Masks: Literature Review as of August 13, 2020
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Methods

For the search multiple search terms were included such as “masks” or “face coverings” with outcomes related to disease, infection, influenza, coronavirus, etc. The search also included terms to only return high level evidence from meta-analyses, systematic reviews, or practice guidelines. Multiple studies, meta-analyses, and reviews have been completed that look at effectiveness of masks within the general public and during mass gatherings to prevent the spread of disease.

Masks in the General Public

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.

Large Gatherings

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**

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**

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 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. Since all participants were influenza positive, this coughing would have included both droplets and aerosols. Therefore, both the N95 and the surgical mask were equally effective in the study at blocking both droplets and aerosols from a positive influenza patient, although the study did use a small sample size.

Two other studies have been done in rapid response to the COVID-19 pandemic. One, done by 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. In a study by Konda et al, differing types of cotton were tested to see 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. One limitation of this study was the air flow rate was lower than that of normal respiration which could have some impact on the results.

Throughout these studies, procedural and cotton masks were relatively similar in efficiency, but it is important to consider one was among influenza patients and the other two were
simulations. Therefore, the control and fit of the mask in the studies may be better than among those in the general public. Overall, effectiveness is dramatically increased with multiple layers for homemade masks. Therefore, single layer masks should be avoided, and 2 or more layers should be considered when constructing.

Cloth Masks\textsuperscript{11, 14-17}

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. 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.

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) but many homemade masks may not follow this template. 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. Therefore, no design stands out as best but reducing gaps on the face should be the priority.

Case Studies Where Masks Reduced Transmission of SARS-CoV-2\textsuperscript{18-20}

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 at preventing the spread of COVID-19.
Conclusion

Overall, the basis for recommending masks in the general public is based upon studies that have investigated how well differing materials block droplets and case studies that have shown a reduction in transmission. When masks are combined with other preventative measures, they become increasingly beneficial. It is important to note that the type of mask worn does not matter, but cloth and homemade masks should have multiple layers of material and fit tight to the face. And lastly, when the general public wears masks, it is more about limiting the spread of virus to others than trying not to become infected themselves.