

Surgical Masks During the Influenza Pandemic of 1918-1920

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During the influenza pandemic of 1918-1920, cloth face-masks were widely used by the public in a futile effort to ward off the deadly infection (Figure 1). More than a century later, it symbolizes “social distancing,” the global strategy to prevent the spread of COVID-19. The late Nathan Belkin of Clearwater, FL, was an executive in the surgical garment industry with an abiding interest in the history of all areas of protective and anti-infective surgical garments, including the surgical facemask. Published in 1997, his history of the surgical facemask provided the outline of the story that follows.¹

Facemasks during surgery became part of aseptic practice from research conducted by Johann von Mikulicz-Radecki (1850-1905), head of surgery at the University of Breslau, and Carl Flügge (1847-1923), a hygienist trained in Kochian bacteriology.² Flügge found that “droplet infection” from surgeons’ noses and mouths was a rich source of germs.^{2,3} Even calm speech scattered oral bacteria into the general environment. As a result of his colleague’s findings, Mikulicz began to wear a face-mask to cover his nose, mouth, and beard, an innovation that he called “*mundbinde*” (lit., “mouth tie”) which he published in 1897.^{1,4}

In April 1904, Alice Hamilton (Figure 2), the famous pioneer of occupational health and activist for women’s rights and peace during the first half of the 20th century, studied the dissemination of streptococci by patients with scarlet fever at the Memorial Institute for Infectious Diseases in Chicago, where she spent the first years of her medical career.⁵ She found that patients with active streptococcal pharyngitis were an inconsistent source of contamination of the hospital environment. However, 46 of 50 surgeons and nurses in apparent good health harbored the organism in their oropharynx. Of that number, 36 spread the organism during coughing and 26 during speaking. She wrote:

Surgeons and nurses may themselves be the source of septic infection in their patients even after all the usual precautions as to disinfection have been observed.



Figure 1. Thompson P. To prevent influenza! New Haven, CT, Illustrated Current News, 1918. National Library of Medicine.

She had a vivid example of the potential of saliva from surgeons in spreading infection:

I was told by a student in a large medical college in Chicago that he had often noticed at the clinics of a certain surgeon that, when the light was from a certain direction, a continuous spray of saliva coming from the mouth of the surgeon while he discoursed to the class and conducted his operation.

She concluded:

Surgeons and nurses should have their mouths protected during the time of an operation.

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Her colleague at the Memorial Institute was George Weaver, physician-in-charge at its associated medical facility, the Durand Hospital. While Mikulicz, Flügge, and Hamilton studied masks as a means to protect patients from germs shed by surgeons, Weaver turned the perspective around. He reasoned that masks might protect his nurses and doctors from infective diseases harbored by their patients.

In 1916, he implemented a mandatory policy of face-masks among nurses at the facility to protect them from cases of diphtheria, scarlet fever, and meningococcemia. No nurse came down with scarlet fever or meningitis once the policy was instituted. The physicians began to wear masks during intubations and examinations of patients suspected of having an infectious disease. Weaver also recognized the role of masks in preventing asymptomatic carriers from infecting others.⁶

His strategy was prescient and timely. Weaver's article appeared in the *Journal of the American Medical Association* in January 1918. Later that month, an outbreak of influenza surfaced in Haskell, KS. Loring Minor, the town doctor, was alarmed by the ferocity of the infection. John Barry, historian and author of *The Great Influenza* (London, Viking Penguin, 2004)⁷, wrote:

... dozens of his patients—the strongest, the healthiest, the most robust people in the county—were being struck down as suddenly as if they had been shot.

His warning to national public health officials was published in *Public Health Reports* (now *Morbidity and Mortality Weekly Report*) in April. By then, it was too late. In early March, the infection was in Camp Funston (today's Fort Riley) 300 miles to the east; from there, it spread to other Army bases as the country mobilized for war. Influenza followed the troops as they boarded ships to France.⁷

All major American cities suffered epidemics in September and October. Physicians, nurses, public health officials enforcing quarantines, and the police—all those who came in contact with the sick—wore facemasks. The San Francisco Board of Health strongly recommended that all residents of the city wear them in public.⁸

As facemasks suddenly became essential to public health, investigators tested their effectiveness. In October 1918, Brewster Doust and Arthur Lyon of the Medical Corps of the US Army reported their experiments testing the barrier function of gauze masks of various designs and thicknesses.⁹ They gargled with a suspension of a *Bacillus prodigiosus*, then considered an innocuous microbe. (It was later rechristened *Serratia marcescens*.) When grown on agar plates, the bacillus produced brilliant red colonies, giving a simple assay to test its spread under test conditions. The infective microbe for influenza



Figure 2. Alice Hamilton. National Institutes of Health.

was then unknown, so they had no way of knowing that the influenza virus, measuring about 100 nm in diameter, was the tenth the size of a 1- or 2-micron bacterium and would require a more impervious barrier.

As they spoke or coughed for 5 minutes behind the test masks, the organisms that escaped from their mouths landed on culture plates placed at various distances. Doust and Lyon found that 10 layers of fine mesh muslin (butter cloth) were the most effective barrier to the appearance of bacteria on the plates.

An influenza outbreak in California in 1919 allowed W.H. Kellogg of the state board of health to examine the incidence of influenza in towns where facemasks were mandatory. Compared with towns where no such policy existed, the rates of illness were no lower. He concluded that while gauze masks restrained the passage of bacilli, those used in practice were ineffective, either too thin, loosened when no one was watching, or removed completely, obviating them as a public health measure.¹⁰

In a modern equivalent of Weaver's study that anticipated the 1918 flu outbreak, a thoroughly modern multicenter prospective randomized appeared in the *Journal of the American Medical Association* in September 2019

just months before the current COVID-19 epidemic.¹¹ In a study conducted during the annual flu seasons of 2011-2015, Lewis Radonovich of the National Institute of Occupational Safety and Health in Pittsburgh and his research group tested whether N95 respirators and conventional medical masks protected doctors and nurses from contracting active influenza infections.

In yet another example of how history repeats, the investigators found that both high-efficiency respirators and the surgical masks permitted similar rates of laboratory-confirmed influenza infection events (8.2% for N95, 7.2% for standard masks). In both groups, mask compliance was incomplete, with only 90% of participants reporting that they “always” or “sometimes” wore their assigned devices and masks.

In a prior study, Radonovich identified several factors that prevented health care personnel from wearing N95 masks: they were hot, uncomfortable, quickly got wet on the inside, made speaking nearly impossible, and most importantly, when properly fitted, difficult to breathe through.¹² Best intentions by homebound tailors aside, facemasks made by volunteers are unlikely to change the negative features of a properly fitted N95 mask, nor offer any more protection against contracting coronavirus.

Today city governments are ordering mandatory face-mask regulations, an echo of those of 1918.^{13,14} Rather than protecting the wearer of the mask, the rationale is to prevent the unintentional shedding of infective material from asymptomatic carriers. It will be interesting whether future epidemiological studies of the COVID-19 epidemic will come to the same conclusions about masks as Kellogg’s studies made a century ago.

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