COVID-19 UPDATE

The Role of Hand Hygiene in the Prevention of COVID-19 Illness

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Preface

Since the outbreak of the COVID-19 pandemic in the U.S. just a few short months ago, our country has undergone dramatic and unprecedented changes. Social distancing, shelter-in-place orders, shuttered businesses, and school closures have brought daily life to a virtual standstill. All of these important public health measures were instituted in an attempt to "flatten the curve" and slow the spread of the 2019 novel coronavirus that causes the COVID-19 illness.

Although it's been established that the primary mode of person-to-person transmission of the 2019 novel coronavirus is through respiratory droplets that are produced when a person coughs or sneezes, the virus can also be spread by touching a contaminated surface or object. Since the COVID-19 outbreak, public health officials have raised the public's awareness about the importance of hand washing in slowing the spread of the coronavirus. According to the U.S. Centers for Disease Control and Prevention (CDC), "*During the COVID-19 pandemic, keeping hands clean is especially important to help prevent the virus from spreading*" [1].

Although it is common knowledge in modern societies that hand washing is an important aspect of good personal hygiene, what is the evidence that it can prevent the spread of germs? In particular, is there scientific evidence that hand washing can prevent the spread of the 2019 novel coronavirus and, thereby, help save lives?

Ignaz Semmelweis: The "Father" of Hand washing

It's rather difficult to comprehend that the direct relationship between hand washing, and the transmission of infectious diseases was not established until mid-19th century. But, as history attests, that is indeed the case. The story of the connection between hand washing and infectious diseases is fascinating and has been hailed as one of the major scientific discoveries and advances that propelled the practice of medicine into the modern day era.

Ignaz P. Semmelweis (1818-1865) was a Hungarian physician and scientist who was described as the "savior of mothers" and is credited as being the "father" of hand washing [2]. In 1847, Semmelweis, working as an obstetrician at Vienna General Hospital in Austria, made a remarkable and, as it turned out, an observation of historical

proportions. He discovered that mothers whose babies were delivered by doctors at his hospital were dying at a significantly higher rate from a condition called *puerperal fever* – an infection of the uterus following childbirth – compared to women who were attended by midwives. The maternal death rate for women delivered by doctors was about 2.5 times higher than for women who were delivered by midwives.

After some detailed investigation, Semmelweis came up with an important clue. He noticed that the doctors who examined pregnant women came directly from performing autopsies and reasoned that puerperal fever must be a contagious disease that was being transmitted to these women through the unwashed hands of these doctors that were contaminated with residual particles from the cadavers. Semmelweis then instituted a policy at the hospital for all doctors to wash their hands with a chlorinated solution (calcium hypochlorite) between autopsy work and examining pregnant women. The results of his hand washing experiment were almost immediate and dramatic. Within 2-months, the maternal mortality rate from puerperal fever at the hospital had declined 90%.

Despite this irrefutable evidence, his hand washing theory was rejected by most of the contemporary medical establishment. He also made a lot of enemies among his peers. In 1865, the increasingly outspoken Semmelweis was committed to an asylum by his colleagues where he died a short-time later after being beaten by a guard [2].

The Germ Theory of Disease

Semmelweis' discovery that hand washing with a chlorinated solution could prevent puerperal fever after childbirth was significantly more influential than even he had realized. Although his theory was rejected by most medical practitioners at the time, more than 20 years later, Louis Pasteur, a French microbiologist, discovered that puerperal fever was an infection caused by bacteria and, thereby, offered a theoretical basis for Semmelweis' observations: *the germ theory of disease*.

In its most basic understanding, the germ theory of disease states that microorganisms, such as bacteria, viruses, and fungi, can invade a living host (humans and animals), reproduce within the host, and cause disease [3].

Although basic forms of the germ theory of disease were proposed by some physicians in the late Middle Ages, these views were not accepted by the mainstream medical establishment of the time. In the 1880s, Robert Koch, a German physician and microbiologist, expanded on the work of Louis Pasteur and provided a sound scientific basis for the germ theory of disease. This theory includes four basic criteria, known as *Koch's postulates*, for demonstrating that a disease is caused by a particular microorganism [4].

- The microorganism must be found in all hosts suffering from the disease.

- The microorganism must be isolated from a diseased host and grown in pure culture in the laboratory.
- The cultured microorganism must cause the same disease when introduced into a healthy experimental host.
- The microorganism must be recovered again from the diseased experimental host.

Although it is now recognized that there are some infectious agents that can cause a disease without fulfilling all of Koch's postulates, nevertheless, the basic concept of the germ theory of disease remains a cornerstone in the practice of modern medicine. We should note that the isolation of the 2019 novel coronavirus from patients suffering from COVID-19 is just the latest example of the clinical significance and usefulness of the germ theory of disease in modern medicine. Once the coronavirus was isolated and identified, its genetic code was rapidly sequenced which opened the door to the development of possible vaccines and treatments for COVID-19.

Why Wash Your Hands?

Hand hygiene is one of the most important steps you can take to avoid getting sick and also from spreading germs to others. Many diseases and conditions, caused by microorganisms such as *Salmonella*, *E.coli*, *norovirus*, and *respiratory viruses* are transmitted by touching objects or surfaces where these germs abound. Even though they are invisible to the naked eye, microorganisms are ubiquitous in nature and can survive and even thrive in almost any environment. In the case of viruses that cause respiratory diseases, including the 2019 novel coronavirus, your hands can become contaminated by touching any objects or surfaces where the virus has been deposited. Viruses can be shed on a surface after someone coughs or sneezes or if a surface was touched by someone who has the virus on their hands [5]. Touching your nose, mouth, or eyes with contaminated hands is the entry point to your respiratory tract where the virus can attach, grow, and cause a respiratory infection.

According to the CDC, up to 1 million deaths per year could potentially be prevented by routine hand washing [6]. Hand washing can also significantly reduce the risk of acquiring respiratory infections [6]. The CDC recommends washing your hands at the following key times when you are most likely to spread or to get infected with germs [7]:

- Before, during, and after preparing food.
- Before eating food.
- Before and after caring for someone at home who is sick.
- Before and after treating a cut or wound.
- After using the toilet and after changing a diaper.
- After blowing your nose, coughing, or sneezing.
- After touching an animal, animal feed, or animal waste.

- After touching garbage.

During the COVID-19 pandemic, the CDC also recommends washing your hands [7]:

- After you have been in a public place and touched an object or surface that may have frequently been touched by other people. This includes door handles, tables, gas pumps, shopping carts, or electronic cash registers/screens.
- Before touching your mouth, nose, or eyes to prevent infecting yourself with the coronavirus.

The CDC also recommends the following "best-practices" for effective hand washing [7]:

- Wet your hands with clean, cold or hot running water and apply soap.
- Lather your hands with soap making sure to cover the back of your hands, fingers, and under your nails.
- Scrub your hands for at least 20 seconds.
- Rinse your hands under clean running water.
- Dry your hands using a clean towel or with an air dryer.

Hand washing is the most effective way to eliminate germs from your hands in most situations. When soap and water are not readily available, use an alcohol-based hand sanitizer that contains at least 60% alcohol.

Coronaviruses Can Survive on Inanimate Surfaces

Although the primary mode of transmission for the 2019 novel coronavirus is via respiratory droplets that are produced when an infected individual coughs or sneezes, emerging evidence suggests that people may also acquire the virus through the air and after touching contaminated objects or surfaces. A brief summary of the scientific evidence supporting the transmission of coronaviruses from contact with contaminated surfaces is presented below:

- A recent study published in the *New England Journal of Medicine* reported that the 2019 novel coronavirus can be detected in aerosols for up to 3 hours; up to 24 hours on cardboard; and from 2 to 3 days on plastic and stainless steel [8].

- A study published in 2018 in *BMC Infectious Diseases* reported that surface swabs from multiple sites with high touch rates at Sweden's major airport detected at least one respiratory virus, including influenza, adenovirus, rhinovirus, or coronaviruses in 9 of 90 (10%) of surface samples [9]. Surface sites at this airport where at least one respiratory virus was detected included hand-carriage luggage trays at the security check-point, tables at the security check point, the handrails of stairs, and buttons at payment terminals.

- An earlier study published in 2016 in the *Journal of Hospital Infection* found that human coronaviruses such as SARS and MERS, close "cousins" of the 2019 novel coronavirus, can persist on inanimate surfaces such as metal, glass, plastic, paper, or Teflon anywhere from 2 to 9 days [10]. The exact time of persistence was dependent on the specific type of virus, the temperature, and the relative humidity.

The fact that many respiratory viruses, including human coronaviruses, can survive on inanimate surfaces for an extended period of time is not absolute proof that contaminated surfaces play an important role in transmission of these viruses. It does, however, suggest that transmission from contaminated surfaces is theoretically possible under the following circumstances:

- The respiratory virus must be shed on a surface from the environment. This can occur when an infected individual coughs/sneezes or touches a surface with hands that are contaminated with the virus.
- The number of virus particles deposited on a surface must be of a sufficiently high concentration to cause an infection.
- The virus must have the capacity to survive on the particular surface for a sufficient period of time.
- Upon touching the contaminated surface, a sufficient number of virus particles must be transferred to the hands to cause an infection when the individual then touches their nose, eyes, or mouth.
- Once a respiratory virus enters the body, the host's immune system plays a key role in determining the course of the infection. In general, most young people with healthy immune systems will either clear the virus without developing any symptoms or they may develop only mild flu-like symptoms. People who are elderly or those with compromised immune systems, on the other hand, will likely develop more severe symptoms that are associated with respiratory tract infections.

Although human coronaviruses can persist on inanimate surfaces for up to 9 days, studies have shown that they can be quickly and efficiently inactivated with many common household disinfectants and antiseptics [11 – 13]. Many common household cleaning agents and disinfectants contain chemicals that can kill viruses within one minute. These antiviral substances include:

- Ethanol
- Hydrogen peroxide
- Sodium hypochlorite
- Triclosan
- Pine oil

- Benzalkonium chloride
- Lauramine

Cleaning and Disinfection of Frequently Touched Surfaces

For routine cleaning and disinfection of frequently touched household surfaces, the CDC recommends the use of common household cleaners and EPA-registered disinfectants [14]. These products typically include instructions for safe and effective use as well as any precautions that should be taken when applying these products, such as wearing gloves and ensuring there is adequate ventilation during use. Routine cleaning and disinfection should be performed on all frequently touched household surfaces, including:

- Tables
- Doorknobs
- Light switches
- Handles
- Desks
- Electronics

The CDC recommendation for cleaning and disinfection also includes the following guidelines for households with people isolated at home with suspected or confirmed COVID-19 disease [14]:

- Household members should educate themselves about COVID-19 symptoms and steps to take to prevent the spread of COVID-19 in homes.
- Clean and disinfect high-touch surfaces daily in household common areas.
- An ill person should stay in a specific room as much as possible and away from other people in their home.
- If possible, the ill person should use a dedicated bathroom and should be provided with supplies and disinfectants to clean and disinfect their dedicated room and bathroom.
- If a separate bathroom is not available, a household member should clean and disinfect it after each use by the ill person.

Hand washing and the 2009 Influenza Pandemic: Lessons Learned

Prior to the outbreak of the current 2019 coronavirus pandemic, during the past century the world experienced four other pandemics, all of which were caused by novel strains of the influenza virus:

- The Spanish flu – 1918
- The Asian flu – 1957

- The Hong Kong flu – 1968
- The H1N1 (Swine) flu – 2009

With respect to the H1N1 pandemic, the CDC estimated that there were approximately 61 million cases, nearly 275,000 hospitalizations, and between 12,000 to 18,000 deaths in the United States. The total number of deaths from the H1N1 pandemic worldwide was estimated to range from 152,000 to 575,000 [15].

The 2019 novel coronavirus and the influenza virus share some common characteristics:

- Both viruses affect the respiratory tract and cause respiratory infections.
- Influenza is a seasonal virus that results in breakouts mainly during the fall and winter. Many experts believe that the 2019 novel coronavirus will also recur during the fall and winter seasons.
- The primary mode of person-to-person transmission of both viruses is through respiratory droplets that are produced when coughing or sneezing.
- Both viruses can be spread by contact such as by touching a contaminated person or a contaminated surface and then touching your mouth, nose, or eyes.

During the 2009 H1N1 pandemic, many countries adopted non-pharmaceutical interventions (NPIs) such as social distancing, use of facemasks, quarantining ill patients, and tracing of contacts of infected individuals to slow and prevent the spread of the virus. Included among these NPI measures was a recommendation for regular hand washing to reduce the risk of transmission from contact with infected people or from touching contaminated surfaces. Many of these same NPIs, including hand washing and adherence to good personal hygienic habits, have also been implemented to attempt to reduce the spread of the 2019 novel coronavirus.

The effectiveness of hand washing as a means of reducing the spread of the 2009 H1N1 influenza virus has been the subject of many studies in the literature. One of the largest studies published was a systematic review and meta-analysis of 15 prior publications that evaluated the effectiveness of hand washing for preventing pandemic influenza infection [16]. The primary finding of this literature review and meta-analysis was that regular hand washing was significantly protective for preventing pandemic influenza infection. The benefit of this protective effect was also related to the frequency of hand washing, meaning that those people who washed their hands more frequently reduced the likelihood of becoming infected with influenza to a greater extent than those who washed their hands less frequently.

Hand washing was also found to be effective for preventing transmission of the SARS coronavirus during the outbreak of the SARS pandemic in 2002 – 2003. Nine of 10 epidemiological studies found that hand washing was protective against SARS transmission when comparing infected cases to non-infected controls [17]. The

protective effects of hand washing in preventing SARS transmission were observed in both health care as well as community settings.

Alcohol-Based Hand Sanitizers and Gels

Although washing your hands with soap and water is the best way to eliminate germs in most situations, when hand washing is impractical or not possible, the CDC recommends the use of an alcohol-based hand sanitizer that contains at least 60% alcohol [18]. You can determine the alcohol content of a particular hand sanitizer by reading the product label. Although sanitizers can quickly reduce the number of germs on your hands in many instances, they do not eliminate all types of germs and may not be effective when your hands are visibly dirty or greasy. When using a sanitizer, apply the product to the palm of one hand and rub your hands together for about 20 seconds. The gel should cover all of the surfaces of your hands and fingers until your hands are dry.

In recommending the use of these products, the CDC also notes that alcohol-based hand sanitizers have been found to inactivate viruses that are genetically related to, and with similar physical properties, as the 2019 novel coronavirus [19]. Most of the evidence supporting the use of hand sanitizers for preventing the transmission viral infections comes from studies conducted with respiratory viruses such as influenza. In general, these studies have shown that alcohol-based hand sanitizers reduced the incidence of respiratory infections in a variety of settings including extended care facilities [20], among university dormitory residents [21], and among household members living in the same home [22]. Based upon the results of these studies, it appears reasonable to recommend the use of hand sanitizers when hand washing is not practical to reduce the risk of transmission of respiratory viruses, including the 2019 novel coronavirus.

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