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Evidence of benefit of N95 respirators, medical (surgical) masks, and cloth facial coverings

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Overall Conclusions:

N95 respirators (N95s), medical masks and cloth facial coverings are able to reduce the spread of COVID-19 as evidenced from studies of influenza and other coronaviruses like SARS, and reports of COVID-19 exposures in community and healthcare settings, and experimental studies. Consistently and correctly wearing facial coverings, having the facial covering fit closely to the face, and using fabrics that are effective in filtering particles made by breathing, talking, and coughing are important factors in maximizing the effectiveness of cloth facial coverings. Use of masks and N95 in the health care settings and masks and cloth facial coverings in community settings must also be coupled with social distancing where possible, hand hygiene, and good ventilation.

Methods

A literature search on evidence and benefits of N95s, medical masks, and cloth facial coverings was conducted using Pubmed on July 1-2 and July 16-17, 2020 based on studies published since December 2019. Below is a summary of the evidence based on a rapid review.

Benefits of medical masks, N95 respirators (N95s) , and cotton facial coverings in preventing influenza, SARS, MERS, and respiratory illnesses in healthcare and community settings

Several authors have conducted systematic reviews on the benefits of N95s, and medical masks, and cotton facial coverings against influenza, SARS, MERS and other respiratory illnesses.[3,4,5,11,14,15,16] Overall, evidence on the effectiveness of masks for prevention of respiratory infection is stronger in health care than community settings. Little recent information on the benefits of cloth facial coverings was available before the COVID-19 pandemic. In the medical setting, cloth masks with 12-16 layers were used prior to availability of N95s and medical masks and were found to protect healthcare personnel from illness.[5]

Recent meta-analysis on the use of medical masks versus N95s in healthcare settings have concluded that the use of N95s might reduce SARS-CoV-1 risk more than medical masks. However, findings from studies on SARS-CoV-1 and influenza were mixed with some studies showing no greater protection with N95s vs medical masks in medical settings. Consistent use of N95s and masks improved their effectiveness.

A recent meta-analysis by Liang, et al estimated that medical masks could reduce viral infections by 80% in healthcare settings and 47% in the community. However, they noted that studies from Asia suggest greater benefit from medical masks likely due to greater consistency in use compared to studies done in Western countries.[14]

A meta-analysis by Chu, et al[4] estimated a possible 85% reduction in transmission with the use of any N95, medical mask, or 12 to 16-layer cotton mask in combined healthcare and non-healthcare settings, although they found a lower impact in community settings compared to healthcare settings.[4]

Interpretation of studies in community settings were limited due to low compliance with medical mask use where the use was compared to no medical mask use with or without efforts to

improve hand hygiene. Household studies in general did not show significant benefit. However, sub-analyses found factors contributing to better effectiveness in medical masks included starting use within 36 hours of a household contact developing illness and greater consistency of medical mask use.

In an experimental study by Leung, et al in Hong Kong in 2013-16, persons with influenza and common human coronavirus and rhinovirus infections were tested for virus laden droplets and aerosols while breathing and coughing. They found that medical masks markedly reduced aerosols (p=0.04) and reduced droplets with coronavirus detected in room air among those with coronavirus infections (p=0.09), although this was not statistically significant due to the small number of coronavirus infected persons (n=17). [13]

Applicability of these studies to SARS-CoV-2 is unknown. [7]

Consistent use of any mask (N95, medical mask and 12 to 16 -layer cloth face covering), and ensuring good fit, are important factors in reducing respiratory illness. Having multi-layer cloth facial coverings that provide good filtration is also important ; filtration varies by fabric type.[5]

Data supporting cloth facial coverings, medical masks, and N95 for COVID-19

Data supporting the benefits of cloth facial coverings, medical masks and N95s for preventing the spread of COVID-19 comes from a number of studies which are detailed below. However, given that COVID-19 is a new pathogen in humans, no randomized controlled studies have been published to date.

Community evidence for medical masks and cloth facial coverings:

Researchers in Hong Kong (HK) examined the use of any mask, respiratory or facial covering in HK and found >97% of the population wore masks while in the community. Mask use was widespread very early in the COVID-19 outbreak given prior population experiences with SARS and influenza pandemics. Even though HK had early cases, is in close proximity to the epicenter of the COVID-19 initial outbreak, and has the second highest person-density in the world, they reported only 129 cases/million persons as of April 8 2020 compared to 1,103/million in the US, 831/million in the UK, and 2251/million in Italy.[2]

Further, through investigation of COVID cases, they found over 3 times as many COVID-19 clusters involved mask-off situations. And for clusters in which the index case had no mask of any sort, they infected an average of >10 other people. In clusters where the index case wore a mask of any sort, they infected an average of <4 people.[2] Thus, secondary infections appear to have been reduced by over 50%.

A contact tracing investigation of SARS-CoV-2 among persons exposed to infected travelers from Wuhan was conducted early in the outbreak in Taizhou, China. The authors did not indicate the type of mask worn. Among 123 contacts of SARS-CoV-2 infected persons where a mask was worn, 10 secondary cases were detected (8%) versus 14 of 74 (19%) contacts of a non-mask wearing infected Wuhan travelers (p<0.01) .[10] In this example, masks reduced secondary infections by over 50%.

Also, in China a study assessed the role of masks in households with COVID-19. When the initial COVID-19 cases in the household wore a mask prior to symptom onset, the risk of infections in household

members deceased 79%. However, starting to wear a mask after becoming ill did not reduce virus spread in the household. [18]

Cotton facial coverings or masks were required in a county in Missouri. One hair stylist (A) developed COVID-19 and transmitted it to a coworker (B) with whom she took non-mask wearing breaks with between clients. Otherwise both stylists wore masks while working with clients. Even though these stylists worked for a combined total of 13 days and with 139 clients while infected with COVID, none of their clients or other stylists, who were also required to wear masks or cloth facial coverings, developed COVID-19 or COVID-19 symptoms. However, 4 of 4 household contacts of stylist A did get COVID-19 infection. [8] Thus, a person who was very infectious to others without a mask, was found to not cause illness in contacts where both she and her contacts wore masks.

Healthcare setting evidence for N95s and medical masks

In a study in the United States, 421 healthcare personnel (HCP) were exposed to two patients with initially unrecognized COVID-19 early in the pandemic. Among the 421, eight (2%) became ill and tested positive for SARS-CoV-2 virus, all of who also had insufficient PPE during aerosolizing procedures (AGP) involving SARS-CoV-2 infected patients.[1]

Wang, et al [17] examined the risk of COVID-19 among HCP exposed to infected patients early in the outbreak (January 2-22, 2020) in a hospital in Wuhan, China. None (0%) of 278 HCP wearing N95s per protocol for HCP working on ICU, respiratory diseases, and infectious diseases wards developed COVID-19. However,10 (4.7%) of 215 HCP working on Hepatobiliary Pancreatic Surgery, Trauma and Microsurgery and Urology wards developed COVID. Neither masks or N95s were worn per protocol on these wards which were thought to be low risk for having COVID-19 patients, however HCP were inadvertently exposed to patients with COVID-19 infection on these wards.[17]

In another study among HCP in China, the authors reported testing environmental samples from COVID-19-positive patients' hospital rooms and surrounding areas. And even though SAR-CoV-2 PCR positive samples were found throughout the room, including floor, knobs, and air ducts, no HCP developed COVID-19; all HCP wore personal protective equipment consistently, including N95s or medical mask as appropriate.[7]

Experimental evidence

Researchers examined the filtering effectiveness of medical masks versus cloth facial coverings using different fabrics. Konda, et al[12] found that various fabrics were capable of filtration of aerosols. Filtration was best with multiple layers of fabric, high thread count, cotton/silk, and cotton/chiffon facial coverings which provided filtering comparable to surgical masks. Gaps between the fabric or mask and the face, however, substantially decreased the filtering effectiveness. "Filtration efficiencies of the hybrids (such as cotton−silk, cotton−chiffon, cotton−flannel) was >80% (for particles <300 nm) and >90% (for particles >300 nm)."[12]

A study by Ho, et al, tested 3-layer cotton facial coverings and medical masks on persons with either influenza (n=205) or suspected COVID (n=6).[9] The study compared the concentrations of particles in a bedroom and car without the volunteers, with volunteers wearing no mask, volunteers wearing a medical mask, and volunteers wearing cotton facial coverings. Cloth facial coverings and medical masks

reduced particles in the air by 2-6 times, respectively, compared to when the participant had no protection.[9]

Modeling studies suggest that even with medical masks or cloth facial coverings that are 70% effective in preventing inhalation and exhalation of infectious virus, countries could achieve rapid reductions in COVID-19 cases if 80-90% of the population consistently used medical masks or cloth facial coverings with at least 70% effectiveness.[6]

Conclusions:

N95s, medical masks and cloth facial coverings are able to reduce the spread of COVID-19 as evidenced by studies of other respiratory viruses, and reports from community settings, healthcare settings, and experimental settings. Consistently and correctly wearing the facial covering, having it fit closely to the face, and using cloth fabrics that are effective in filtering particles made by breathing, talking, and coughing are important factors in maximizing the effectiveness of masks. Use of masks (N95 and medical) and cloth facial coverings in both the healthcare and community settings must also be coupled with physical distancing where possible, proper hand hygiene, and good ventilation.

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