Masks: Literature Review as of November 12, 2020

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Methods[1]

This rapid review of evidence was originally conducted to identify studies connecting mask use to clinically important outcomes. Multiple sources were searched with terms such as "masks" or "face coverings" with outcomes related to disease, infection, influenza, coronavirus, etc. The original focus was on high level evidence; however, in the months since the beginning of the COVID-19 pandemic, many studies and reviews have been completed that look at effectiveness of masks. As such, we have updated the review as needed. Additionally, the CDC recently published a scientific brief on masks that corresponds well to our findings.

Masks in the General Public[2–9]

For the general public, the results show that masks can be an effective intervention to help minimize the spread of disease but are more useful when combined with other interventions such as physical distancing and hand washing. There have been some influential reviews and meta-analyses that have explored this. The most influential of these reviews may be the Cochrane review by Jefferson et al. They found that most studies have low quality evidence due to their observational nature and while masks offer a protective effect from respiratory viruses and reduce one's own risk of infection, simple surgical masks may be as adequate as N95 respirators. Most studies included within the review focus on using a combination of disease prevention methods (ie: handwashing, social distancing) in addition to mask wearing to reduce personal risk of infection. The meta-analysis found, from the included case-control studies, when a mask is worn the odds of acquiring an infection or respiratory illness is greatly reduced (OR = 0.32, 95% CI: 0.26 – 0.39). Other reviews such as one from Saunders-Hastings et al., find that masks may be protective against acquiring a new infection. They used data from the 2009 influenza pandemic to find that masks offered a protective effect, although this was found to be statistically insignificant. A meta-analysis of randomized control trials has similar findings that masks may offer a protective effect when looking at general influenza-like illnesses, but that effect is statistically insignificant. But in those RCTs, when masks are paired with additional preventative measures, they have a significant reduction in risk of influenza. And finally, a recent meta-analysis by Chu et al. shows a large reduction in personal risk of infection from viruses including SARS, MERS, and COVID-19 when a mask is worn versus no mask (OR = 0.15, 95% CI: 0.07 – 0.34), suggesting that masks may be effective at protecting the wearer from new infection compared to wearing of no mask. The conclusions of these reviews also suggest the use of masks is to protect others and limit transmission to another versus only trying to protect oneself. Additionally, a recent model suggests that universal mask use would lead to a reduction of 815,600 deaths (95% UI 430,600 to 1,491,000 deaths) between August 26th 2020 and January 1st 2021.

Large Gatherings[10,11]

For large gatherings, such as the Hajj pilgrimage or sporting events, reviews have suggested that mask wearing will reduce the spread of disease in those large groups. Retrospective studies of large events indicate those who wore masks during the event have lower risk of disease or symptoms post-event (RR = 0.89, 95% CI: 0.84 – 0.94). While being on a college campus is not a large gathering, there is much interaction with others, so this review may be helpful in justifying mask wearing while on campus.

Mask Type[2,12]

For the general public, the type of mask does not matter as no significant difference was found in rate of infection between N95 wearers and procedural mask wearers, over multiple studies. When the general public does wear an N95 respirator they offer themselves no more protection than a surgical mask but may be removing that from a healthcare worker, where studies show that N95 masks are more effective at reducing transmission when compared to procedural masks. Given this, any recommendation related to a medical mask should be for a procedural mask to allow better access to N95s for healthcare workers.

Mask Effectiveness[13–21]

As previously mentioned, the type of mask worn by a member of the public has not been shown to be any more beneficial than another at reducing the risk of infection. There are an increasing number of studies exploring the efficacy of differing types of masks and masks materials at filtering out viral particles from breathing, and only recently have cloth masks been investigated. A 2009 study by Johnson et al., using 9 influenza positive participants found that N95 respirators and procedural masks were similar in the amounts of influenza virus filtered by masks when participants coughed directly onto a petri dish.

Several studies comparing masks made of different materials as well as the filtration efficiency of various materials homemade masks might be made of have been published in recent months. Ma et al. compared the efficacy of N95 respirators, procedural masks, and a homemade cotton mask. They found the percentage of virus that was blocked was 99.98%, 97.14%, and 95.15%, respectively, over the course of 100 simulated human breaths. Limitations of this study included using aerosol particles between 3.0 μm and 5.0μm, which is much larger than Sars-Cov-2, and unclear data about how many masks were tested and the actual makeup of the homemade cotton mask. Konda et al. tested differing types of cotton to determine the efficacy of blocking particles of differing sizes. They found that cotton with ≥600 threads per inch filtered 80% or more of particles less than 300 nm and over 98% of particles greater than 300 nm in size. The cotton masks tested were similarly efficient when compared to procedural masks but less effective than an N95 respirator that fit properly though air flow rate in the study was lower than that of normal respiration which could have impacted the results. More recent studies have used experimental setups that attempt to mimic typical airflows in public spaces or conditions commonly used when fit testing N95 masks to measure the filtration

efficiency and air resistance (i.e. breathability) of various mask materials and combinations of materials, including filtering materials such as coffee filters and vacuum bags. These studies have shown that multiple layers of fabrics are more effective at filtration than single layers though users may experience more air resistance. Commonly available materials such as 100% cotton in multiple layers perform well. Other materials such as polypropylene and silk are also effective due to other fabric properties such as electrostatic charge and hydrophobicity, respectively.

Cloth Masks[13,16–18,22–24]

Troubles in the supply chain for surgical masks may necessitate the general public to rely heavily on cloth and reusable masks. Because of this, two questions become pertinent, namely, what material is best for cloth masks and what design? The literature is mixed on the best specific material to be used in a cloth mask, but the common theme seems to be that high quality cotton or a mix of cotton with silk products will be effective at source control *as long as there are multiple layers*. Highly permeable fabric, such as T-shirt cloth, may block droplets with an efficacy similar to that of medical masks, while still maintaining comparable breathability. Studies have suggested that cloth face coverings, especially those with multiple layers, may help reduce droplet transmission of respiratory infections. A single layered cotton mask has been shown to be completely outperformed by double or triple layered cotton masks. Therefore, a recommendation for masks should focus on including multiple layers of material in the construction of the mask. One study found that increasing a single-layer mask to a double-layer increased the efficiency to block droplets (83.1% to >94% at 25mm from the inhaler).

The design of the mask is less obvious through the literature. When studies are done on the materials of the mask, the common study design is fitting the material to a manakin or other simulated breathing machine using a square or rectangular cutout of material, not a mask itself. Because of this, no specific construction design has been shown to be the best. The CDC has released a simple mask design for the general public (https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-to-make-cloth-face-covering.html) as well as guidance about wearing masks (https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover-guidance.html). Based upon studies that looked at the fit of masks, the key design component is the mask fits tight to the face with no gaps. Across studies in which gaps were present, the efficacy of source control was reduced. The studies which have shown multiple layers of material to be effective in source control had no gaps in material.

Case Studies Where Masks Reduced Transmission of SARS-Cov-2[25–27]

There have been numerous documented cases where masks have been attributed to a decrease in the spread of SARS-Cov-2. The most telling example comes from Springfield, Missouri, where two hairstylists were symptomatic with COVID-19. Between the two of them, they had 139 clients that spent at least 15 minutes with them. Of 104 of the contacted clients, all reported wearing a mask for at least some of the appointment and none of clients tested positive for COVID-19. The absence of infection of SARS-Cov-2 has been attributed to mask

wearing. In Beijing, a retrospective cohort of families with at least one laboratory confirmed COVID-19 case found that mask use by the primary case and family members was associated with a large decrease in the risk of transmission. And finally, a study comparing states that mandated face mask use with those that did not found that requiring a face mask while in public averted hundreds of thousands of new cases of COVID-19. All of these demonstrate that while face masks are not 100% effective, they are highly effective at preventing the spread of COVID-19.

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