

Cloth Face Coverings for Use as Facemasks During the Coronavirus (SARS-CoV-2) Pandemic: What Science and Experience Have Taught Us

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ABSTRACT

The current coronavirus (severe acute respiratory syndrome coronavirus 2 [SARS-CoV-2]) pandemic has resulted in severe shortages of personal protective equipment, including respiratory protective equipment, such as N95 respirators. This has led some government agencies to suggest the use of cloth face coverings (CFCs) by health-care providers and the general public as a last resort when standard respiratory protective equipment is unavailable. Although such coverings have been in use for over a century and have found widespread use during some previous pandemics, research data are relatively scant for the protective value of this measure. This article, a literature review, explores the development of CFCs and reviews available scientific research regarding the efficacy of this intervention as a preventive measure in the spread of airborne infectious diseases

Key Words: cloth face coverings, efficacy, infection control, pandemic, surgical masks

The current coronavirus (severe acute respiratory syndrome coronavirus 2 [SARS-CoV-2]) pandemic has resulted in worldwide shortages of personal protective equipment, especially respiratory protective equipment, such as N95 respirators and surgical facemasks (SMs). This shortage has resulted in a precarious dilemma for many individuals, including health-care providers (HCPs) administering front-line care to pandemic victims and other caregivers of infected persons. Inadequately protected HCPs and caregivers risk being infected themselves and become a contact source for spreading the coronavirus. If HCPs are not suitably protected, the health-care system can no longer function at the requisite level necessary to address the pandemic. Attempts to increase the manufacture and supply of respirators and SM during a pandemic are necessarily time-dependent due to such issues as disrupted supply lines, decreased availability of manufacturing materials, re-tooling issues, and availability of healthy industrial workers.

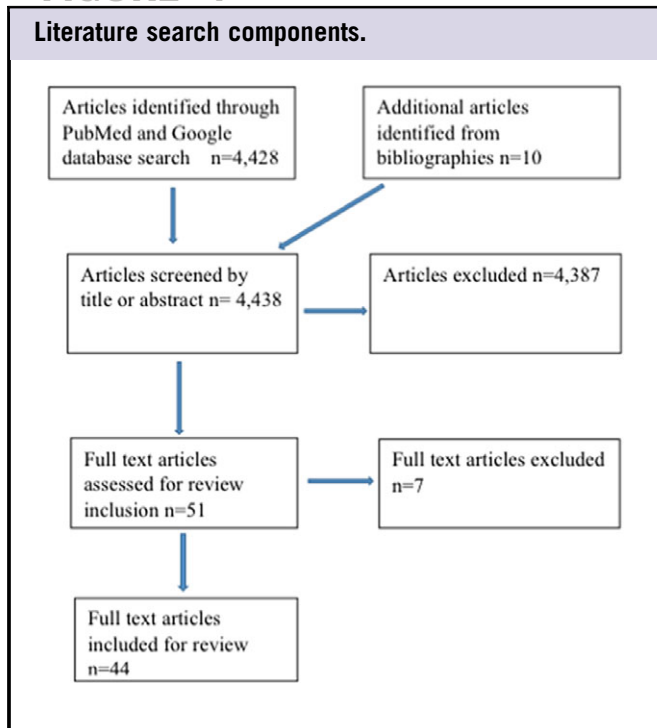
This lack of commercially available respiratory protective equipment has spawned the idea of the fabrication and use of homemade cloth face coverings (CFCs) as a temporizing measure while awaiting the manufacture and delivery of commercially manufactured products. The use of CFCs by the public could also free up limited supplies of SMs and respirators for HCPs. The recent Centers for Disease Control and Prevention (CDC) recommendation that “cloth face coverings be worn in public settings

where other social distancing measures are difficult to maintain (eg, grocery stores and pharmacies), especially in areas of significant community-based transmission¹” further highlights the potential for widespread use of this controversial measure. The difficulties inherent in studying the effect of CFC use on large populations have resulted in widespread dispersal of information regarding this intervention that is largely founded on assumptions. Based on the results of a literature search and their prior research experience with the National Institute for Occupational Safety and Health’s National Personal Protective Technology Laboratory, a government agency that tests and certifies respiratory protective equipment, the authors provide an overview of the development of CFCs and their functional capabilities compared with commercially available SMs (the type of commercial mask most likely to be used by the general public²).

METHODS

An English-language literature search was conducted from March 27, 2020, to April 6, 2020, using the PubMed database for the search terms cloth mask, cloth facemask, cloth face coverings, homemade mask, homemade face covering, filtration, source control, and efficacy. Additionally, an Internet search with the Google engine was performed using the search terms cloth masks, homemade masks, filtration, efficacy, government recommendations, and randomized trials. Articles were deemed pertinent by title and

FIGURE 1



abstract review of both authors; culled articles were then read fully by both authors for agreement on inclusion. Bibliographies of culled articles were scanned for possible additional references.

RESULTS

A total of 4428 published peer-reviewed articles was retrieved, of which 41 articles were determined to be related to the topic after review of titles and abstracts by both authors. Another 10 peer-reviewed research publications were gleaned from the bibliographies of the aforementioned 41 publications for a total of 51 articles considered for possible inclusion. After a full read of all 51 articles, 7 were excluded, leaving a total of 44 articles to serve as the basis for this review. Additionally, 1 government review of respiratory protection and 13 Web sites (11 government sites, 1 private industry site, 1 university site) related to the topic were retrieved and incorporated into the report (Figure 1). The results of the literature review are summarized by category, as follows:

Evolution of CFCs as Surgical Facemasks

The concept of a facemask was initially introduced in 1897 by the Polish surgeon Mikulicz-Radecki,³ based on the theory of the infectious nature of exhaled respiratory droplets in the transmission of tuberculosis, as proposed by the German physician Flügge.⁴ The first efforts at fabricating facemasks used the

use of multiple layers of gauze applied over the mouth of surgical staff in an attempt to protect sterile surgical fields and surgical patients from aerosol droplets generated by staff, as well as to protect the surgical staff from blood and other body fluids expelled during surgery.⁵ In 1905, Alice Hamilton, a physician at the Memorial Institute for Infectious Diseases (Chicago), proposed the use of facemasks in surgery to prevent surgical infections after her studies demonstrated that streptococci were expelled from the mouth of surgeons by “invisible sputum from coughing, speaking, whispering, crying or breathing forcibly from the mouth”.⁶ In 1918, Capps demonstrated the utility of facemask use by staff and patients alike in suppressing the spread of measles and scarlet fever in hospital wards.⁷ The use of facemasks by surgical staff became routine, although not universal, by 1920,⁸ and over the past several decades has been used by medical staff and the general public as protection from airborne large respiratory aerosol droplets.⁹

Descriptive Characteristics of SMs and CFCs

SM are Food and Drug Administration (FDA) approved medical devices that provide barrier protection against large droplets ($>5 \mu\text{m}$) expelled from the respiratory tract of the wearer (source control) and protect the wearer’s mouth, nose, and part of the facial skin from exposure to large aerosol splashes, sprays, and splatter of body fluids from other sources. SMs are not considered respirators (eg, N95 respirators) because they cannot filter small airborne particles, vapors, or gases. Moreover, because of their loose fit, as opposed to the tight fit of respirators, they do not prevent air leakage around the edges of the mask during inhalation.¹⁰⁻¹² SM are disposable and generally consist of 3-4 layers of nonwoven bonded fabric, often overlapping 2 layers of filters, the combination of which is capable of filtering out particles that are $\geq 1 \mu\text{m}$ in diameter, thereby trapping bacteria of that size or larger.¹³ The FDA does not test SMs, but relies on test data supplied by manufacturers (fluid resistance, efficiency for particulate filtration [using $0.1 \mu\text{m}$ latex spheres], and bacterial filtration [using $3.0 \mu\text{m}$ particles containing *Staphylococcus aureus* bacteria], differential pressure [pressure drop across a SM], and flammability).^{12,14} FDA approval is granted if the manufacturer-supplied data is equivalent or better than currently approved SM.¹⁴

CFC were initially made for surgical personnel and were composed of multiple layers of gauze that covered the mouth.¹⁵ Gauze likely was used because it was readily available in the health-care setting given its use as bandages, wound dressings, and surgical sponges. During the Manchurian plague (1910-1911), CFCs were made of 2 layers of gauze encasing a 4- × 6-inch piece of absorbent cotton.¹⁶ Cotton CFCs were in widespread use by the public and HCPs during the 1918 Spanish influenza and the use of cotton and gauze CFC continued through the first half of the 20th century until

the introduction of disposable facemasks in the 1950s and 1960s.¹⁷ Over the ensuing years, several other common fabrics have been used for CFCs, including polyester, cotton/polyester combinations, fleece, and linen.¹⁸ Although there are no universal guidelines for fabricating CFCs, suggestions from fabric experts and health-care agencies highlight the need to preferentially use breathable, tight-weave cotton fabrics (double layered, if possible), ideally with a moisture-wicking (eg, microfleece) middle layer and avoidance of knit fabrics (create holes when they stretch) and woolens (may irritate the skin of sensitive individuals).¹⁹⁻²¹ Fabrics should be prewashed in hot water to disinfect and preshrunk before CFC construction²¹; shrinkage through repeated washing of gauze has previously been shown to increase the protective nature of the fabric.²²

Protection Afforded by Cloth Face Coverings

a) Protection Factors

A respirator's ability to protect is greatly dependent on leakage at the face/respirator interface and through its filter and exhalation valve (if so equipped), with the fit of the respirator to the face as the primary component. Quantification of the protection afforded by tight-fitting respirators (eg, N95 respirators) can be obtained by Occupational Safety and Health Administration (OSHA) quantitative fit testing that measures the concentration of airborne challenge aerosol particles in the environment and particles within the space between the wearer's face and the inner surface of the respirator (dead-space) during various activities.²³ The ratio of the 2 concentrations is termed the fit factor and a minimum passing score of ≥ 100 is derived from the N95 respirator's assigned protection factor of 10 (the expected workplace protection afforded by a respirator or class of respirators indicating that no more than one-tenth of contaminants will leak into the respirator) multiplied by a safety factor of 10 (that compensates for the likely better fit of a respirator within controlled laboratory settings compared with the work environment).²⁴ A score of 100 from a quantitative fit test indicates that $\leq 1\%$ of challenge aerosols enter the deadspace of the respirator. Although the loose fit of SMs and CFCs makes quantitative fit testing unwarranted, a small number of research studies have fit tested SMs and CFCs to determine what protection may be afforded the wearer.

Three human studies of SMs have demonstrated protection factors ranging from 1.3 to 6.5, considerably less than a properly fitting N95 respirator.²⁵⁻²⁷ Another human study reported protection factors ranging from 2 to 12 for SMs.²⁸ Dato et al.²⁹ tested a CFC of 2-ply heavyweight tee-shirts in 8 inner layers arranged in different orientations and having 3 sets of ties on 3 subjects and reported nonpassing OSHA fit factors 67, 13, and 17 for 3 individuals tested, indicating significant penetration through the CFC material, leakage around the seal of the CFC, or both, that indicate a low protection factor.²⁹ A study of 20 subjects testing 4 models of SM reported fit factors ranging from 2.5 to 9.6.³⁰ van der Sande et al.²⁷ reported protection factors ranging from 2.2 to 3.2 for adults and 1.9-2.2 for

TABLE 1

Protection factors and fit factors of surgical masks (SM) and cloth face coverings (CFC)

Reference	Protective Factor		Fit Factor	
	SM	CFC	SM	CFC
Kournikakis et al. ²⁵	1.6-5.6			
Lee et al. ²⁶	2.4 (mean)		1.7-2.5	
Gwan et al. ²⁸	2-12			
van der Sande ²⁷			4.1-5.3*	2.2-3.2*
			3.2-4.9§	1.9-2.2§
Davies et al. ²			5 (median)	2 (median)
Oberg et al. ³⁰			2.5-9.6	
Dato et al. ²⁹				13-67

*Adults.

§Children.

children wearing CFCs made from tea cloth. Davies et al.² noted that CFCs fabricated from tee-shirts provided a median fit factor (2) less than half that of SMs (5) in 21 subjects (Table 1).

b) Viral Penetration

Nonhuman studies of SM and CFC materials have examined the penetration of viral aerosols or aerosols that are representative of viruses (20-400 nm). A study of 2 models of SM from the same manufacturer, challenged with MS2 virus, noted widely different viral penetrations of 20.5% and 84.5% at a flow rate of 85 L/min.³¹ Another study evaluating 7 different models of SMs to direct challenge with influenza aerosol reported a general reduction in exposure of 1 log or less.²⁸ Rengasamy et al.¹⁸ reported that the penetration levels for 400 nm aerosol particles at a standard face velocity for testing filters (5.5 cm s^{-1}) reached 73-87% for commercial cloth masks; the 3 sweatshirt and tee-shirt models were in the 30-61% and 56-79% ranges, respectively, for 20-nm size particles and increased to 80-93% and 89-97% as particles reached 1000 nm. Another study² noted that SM had maximum filtration efficiency (ability of a respirator filter to prevent the passage of aerosol particles) of 89.5% for viral-sized particles and CFC of various fabrics (100% cotton tee-shirt, scarf, tea towel, pillow case, cotton/polyester mix, linen, silk) had efficiencies of 48.8-70.2%. Lee et al.²⁶ reported that 3 models of SMs had the most penetrating particle sizes ranging from 20 to 200 nm, the size range that includes SARS-causing coronaviruses and influenza viruses.

Aerosol testing of 2 models of cloth masks against polystyrene particles of diameters of 1.0 nm and 2.5 nm, and particles with virus-sized dimensions (30, 100, and 500 nm), indicated filtration ranging from 15 to 57% that decreased with decreasing particle size and was inferior to results for SM.³² MacIntyre et al.³³ reported aerosol penetrations of 97% and 44%, respectively, for cloth face masks commonly used in Asia and medical

TABLE 2

Viral Penetration Studies of SMs and CFCs		
Reference	SMs Study Type	Findings
Balazy et al. ³¹	Nonhuman	Viral penetrations of 20% and 84.5% for 2 models of SM from same manufacturer (flow rate 85 L/min)
Gawn et al. ²⁸	Human	Reduction in viral exposure influenza aerosols <1 for 7 models of SM
Lee et al. ²⁶	Nonhuman	Most penetrating particle size for 3 models of SM was 20-200 nm
Davies et al. ²	Human	89.5% filtration efficiency against virus-sized particles for SM
MacIntyre et al. ³³	Nonhuman	97% viral penetration through SM
CFCs		
Jung et al. ³⁴	Nonhuman	97% penetrations of virus-sized particles for CFC
Rengasamy et al. ¹⁸	Nonhuman	Particle (20 nm) penetrations of 30%-61% for sweatshirt CFC and 56%-79% for tee shirt CFC
Davies et al. ²	Human	48.8-72.2% filter efficiency of virus particles for CFC
Shakya et al. ³²	Nonhuman	Filtration efficacy of 15-57% for 4 types of CFC
MacIntyre et al. ³³	Nonhuman	Filter penetrations of 97% for CFC

masks. Testing handkerchiefs of cotton, gauze, or towel material to sodium chloride aerosols of 75 ± 25 nm count median diameter indicated penetrations of 97% using an automated filter tester at a flow rate of 95 L/min (normal breathing flow rate is 15-30 L/min)³⁴ (Table 2).

c) Bacterial Penetration

A human study testing the efficacy of various fabrics (eg, bath towel, cotton shirt, handkerchief) noted filtration efficiencies of 28-73% against *Bacillus globigii* aerosols (2000 nm).³⁵ A mannequin study, using aerosolized droplet nuclei in the range of bacterial sizes (1.0-2.5 μ m), noted filtration efficiencies of 33.1% for SM and 11.3% for bandanas.³⁶ Another study², using a closed-circuit filter testing system, demonstrated bacterial filtration efficiencies of 96.3% for SM and 60-83.2% for various common fabrics used for CFC (100% cotton tee-shirt, scarf, tea towel, pillow case, cotton mix, linen, silk). Research using green cotton fabric used for hospital operating room gowns showed a bacterial penetration of 48.6%³⁷ (Table 3).

d) Source Control

Although a primary function of SMs and CFCs is serving as a barrier to exhaled respiratory particles (source control), research data addressing this topic are relatively scarce. A mannequin study using a mechanical cough machine reported that a SMs captured roughly 20% of exhaled aerosols during

TABLE 3

Bacterial Penetration Through SMs and CFCs		
Reference	SMs Study	Findings
Bowen ³⁶	Nonhuman	Filtration efficacy of 31.1% for bacterial-size particles with SM
Davies et al. ²	Human	Filtration efficacy of 97.5% for SM against <i>Bacillus atrophaeus</i>
CFCs		
Guyton et al. ³⁵	Human	Filtration efficacies of 28%-73% for CFC against <i>Bacillus globii</i> aerosols
Bowen ³⁶	Nonhuman	Filtration efficacy of 11.3% for CFC (bandana) against bacterial-size particles
Davies et al. ²	Human	Filtration efficacy of 60%-83.2% against <i>Bacillus atrophaeus</i>

coughing 20 cm away from a second mannequin that wore no mask. The same study reported that source control during coughing, using a SM or N95 respirator was statistically superior to the same protection on the receiver, whereas during tidal breathing source control was comparable or superior to protection for the receiver.³⁸

Experiments by Davies et al.² showed that both SMs and CFCs reduced the mean microorganisms expelled by volunteers when coughing, with SMs being more effective at decreasing the number of microorganisms expelled than CFCs, especially at lower particle sizes. Overall, the CFCs was very tolerable, but functioned only one-third as well as a SM. A human study of 37 volunteers noted a 3.4-fold decrease in influenza viral copy numbers of large and small droplets expelled during breathing with SMs.³⁹ Hui et al.⁴⁰ used a human patient simulator in a supine position and reported that, during a simulated cough, the exhaled air dispersion distances were 68, 30, and 15 cm with no mask, SM, and N95 respirator, respectively. A study of 246 adults and children,⁴¹ investigating the impact of wearing SMs on shedding of seasonal coronavirus, rhinovirus, and influenza virus during breathing and coughing, reported a significantly reduced detection of influenza virus RNA in respiratory droplets and coronavirus RNA in aerosols, with a trend toward reduced detection of coronavirus RNA in respiratory droplets. A recent small study of coronavirus disease 2019 (COVID-19) patients,⁴² with baseline viral load of 5.66 log copies/mL, reported 2.56, 2.42, and 1.85 log copies/mL in Petri dishes placed 20 cm away from coughing patients who wore no mask, a SM, and cloth facemask, respectively (Table 4).

DISCUSSION

Scientific research data on the protective value of CFCs are very limited and precludes indepth interpretations of their value as a public health measure. Available data suggest that the protective factor of tested CFC generally is approximately half that of a SM, but variability exists (Table 1). Nonetheless, inasmuch as a protective factor >1 indicates some protection²⁷

TABLE 4

Source Control Studies of SMs and CFCs

Reference	Study Type	Results
SMs		
Patel et al. ³⁸	Mannequin aerosol study	SM capture of radiolabeled particles ~5%-20% during tidal breathing and ~35%-40% during coughing
Davies et al. ²	Human study (21 subjects)	SM 89.5% capture of virus (23 nm) during coughing ($P < 0.001$)
Milton et al. ³⁹	Human study (37 subjects)	SM 3.4-fold reduction in influenza RNA copies during tidal breathing and coughing ($P < .001$)
Hui et al. ⁴⁰	Patient simulator (seated)	Sagittal and lateral expelled air dispersions during coughing with an SM were 30 cm and 28 cm compared with 68 cm and 0 cm without a SM
Leung et al. ⁴¹	Randomized human study	Significantly reduced detection of (246 adults and children) influenza RNA in respiratory droplets and coronavirus in respiratory aerosols with SM
Bae et al. ⁴²	Human study (4 patients)	During coughing, median viral loads with COVID-19 disease) were 2.56 and 2.42 log copies/mL, respectively, without and with a SM
CFCs		
Davies et al. ²	Human study (21 subjects)	CFC 48%-72.4% capture of virus (23 nm) during coughing
Bae et al. ⁴²	Human study (4 patients)	During coughing, median viral loads with COVID-19 disease) were 2.56 and 1.85 log copies/mL, with and without a CFC

and CFCs have shown protective factors ranging from 1.8 to 3.2 (Table 1), their use offers some potential benefit. Given that the ability to prevent leakage into SMs or CFCs is primarily related to their seal to the face, limited available fit factor data suggest that some fabrics used to make CFCs could offer better facial sealing qualities than some models of SMs.² For example, it has been shown that an overlay of a layer of nylon hosiery can significantly enhance the fit of CFCs or SMs.⁴³ Other techniques, such as use of a layer of petroleum jelly (Vaseline),³⁷ or taping,²⁵ at the face/interface of SM or CFC may also enhance fit. Additionally, one cannot overestimate the potential impact of the type of tethering device (eg, encircling ties, elasticized straps, elasticized ear loops)² and the presence or absence of a moldable nasal bar upon securing a good fit of SMs, CFCs, and respirators.

Viral penetrations through SMs and CFCs (Table 2) are variable, based upon fabric features (eg, weave, thickness, porosity) and flow rates used for testing. However, on average, CFCs tend to perform at a level \leq half that of SM regarding viral penetration. The larger dimensions of bacteria, in comparison

with viruses (Table 3), make them more amenable to capture by some CFCs, but, as with viral penetration, their performance is dependent upon fabric factors. Recent research has demonstrated that the best textiles for CFC construction are fabric hybrids (cotton/silk, cotton/chiffon, cotton/flannel) in multiple layers because of their filtration efficiencies and the added potential benefit of particle attraction and capture by means of their electrostatic properties.⁴⁴ Other textile advances, such as a newly developed washable, electrostatic cotton that has been developed in South Korea and can serve as a filter insert into CFCs,⁴³ will be important in determining the optimum fabrics for CFC construction. However, regardless of the filtration capabilities of the materials used for fabricating CFCs, it is the snugness of the fit of CFCs to the face that also will have a major impact on its protective abilities.

Inasmuch as CFCs cannot be considered respirators, source control remains a hoped-for primary feature in risk reduction. Although some decrease in viral shedding by humans through the use of CFCs has been reported,² and decreased dispersal distances during cough have been demonstrated for barrier protection,⁴⁰ the limited data available preclude a definitive overall assessment of the value of this intervention (Table 4). An optical study,⁴⁵ using schlieren photography, indicates that coughing results in massive air leakage around the top and sides of SMs, so that other factors are also important in source control (eg, distance between individuals, air exchanges within rooms, air dilution outdoors). Nonetheless, the fact that CFCs have been shown to have some positive effect as source control (Table 4), however limited, would seem to make it intuitive to promote their use.

There are several objective and subjective benefits from wearing CFCs. In the context of the unavailability of adequate respiratory protective equipment, as with the current SARS-CoV-2 pandemic, having some protection may be better than nothing at all,^{2,27,42} while accepting that CFCs will generally not function as well as SMs or respirators. However, the CFC must be well constructed and used appropriately within an accepted framework that includes frequent handwashing, ensuring that the mask covers the nose, mouth, and chin regions, avoidance of touching the outer aspect of the mask with the hands, snug application of the tethering devices (eg, straps, elastic ties) to avoid gaps between the face and CFC thereby improving fit, change out of CFCs when damp or soiled with body fluids, daily washing and drying of CFCs, removal from behind the head using the posterior aspects of tethering devices for grasping (followed by handwashing), and no sharing of the CFCs with others.⁴⁶ In addition to some (limited) infection control potential, CFCs may serve to highlight not touching the face, the promotion of civic duty, and serve as a reminder of the need for social distancing. HCPs using CFCs should concurrently wear a face shield,⁴⁷ if available, that addresses eye protection and provides additional protection from exhaled large droplets and splashes, sprays, and spatter of body fluids.⁴⁸

Negative aspects of CFC use are limited protection, improper use and handling that may help spread infection, inducement of a false sense of security, loss of facial clues in communication, and some impairment in speech clarity. Other negative CFC issues include their lack of standards testing, poor fit that leads to increased manipulation of the CFCs and increased chance for infection, poor face sealing characteristics allowing for greater leaks, possibly some difficulty with breathing and liquid diffusion of infectious agents through damp CFCs.^{33,49,50} Studies addressing physiological responses to SMs and N95 respirator wear at HCP work rates over 1-2 h have shown that, in general, respiratory, cardiovascular, and thermal (core temperature) responses are mild,⁵¹⁻⁵⁴ and this would likely apply to CFCs (depending on fabric factors). It should be emphasized that, for some individuals (eg, poorly controlled asthmatics, persons with a history of panic attacks or claustrophobia), wearing of CFCs may be problematic.

Perhaps the most important, unresolved issue of the use of CFCs and SMs is their actual impact on the public in terms of disease transmission. Large population-based studies on this theme are inherently difficult to accomplish because of numerous confounding variables (vaccination rates, compliance, quarantine mandates, etc.). A recent review of smaller studies of facemask use⁵⁵ in community settings (4 studies of 143 to 617 households and 2 university student studies of 1178 and 1437 students), that generally also incorporated hand hygiene, found that hand hygiene alone was not effective against viruses, thereby suggesting that facemasks were the protective component. A recent large population-based study⁵⁶ from Hong Kong (population 7.45 million) with facemask compliance estimated at 95%-97% based on periodic surveillance of all 18 of its administrative districts, reported that the incidence of COVID-19 cases during the first 100 d of the coronavirus outbreak was significantly lower (126 cases per million population) than similarly geographically sized and populated Singapore (259.8 cases per million population), where the government initially discouraged the public from wearing facemasks to conserve them for HCPs. This is indeed encouraging evidence, but needs to be reinforced by further studies.

Guidelines from the World Health Organization (WHO) during the coronavirus pandemic are that SMs and CFCs should not be worn by the general public, but rather by HCPs and caregivers of infected persons as protection from large aerosols and body fluids, by infected patients as a source control, and by others who are actively sneezing and coughing (could be an otherwise asymptomatic infected individual).⁵⁷ The European Centre for Disease Prevention and Control has released guidance on the use CFCs by HCPs when SMs and respirators are unavailable, stating that they are inferior to SMs and should be used only as a last resort.⁵⁰ The recent concern over the spread of SARS-CoV-2 by asymptomatic carriers has prompted the CDC to recommend the use of CFCs by the general populace in public settings where social distancing may be difficult.¹ The compulsory use of CFCs in some Asian (eg, China) and

European countries (eg, Austria, Czech Republic, Slovakia)⁵⁸ indicates that this measure will become more commonplace throughout the world now, and possibly with other infectious outbreaks. Guidelines continue to develop as experience with the SARS-CoV-2 increases, but increased scientific research into the use and value of CFC is clearly warranted.

Strengths of the current study are that it reports on a timely topic of significant public health importance and offers a synopsis of the scientifically determined data on the protective capabilities of CFC. Limitations of the current report are that the literature search used only 2 search engines and was limited to English language articles. Also, the limited number of scientific articles precludes a definitive analysis of the overall value of CFCs in pandemic situations.

CONCLUSIONS

In the face of the SARS-CoV-2 pandemic, the issue of personal protective equipment has become of paramount importance. Recommendations for the general public use of CFCs have not been made on an empirical basis, but rather on the assumption that (hopefully) some benefit can be attained. The available, but relatively scant, laboratory data and rare human research data on the use of CFCs tend to suggest some limited value to their use as barrier protection, but generally this benefit will be half or less than that of SMs and significantly less than that of N95 respirators. The use of CFCs is not without potential risks and must be used in conjunction with other infection control measures. CFCs are a low tier of infection control measures, the value of which is currently uncertain, and should be used only when other respiratory protective equipment is scarce or unavailable, while cognizant of their limitations. Research is sorely needed on the impact of CFCs on the respiratory transmission of infectious agents.

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