Archives of Medical Research 51 (2020) 363–374

Archives of Medical Research

REVIEW ARTICLE

A Review of Current Interventions for COVID-19 Prevention

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Received for publication April 24, 2020; accepted April 27, 2020 (ARCMED_2020_549).

The recent outbreak of CoVID-19 is declared as a global public health emergency of international concern by the World Health Organization (WHO). A fresh figure of 2268011 positive cases and 155185 death records (till April 18th 2020) across the worldwide signify the severity of this viral infection. CoVID-19 infection is a pandemic, surface to surface communicable disease with a case fatality rate of 3.4% as estimated by WHO up to March 3rd 2020. Unfortunately, the current unavailability of an effective antiviral drug and approved vaccine, worsen the situation more critical. Implementation of an effective preventive measure is the only option left to counteract CoVID-19. Further, a retrospective analysis provides evidence that contemplates the decisive role of preventive measures in controlling severe acute respiratory syndrome (SARS) outbreak in 2003. A statistical surveillance report of WHO reflects, maintaining a coherent infection, prevention and control guideline resulted in a 30% reduction in healthcare-associated infections. The effectiveness of preventive measures completely relies on the strength of surface disinfectants, the composition of hand sanitizer, appropriate material for the manufacture of personal protective equipment (PPE). This review enlightens the various preventive measures such as a suitable selection of surface disinfectants, appropriate hand sanitization, and empowering the PPE that could be a potential intervention to fight against CoVID-19.

Key Words: CoVID-19, Surface disinfectant, Hand sanitizer, Personal protective equipment.

Introduction

Viral infections remain a critical issue since the year 1000 when the poxvirus spread through a wide region of China (1). The large death report in poxvirus infection is often linked to the black death bubonic plague, which kills 75–200 million people in the European continent during the period 1347–1351 (2). In the year 1901 yellow fever caused by Flavivirus, a filterable agent reported as the first human infected virus responsible for the death of more than 50 million people (3). Further, in the year 1918–1920 pandemic, Spanish flu (H1N1) is considered to be the greatest medical holocaust in that period affecting millions of people across the worlswide (4). In the ascent of the timeline different viral infections show their significant impact and responsible for millions of deaths in different countries.

A recent unprecedented outbreak of Coronaviruses (COVID-19) in Wuhan city of China is declared as a global emergency by WHO. A statistical report suggests that, out of 195 countries, coronaviruses have been spread to 178 countries with the total case of 22,68,011 coronavirus infections, and a death record of 1,55,185 have been reported (till April 18th 2020) (5). In a comprehensive outlook, vaccination and antiviral drug therapy are given the foremost priority fight against viral infections. In the last few decades, a large vaccination programmed has been launched to fight against viral infections like polio, smallpox, and hepatitis, etc. A vaccine is assessed by its efficacy and its effectiveness. In the case of the influenza vaccine, effectiveness is lower than the efficacy. This is because influenza often misleads with other influenza-like illnesses and secondly wide diversification in the viral genome. The effectiveness of the viral vaccine is the major concern as a metanalysis report found that effectiveness against flu shows a maximum of 67% in 2012 and thereafter it reduces as mentioned in Figure 1 (6). Havrix a viral vaccine licensed from USFDA in 1995 for the treatment of hepatitis A. The literature survey reports that

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0188-4409/$ - see front matter.
https://doi.org/10.1016/j.arcmed.2020.04.020

3−20% of acute hepatitis A is observed in previously vaccinated patients. Interestingly most of the relapse cases against hepatitis A vaccine have reported within a short duration of time (less than 3 weeks) (7).

The other major challenging factor for the development of a vaccine against RNA virus is its ultra-fast mutation rate and critical adverse effects associated with it. For instance, initial trails of the Flu vaccine in 2009 show mild adverse effects like tenderness in muscles, pain at the injection site, headache, malaise, and muscle pain (8). WHO recommended this vaccine for the different flu-like syndrome as there are no significant differences in their adverse effects. When vaccination covered to a large population, then severe side effects like anaphylaxis and febrile convulsions were noticed. Looking into the severity of adverse effects, GlaxoSmithKline recalls its vaccine from the market (9). In the later part of 2009, a peripheral nervous system associated side effects i.e., Guillain Barr's syndrome was observed (10). Chris Shaw, a neuroscientist at the University of British Colombia expressed the concern that adverse effects may not necessary to appears immediately rather it may take a timeline of 5−10 years as observed in Gulf war syndrome on exposure to the Anthrax vaccine (11). Henceforth, it is a very critical challenging aspect to access the effectiveness of the viral vaccine, especially against RNA viruses. The second priority is given to antiviral treatment to curb viral infections. There is a lot of antiviral therapeutics available in the global market to fight against viral infections. The recent outbreak of influenza in the year 2008, the two most popular neuraminidase inhibitors Oseltamivir and Zanamivir have been prescribed to control seasonal influenza worldwide. However, the treatment is most effective when prescribed as early as possible after the symptoms developed. The effectiveness of the drug markedly reduces after 48 h of administration. Looking into the antiviral potential, adverse effects such as gastrointestinal associated problems, respiratory problems musculoskeletal symptoms were compromised. After more than eight years of global dominance, the cases of drug resistance have been reported in various scientific documents. In the initial phase of the clinical trial in 2008, drug resistance and population surveillance were very low and further shows highest percentage resistance of 1.9% in the year 2013−2014 influenza season, as compared to the 2012−2013 and 2014−2015 seasons where drug resistance estimated as 0.6 and 0.5%, respectively (12). In comparison to the other microbial infections (bacterial and fungal), developing an antiviral therapy is always remain a tough assignment to the scientific community. The primary reasons are the highly complex structural ambiguity and unable to identify the viral targets that make the process more complicated to design a selective and effective antiviral therapy (13). Currently, the unavailability of effective antiviral drug therapy in the global market worsens the situation to a greater extent. Lacking in the concrete information regarding the mode transmission, contact precautions should be an ideal approach to reduce the risk of transmission of newly emerging COVID-19 infection. As per WHO guidelines, infection prevention and control (IPC) is a practical, evidence-based approach to prevent patients and health workers from being harmed by avoidable infections. Statistics revealed that maintaining effective IPC resulted in a >30% reduction in healthcare-associated infections (HAIs) (14). Hence, considering the global emergency of CoVID-19 infections, preventive care is the only option left to restrict its spreadability. Infections associated with coronavirus may spread by contact,

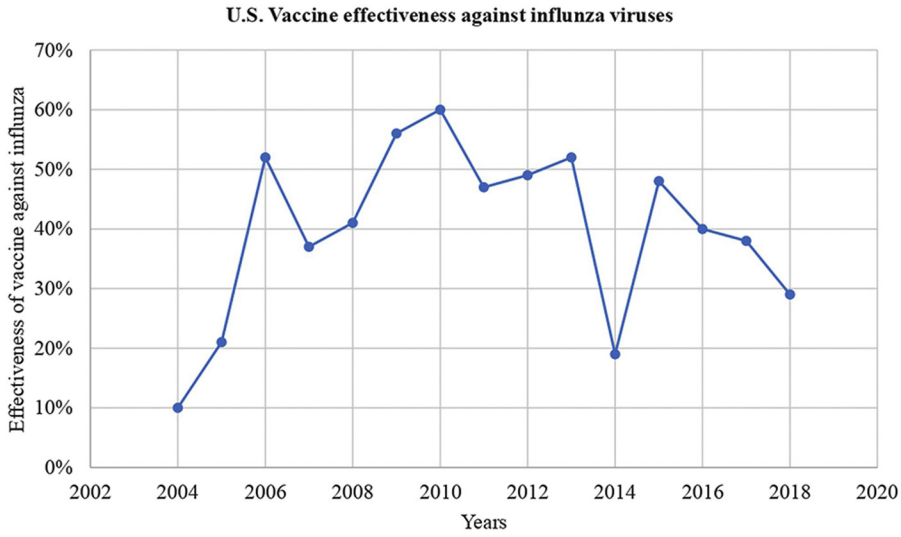

Figure 1. Effectiveness of influenza vaccine against over the year (2004-2018).

droplet, and airborne transmission. These transmissions will be minimized by taking an appropriate preventive major. The foundation of preventive major against viral infection is initiated with the routine practice of using an effective soap/hand sanitizer/rub, personal protective equipment (suitable mask, eye/face protector, and gowns). For instance, the use of antiseptic hand soaps provides a greater reduction in the number of microbes over a short period as compared with regular soaps (15). In addition, alcohol base sanitizer restricts the viral growth by precipitating the surface proteins that break the chain of transmission of coronavirus. Moreover, the strength of alcohol is the key factor that determines the biocidal potentiality of the sanitizers/rub. Historical evidence confined the case of coronavirus existence since 1960s in the patient with common cold-like symptoms (16). Tyrrell and Bynoe found a virus obtained in a culture media containing an infected human embryonic tracheal organ and named as B814. At the same time, another virus strain was detected in the tissue culture from a sample obtained from the respiratory tract of an adult patient and named as Humre virus after the name of the discoverer Hamre and Procknow, later on, it was renamed as 229E. In the year 1965, Robert Chanock termed these above virus strains as ‘‘OC’’ to describe that they can be grown in organ culture. Due course of time different strains of coronaviruses such as SARS-CoV in 2003, H-CoV NL63 in 2004, HKU1 in 2005, MERS-CoV in 2012, and SARS-CoV-2 (formerly known as CoVID-19) in 2019 has been reported for an epidemic/pandemic infections across the worldwide by the research community as mentioned in Figure 2 (17,18). CoVID-19 is an enveloped, positive-sense, single-stranded RNA virus with the largest genomic configuration of 26−32 Kb amongst all RNA viruses (19). Coronavirus is a zoonotic virus in which the bat tends to be the most suitable primary host to transmit viral infections. The scientific report predicted that disturbing the natural habitat appears to be stressed in the animal and makes them shed even more viruses in their biofluid like saliva, urine, and feces. These biofluids and feces in our surrounding makes CoVID-19 suitable for spreading the infection through the surface (20). To curb this pandemic infection of CoVID-19, preventive care will play a significant role. The current review emphasizes the various critical aspects associated with the selection of different preventive gadgets such as surface disinfectant, hand hygiene, personal protective equipment that constrain the global spreadability of CoVID-19 infections.

Role of Preventive Care in COVID-19 Infections

The major preventive gadgets include an effective surface disinfectant, hand hygiene, personal protective equipment (suitable mask, eye and face protector). Coronavirus infection is a surface to surface, airborne, contagious disease characterized by fever, shortness of breath and coughing. Surfaces of both animate and inanimate may play a prominent role in the spreading of CoVID-19 infection.

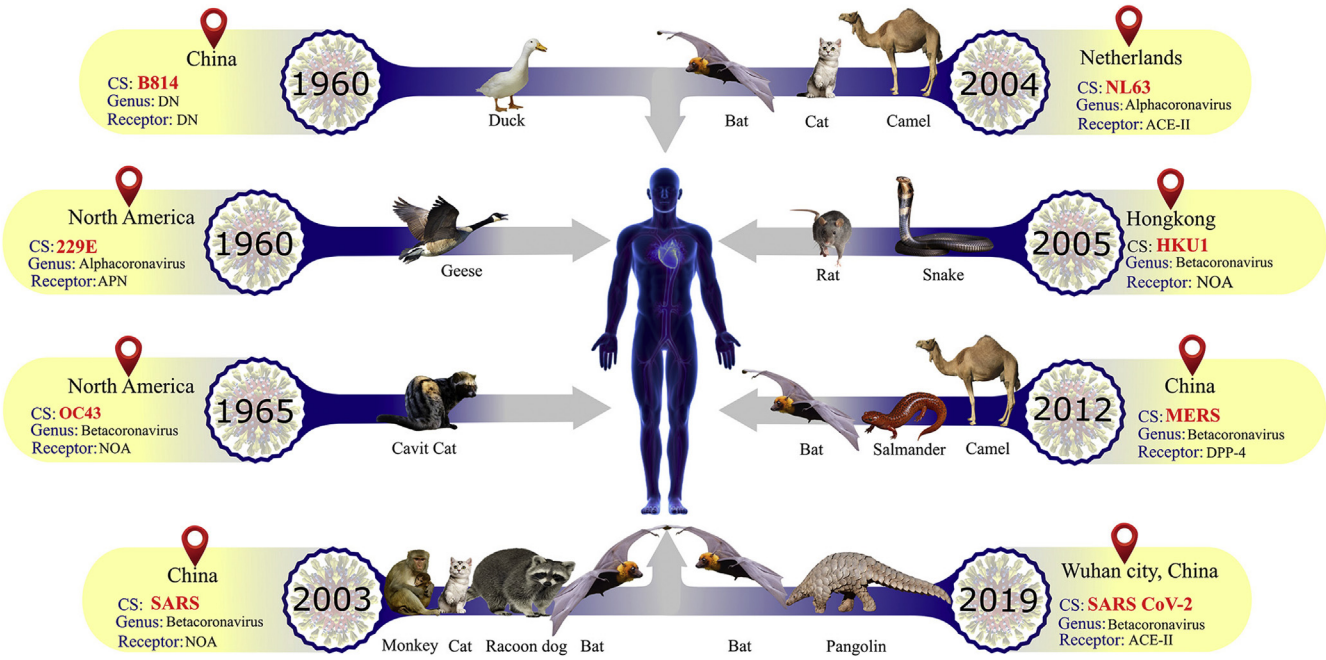

Figure 2. Timeline of coronavirus. CS, Coronavirus strain; APN, amino-peptidase-N receptor; ACE-II, Angiotensin-converting enzyme II; NOA, N-acetyl-9-O-acetylneuraminic acid; DPP-4, Dipeptidyl peptidase 4; SARS, Severe acute respiratory syndrome; SARS CoV-2, Severe acute respiratory syndrome-2 also known as COVID-19/2019-nCoV; MERS, Middle East Respiratory Syndrome.

Surface Disinfectant

Inanimate surfaces are the most prone site for the transmission of CoVID-19 infection from one to another. Depending upon the nature of the surface, pH, temperature and relative humidity of the surrounding, virus persistence time varies from 1–9 d (21). The persistence time in different inanimate subjects is mentioned in Figure 3. The highly risk exposed surface areas need to be mopped frequently with a suitable disinfectant. The characteristic feature of an ideal disinfectant must have low contact time with significant antiviral activity. Currently, the United States Environmental Protection Agency (USEPA) recommended some disinfectants against CoVID-19 as mentioned in Table 1 (22).

In general, quaternary ammonium compounds, hydrogen peroxide, alcohol (ethanol, isopropyl alcohol, phenol), aldehyde, hypochlorous acid, octanoic acid, citric acid conjugate with silver ions, sodium hypochlorite, sodium bicarbonate, etc. are the key ingredient responsible for the virucidal activity. Alcohols, ethanol (78–95%) and isopropanol (70–100%) have been used as an effective disinfectant as they show potent virucidal activity with a negligible toxic effect on human skin. All lipid enveloped virus gets inactivated within 2 min. The mechanism of action alcohol-based disinfectant is poorly understood however, surface protein precipitation may be one of the key mechanisms that are responsible for the virucidal activity. Besides this, quaternary ammonium compounds (QACs) are most widely integrated into the surface disinfectant formulation. QACs consist of central nitrogen as a cationic portion surrounded by the negatively charged halogen anion portion. QACs are classified according to the nature of alkyl groups (R groups) which includes the number of nitrogen

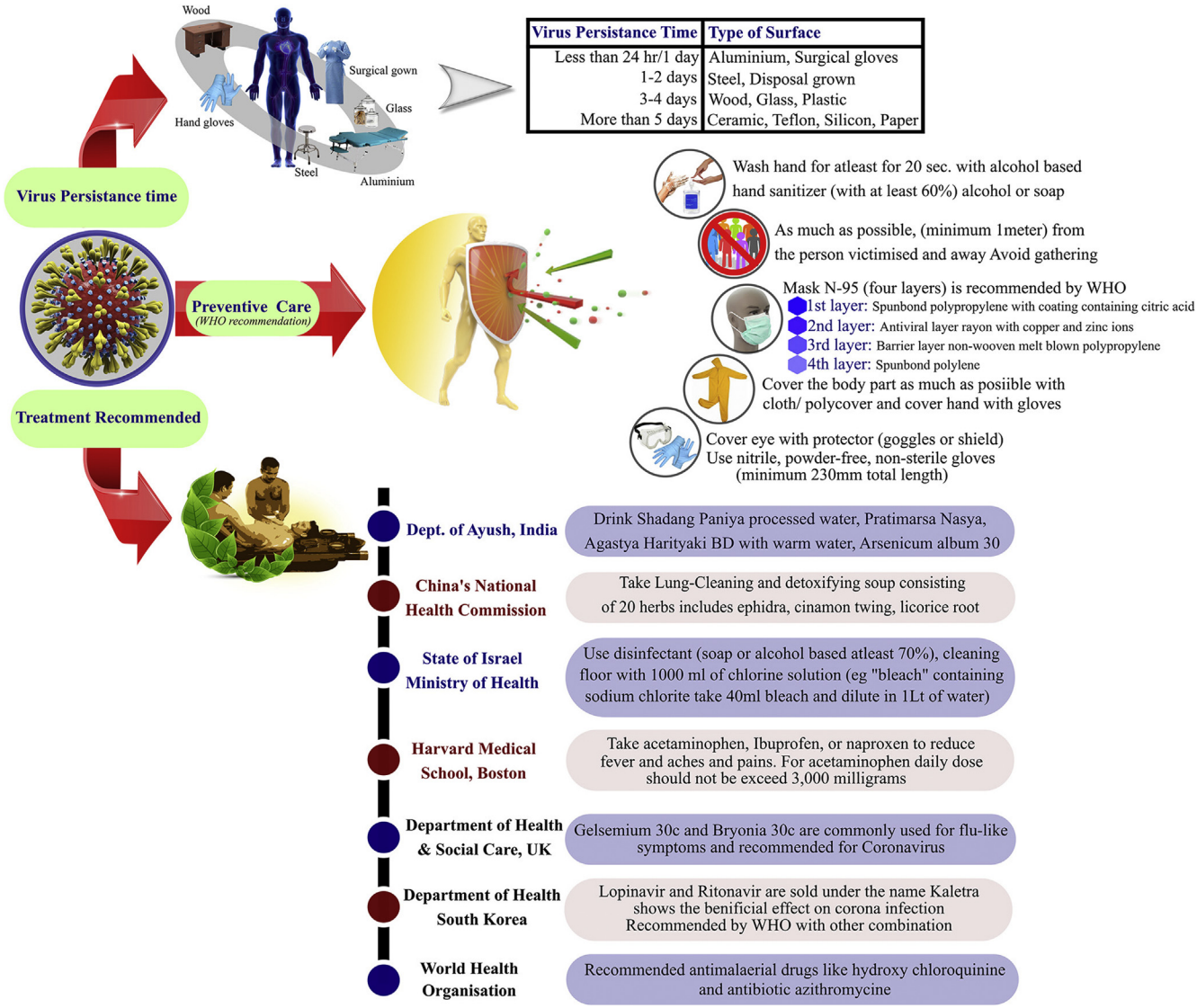

Figure 3. A schematic diagram elaborates the timespan of the virus in different inanimate objects, along with different protective majors assign during viral infection and recently recommended treatment against CoVID-19 viral infection.

Table 1. List of disinfectants for use against SARS-CoV-2/CoVID-19 as per USEPA

Sl. no.	Active ingredient/s	Company name	Product name	Composition	Contact time (min.)
1.	Quaternary ammonium salt derivatives	Mason Chemical, Company	MAQUAT 50DS	Alkyl (C14 60%, C16 30%, C12 5%, C18 5%) dimethyl benzyl ammonium chloride 25% Alkyl (C-12 68%, C-14 32%) dimethyl ethylbenzyl ammonium chloride 25.0%	10
2.	Hydrogen peroxide	S.C. Johnson, Professional	Nathan 2	Hydrogen peroxide:0.5%	5
3.	Peroxyacetic acid	Evonik	Peraclean 15	Peracetic acid: ≥14- 17 Hydrogen peroxide: ≥20-≤30 Acetic acid: ≥15-≤20	1
4.	Hydrogen peroxide; Peroxyacetic acid	Mason Chemical, Company	Maguard 1522	Peracetic acid: 15% Hydrogen peroxide: 22%	1
5.	Hydrogen peroxide; Ammonium carbonate and Ammonium bicarbonate	Kimberly-Clark, Global Sales LLC	Victor Spray	Hydrogen peroxide: 3.30% Ammonium carbonate and Ammonium bicarbonate:1.38%	5
6.	Octanoic acid	Ecolab Inc	65 Disinfecting Heavy Duty Acid Bathroom Cleaner	Octanoic acid: 5-10%	2
7.	Phenolic	Wexford Labs, Inc	Wex-cide 128	Ortho-benzyl-parachlorophenol: 3.03% Orthophenyl phenol: 3.40%	10
8.	Quaternary ammonium, ethanol	North American, Infection Control, LTD	Wedge Disinfectant	Didecyldimethyl ammonium chloride:0.33% Ethanol:72.5%	1
9.	Sodium chlorite	Odorstart LLC	Performacide	Sodium chlorite: 30.5%	10
10.	Sodium hypochlorite	James Austin, Company	Austin A-1 Ultra Disinfecting Bleach	Sodium hypochlorite: 6.0%	10
11.	Ethanol	Reckitt, Benckiser	Lysol Neutra Air	Ethanol: 15-30% Butane: 15-32% Propane:5-10% 2,2'-(ethylene dioxy)diethanol: 5-10%	0.5
12.	Hypochlorous acid	Simple Science, Limited	Cleansmart	Hypochlorous acid:0.017%	10
13.	Quaternary ammonium; Isopropanol	Palermo, Healthcare LLC	Discide Ultra Disinfecting Spray	Propan-2-ol:50-100% V/V Quaternary ammonium compounds: ≤2% Benzyl-C7-17-alkyldimethyl chloride: ≤5%	0.5
14.	Silver ion; Citric acid	ETI H_2O Inc	Sdc3a	Silver: 0.003% Citric acid:4.846%	1
15.	Sodium hypochlorite; Sodium carbonate	W.M. Barr & Company Inc	Mold Armor Formula 400	Sodium hypochlorite: 4.0% Sodium carbonate: 1.0%	0.5

atoms, branching of the carbon chain, and the presence of aromatic groups. Variations in the chain length, nuclear size, and basicity of the complex decide the antimicrobial potentiality. For instance, an increase in the chain length from C_{12}−C_{16} show the greatest antimicrobial activity. These agents are membrane activating groups as they directly interact with the cytoplasmic membrane of bacteria and yeast (23). The presence of long nonpolar tail makes them effective against a lipid-containing virus such as CoVID-19 (i.e., phospholipid layering). The long chain of hydrocarbon act as permeability enhancer that influences the surface-active properties whereas the cationic portion binds to negatively charged nucleic acids condensed inside the capsid leads to virucidal activity (24). Other major class of disinfectant includes halogen compounds i.e., hypochlorous acid, hypochlorite ions. Sodium hypochlorite solutions can be prepared by absorbing chlorine in sodium hydroxide solution to give a mixture of hypochlorous acid (HOC1) and sodium hypochlorite (NaOCl) and as mentioned below.

$$Cl_2 + H_2O \xrightarrow{\text{favored in alkaline pH}} HOCl + H^+ + Cl^-$$

$$HOCl + NaOH \xrightarrow{\text{favored in alkaline pH}} NaOCl + H^+$$

The biocidal potency of HOCl is superior to NaOCl as it selectively binds with unsaturated bonds lipid layering that disrupts cellular integrity and increases permeability. Moreover, hypochlorous acid is a potent oxidizing agent as compared to sodium hypochlorite. The dynamic equilibrium exists between hypochlorous acid and sodium hypochlorite is significantly affected by the pH of the medium. At alkaline pH, the equilibrium favored the formation of more stable sodium hypochlorite whereas, at acid pH, the equilibrium favored the formation of less stable hypochlorous acid. It is recommended that a 1:100 dilution of 5% sodium hypochlorite is the usual use to disinfectant by mopping the nonporous surfaces of contact time of ≥10 min whereas disinfecting the items by immersion prefer a contact time of 30 min (25,26). The other disinfectants include peroxides and peracids act by inducing the generation of free radicals such as superoxide ion, hydroxyl ion, peroxyl ion, hydrogen peroxide radicals, etc. that oxidize essential lipids, proteins, and nucleic acids that lead to virucidal activity. The peroxides and peracids based disinfectants (hydrogen peroxide vapor/aerosolized hydrogen peroxide) are best considered for the terminal disinfectant category by replacing formaldehyde as it associated with severe neuro and systemic toxicity (27,28). Further, experimental evidence suggests that various strength of disinfectants such as ethanol, iso-propanol, the combination of 45% iso-propanol with 30% n-propanol, glutardialdehyde, formaldehyde, povidone-iodine were found to be (78−95%), (70−100%), (0.5−2.5%), (0.7−1%) and (0.23−7.5%) respectively that effectively inactivate coronavirus with the high value of 4 log10 reduction factor (21).

Hand Hygiene

Human to human transmission contributes a major part to make this infection pandemic. CoVID-19 transmission is spread via droplets, cough, contaminated hands/surfaces, etc. However, the prevention of person to person transmission can be reduced by frequent washing with soap and water or disinfectant the hands with an alcohol-based sanitizer as recommended by WHO. The analytical surveillance of a WHO report suggests that improving hand hygiene practices may reduce pathogen transmission in health care by 50%. Alcohol is being used as a common disinfectant/biocidal agent from the ancient era. The disinfectant property/biocidal potency of alcohol is depending upon the strength and type of alcohol being used. The antiviral activity of different alcohols can be determined by evaluating the viral infectivity index ($\log_{10}$ value). Viral infectivity is the ability of a virus to penetrate the host cell and use its resources for further production of infectious viral particles (29). In the year 2017, WHO developed two preventive hand rub formulations WHO-I, II against Ebola virus, Human influenza A virus, and Modified vaccinia Ankara strain. Considering the viral infectivity index, formulation (WHO-I) composed with ethanol (85% v/v), glycerol (0.725% v/v) and hydrogen peroxide (0.125% v/v) shows better antiviral activity than the other formulation (WHO-II) composed of isopropanol (75% w/w), glycerol (0.725% v/v) and hydrogen peroxide (0.125% v/v) (30). The biocidal activity of alcohol is mediated through the coagulation of microbial surface proteins. Experimentally it is observed that alcoholic concentration below 50% shows the negligible biocidal activity (bactericidal, virucidal, or fungicidal properties). Alcoholic concentration >90% coagulates the microbial proteins instantly. Consequently, the coagulated proteins act as a shield for the rest of the microbial proteins, hence it requires a longer contact time for biocidal responses. For instance, a 50% isopropyl alcoholic strength kills *Staphylococcus aureus* in less than 10 s while 90% strength of isopropyl with a contact time of over two hours and seems to be ineffective. Moreover, alter in the chain length of aliphatic alcohol virucidal activity is varied. For instance, the virucidal activity of the lower aliphatic alcohols increases in the series methyl <ethyl < propyl <butyl <amyl, for lipophilic viruses, whereas reverse order is generally true for hydrophilic virus like picornaviruses (31). Further, the antiviral efficacy of alcohol-based disinfectant may potentiate by adding with some organic/inorganic acid such as citric acid, L-lactic acid, peroxyacetic acid, fumaric acid, phosphoric acid, etc. (32,33) The incomplete dissociation of organic acids into ionic species increases their lipophilic nature and their ability to penetrate the contaminated biological materials (31).

Incorporating citric acid in alcohol-based disinfectant, the inactivation viral particles is observed less than 1 min (33). A 55% ethanol concentration mix with 0.7% v/v phosphoric acid shows the potent virucidal activity with a mean log10 reduction value >4 on the exposure time of 30 s. Similar type of observations were notices with 73.5% ethanol + 0.2% peracetic acid, 78.8% ethanol + 0.1% citric acid + 1% lactic acid with mean log10 reduction value >4 on exposure time of 30 s (34). A predefined concentration range for ethanol (60−70%) and isopropyl alcohol (70−72%) is preferred as an effective disinfectant/biocidal agent. Based on the above findings, the selection of disinfectant/biocidal agents for a sanitizer may play a substantial role in providing effective hand hygiene. The recent statistical analysis on the sale of hand sanitizer in the global shows a sharp hike in the last few months. Some best sell hand sanitizers are given in Table 2.

However important precautions must be taken into consideration while using frequent alcohol-based hand sanitizer. The oil secreted from the sebaceous gland of the skin surface is composed of free fatty acids, specifically lauric acid and sapienic acid, that possess the inherent antiviral activity (44). Frequent use of alcohol-based hand sanitizers may wash out the oils from skin surface that resulted in dehydrated skin. Furthermore, dehydrated skin is characterized by cracked cuticles that may offer easy accessibility pathogens to penetrate the deeper layer of the skin leads to promote microbial infection. Apart from it, the fire hazard potential of alcohol-based sanitizer is another unavoidable risk factor for the domain of public health. In contrast, washing with soap provides an advantage over alcohol-based hand sanitizer as it comes with zero fire hazard potential. Soap is a salt of fatty acid composed of solid fat (olive oil, coconut oil, palm oil, rice bran, sunflower seed oils, and lard), emollient and texture enhancer (glycerine, sorbitol), surfactant (sodium lauryl sulfate alkyl benzene sulfonate alkyl phenol ethoxylate linear alkyl sulfonate), water softener (penta sodium pentetate, tetrasodium etidronate, and tetrasodium EDTA) (45). Each soap molecule has a long tail of a hydrocarbon chain with an anionic carboxylated head. The non-polar head of the surfactant tightly binds with the phospholipid layer of the viral envelope. Intrusion during washing with water is enough to break the virus's coat that destroys the virus viability. However, the cleaning action of the soap is depending upon the nature and composition of the fat. Depending upon the applications, different types of fats are used in the preparation of soap such as olive oil for providing extra mildness, coconut oil for lather, castor oil for moisturization, etc. Further, investigation of the fatty base, explore the dynamic potentiality of the fatty acids. The cleansing property of the soap is depending upon the hydrocarbon chain length, degree of unsaturation of the fatty acid. Hydrocarbons with shorter chain length possess good lathering profiling due to enhanced water solubility. However, hydrocarbon chain length less than 10 (<C10:0) shows poor lathering profiling with objectionable odor and skin irritation. Conversely, fatty acids with longer chain length (C16:0−C18:0) enhance the cleansing property with reduced lathering ability due to poor water solubility (46). More interestingly, fatty acids like palmitic acid, stearic acid, oleic acids, etc. provide a greater extent of

Table 2. List of best sell sanitizers with antiseptic or biocidal agents in the global market

Sl. no.	Brand	Country	Component	Reference
1.	Purell	New York	Ethyl alcohol 70% v/v, Water (Aqua), Isopropyl Alcohol, PEG-12 Dimethicone, Caprylyl Glycol, Glycerin, Isopropyl Myristate, Tocopheryl Acetate, Fragrance (Parfum)	(35)
2.	Dettol	UK, China	Denatured Alcohol- 69.4% w/w, Water PEG/PPG17/6 copolymer, Propylene glycol, Acrylate /C10-30 alkyl acrylate, cross polymer, Tetrahydroxpropyl ethylenediamine, Perfume	(36)
3.	Lifebuoy	India	Ethyl alcohol 95%, Isopropyl alcohol 10%, tocopheryl acetate 0.05%perfumed gel base 100%	(36)
4.	Himalaya	India	Dhanyaka 0.30 mg, ushira 0.30, Nagaramusta 0.25 mg, Shati 0.10 mg, Nimba 0.05 mg	(37)
5.	Godrej	India	Ethyl Alcohol 95% (v/v) I.P. (Denatured with Isopropyl Alcohol 3% (w/w)) 64% (w/w), Water, Glycerin, Acrylates/C10-30 Alkyl Acrylate Crosspolymer, Triethanolamine, Perfume.	(38)
6.	Zuci	USA	Strwberry extract, Salicylic acid, Vitamin E	(39)
7.	Sterillium	India	Propan-2−ol, Propan-1−ol, Mecetronium ethyl sulfate, glycerol, Tetradecane-1-ol, Fragrances, Patent blue V, purified water.	(36)
8.	3M	USA	Chlorhexidine Gluconate 0.5% w/v and Ethyl Alcohol IP 70% v/v	(40)
9.	Savlon	India	Ethanol IP 66.5% V/V, Isopropyl Alcohol I.P 3.5% V/V, Permitted Colours Used, Gel-Based Q.S.	(41)
10.	Germ-X	USA	Aloe Barbadensis Gel, Carbomer, FD&C Blue No. 1, FD&C Yellow No. 5, Fragrance, Glycerin, Isopropyl Alcohol, Isopropyl Myristate, Propylene Glycol, Tocopheryl Acetate, Water	(42)
11.	Mountain fall	USA	Ethyl alcohol 75%, Water, Glyceryl caprylate, Isopropyl myristate, Tocopheryl acetate, Acrylates/C10-30 alkyl acrylate cross polymer, fragrance, benzophenone-4	(43)

protection against viruses. Induction of endoplasmic reticulum stress responses and inhibition of autophagic flux seems to be the most promising molecular mechanism that down-regulate the viral growth (47,48). A wide range of fat bases used for the preparation of soap has differed in the concentration of these antiviral fatty acids. Henceforth, the selection of suitable raw ingredients is essential to prepare an effective soap for providing the utmost care against viral infections.

Personal Protective Equipment (PPE)

Preventing the exponential spreadability of CoVID-19 infection is completely relies on the use of an effective PPE which includes face masks/respirators, gloves, goggles/face shields, and gowns (49).

Face Mask/Respirators

The recent report of WHO (March 29th 2020) describes CoVID-19 may be an air born infection transmitted through, respiratory droplets. Droplet transmission occurs within a short range of 1m with someone who is diagnosed with respiratory syndromes like coughing and sneezing. The infective respiratory droplets $>5-10$ μm in diameter potentially adhere to the mucosae of mouth and nose and later on invade into the epithelial layer of the upper respiratory and gastrointestinal tract (50). A physical barrier at the checkpoint may reduce the spreadability of droplet mediated viral infection. For instance, the experimental evidence has shown that the use of a protective mask helped to reduce the transmission of tuberculosis by 50% as compared with the patient without a mask. Different masks such as paper mask, dust mask, face mask, surgical mask, laser mask, respirator, etc. are available in the global market. US surgeon General discouraged not to use face mask in the community with the argument that face masks will not provide effective protection against coronavirus infection. In the same context, surgical mask will not provide complete protection against the viral infection as it provides one-way protection i.e., restrict the flow of particulate/microbes/infected droplet from the wearer end only (51). Besides this, surgical mask dampened with saliva/biofluid/moisture not only loses its protective characteristic but also it provides a suitable environment for microbes to breed. Henceforth, the selection of suitable effective mask is a critical aspect of the prevention of coronavirus infection. An ideal mask must be built with soft smooth material with characteristic features like breathability, and protection against the microbes (especially virus) and infected droplets. The technical parameters such as bacterial filtration efficiency (%), submicron particulate filtration efficiency (%), breathing resistance/differential pressure (mm of H_2O cm^2), resistance to penetration by synthetic fluid (minimum pressure in mm Hg for pass result) may play a crucial role in the selection of mask. USA center for disease control and WHO recommends N95/P100 respirators with three-level protection FFP1, FFP2, and FFP3 against COVID-19 infection as they filter out 99.9% of 0.3 micron particles. The US National Institute for Occupational Safety and Health (NIOSH) classifies particulate filtering mask/filtering facepiece respirators (FFRs) into nine categories symbolize alphanumerically as N95, N99, N100, P95, P99, P100, R95, R99, and R100 (52). The alphabets N, P, and R, designation describe 'not resistant to oil', 'somewhat resistant to oil', and 'strongly resistant to oil' respectively whereas the numeric characters 95, 99, and 100 describe filter's minimum filtration efficiency with 95, 99, and 99.97%, respectively. According to the European standard (EN 149:2001), FFRs are categorized into FFP1, FFP2, and FFP3 with minimum filtration efficiencies of 80, 94, and 99% respectively. Comparing the filtration efficiency, FFP2 respirators are approximately equivalent to N95 FFRs and recommended for the use in the prevention of COVID-19 infection in the USA and other countries (53). Looking into the global market, different brands of FFRs with a brief description are listed in Table 3.

Emphasizing the preventive care WHO called for a 40% increase in the production of protective mask/FFRs. Meanwhile, the rational distribution of mask/FFRs needs to be priorities for the frontline health-care workers and the most vulnerable populations in communities. Huge scarcity of N95 respirators in the local market, people of some region opt for makeshift alternatives or repeated usage of disposable surgical masks that could jeopardize the protective effect and even increase the risk of infection (51). High filter efficiency mask/FFRs may not solely uplift the global burden of COVID-19 infection. Overviewing the current status, an antiviral mask may be an effective approach to constrict the spreadability of COVID-19. Cufitec® surgical mask is approved by USFDA and manufactured with the revolutionary technology which claims the mask not only protects the inhalation but also inactivate 99.99% of the influenza virus on five minute contact with the surface of the mask (64). The antiviral mask consists of multilayers; Outer layer is spunbond polypropylene with a sialic acid coating that restrict the penetration of macromolecules size >0.5 micron and trap the microparticulate size <0.5 microns, Antiviral layer consist of Zinc and copper granule that will kill the trapped virus, non-active layer compose with special non-woven fiber to filter out the particulate less than 0.3 microns and the inner layer is a fluid resistance layer. The mechanism underlines the molecular mimicry as the outermost layer composed of sialic acid (natural receptors) that covalently binds the surface spike protein of coronavirus (65). Once the viruses are permanently trapped then the presence of high electropositive metal ions such as zinc and copper disrupt the membrane integrity leads to damage of DNA and essential proteins that lose the cell viability. Apart from it some of the commercial mask equipped with a layer of activated charcoal as a strong adsorbent layer. The adsorption potency of charcoal

Table 3. Specification of different masks/FFRs available in the market against COVID-19 viral infection

Sl. No	Manufacturer	Model no	Specification	Drawbacks	Reference
1.	3M	Particulate Respirator 8210	•. Building material: Polycarbonate Composed of three layers filters out the largest dust particles that purifying the polluted air by up to 95%. •. Cushioning nose foam •. Filtering efficiency range: at least 95% •. NIOSH approved	•. Cannot eliminate the risk of contracting infection, illness, or disease •. No provision for antiviral protection	(54)
2.	Honeywell	H801V N95Respirator	•. Ultrasonically-welded, latex-free knitted headbands for maximum comfort in hot and humid conditions •. Honeywell delivers complete respiratory solutions from dust masks to respirators. •. BIS certified for P1 class of filtering efficiency - filtration efficiency ranging 95%	•. Don't come with a breathing valve •. Uncomfortable to wear over a long time.	(55)
3.	Prestige Ameritech	ProGear-RP88020	•. NIOSH and FDA approved N95 Respirator •. Filters out 99% of particles down to 0.1 microns •. Fluid resistance: 160 mm of Hg •. PFE: 98.5% at 0.1 Microns, BFE: 99.6%	•. Don't come with a breathing valve	(56)
4.	Aero	Aero Pro AP0028	•. At least 95% filtration efficiency against solid and liquid aerosols that do not contain oil •. High filtration efficiency (over 99.99%) with very low breathing resistance and long lifetime for use. •. Defense against influenza (avian flu, swine flu) and TB exposure control.	•. Don't come with a breathing valve	(57)
5.	Vog	VMCV Vogmasks	•. Coconut shell carbon bonded to the textile •. Viral Filtration Efficiency: $>99.9\%$ •. Bacterial Filtering Efficiency: $>99.9\%$ •. Comfortable Breathing Resistance •. Latex-free spandex trim and earloop •. minimum efficiency for each filter of $>95\%$ ($>1\%$ penetration) •. Two exhalation valves for facilitating the exit of moisture and CO_2 from the interior of the mask.	•. Ineffective in oily environments	(58)
6.	Atlanta Healthcare's Cambridge	Basic Pollution Face Mask	•. Breathing life up to 90 hrs •. The carbon filter layer protects from harmful dust, pollen, airborne allergens, microscopic particulate matter such as pm 10, 2. 5 and 0. 3, Virus and bacteria. •. It has a filtration level equivalent to N 95	•. Susceptible to high heat, pressure, and cleaning with soap or detergents	(59)
7.	AlphaPro Tech	Alpha Air- BL 5005	•. High value for clean, comfortable and provide outstanding particle filtration down to 0.1 microns. •. Differential Pressure: 4.4 mm H_2O/cm^2 •. Filtration Efficiency: 93.5%	•. Don't come with antiviral protection	(60)
8.	Ansell	Sandel Respiratory face mask	•. Duckbill style with headband •. 3 levels of Protection: FFP1, FFP2, and FFP3 •. Differential Pressure:160mm of Hg •. Prevent the risk of cross-contamination	•. Don't come with an antiviral protective layer •. Don't come with a breathing valve	(61)
9.	Kowa	PM2.5-Blocking Three-Dimensional High-Adhesion Face Masks	•. Inbuild material: polypropylene, polyester •. A High-spec filter is a mask that cuts 99% of fine particles in the air and strongly prevents intrusion.	•. Cannot be reused •. Eyeglasses may be clouded •. Don't provide virus protection	(62)
10.	Oxypure	Oxypure N99 Tested Washable Pollution Masks	•. N99 certification by Nelson Labs of The United States •. Filtering performance of more than 99% percent of particulate pollution particles including PM10, PM2.5, and even PM 0.3 microns. •. Detachable valve for simple washing •. Specifically designed for heavy dust and smog areas	•. Ineffective in oily environments	(63)

depends upon the source of charcoal obtained. The adsorption potentiality of the activated charcoal not only trapped the virus particulates but also promote the inactivation of the virus particulate by adsorbing the surrounding moisture (66). Looking into the diversified specification, the selection of an effective mask may contribute a significant landmark in the spreadability of CoVID-19 infection.

Gloves. Transmission through contaminated hands share a major contribution to the spreadability of CoVID-19 infection. A report analyzed that people in the metro politician city touched their faces and common objects with an average time interval of 3.6 and 3.3 times per hour respectively (67). The use of nitrile gloves is preferred over latex gloves because they resist some chemicals, including certain disinfectants such as chlorine. The latex-based hand gloves show a high rate of allergic reactions to a major part of the population. However, the unavailability of nitrile gloves may provide the option for the use of latex gloves. Nonpowdered gloves are preferred to powdered gloves as a powder (i.e., corn starch powder, lycopodium powder, and talc) initiate the skin irritation resulted in allergic reaction on prolonged usage (68).

Goggles/Face shield. The presence of mucus in the eyes make a favorable site for virus sustainability. So, it is recommended by WHO to wear a protective transparent glass, zero power, well-fitting goggles/face shield that covers from all sides with elastic band/or adjustable holder. As per the European standard directive 86/686/EEC, EN 166/2002 and ANSI/SEA Z87.1-2010, an effective googles/facemask is manufactured from acetate, propionate, and polycarbonate that offers improved visual clarity and optical quality with the potential for less eye strain (69).

Gowns. Health professionals are at the forefront of risk to CoVID-19 infection due to the possibility of frequent contact. Gowns/Coveralls are designed to protect from exposure to the virus. These gadgets typically provide 360° protection because of their unique design that able to cover the whole body. As per the recent memo outline of the Centers for Disease Control and Prevention, reusable hospital gown is not recommended as they are prone to ripping and would require special sterilization processes to be safely reused. Recently, the director of Ford automobile company announced to lunch a lightweight fabric washable gown from the material used for the manufacture of airbags. The gowns are prepared from water-resistant Nylon 6,6 material with a silicone coating, that can be laundered and reused up to 50 times. Meanwhile, the company conducted internal tests to make sure that the gown will meet the standards set by the American Society for Testing and Materials (ASTM F3352-19) and the Association for the Advancement of Medical Instrumentation (ANSI-AAMI PB70-2012). However, the percentage retaining mechanical strength after subsequent washing is an interesting fact that needs to be evaluated (70). Due course of time, the health department of different countries and WHO provides various preventive health care memos in the public domain that could help to restrict the spreadability of CoVID-19 infection worldwide and are mentioned in Figure 3 (71,72).

Conclusion

A retrospective analytical survey of past epidemic/pandemic outbreak reflects the preventive care always given foremost priorities to curb the spreadability of infections. Further, the surface to surface transmissibility of CoVID-19 infection requires critical attention to empower the supportive measures like the proper selection of surface disinfectants, improve hand sanitization, and upgrade PPE. Virus sustainability approximately varies from a few hours to 9 d in different inanimate surfaces. The selection of a suitable surface disinfectant is considered to be the first pillar to stand against the spreading of CoVID-19 infection. Potent surface disinfectants like ethanol, isopropanol, a combination of 45% iso-propanol with 30% n-propanol, glutardialdehyde, formaldehyde, povidone-iodine were found to be effective in the strength range of (78−95%), (70−100%), (0.5−2.5%), (0.7−1%) and (0.23−7.5%) respectively that inactivate coronavirus with a high value of 4 log10 reduction factor. Hand sanitization is the second pillar of supportive care to restrict the layout of this viral infection. The strength of ethanol (60−70%) and isopropyl alcohol (70−72%) is the optimum strength that is recommended for effective virucidal activity. However, the antiviral potentiality of lower alcoholic strength may be enhanced by mingled with some organic acids like 0.7% phosphoric acid, 0.2% peracetic acid, 0.1% citric acid 1% lactic acid. PPE is considered as the third pillar that strengthens the foundation of preventive care. N95 mask/respirators or equivalent FFP2 respirators prepared from polycarbonate material with a high value of BFE and low differential pressure (breathability) is the best suitable gadget for maximum protection with better comfortability. However, stability and toxicity associated with surface disinfectants, unavailability of suitable sterilization protocol for reuse of PPE are the critical challenges that need to be further investigated.

Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.arcmed.2020.04.020.

Declaration of Competing Interest

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial

interest in or financial conflict with the subject matter or materials discussed in the manuscript. All the authours involved in the preparation of this manuscript declare no conflict of interest.

References

1. Ochmann S, Roser M. Smallpox: disease, transmission and symptoms. 2020. https://ourworldindata.org/smallpox#citation. Accessed April 18, 2020.
2. DeWitte SN. Mortality risk and survival in the aftermath of the medieval Black Death. PLoS ONE 2014;9:e96513.
3. Woolhouse M, Scott F, Hudson Z, et al. Human viruses: discovery and emergence. Phil Trans R Soc B 2012;367:2864−2871.
4. Potter CW, Jennings R. A definition for influenza pandemics based on historial records. J Infect 2011;63:252−259.
5. WHO. Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care. Infection Prevention and Control of Epidemic- and Pandemic-Prone Acute Respiratory Infections in Health Care 2020. www.who.int/about/licensing/copyright_form/en/index.html. Accessed April 18, 2020.
6. Osterholm MT, Kelley NS, Sommer A, et al. Efficacy and effectiveness of influenza vaccines: a systematic review and meta-analysis. Lancet Infect Dis 2012;12:36−44.
7. de Paula VS. Laboratory diagnosis of hepatitis A. Future Virology 2012;7:461−472.
8. Trombetta CM, Gianchecchi E, Montomoli E. Influenza vaccines: Evaluation of the safety profile. Hum Vaccin Immunother 2018;14:657−670.
9. Li X, Lin Y, Yao G, et al. The Influence of Vaccine on Febrile Seizure. Curr Neuropharmacol 2018;16:59−65.
10. Wajih Ullah M, Qaseem A, Amray A. Post Vaccination Guillain Barre Syndrome: A Case Report. Cureus 2018;10:e2511.
11. Petrik MS, Wong MC, Tabata RC, et al. Aluminum adjuvant linked to Gulf War illness induces motor neuron death in mice. Neuromolecular Med 2007;9:83−100.
12. Duwe S. Influenza viruses - antiviral therapy and resistance. GMS Infect Dis 2017;5:Doc04.
13. Visher E, Whitefield SE, McCrone JT, et al. The Mutational Robustness of Influenza A Virus. PLoS Pathog 2016;12:e1005856.
14. Hearn P, Miliya T, Seng S, et al. Prospective surveillance of healthcare associated infections in a Cambodian pediatric hospital. Antimicrob Resist Infect Control 2017;6:16.
15. Embil JM, Dyck B, Plourde P. Prevention and control of infections in the home. CMAJ 2009;180:E82−E86.
16. Al-Osail AM, Al-Wazzah MJ. The history and epidemiology of Middle East respiratory syndrome corona virus. Multidiscip Respir Med 2017;12:20.
17. Shereen MA, Khan S, Kazmi A, et al. COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses. J Adv Res 2020;24:91−98.
18. Lai C-C, Shih T-P, Ko W-C, et al. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. Int J Antimicrob Agents 2020;55:105924.
19. Li H, Liu S-M, Yu X-H, et al. Coronavirus disease 2019 (COVID-19): current status and future perspectives. Int J Antimicrob Agents, 2020105951.
20. Ilea A, Andrei V, Feurdean CN, et al. Saliva, a Magic Biofluid Available for Multilevel Assessment and a Mirror of General Health-A Systematic Review. Biosensors (Basel) 2019;9.
21. Kampf G. Potential role of inanimate surfaces for the spread of coronaviruses and their inactivation with disinfectant agents. Infection Prevention in Practice 2020;2:100044.
22. United States Environmental Protection Agency. List N: Disinfectants for Use Against SARS-CoV-2. https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2. Accessed April 18, 2020.
23. Wieczorek D, Dobrowolski A, Staszak K, et al. Synthesis, Surface and Antimicrobial Activity of Piperidine-Based Sulfobetaines. J Surfact Deterg 2017;20:151−158.
24. Requião RD, Carneiro RL, Moreira MH, et al. Viruses with different genome types adopt a similar strategy to pack nucleic acids based on positively charged protein domains. Sci Rep 2020;10:5470.
25. Chen CJ, Chen CC, Ding SJ. Effectiveness of Hypochlorous Acid to Reduce the Biofilms on Titanium Alloy Surfaces *in vitro*. Int J Mol Sci 2016;17.
26. Carr AC, van den Berg JJ, Winterbourn CC. Chlorination of cholesterol in cell membranes by hypochlorous acid. Arch Biochem Biophys 1996;332:63−69.
27. Songur A, Ozen OA, Sarsilmaz M. The toxic effects of formaldehyde on the nervous system. Rev Environ Contam Toxicol 2010;203:105−118.
28. Gebel J, Exner M, French G, et al. The role of surface disinfection in infection prevention. GMS Hyg Infect Control 2013;8.
29. Sanjuán R. Collective properties of viral infectivity. Curr Opin Virol 2018;33:1−6.
30. Siddharta A, Pfaender S, Vielle NJ, et al. Virucidal Activity of World Health Organization-Recommended Formulations Against Enveloped Viruses, Including Zika, Ebola, and Emerging Coronaviruses. J Infect Dis 2017;215:902−906.
31. Springthorpe VS, Sattar SA. Chemical disinfection of virus-contaminated surfaces. Critical Reviews in Environmental Control 1990;20:169−229.
32. Cottingim KM, Verma H, Urriola PE, et al. Feed additives decrease survival of delta coronavirus in nursery pig diets. Porcine Health Manag 2017;3:5.
33. Ionidis G, Hübscher J, Jack T, et al. Development and virucidal activity of a novel alcohol-based hand disinfectant supplemented with urea and citric acid. BMC Infect Dis 2016;16:77.
34. Kampf G. Efficacy of ethanol against viruses in hand disinfection. J Hosp Infect 2018;98:331−338.
35. Gojo. Hand Sanitizers. https://www.gojo.com/en/Product/5055-1W. Accessed April 14, 2020.
36. Jain VM, Karibasappa GN, Dodamani AS, et al. Comparative assessment of antimicrobial efficacy of different hand sanitizers: An *in vitro* study. Dent Res J (Isfahan) 2016;13:424−431.
37. Clickoncare. Himalaya PureHands Orange Hand Sanitizer 60% Alcohol, 500ml - Kills 99.9% Germs. https://www.clickoncare.com/himalaya-purehands-orange-hand-sanitizer-500ml. Accessed April 15, 2020.
38. Nykaa. Godrej Protekt Instant Hand Sanitizer. https://www.nykaa.com/search/result/?ptype=search&q=Godrej%20Protekt%20Instant%20Hand%20Sanitizer&root=search&sourcepage=search&searchType=Manual. Accessed April 18, 2020.
39. Health and glow. Zuci Natural Hand Sanitizer. https://m.healthandglow.com/zuci-junior-strawberry-hand-sanitizer-with-moisturizers-and-vitamin-e-250ml/p/NTMyNjIy. Accessed April 18, 2020.
40. 3M Science applied to life. 3M^{TM} Avagard CHG Handrub. https://www.3mindia.in/3M/en_IN/company-in/all-3m-products/~/3M-Avagard-CHG-Handrub-500-ml-24-Bottles-Per-Case/?N=5002385+8711017+3291942800&rt=rud. Accessed April 18, 2020.
41. Big basket. Savlon Hand Sanitizer Gel. https://www.bigbasket.com/pd/40166033/savlon-hand-sanitizer-gel-55-ml-bottle/. Accessed April 17, 2020.
42. Germ-X. Germ-X® Aloe Hand Sanitizer. http://germx.com/products/germ-x-aloe-hand-sanitizer-8-fl-oz/. Accessed April 18, 2020.
43. Mountain Falls. Mountain Falls Hand Hygiene. http://mymountainfalls.com/products/#handcare. Accessed April 12, 2020.
44. Wertz PW. Lipids and the Permeability and Antimicrobial Barriers of the Skin. J Lipids 2018;2018:1−7.

45. Ayorinde FO, Garvin K, Saeed K. Determination of the fatty acid composition of saponified vegetable oils using matrix-assisted laser desorption/ionization time-of-flight mass spectrometry. Rapid Commun Mass Spectrom 2000;14:608−615.
46. Prieto Vidal N, Adeseun Adigun O, Pham T, et al. The Effects of Cold Saponification on the Unsaponified Fatty Acid Composition and Sensory Perception of Commercial Natural Herbal Soaps. Molecules 2018;23:2356.
47. Gunduz F, Aboulnasr FM, Chandra PK, et al. Free fatty acids induce ER stress and block antiviral activity of interferon alpha against hepatitis C virus in cell culture. Virol J 2012;9:143.
48. Librán-Pérez M, Pereiro P, Figueras A, et al. Antiviral activity of palmitic acid via autophagic flux inhibition in zebrafish (Danio rerio). Fish Shellfish Immunol 2019;95:595−605.
49. Livingston E, Desai A, Berkwits M. Sourcing Personal Protective Equipment During the COVID-19 Pandemic. https://jamanetwork.com/journals/jama/fullarticle/2764031. Accessed April 17, 2020.
50. WHO. Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations. Accessed April 18, 2020.
51. Feng S, Shen C, Xia N, et al. Rational use of face masks in the COVID-19 pandemic. Lancet Respir Med, 2020;. S221326002030134X.
52. United States Food and Drug Administration. N95 Respirators and Surgical Masks (Face Masks). https://www.fda.gov/medical-devices/personal-protective-equipment-infection-control/n95-respirators-and-surgical-masks-face-masks. Accessed April 18, 2020.
53. Lee SA, Hwang DC, Li HY, et al. Particle Size-Selective Assessment of Protection of European Standard FFP Respirators and Surgical Masks against Particles-Tested with Human Subjects. J Healthc Eng 2016;2016:1−12.
54. 3M Science applied to life. 3M^{TM} Particulate Respirator 8210, N95 160 EA/Case. https://www.3m.com/3M/en_US/company-us/all-3m-products/~/3M-Particulate-Respirator-8210-N95-160-EA-Case/?N=5002385+3294780268&rt=rud. Accessed April 18, 2020.
55. Honeywell. Honeywell H801 Series. https://www.honeywellsafety.com/Products/Respiratory_Protection/Honeywell_H801_Series.aspx?site=/mei. Accessed April 10, 2020.
56. Medequipdepot. RP88020 Prestige Ameritech N95 Respirator, Regular. https://www.medequipdepot.com/products/rp88020-prestige-ameritech-n95-respirator-regular-6-bx-sold-as-bx.html. Accessed April 9, 2020.
57. Aeropro. Aero Pro AP0028 NIOSH N95 Surgical Mask. https://aeropro.en.taiwantrade.com/product/aero-pro-ap0028-niosh-n95-surgical-mask-226230.html. Accessed April 2, 2020.
58. Vogmask. Premier Vogmask VMCV. https://www.vogmask.com/products/waves-vmcv. Accessed April 18, 2020.
59. Atlanta Healthcare. Atlanta Healthcare Cambridge N95 Mask. https://www.atlantahealthcare.in/category/cambridge-n95-masks/. Accessed April 11, 2020.
60. AlphaAir® Masks. Critical Cover® AlphaAir® Masks. http://www.alphaprotech.com/product/161.aspx?catid=29. Accessed April 5, 2020.
61. Ansell. SANDEL® Respiratory face masks. https://www.ansell.com/eu/en/products/sandel-respiratory-face-masks. Accessed April 12, 2020.
62. Dokodemo. PM2.5-Blocking Three Dimensional High-Adhesion Face Masks 5 Masks. https://dokodemo.world/en/es/products/219241/. Accessed April 16, 2020.
63. Amazon.In. Oxypure N99 Tested Washable Designer Pollution Masks Men/Women/Kids Size (Medium, Plain Navy). https://www.amazon.in/Oxypure-Tested-Washable-Designer-Pollution/dp/B076HZMY36. Accessed April 18, 2020.
64. United States Food and Drug Administration. Cufitec Surgical Mask: Surgical Mask With Antimicrobial/antiviral Agent. https://fda.report/PMN/K182766. Accessed April 18, 2020.
65. Tortorici MA, Walls AC, Lang Y, et al. Structural basis for human coronavirus attachment to sialic acid receptors. Nat Struct Mol Biol 2019;26:481−489.
66. Yang J, Zang W, Zhang Z, et al. The Enhanced and Tunable Sustained Release of Pesticides Using Activated Carbon as a Carrier. Materials 2019;12:4019.
67. Alonso WJ, Nascimento FC, Shapiro J, et al. Facing ubiquitous viruses: when hand washing is not enough. Clin Infect Dis 2013;56:617.
68. Srinivasan S. Powdered gloves: Time to bid adieu. J Postgrad Med 2018;64:67−68.
69. Roberge RJ. Face shields for infection control: A review. J Occup Environ Hyg 2016;13:235−242.
70. Quito A. Ford is using airbag material to make reusable hospital gowns for Covid-19 responders. https://qz.com/1837127/ford-turns-airbag-material-into-ppe-for-covid-19-responders/. Accessed April 14, 2020.
71. Pawar AY. Combating Devastating COVID -19 by Drug Repurposing. Int J Antimicrob Agents, 2020105984.
72. Olsen M, Cook SE, Huang V, et al. Perspectives: Potential Therapeutic Options for SARS-CoV-2 Patients Based on Feline Infectious Peritonitis Strategies: Central Nervous System Invasion and Drug Coverage. Int J Antimicrob Agents, 2020105964.