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EDITORIAL COMMENTARY

The Role of Face Protection for Respiratory Viral Infections: A Historical Perspective

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In medical history, the miasma theory was prevalent [1]. Cholera and plague were thought to be caused by "bad air" (night air) [2, 3]. In antiquity, masks were worn to prevent plague, and as recent as the late 19th century, masks were worn to prevent cholera. Since plague epidemics were due to rat fleas and cholera was due to contaminated water, the masks were useless. Today, during the coronavirus 2019 (COVID-19) pandemic, masks are recommended and used for personal protection throughout the world. Mucosal surfaces are the sites of respiratory virus infections. These sites include the posterior throat, nasopharynx, and conjunctiva. Today, the universal use of masks for protection against COVID-19 infection neglects consideration of the eyes as a site of possible infection.

USE OF MASKS IN COVID-19–INFECTED PEOPLE

The vast majority of people with COVID-19 infection are asymptomatic or only mildly ill. It was suggested to me by a Centers for Disease Control and Prevention friend that if a person with an asymptomatic or mildly symptomatic infection wears a face mask, the spread of infection from the mask wearer to others would be prevented. To me, this seemed to be a logical assumption. In a recent article, Leung et al showed this to be true for a nonnovel coronavirus, seasonal influenza, and a rhinovirus [4].

ROUTES OF RESPIRATORY VIRAL INFECTIONS

Eleven respiratory virus chapters in the 8th edition of *Feigin and Cherry's Textbook of Pediatric Infectious Diseases* were reviewed [5]. Human parvovirus infection occurred experimentally via intranasal inoculation, and it was assumed that the nasopharynx is the route of infection. The route of human bocavirus infection was assumed to be the nose via respiratory droplets. Adenoviral infections can occur via the mouth, nasopharynx, and the conjunctiva. Rhinovirus transmission has been studied extensively. Volunteer studies involved intranasal inoculation, but it was observed that eye rubbing could also result in transmission. With influenza, parainfluenza, and human metapneumovirus, it is assumed that the site of infection is the nasopharynx; the conjunctiva has not been studied. In studies with nonnovel coronaviruses, intranasal inoculation resulted in infection. No conjunctival studies were carried out. In measles, infection was acquired via the nasopharynx and the conjunctiva.

Respiratory syncytial virus (RSV) causes seasonal respiratory infections and illnesses throughout the world. RSV infections in young infants are frequently severe, as are infections in older adults with chronic pulmonary disease. Studies conducted decades ago in healthcare workers with RSV suggested that face masks did not prevent RSV infection in those workers.

In the clinical setting, healthcare workers frequently became infected and ill with RSV infections. Although the illnesses were not very severe, they nevertheless disrupted schedules and led to the spread of virus to high-risk patients. In the 1980s, C.B. Hall and colleagues at the University of Rochester, our University of California–Los Angeles (UCLA) group, and others carried out RSV studies in healthcare workers [6–10]. At Denver Children's Hospital, Murphy et al looked at the effectiveness of gowns and masks in preventing RSV infection in pediatric hospital personnel [6]. They found that gowning and masking did not increase personal protection against RSV infection above that which was provided by the usual hand-washing routine [6]. We at UCLA and Hall and her colleagues were both aware that conjunctional surfaces could be a site for RSV infections [7–10]. Our group compared standard isolation precautions with standard procedures supplemented by the use of masks and goggles. Among the healthcare workers who wore masks and goggles for clinical care, the infection rate was 5% compared with 61% among the healthcare workers who did not wear masks and goggles [10]. I made an additional unpublished observation that masks and goggles were more effective for

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nurses (who were predominantly females at the time of the observation) than for doctors (who were predominantly males at the time of the observation). This was because the doctors frequently touched their masks without following up with hand washing, whereas the nurses practiced hand washing.

In a study by Gala et al, it was found that face shields were highly effective in preventing RSV infections in healthcare worker as well as in preventing hospital-associated RSV infections [9]. Hall et al instilled a safety-tested live strain of RSV into the nose, eye, or mouth of 32 volunteers using various concentrations of virus [8]. At a dose of 5.2 $\log^{10}$ $TCID_{50}$ (tissue culture infective dose), 3 of 4 volunteers inoculated via the nose were infected, 3 of 4 volunteers inoculated via the eyes were infected, and only 1 of 8 volunteers inoculated via the mouth was infected. However, the RSV infection in that one volunteer may have been due to secondary spread and not the oral inoculation. This supports the belief that the nasal and conjunctival mucosae are more commonly sites of inoculation than the oral mucosa. I am not aware of any studies that have examined attempts to prevent RSV infections in persons other than healthcare workers.

CONCLUSIONS

Billions of people around the world are wearing various types of face masks for personal protection against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. However, until very recently, few studies have demonstrated the effectiveness of masks for protection against COVID-19 infection or transmission of SARS-CoV-2. A recent systematic review of multinational observational studies in healthcare and nonhealthcare settings demonstrated that physical distancing of 1 meter (3 feet) or more, the use of face masks, and eye protection were associated with reduced risk of transmission of SARS-CoV, Middle East respiratory syndrome-CoV, and SARS-CoV-2 [11]. We should continue to promote social distancing, the wearing of face masks, and the wearing of eye protection as well.

Note

Potential conflicts of interest. The author reports no conflicts of interest. The author has submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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