Protective Masks

April 4th 2020

Summary

Based on our current understanding, it is readily apparent that respiratory spread represents a significant potential mode of virus transmission. While there are technical distinctions between "droplets" and "aerosols" generated from a cough or a sneeze, the bottom line is that both are created in varying ratios. Aerosolized particles are much smaller and will hang around in the air much longer (30 min to a few hours in a closed room), while droplets will fall to the floor within a minute or so.

It is likely a matter of time until widespread wearing of masks in public becomes routine, if not mandated. Owing to the ongoing severe shortage of N95 and surgical masks, however, public health officials are hesitant to recommend that everyone wear a manufactured mask, as production and distribution should be prioritized for hospital workers and ill patients.

Masks provide protection against SARS-CoV-2, but the level of protection varies by the type of mask:

- N95 respirators, when worn correctly (shown in this video), are able to filter 95% of particles 0.1 to 0.3 microns, and are estimated to be 91% effective in preventing airborne viral transmission (protecting the wearer from others infected). These types of masks are used in medical settings and reserved for high-transmission-risk situations. Note that all studies on effectiveness for these masks assumes a testing procedure called a "fit-test" has been completed, in which the mask is fitted for an airtight seal (requires one to be clean-shaven).

- By contrast, traditional surgical masks are about 68% effective in preventing viral transmission and primarily protect others from the virus, if the wearer were to cough or sneeze. Aerosols can easily bypass the sides of these masks, so they are less effective at protecting the wearer from others infected.

- While masks can and should be re-used given the shortage, measurable amounts of virus can stay on the surface of the mask for several days, and unlike most other objects, masks are placed directly on the face over the nose and mouth. There are a wide range of potential methods for mask sanitation, but some require equipment that is not practical to use outside an institutional setting, and the efficacy of these methods is not known- methods include heating, chemical solvents, and 254nm UV-C light exposure. Updated guidelines for healthcare setting decontamination can be found here.

- As of April 4, 2020 the CDC has officially recommended that all Americans wear cloth masks or a scarf in public to "help slow the spread" of COVID19. If everyone wears a mask, individuals protect one another, reducing overall community transmission. Homemade masks do not protect against aerosolized particles but can protect against transmission via larger droplets. They are significantly less effective than surgical masks but are better than not having a protective barrier at all. That being said, social distancing, staying at least six feet away from others in public spaces, and staying home, are important measures to keep in place at this time.

FAQ

Q: What is classified as a droplet compared to an aerosol?

- In general, droplets are larger (< than 10 microns and sometimes much larger) and settle more quickly. Aerosols are smaller (less than 10 microns) and stay airborne for longer.

Q: What are the different kinds of masks and how do they compare (Table 1)?

- N95 medical grade masks are able to capture 95% of 0.3 micron air particles and are the most effective protection against aerosols (the smallest type of particles). A small Korean study reported that, aside from N95 masks, other types of masks did not protect against the majority of aerosol particles (surgical masks) and make-shift coverage (1-4 layers of cotton handkerchief) did not provide any protection from aerosols. Although regular surgical masks are less effective than N95s, there is evidence that they offer better protection than not wearing a mask at all.

Type of Mask	N95	Surgical	Homemade
Effectiveness	Blocks 95% particles as small as 0.3 microns; effective against aerosols	Research suggests ~68% against viruses generally but only ~40.9% against aerosols	Unknown, but will be variable due to different materials. Some protection against droplets but likely <2% against aerosols
Fit	Tight, seal checked	Loose	Loose, no manufacturing standards
Whom does it protect?	Both wearer and others	Primarily others, wearer against large particles	Primarily others, wearer against large particles
Can it be disinfected?	requires special equipment or materials	requires special equipment or materials	Yes, easily at home
Are they in short supply?	Yes	Yes	No

Table 1. Mask type comparison

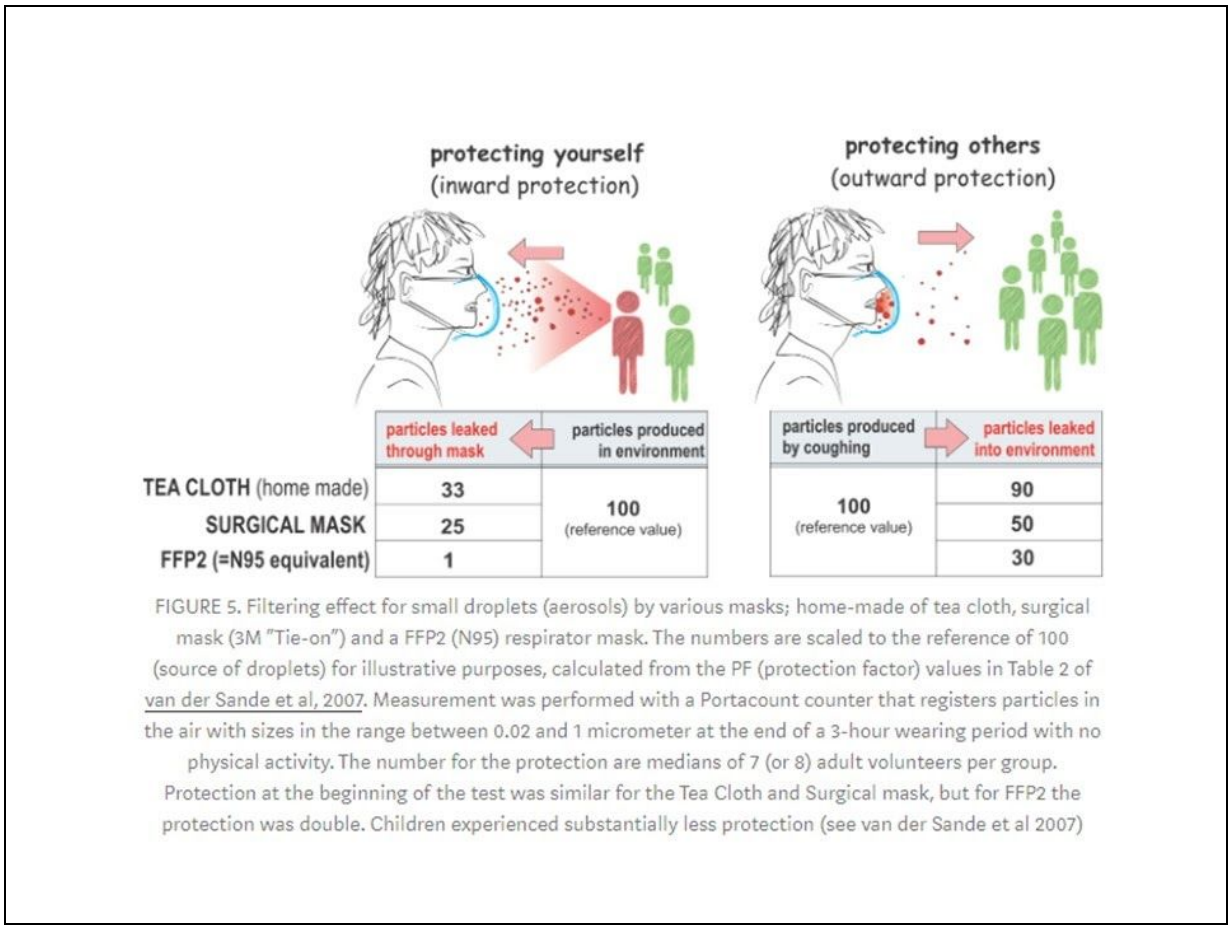
Q: Do we recommend that the general public wear surgical masks?

- Widespread mask wearing could be a key component in preventing pre-symptomatic transmission. The CDC now recommends all citizens to wear a cloth mask or scarf covering in public.

- There is concern about causing further shortages of N95 and other medical-grade masks that are needed for health care workers so there is hesitance to formally recommend widespread surgical mask wearing. Healthcare workers, COVID19 patients, and their caregivers continue to be prioritized in protective mask distribution.

Q: What are the limitations of wearing a mask?

- N95 masks can protect health care workers from being infected by those around them. But surgical masks primarily protect others from the wearer (source control), rather than the wearer from others (onward transmission) (Figure 1).
- To be most effective in protecting from others infected, surgical masks must be worn *en masse* to produce a community-wide protective effect. However, the U.S. does not have enough supply for everyone to wear surgical masks.



	particles leaked through mask	particles produced in environment	particles produced by coughing	particles leaked into environment
TEA CLOTH (home made)	33	100 (reference value)	100 (reference value)	90
SURGICAL MASK	25			50
FFP2 (=N95 equivalent)	1			30

FIGURE 5. Filtering effect for small droplets (aerosols) by various masks; home-made of tea cloth, surgical mask (3M "Tie-on") and a FFP2 (N95) respirator mask. The numbers are scaled to the reference of 100 (source of droplets) for illustrative purposes, calculated from the PF (protection factor) values in Table 2 of van der Sande et al, 2007. Measurement was performed with a Portacount counter that registers particles in the air with sizes in the range between 0.02 and 1 micrometer at the end of a 3-hour wearing period with no physical activity. The number for the protection are medians of 7 (or 8) adult volunteers per group. Protection at the beginning of the test was similar for the Tea Cloth and Surgical mask, but for FFP2 the protection was double. Children experienced substantially less protection (see van der Sande et al 2007)

Figure 1. Comparison of masks' ability to protect the wearer and others

Q: How long is the virus detectable on the outside of a mask?

- One study (not yet peer reviewed) found a "significant level of infectious virus" on a mask 7 days after the virus was pipetted onto the mask surface. Therefore, it is important to remove the mask properly and wash your hands following mask removal.

Q: Why is there a shortage of masks?

- China produced half of world mask supply prior to the pandemic, and while the country increased production by a factor of 12 and also bought foriegn-made masks during pandemic, but is now hesitant to export its stockpile.
- Domestic production of N95 masks has increased but is largely dependent upon one primary supplier, 3M, that also supplies masks internationally.

Q: Given the mask shortage, how effective are homemade masks?

- Homemade masks do not significantly block aerosolized particles though may capture larger droplets. One small study concluded that homemade cotton cloth masks were preferable to no protection, but the authors did not recommend them for protection from aerosols.

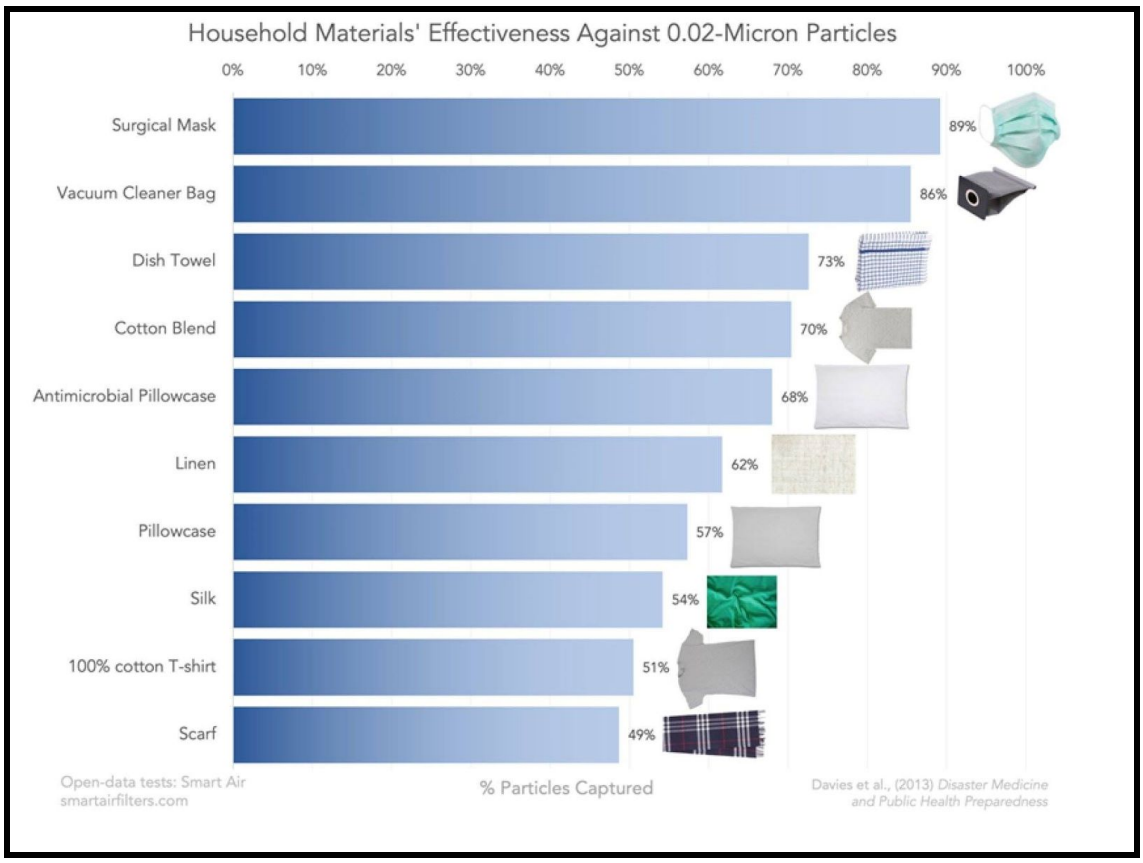


Figure 2. Effectiveness of various materials against 0.02 micron particles

Q: Can a mask be disinfected or sanitized and reused?

- In past epidemics, masks have been sanitized with various agents (e.g., ethylene oxide, UV or gamma irradiation, ozone, and alcohol) when supplies ran low. A recent JAMA editorial collected additional suggestions for disinfectants, including heat (eg, autoclave), ozone, hydrogen peroxide, bleach, isopropyl alcohol, microwave, copper sulfate, methylene blue with light, sodium chlorine, iodine, and hypochlorous acid
- The University of Nebraska has begun decontaminating masks and other equipment with UV light so they can be reused for at least a week
- Reports indicate that N95 masks can be decontaminated without significantly damaging the mask and as of 30 March, lab management company Battelle has received emergency authorization (EUA) to put into use a system for decontamination using concentrated hydrogen peroxide.

Q: What are N95 mask manufacturing criteria?

- While surgical masks are regulated by the FDA only, the Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health (NIOSH) and Occupational Safety and Health Administration (OSHA) also regulate N95 masks. Under normal circumstances masks must be certified by at least one of these agencies, which includes being made in an approved facility, but expedited approval procedures are now available. This seems likely to result in approval for facilities that did not previously manufacture these products or which want to expand or modify current operations.

Q: What are indications that mask production will increase?

- Trump has authorized the HHS Secretary to employ the Defense Production Act (which authorizes the government to compel private industry to produce necessary goods for national defense or public safety), but further action does not appear to have been taken
- He says several American companies (e.g., Hanes, General Motors) are planning to manufacture masks (though not N95), but not many details have been provided and manufacturers such as Honeywell, 3M, and even fashion designers will produce masks and have started to increase existing production.