rationale

- Simple medical masks or improvised facial coverings directly capture exhaled aerosols and particles by surface adhesion in addition to direct filtration.

Aerosols are tiny water droplets and biological particulate matter created in the lower lung from surface film disruption and in the upper airways by turbulence during normal breathing [1]; coughing and sneezing add significant amounts of aerosols to the normal exhalation baseline. The aerosol fraction of breath is comprised of the fluids lining lung surfaces and carries all types of dissolved materials, including proteins, metabolites, and smaller polar compounds, as well as bacteria and viruses, if present. As they enter the surrounding air, aerosols begin to dry and ultimately only the dissolved materials, including the virions, remain.

Although exhaled breath may leak around an inexpensive mask or cloth, the justification for their use is that wet particles and aerosols impact onto mask surfaces kinetically and begin to form a layer on the fibers that further help collect particles. The question remains if there is scientific evidence that this mechanism is realistic.

3 Author to whom any correspondence should be addressed.
4 www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover.html.

Two recent journal articles support this concept. The first article compared various masks and respirator surfaces for adsorption and recovery of human exhaled aerosol content [2]. The second used disposable hospital masks as a sampling medium for exhaled breath aerosol where cancer sniffing dogs and state-of-the-art analytical instrumentation were compared for pre-clinical cancer screening [3]. In both articles, a wide variety of endogenous human materials were found on disposable masks, including human cytokines, fatty acids, fatty acid methyl esters, and other compounds with monoisotopic masses ranging from 330 to 1700 Da. The cytokines analyses from these studies are of particular interest. Cytokines are small proteins that are highly specific for humans, and they were found in all samples extracted from exhaled breathing surfaces. Moreover, the disposable masks demonstrated statistically higher capture/recovery of cytokines from disposable hospital masks than from other (non-porous) ventilator surfaces. This confirms that the residues found on mask inner surfaces are definitely of human origin, not from environmental contamination, and that they act as a barrier for small molecules to retain at least a fraction of these.

Because these analyses were performed long after the aerosols had dried, it is reasonable to conclude that the aerosol contents remain adhered to surfaces that they encounter even after the wet layer has evaporated. Nevertheless, these studies do not shed light on the proportion of aerosols retained by the masks versus transmitted through the masks.

4. Summary

Various mask surfaces, especially porous paper and polypropylene meshes from standard disposable masks, have been shown to capture materials dissolved or suspended in exhaled aerosols. The cytokines, which are the largest of the endogenous chemicals found in the studies mentioned, are still quite small in comparison to SARS-CoV-2 virions. If the simple masks are capturing these smaller molecules, it stands to reason that they also trap the larger virus particles.

Certainly, disposable masks, scarves and bandanas are less effective than high-grade personal protective equipment (PPE) facemasks because not all of the breath is forced through the material, but can generally leak past the edges. The scientific explanation for the collection of breath aerosols therefore revolves around a different mechanism. Observations from the abovementioned studies indicates that the proximity of the surface (mask, or respirator) to the humid exhaled breath, and the kinetic properties of aerosols and particles that 'crash' into these surfaces, are likely responsible for reducing the transmission of breathborne aerosols rather than direct filtration. As such, the inexpensive masks (and alternatives) may not protect the wearer from inhaling external environmental contaminants, but may reduce the viral load exhaled from an asymptomatic person. Further, the physical barrier of a facemask will act to disrupt the turbulent gas clouds that arise during unimpeded exhalation, cough or sneeze, that can otherwise span 7–8 m [4].

Wearing some form of exhaled barrier out in public during pathogen outbreaks is an altruistic act serving not only as a form of enhanced cough or sneeze etiquette, but also to reduce the aerosols emitted from normal breathing or when talking. Without daily testing, nobody can be certain that they are not an asymptotic disease vector. Scientifically, this is a positive step towards helping combat the current COVID-19 pandemic.

5. Caveats

- Wearing disposable masks or improvised facial covers should be treated as an addition to social distancing serving to protect others from the wearer's exhaled aerosols, not necessarily to protect the wearer.
- Reusing the paper/disposable masks is not generally recommended, but currently, '*use until soiled*' is common practice due to shortages. Cloth improvised masks can be laundered with soap and water and reused.
- Using these masks has a valid scientific rationale for reducing the transmission of exhaled aerosols into the immediate environment, but as yet, quantitative data (how much is removed) will require specific testing.

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