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SYNOPSIS

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2019-nCoV – What We Know So Far About…Wearing Masks in Public

Introduction

"What We Know So Far" documents are intended to provide an overview of some of the published and unpublished reports related to emerging issues with respect to coronavirus disease 2019 (COVID-19). The reports are found through ongoing scanning of the published literature and scientific grey literature (e.g., ProMed, CIDRAP, Johns Hopkins Situation Reports), as well as media reports. It is recognized that there may be additional information not captured in this document. As this is a rapidly evolving outbreak, the information will only be current as of the date the document was written.

Key Points

- The majority of studies have not demonstrated benefit in cluster randomized controlled trials evaluating the effect of members of the general public wearing masks in non-healthcare settings to prevent the acquisition of viral respiratory infections.
- Public mask wearing is potentially beneficial as source control when worn by a person with respiratory symptoms when exposure to public spaces is unavoidable and physical distancing is not possible (e.g. traveling for medical care). The role in preventing spread from asymptomatic or pre-symptomatic individuals is unknown, but theoretical.
- There is variability in the effectiveness of homemade and cloth masks. Several studies have found that they provide inferior protection against droplet and aerosol particles compared to surgical masks and N95 respirators.
- If masks are not used appropriately, and not combined with meticulous hand hygiene, there is a theoretical risk of increased infection risk through self-contamination.
- Recommending indiscriminate public wearing of medical masks may result in additional critical shortages of masks needed to protect front-line healthcare workers, and any potential benefits of mask wearing are likely less impactful than physical distancing and hand hygiene.

Background

The use of masks for the general public has been discussed as a possible consideration among various COVID-19 pandemic mitigation strategies. Media reports from the United States and Canada have advocated for a recommendation for the general public to wear masks based on observations of COVID-19 epidemiologic trends in countries where mask wearing in public is common practice.[1,2] The World Health Organization revised guidance on the use of masks in the context of COVID-19, emphasizing conservation of medical masks for healthcare workers, the importance of other infection prevention measures, and providing a framework for decision makers when considering public masking

recommendations.[3] The CDC now recommends that the general public wear cloth face coverings in public settings where physical distancing measures are difficult to maintain.[4] The Public Health Agency of Canada (PHAC) has released a statement that Canadians can use non-medical masks in tandem with physical distancing, hand hygiene, and other measures to limit the transmission of COVID-19.[5] The rationale for this statement is emerging evidence of pre-symptomatic transmission.[6] This document reviews the available evidence for wearing a mask to prevent respiratory viral infections in non-healthcare settings including evidence surrounding homemade masks.

Evidence on Mask Wearing in Non-Healthcare Settings

There have been several studies on the use of ***medical masks*** outside of the hospital setting. These studies have evaluated the effectiveness of masking household members and individuals in other confined spaces (e.g. university residences, airplanes) to prevent acquisition of respiratory infections. In the majority of studies, no significant benefit from wearing masks was identified. Studies that demonstrated a benefit were associated with enhanced hand hygiene measures. There have been no high quality studies evaluating the impact of mask wearing by large segments of the population in public settings.

- Saunders-Hastings et al. 2017 conducted a systematic review and meta-analysis on the effect of personal protective measures on pandemic influenza transmission. The meta-analysis found regular hand hygiene provided a significant protective effect against pandemic viral transmission, but the effect of facemask use was not statistically significant.[7]

- Aiello et al. 2012 conducted a cluster randomized controlled trial (RCT) in university residents comparing three arms: hand hygiene (HH) + masking, masking alone, or control. They found no effect in the primary analysis of influenza-like illness (ILI) or laboratory-confirmed respiratory infections. However, there was a significant effect on ILI in weeks 3-6 of the study in the mask + HH arm, but not in the mask-only arm, suggesting the effect may have been due to HH.[8]

- Suess et al. 2012 conducted a cluster RCT comparing masking, masking + HH, or control in 84 households with influenza pH1N1 infection in the 2009/10 and 2010/11 seasons. There was no significant effect from either intervention in the primary analysis. There was a potential effect observed in the subgroup that implemented masking + HH within 36 hours of symptom onset of the index case.[9]

- Aiello et al. 2010 performed a cluster RCT in university residence halls with 3 arms; masking, masking + HH, or no intervention. In the primary adjusted analysis there were no significant differences in the mask only group (relative risk (RR) 0.90, 95% confidence interval (CI) 0.77-1.05) or mask + HH group (RR 0.87, 95% CI 0.73-1.02).[10]

- Simmerman et al. 2011 performed a cluster RCT of families in Thailand during the influenza H1N1 pandemic comparing HH, HH + masking, or control to prevent influenza transmission in households with an influenza-positive child. There were no differences in clinical or laboratory-confirmed influenza in either intervention arm. However, due to the H1N1 pandemic, mask use and HH substantially increased amongst control participants during the study period.[11]

- Larson et al. 2010 conducted a cluster RCT in households comparing health education (HE), HE + HH, or HE + HH + masking on incidence and secondary transmission of upper respiratory tract

infections and influenza. There was a significant decrease in secondary respiratory infections in the HE + HH + mask group compared to HE alone (odds ratio (OR) 0.82, 95% CI 0.70-0.97). This study did not evaluate a masking-only group.[12]

- Cowling et al. 2009 performed a cluster RCT of households with confirmed influenza patients.[13] Households (≥3 people) were randomized to either HE (control), HH, or HH + masking. There was no statistically significant difference in either laboratory confirmed or clinical influenza infection between the three groups. In a post-hoc analysis limited to those that applied the intervention within 36 hours of symptom onset in the index case, mask + HH reduced laboratory-confirmed influenza infections (OR 0.33, 95% CI 0.13-0.87), but not clinically defined influenza. The authors conclude that if applied early, masks + HH for household contacts of influenza infected individuals may be effective.[13]

- MacIntyre et al. 2009 performed a cluster RCT of parental masking after a child was diagnosed with a respiratory illness. They compared surgical mask, N95 respirator, or control. There were no significant differences between either type of mask and control.[14]

- Zhang et al. 2013 conducted an observational study that evaluated the risk of influenza pH1N1 on two international flights, after several patients developed infections. They found that on one flight from New York to Hong Kong there were 9 infections in passengers that did not wear face masks compared to 32 asymptomatic controls, of whom 15 (47%) wore masks. The index case was never identified. The authors concluded that wearing a mask on this flight was potentially protective.[15]

- There is a body of literature on wearing masks at mass gatherings (e.g. Hajj). Barasheed et al. 2016 performed a systematic review of 25 studies. The studies were heterogeneous and generally of poor quality; however, the authors pooled results from 13 studies of masking involving 7,652 participants and found a small but significant protective effect against respiratory infections (RR 0.89 95% CI 0.84-0.94).[16]

Mask Wearing as Source Control

Masks have two potential functions. They may protect the wearer of the mask from exposure, or protect individuals from exposure to respiratory aerosols/droplets from the mask wearer, referred to as source control. Studies to date have found that the use of medical masks may reduce the amount of aerosol shedding of some bacteria and viruses from symptomatic individuals. One study has specifically evaluated COVID-19 and found that neither medical nor cotton masks adequately filtered COVID-19 virus from symptomatic patients.[17] The impact of masking asymptomatic or pre-symptomatic individuals as source control has not been studied.

- Canini et al. 2010 performed a cluster RCT of masking the index patient to prevent secondary household influenza-like illness (ILI). There were no significant differences between mask and control groups.[18]

- MacIntyre et al. 2016 performed a cluster RCT of masks for patients with ILI (n=123) compared to controls (n=122) evaluating the risk of secondary cases in household contacts.[19] There were no statistically significant differences in the primary outcomes in the intention to treat analysis. As one third of controls wore masks, the authors conducted a per protocol analysis and there

was a statistically significant protective effect in clinical respiratory infections, but not laboratory confirmed respiratory infections.[19]

- Stockwell et al. 2018 found that mask wearing significantly reduced the release of *Pseudomonas aeruginosa* aerosols during coughing in people with cystic fibrosis compared to uncovered coughing. The results were similar for surgical masks and N95 respirators.[20]

- Milton et al. 2013 examined exhaled breath samples from symptomatic people infected with seasonal influenza viruses and found that masks reduced the amount of viral aerosol shedding by 3.4 fold overall, ranging from 2.8 to 25 fold depending on particle size.[21]

- Dharmadhikari et al. 2012 studied patients with multidrug-resistant tuberculosis and demonstrated that surgical mask wearing significantly reduced transmission in experimental conditions.[22]

- Leung et al. studied medical mask wearing in 246 symptomatic individuals with influenza and seasonal coronaviruses. They found a significant reduction in virus by polymerase chain reaction testing of droplets and aerosols in the 124 individuals randomized to wearing masks. This study did not confirm if the quantity of virus was infectious.[23]

- Bae et al. evaluated the effectiveness of surgical and cotton masks in filtering COVID-19. Four patients with active COVID-19 were given medical and cotton masks to wear while coughing five times into a petri dish held 20cm from their faces. They repeated this without a mask as well. Viral loads of COVID-19 were similar with and without either type of mask both on the petri dish and from swabs of the external surface of the masks. The authors conclude that while previous evidence suggests masks may be effective as source control for other pathogens this small study suggests they do not adequately filter COVID-19.[17]

Homemade and Cloth Masks

Given the challenges in maintaining personal protective equipment supply during the COVID-19 pandemic, the use of homemade and/or cloth masks in public is a topic of much discussion. The CDC has recently recommended the use of cloth masks for the general public.[4] However, PHAC suggests that homemade masks be used with caution as there is variability in the effectiveness of homemade masks.[24] The evidence suggests there is variability in the effectiveness of cotton masks and that they are generally inferior to medical masks. The one small study of COVID-19 patients demonstrated that cotton masks did not filter COVID-19.[17]

- Ma et al. 2020 conducted an experiment, using an avian influenza virus, on the comparable efficiency between N95, surgical masks, and homemade masks (made from 4 layers of “kitchen paper” plus 1 layer of polyester cloth) to block aerosols. They found that the masks blocked 99.9%, 97.1%, and 95.1% of aerosols, respectively.[25]

- Davies et al. 2013 in an experimental study found that masks made from cotton t-shirts had about 50% the median-fit factor of surgical masks. Both masks blocked microorganisms expelled; however, surgical masks were three times more effective.[26]

- Dato et al. 2006 fashioned a nine-ply (one outer layer and eight inner layers) face mask out of heavy-weight cotton t-shirt material, and achieved a maximum fit factor of 67 using quantitative measurements (a Portacount Fit Tester), with minimal discomfort or difficulty breathing reported in the three test subjects. Note that National Institute for Occupational Safety and Health (NIOSH)-approved N95 respirators are required to have a fit factor of 100.[27]

- Rengasamy et al. 2010 similarly found in experimental conditions that cloth masks and various fabric materials were much less efficient than N95 respirators at filtering various size aerosols.[28] Polydisperse (various size) and monodisperse (specific size) NaCl aerosols penetration was measured with NIOSH particulate respiration certification methods, at face velocities of 5.5 and 16.5cm s^{-1} flow rates. Percentage penetration (ratio of downstream to upstream concentration) for cloth masks and fabric ranged from 40-90% for polydisperse aerosols, compared to N95 penetrations of 0.12% and <5% at the lower and higher velocities, respectively. For monodisperse aerosols penetration varied by particle size and fabric type in the 20-1000 nm range. Certain fabrics (e.g., towels and scarves) had slightly lower penetration (around 20-80% for towels, increasing with particle diameter), which was noted by the authors to be comparable to other studies of surgical mask penetration levels (measured in cited studies ranging from 51-89%). They conclude that fabric materials provide minimal respiratory protection to the wearer from aerosol sized particles, but that "the use of improvised fabric materials may be of some value compared to no protection at all when respirators are not available."[28]

- MacIntyre et al. 2015 conducted a cluster RCT (N=1,607) on the effectiveness of cloth or surgical masks, compared to routine practices (personal protective equipment as needed), in hospital healthcare workers.[29] The primary outcomes were rates of ILI or laboratory-confirmed respiratory viral infection. Infection rates were highest in the cloth mask group, with a RR for ILI of 13 compared to the medical mask arm, and a RR for ILI of 6.6 compared to control arm, and a RR for laboratory confirmed virus of 1.7 compared to the medical mask group. Penetration of particles in cloth masks was 97%, compared to 44% in the medical masks.[29]

- Van Der Sande et al. 2008 compared homemade tea cloth masks, surgical masks, and FFP-2 (European equivalent of N95 respirators) in healthy volunteers performing various physical maneuvers and measuring quantitative differences in particles with a Portacount.[30] They calculated median protection factors (or PFs, the ratio of particle concentrations sized 0.02-1 µm outside to inside the mask) of 2.2-3.2 for cloth masks, 4.1-5.3 for surgical masks, and 66-113 for FFP-2 respirators. Marginal protection was seen for all mask types when testing for reduction in outgoing transmission of respiratory particles.[30]

Risks Associated with Wearing Masks

If masks are not used appropriately, there is a theoretical risk of increased infection risk through self-contamination. The external surface of the mask may become contaminated and touching one's face is a common practice.

- MacIntyre et al. 2015 found that healthcare workers who wore cloth masks on a continuous basis had higher ILI and laboratory-confirmed respiratory virus infections when compared to

standard practice. They cautioned that factors such as moisture retention, reuse of cloth masks, and poor filtration may result in increased risk of infection.[29]

- Kwok et al. 2015 found face touching is a frequent behaviour in their observational study of medical students. Face touching happens up to 23 times an hour, with almost half involving mucous membrane contact. The mouth was touched most often, followed by nose, eyes and a combination thereof.[31]

- The study by Bae et al. discussed above demonstrated contamination of the external mask surfaces with COVID-19, for masks worn by symptomatic patients, which raises concerns of increasing transmission risk if masking is not associated with meticulous hand hygiene.[17]

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