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Epidemiological and Disinfectants as Controlling Aspect on COVID-19

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Abstract

Coronavirus disease (COVID-19) caused severe acute respiratory syndrome. This as endemic one transported all over the world. It caused death in a huge number of populations all over the world. This novel virus spread mainly through respiratory droplets and close contact.

As disease progressed, a series of complications tend to develop, especially in critically ill patients. This review deals with epidemic consideration of the virus, a part from supportive care, no specific treatment has been established for COVID-19, so effect of some environmental conditions, pH, and disinfectant material to avoid contamination, such as alcohol, chlorinated compounds and surfactants.

Key words

coronavirus disease 2019; (COVID-19), epidemiology; characteristics; disinfectants, surfactants

Introduction

Currently, coronavirus disease 2019 (COVID-19) consider a significant threat to global health. World Health Organization (WHO) has declared this outbreak as a “public health emergency of international concern” on January 31, 2020. Within the first two months of the outbreak, the epidemic spread rapidly around the country and the world. As of March 2020, a total of 80 868 confirmed cases and 3101 deaths had been reported in Chinese mainland by National Health Commission of China, and 90 other countries are affected. COVID-19 as an emerging disease has unique biological characteristics, clinical symptoms, and imaging manifestations, though considerable progress has been made on the clinical management. This article will summarize the epidemiological, etiological, clinical, pathological (profile of COVID-19) and review the latest advancements in the prevention (disinfectants used).

Epidemiology of covid-19

Over the past few decades, a large number of people have been affected with the epidemics, caused by coronavirus family (SARS-2003, MERS-2012, and COVID-2019) in the world. Nevertheless, there is substantial genetic dissimilarity between pathogens of the three previous epidemics, in particular MERS with COVID-19. In the previous epidemics, initial hotspots of diseases were Middle East, Saudi Arabia (MERS) and China and animal to human, and then human to human transmissions of pathogens were reported in other countries [1,2]. For COVID-19, as suggested by epidemiological evidence in China, this outbreak began from a seafood and live animal shopping center in Wuhan, Hubei Province on December 12, 2019. However, similar to two previous epidemics, the current epidemic also switched to human to human transmission immediately, and swept through most regions in China even faster than the previous pandemics [1].

Recent epidemics of viral respiratory diseases in the world have started from China (except for MERS that originated in Saudi Arabia), and there are several possible reasons for this. From an economic perspective, China has emerged as one of the leading countries in the production of various commodities, especially in the past decade, and given the enormous volume of trade, tourism and military transactions with other countries, there was no doubt that the virus would spread to other parts of the world [2] .

China has already acknowledged the possibility of a new virus epidemic in the future and has consequently stressed the importance of formulating a policy to improve the healthcare system and preparedness after the two previous epidemics. This country rearranged its health plan in the wake of MERS epidemic in 2012, establish a new web-based service for quick alarming in case of an emerging disease with unknown origin through common surveillance system. In the wake of conditions ensuing SARS epidemic and severe criticisms leveled by international institutions regarding delayed provision and sharing of data by China government, this country has started extensive collaborations with international institutions from the early days of the recent epidemic, and established a publicly available database of line list of cases through coordinating with Johns Hopkins University [3] .

Moreover, China scaled up public health measures and quarantined many cities, bearing the grave economic consequences of this action to prevent the spread of the disease to other parts of the world. Although, China has been struggling with tough conditions in the previous month, reduction in the number of incidence cases and interruption of transmission indicate its successful measures to control the recent epidemic and highlight the importance of timely and appropriate decisions through activating human and material resources for addressing a serious global threat [4].

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WHO has announced that Coronavirus epidemic is progressively increasing in three countries, including Italy, South Korea, and Iran. The shared string that links these three countries is the pandemic of MERS in 2013, which was transmitted through close human-to-human contacts [4].

Transmission and Incubation period .

Human to human transmission via either respiratory droplets or close contacts was initially proposed as the main routes of transmission of the pathogen based on experience gained in the previous two epidemics caused by coronaviruses (MERS-CoV and SARS-CoV) [5] . According to the world Health Organization (WHO) report, 2019-nCoV is a unique virus that causes respiratory disease, which spreads via oral and nasal droplets. Moreover, the pathogen of COVID-19 can float in the air in the form of aerosols and cause infection in healthy people [6].

There is a limited number of evidence on oral-fecal transmissibility of the pathogen. However, COVID-19 RNA was found in fecal specimens of 2 to 10% of confirmed patients with gastrointestinal symptoms such as diarrhea, so fecal-oral transmission should be taken into account as a probable route through case investigation [7].

Incubation period (the time from infection to the onset of symptoms) for the new pathogen varies from 2 to 14 days in human to human transmission. Furthermore, median incubation period was reported as 5-6 days (ranged from 0-14 days) in WHO report. While another study in China reported longer incubation times up to 24 days [8].

Infectivity

The degree of transmissibility or contagiousness of the coronavirus (infectivity) was studied. In general, epidemiologists use mathematical formulas with clear and acceptable assumptions to calculate the infectivity index. For this purpose, "basic reproduction number" termed R_0 is used, and it indicates the expected number of cases directly infected by one contagious case in a population, for COVID-19, the calculated value in a study was slightly higher and the index value based on data calculated in Wuhan, China was 2.2 and it shows that the infectivity of COVID-19 is higher than previous epidemics originated by coronavirus . In other studies, R_0 has been reported with different values, the lowest of which corresponds to the WHO report of 1.95 and the highest value is 6.47. A review study estimated an average R_0 for COVID-19 of 3.28. As an explanation for variety of the calculated indices is that different calculation methods were used and calculations were done at different times of epidemics [9,10].

Symptoms

The symptoms of COVID-19 infection appear after an incubation period of approximately 5.2 days. The period from the onset of COVID-19 symptoms to death ranged from 6 to 41 days with a median of 14 days.

This period is dependent on the age of the patient and status of the patient's immune system. It was shorter among patients > 70-years old compared with those under the age of 70.

There are similarities in the symptoms between COVID-19 and earlier beta-coronavirus such as fever, dry cough, dyspnea, and bilateral ground-glass opacities on chest CT scans. However, COVID-19 showed some unique clinical features that include the targeting of the lower airway as evident by upper respiratory tract symptoms like rhinorrhoea, sneezing, and sore throat.

In addition, based on results from chest radiographs upon admission, some of the cases show an infiltrate in the upper lobe of the lung that is associated with increasing dyspnea with hypoxemia [11-14].

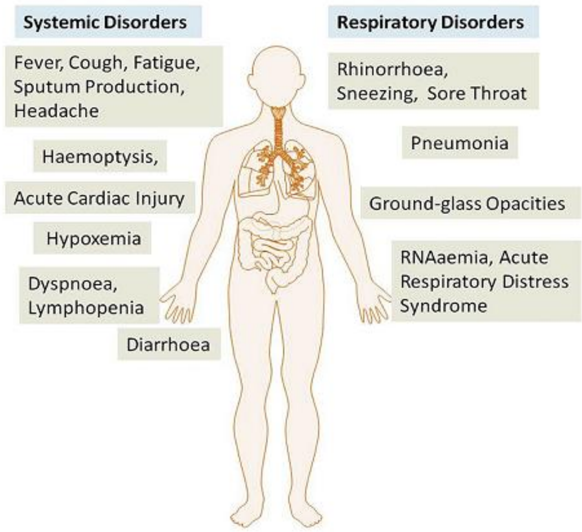

Figure 1: Schematic diagram shows some symptoms of Coronavirus. [11]

Pathogenicity

An important concern in the recent pandemic is the capability of the pathogen to establish and induce infection with different clinical manifestations in human. According to WHO report, about 82 percent of COVID-19 patients have mild symptoms and were recovered immediately. As of 20 February, there were 18264 (24%) recovered cases in China and recovery and mortality rates of the disease among severe cases in Guangdong were 26.4 % and 13.4%, respectively. Median time for onset of symptoms to recovery in mild and severe cases was 2 and 3-6 weeks, respectively. Furthermore, time interval between onset and developing severe symptoms such as hypoxia was one week. In case studies that were conducted outside of mainland China, time of onset of symptom(s) to recovery was 22.2 days. Moreover, average time of onset of symptom(s) to death varies from 20.2 to 22.3 days. Results of a case-series study on six infants (45-days to one-year) infected with COVID-19 in China indicated mild symptoms of the disease in this age group with no need for further intensive care.

According to WHO report, COVID-19 disease among children seems to be rare with mild symptoms, about 2.4% of total cases were reported in children and adolescents (aged less than 19 years), while older cases aged over 60 years and those with a background of chronic diseases were at higher risk of developing severe disease and death. Even though age is an important deterministic factor for severity of symptoms, other risk factors such as having a history of underlying diseases and/or co-infection with other infections like Influenza virus and Klebsiella may accelerate the progress of symptoms and lead to poor prognosis of the disease [15,18].

Virulence

The virulence of a disease is usually measured on the basis of indicators such as mortality rate and disability. Compared with the previous two epidemics (SARS and MERS), the case fatality rate was lower and approximately 2% in COVID-19, and only less than 15% of patients would seek hospital services. However, the case fatality rate of SARS and MERS was 10% and 34%, respectively. Results of a study in China revealed the overall case fatality rate of 2.3% for COVID-19 However, due to the rapid spread of COVID-19, there is a higher number of death cases in the recent pandemic (N=3043, up to 02 March 2020) compared to SARS and MERS (N=1871) . There is a poor prognosis for the disease in middle and older aged patients. In a study on 44672 confirmed cases in China, case fatality rate was highest in the group of over 80 years (14.77%), followed by the age group between 70 to 80 years (7.96%) and no mortality was reported in age group below 10 years . Even though death outcome is uncommon in young people, a few deaths are reported in this age group in China and Iran [19,21].

Structure of Coronavirus

Figure 2 shows the structure of coronaviruses. **SARS-CoV-2** is the causative pathogen of **COVID-19**, identified as the seventh type of corona virus to infect humans. Six other kinds of corona viruses are known to cause human disease, including severe acute respiratory syndrome corona virus **(SARS-CoV)** and Middle East respiratory syndrome corona virus **(MERS-CoV)** with high mortality rate. According to the genome characteristics, corona virus is separated into four genera: α-CoV, β-CoV, γ-CoV, and δ-CoV . Deep sequencing revealed that this novel coronavirus isolated from lower respiratory tract samples of patient with COVID-19 belongs to β-CoV .[1]. Coronavirus has the appearance of crown under electron microscopy. The genome of enveloped CoVs is a single stranded positive sense RNA **(+ssRNA)** with 5′ cap structure. It seems to attach by opening and closing. Each spike is made of **three identical proteins** twisted together.

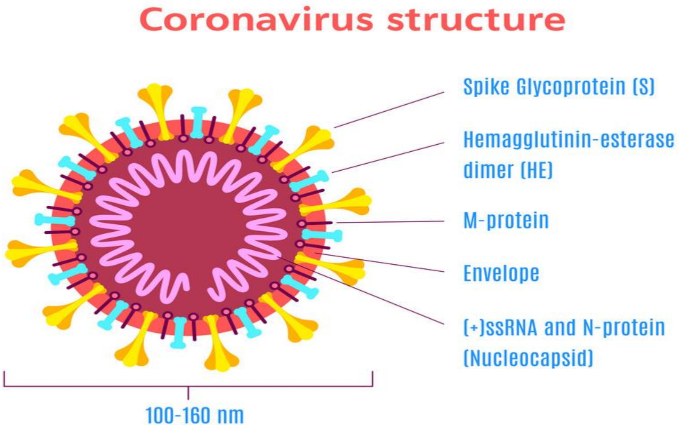

Figure 2: Structure of Coronavirus [22]

All coronaviruses share the same genome organization and expression pattern, with two large overlapping reading frames (ORF1a/b) which encode 16 nonstructural proteins, followed by ORFS for four major structural proteins: spike (S), envelope (E), membrane (M), and nucleocapsid(N) [22].

Effect of pH on the Cronaviruses and environment

Cronaviruses survived well in an environment with a pH of about 6 and was unable to survive at a pH of 8 and above. The WHO advises people to stay more than one meter away from the sick, to regularly and thoroughly clean hands, and to avoid touching eyes, nose and mouth [23].

Effect of temperature, humidity and UV light on the transmission of coronavirus

According to the data analyzed by the researchers: High temperature and high relative humidity significantly **reduce** the transmission of COVID-19. An increase of just one degree Celsius and 1% relative humidity increase substantially lead to lower the virus's transmission. The severity is negatively related to temperature and relative humidity using 14 countries with more than 20 new cases during this period [24]

Disinfectants for Use Against SARS-CoV-2.

Contact transmission of COVID-19 can occur when contaminated hands touch the mucosa of the eyes, nose or mouth. It can also be transmitted between surfaces via contaminated hands. Hand hygiene is the most effective single practice that can be used to decrease the spread of infections through multimodal measures [25]. Therefore, hand hygiene is paramount in preventing the spread of the COVID-19 and other viruses and bacteria. Furthermore, healthcare workers are encouraged to observe the five moments of hand hygiene [26].
All products on this list meet EPA's criteria for use against SARS-CoV-2, the virus that causes COVID-19:
Alcohol
Chlorine and chlorine compounds
Formaldehyde
Glutaraldehyde
Hydrogen peroxide
Iodophors
Ortho-phthalaldehyde (OPA)
Peracetic acid
Peracetic acid and hydrogen peroxide
Phenolics
Quaternary ammonium compounds
Silver ions [27,28]
The same disinfectants were recommended by CDC guidelines for disinfection and sterilization in healthcare facilities for 2008 [29].
In the healthcare setting, "alcohol" refers to two water-soluble chemical compounds ethyl alcohol and isopropyl alcohol that have generally underrated germicidal characteristics. FDA has not cleared any liquid chemical sterilant or high-level disinfectant with alcohol as the main active ingredient. These alcohols are rapidly bactericidal rather than bacteriostatic against vegetative forms of bacteria; they also are tuberculocidal, fungicidal, and virucidal but do not destroy bacterial spores. Their cidal activity drops sharply when diluted below 50% concentration, and the optimum bactericidal concentration is 60%–90% solutions in water (volume/volume).

Microbicidal Activity.

Ethyl alcohol, at concentrations of 60%–80%, is a potent virucidal agent inactivating all of the lipophilic viruses (e.g., herpes, vaccinia, and influenza virus) and many hydrophilic viruses (e.g., adenovirus, enterovirus, rhinovirus, and rotaviruses but not hepatitis A virus (HAV) or poliovirus).
Isopropyl alcohol is not active against the nonlipid enteroviruses but is fully active against the lipid viruses.
Studies also have demonstrated the ability of ethyl and isopropyl alcohol to inactivate the hepatitis B virus(HBV) and the herpes virus, and ethyl alcohol to inactivate human immunodeficiency virus (HIV) , rotavirus, echovirus, and astrovirus.

Mechanism of alcohol in Destroying viruses :

Alcohol attacks and destroys the envelope protein that surrounds some viruses, including coronaviruses. This protein is vital for a virus's survival and multiplication.

Uses of alcohols in prevention against COVID-19

Topical: as a hand sanitizers: Alcohol-based hand sanitizers contain varying amounts and types of alcohol, often between 60 % and 95 % and usually isopropyl alcohol, ethanol (ethyl alcohol) or n-propanol.

Inhalation: ethanol vapor inhalation helps to raise the ethanol concentration on the mucous membrane inside our recuperatory tract, where the viruses are suppose to remain and incubate [29].

Chlorine and Chlorine Compounds

Hypochlorites, the most widely used of the chlorine disinfectants, are available as liquid (e.g., sodium hypochlorite) or solid (e.g., calcium hypochlorite) [28]. The most prevalent chlorine products in the United States are aqueous solutions of 5.25%–6.15% sodium hypochlorite, usually called household bleach. They have a broad spectrum of antimicrobial activity, do not leave toxic residues, are unaffected by water hardness, are inexpensive and fast acting, remove dried or fixed organisms and biofilms from surfaces, and have a low incidence of serious toxicity. Sodium hypochlorite at the concentration used in household bleach (5.25-6.15%) can produce ocular irritation or oropharyngeal, esophageal, and gastric burns.
Other disadvantages of hypochlorites include corrosiveness to metals in high concentrations (>500 ppm), inactivation by organic matter, discoloring or "bleaching" of fabrics, release of toxic chlorine gas when mixed with ammonia or acid (e.g., household cleaning agents) , and relative stability.

Alternative compounds.

Chlorine dioxide, sodium dichloroisocyanurate, and chloramine and Superoxidized water. The microbicidal activity of chlorine is attributed largely to undissociated hypochlorous acid (HOCl). The dissociation of HOCI to the less microbicidal form (hypochlorite ion OCl^-) depends on pH. The disinfecting efficacy of chlorine decreases with an increase in pH that parallels the conversion of undissociated HOCI to OCl.
"Superoxidized water" has been tested against viruses. Freshly generated superoxidized water is rapidly effective (<2 minutes) in achieving a 5-log_{10} reduction of poliovirus, HIV [28, 29].

Quaternary Ammonium Compounds.

Quaternary ammonium compounds (QACs) are among the most commonly used disinfectants. They are membrane-active agents interacting with the cytoplasmic membrane of bacteria and lipids of viruses. The wide variety of chemical structures possible has seen an evolution in their effectiveness and expansion of applications over the last century, including non-lipid-containing viruses (i.e., noroviruses). Selection of formulations and methods of application have been shown to affect the efficacy of QACs. Their hydrophobic activity also makes them effective against lipid-containing viruses. QACs also interact with intracellular targets and bind to DNA . They are also effective against non-lipid-containing viruses [28, 30].

Silver ions

Antiviral activity of silver nanoparticle/chitosan composites against H1N1 influenza A virus [31]. Previous studies showed that Ag NPs have antiviral activity against influenza A virus . Although the mechanism of action has not been well investigated, it is likely that the antiviral activity of Ag NPs against several other types of viruses is due to direct binding of the Ag NPs to viral envelope glycoproteins, thereby inhibiting viral penetration into the host cell [31].

Surfactants

Inactivation of influenza virus (avian influenza virus H5N3 and Human influenza virus H3N2) by surfactants(Sodium dodecyl sulfate (SDS), sodium laureth sulfate (LES) and oleic acid) [32]. It is generally believed that the mechanism of influenza virus inactivation by a surfactant is fusion with the envelope membrane by a hydrophobic interaction. This is because the influenza virus surface is covered by a lipid bilayer of the envelope membrane that interacts readily with the hydrophobic group of a surfactant [32, 33].

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