

Side Effects of Using Disinfectants to Fight COVID-19

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Coronavirus refers to a group of widespread viruses. The name refers to the specific morphology of these viruses because their spikes look like a crown under an electron microscope. Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered crown-shaped virus. Human-to-human transmission of the coronavirus is through coughing, sneezing, discharge from the nose and mouth. The virus can be transmitted from 1 to 2 meters through coughing or sneezing. Another way of transmission is by hand contact with the environment and virus-infected surfaces. Various substances are used to disinfect the body and surfaces. However, improper and unsafe use of these disinfectants can lead to other toxic effects in people that can be far more dangerous than the virus itself.

Introduction

Coronavirus refers to a group of widespread viruses. The name refers to the specific morphology of these viruses because of the spikes on their surface that look like a crown under an electron microscope [1]. Coronaviruses are a large family of viruses, infecting animals and humans with diseases ranging from colds to more severe illnesses such as Middle East Respiratory Syndrome (MERS-CoV) and Acute Respiratory Syndrome (SARS-CoV) [2][3][4]. In November 2019 a new coronavirus was described in China that has never been seen in humans before [5]. On February 11, 2020, the Corona Virus Research Group of the International Committee for the Classification of Viruses officially named it SARS-CoV-2 and identified it as the SARS-CoV sister virus [6][7][8].

The disease caused by SARS-CoV-2 is called Coronavirus Disease 2019 (COVID-19) [7]. Coronavirus belongs to the genus Coronavirus, the family Coronaviridae, and the order Nidovirales. The virus has the largest genome known among RNA viruses [9]. So far, the coronavirus infection has only been seen in vertebrates, causing respiratory, gastrointestinal, and neurological diseases in humans and animals. Many of the viruses that infect humans are essentially viruses that are transmitted from animals. When viruses mutate in animals, they can infect humans, multiply in the human body, and spread among humans [10][11][12]. Most people infected with the COVID-19 virus experience mild to moderate respiratory illness and recover without special treatment. Older people and people with major medical problems such as cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to get a serious illness. The best way to prevent and slow down the transmission is to be fully aware of the COVID-19 virus, the disease, and how it spreads. Washing your hands or disinfecting them with alcohol-based items repeatedly and without touching your face can prevent its spread. Currently, there is no specific vaccine or treatment for COVID-19. However, many clinical trials are underway that assess potential treatments. According to the latest information, the human-to-human transmission of the coronavirus is through coughing,

sneezing, discharge from the nose and mouth. The virus can be transmitted from 1 to 2 meters through coughing or sneezing. Another way to transmit, contact hands with the environment and virus-infected surfaces such as equipment, door handles, desks and chairs, valves, stair railings, switches, and electrical outlets, and all common items (banknotes, documents) hand in hand and so on, so it is important to wash hands and face with soap and water after contact with any person or suspicious objects [1][13][14][15][16][17]. The table below shows the persistence of the coronavirus on different surfaces (Table 1)[18].

Type of surface	Virus	Strain/Isolate	Inoculum (viral titer)	Temperature	Persistence	
Steel	MERS-CoV	Isolate HCoV-EMC/2012	10 ⁵	20°C	48 h	
	HCoV	Strain 229E	10 ³	21°C	5 d	
Aluminium	HCoV	Strain 229E and OC43	5×10 ³	21°C	2-8 h	
Metal	SARS-CoV	Strain P9	10 ⁵	RT	5 d	
Wood	SARS-CoV	Strain P9	10 ⁵	RT	4 d	
Paper	SARS-CoV	Strain P9	10 ⁵	RT	4-5 d	
			Strain GUV6109	10 ⁶	RT	24 h
				10 ⁵		3 h
			10 ⁴		< 5 min	
Glass	SARS-CoV	Strain P9	10 ⁵	RT	4 d	
	HCoV	Strain 229E	10 ³	21°C	5 d	
Plastic	SARS-CoV	Strain HKU39849	10 ⁵	22-25°C	≤ 5 d	
			Isolate HCoV-EMC/2012	10 ⁵	20°C	48 h
					30°C	8-24 h
	SARS-CoV	Strain P9	10 ⁵	RT	4 d	
	SARS-CoV	Strain FFM1	10 ⁷	RT	6-9 d	
	HCoV	Strain 229E	10 ⁷	RT	2-6 d	
PVC	HCoV	Strain 229E	10 ³	21°C	5 d	
Silicon rubber	HCoV	Strain 229E	10 ³	21°C	5 d	
Surgical glove (latex)	HCoV	Strain 229E and OC43	5×10 ³	21°C	≤ 8 h	
Disposable gown	SARS-CoV	Strain GUV6109	10 ⁶	RT	2 d	
				10 ⁵		24 h
				10 ⁴		1 h
Ceramic	HCoV	Strain 229E	10 ³	21°C	5 d	
Teflon	HCoV	Strain 229E	10 ³	21°C	5 d	

Table 1: Persistence of coronaviruses on different types of surfaces [18].

*MERS = Middle East Respiratory Syndrome; HCoV = Human Coronavirus; SARS = Severe Acute Respiratory Syndrome; RT = Room Temperature

The human coronavirus is sensitive to ultraviolet and heat rays [19][20]. It can survive for several years at -60° C. But as the temperature rises, the resistance of the virus decreases. Coronavirus can be effectively inactivated after 30 minutes at 56° C. The human coronavirus is not resistant to acids and alkalis, and the optimum pH is 7.2 [21][22][23]. Fat-soluble solvents such as ether, 70% ethanol, chlorine-containing disinfectant solutions, proxy acetic acid, and chloroform can inactivate the virus. But chlorhexidine can't effectively inactivate it. Antiseptic agents are used on inanimate surfaces while disinfectants are used on the skin, mucosa and living surfaces. Antiseptic agents are harmful to the skin and healthy areas, while disinfectants can be used on the skin and healthy areas and are harmless. Antiseptic agents have the most destructive and killing effects of bacteria

(biocidal), while disinfectants are more likely to inhibit the growth of bacteria (biostatic). Alcohol has both disinfectant and antiseptic properties. There are different types of disinfectants in physical and chemical groups [1-24].

Physical disinfectants

1.Heat 2. Exhausted by cold 3. Drying 4. Radiation (heat is used in various forms such as burning, boiling, intermittent heat of water vapor with pressure and dry heat) [24].

Chemical disinfectants

Aldehyde (formaldehyde), formal chemical sterilizers (such as ethylene oxide ETO), acids (acetic acid, hydrochloric acid), alcohols, phenols and their derivatives (phenol, detol, hexachlorophene, chlorhexidine, chlorhexidine), alkalis (bicarbonate), bicarbonate sodium, sodium (oxygenated water), halogens (oxygenated water), heavy metals such as mercury, surfactants or detergents including: cationic surfactants, anionic surfactants (soaps), non-ionic surfactants (sulfate derivatives in dishwashing liquid and detergent powder), amphoteric surfactants (main surfactants and carpet shampoos, baby shampoos) [25][26].

The following Table shows the effect of several samples of disinfectants and antiseptics recommended for coronavirus (Table 2).

Biocidal agent	Concentration	Virus	Strain / isolate	Volume / material	Organic load		Reduction of viral infectivity (log10)
Ethanol	70%	HcoV	Strain 229E	20 µl/ stainless steel	5% serum	1 min	>3.0
Benzalkonium chloride	0.04%	HcoV	Strain 229E	20 µl/ stainless steel	5% serum	1 min	<3.0
Sodium hypochlorite	0.5%	HcoV	Strain 229E	20 µl/ stainless steel	5% serum	1 min	>3.0
	0.1%	HcoV	Strain 229E	20 µl/ stainless steel	5% serum	1 min	>3.0
	0.01%	HcoV	Strain 229E	20 µl/ stainless steel	5% serum	1 min	<3.0
Glutardialdehyde	2%	HcoV	Strain 229E	20 µl/ stainless steel	5% serum	1 min	>3.0

Table 2: Inactivation of coronaviruses by different types of biocidal agents in carrier tests[18].

Due to the harmful effects of improper and unsafe use of those antiseptics and disinfectants, which in some cases lead to severe side effects in people, the effects and consequences of these substances on humans are discussed below.

Sodium hypochlorite

The use of sodium hypochlorite in the production of bleach for disinfection and polishing of surfaces has been common for 200 years as 10-15% solution and pH = 13 for industrial use and 5% concentration with pH = 11 for in-home use. The American Industrial Hygienists Association (AIHA) has stated that the amount of sodium hypochlorite encountered every 15 minutes is 2 mg per cubic meter. (AIHA / WEEL-STEL: 2mg / m3) It should be noted that, according to chemical hazard rhombus, the above substance has a slight instability (code 1), the risk of oxidation (OX) and the serious risk of damage to the respiratory system (code 3) [27-28]. Sodium hypochlorite is a toxic substance. Its color is close to yellow and its taste and smell are spicy [29]. Its antiseptic properties are due to the production of free chlorine [30]. When sodium chloride is used, chlorine gas is

emitted, which is one of the uses of chlorine gas, due to its toxic nature, for military purposes and as a chemical weapon. For the first time during World War I on April 22, 1915, the Germans used this gas against British forces [31-32]. Since then, chlorine gas has been classified as a chemical weapon by the group of Choking Agents [33]. One of the causes of gas poisoning in non-industrial environments such as homes is the mixing of acidic compounds (pipe openers and scavengers) with household bleaching products that contain hypochlorite, especially indoors and without proper ventilation [34]. Adding acid to a solution containing hypochlorite causes chlorine gas to evaporate. Adding ammonia to this type of product may cause active chlorine species such as chloramine. The signs and symptoms of chlorine gas poisoning appear in different forms depending on the concentration and time of contact with it [30]. At concentrations below 1 ppm, the signs and symptoms are mild and minor. At concentrations of 1-5 ppm, mild irritation of the mucous membranes occurs. 5-15 ppm concentrations may lead to moderate stimulation of the upper airways. Higher concentrations than 30 ppm may cause shortness of breath, nausea, chest pain, and coughing immediately. The results of the studies showed that exposure to chlorine gas at concentrations of 35-31 ppm for one hour may be fatal. Inhalation of 1000 ppm chlorine gas may be fatal for several minutes [35]. Chlorine gas at high concentrations (such as in industrial accidents) can damage the mucous membranes of the airways [31]. The hydrochloric acid produced by the reaction of chlorine with water may also cause secondary tissue damage [30]. In contact with low chlorine concentrations (such as the release of chlorine gas due to the addition of acid to household cleaning products), irritation occurs in the airways [35]. Chlorine irritates the respiratory tract, causing gas to swell in the mucous membranes and burn the skin in the liquid state [36]. Its 3.5 ppm value is required to be recognized as a distinctive odor, and its 1000 ppm value is lethal [37]. That's why chlorine was one of the gases used during World War I [31]. Exposure to this gas should not exceed 0.5 ppm (with an average weight of 8 hours - 40 hours per week) [38]. Intense exposure to large amounts of concentrated chlorine (but not lethal) can cause lung edema or dehydration, which is a very serious condition. Constant contact with small amounts of it weakens the lungs and increases the vulnerability of the lungs to other diseases, especially coronavirus [35].

Methanol

Methanol has detrimental effects on eyes and is absorbed through the skin [39]. Between methanol with metals such as potassium, magnesium, oxidizers such as barium chloride, bromine chlorine, hydrogen peroxide, and sodium have explosive condition if there is heat. Methanol reacts strongly with chloroform, dimethyl zinc, cyanide chloride, and nitric acid. In the case of thermal decomposition, methanol is produced into carbon dioxide (CO₂, CO) and formaldehyde [40-43]. Methanol is a toxic substance, and drinking it causes blindness and even death. Masks and gloves should be used when using methanol because it can also be absorbed through breathing, skin, and drinking. Symptoms of methanol drinking include headache, dizziness, nausea, imbalance, anxiety, drowsiness, and eventually anesthesia and death [44].

Hydrogen Peroxide

In the past, oxygenated water was used to dress up infectious wounds due to its antiseptic properties, but today it is no longer used in dressings due to its damage to adjacent tissues and is only occasionally used to disinfect equipment or surfaces [45-46]. Because it sometimes used to treat bad odors. In erythema tablets, 36% of hydrogen peroxide is bound to 64% urea, and when these tablets are placed in the mouth, it releases oxygen. So it kills germs in the mouth and bleaches teeth [47]. Dilute oxygenated water is also used for gargling and is effective in making cold medicines. Hydrogen peroxide solution can corrode when used on metal objects for a long time [48]. In many countries, hydrogen peroxide is used to purify drinking water. However, high doses of this substance can cause blisters in the mouth and inflammation of the abdomen and can lead to diarrhea and vomiting. Concentrated hydrogen peroxide catches fire immediately if it is placed next to flammable materials. Hydrogen peroxide compounds are highly reactive and volatile [49-50]. Safety precautions must be taken when using this compound. If you use this compound regularly,

you must protect yourself against the side effects of this compound.

Safety Tips Use of Disinfectants

Buy disinfectants and alcohol in the required amount, avoid excessive storage, and keep out of the reach of children. When preparing a disinfectant solution, follow the safety tips and do not do it front of children. so do not use methanol on hot surfaces, near gas flames, and light cigarettes. and turn it off if it catches fire by using extinguishers other than water. Avoid contact of disinfectants antiseptics agents and methanol with the eyes. Cleaning your personal equipment that impregnated with alcohol or after use put in the trash. When using disinfectants and antiseptics agents use appropriate filter or cartridge respirators with enclosed glasses, appropriate clothing, hats and other personal protective equipment's safely. Also, for using them refer to material safety data sheets.

References

References

1. WHO. Coronavirus: who; 2020 [Available from: https://www.who.int/health-topics/coronavirus#tab=tab_1].
2. Chan Jasper F. W., Lau Susanna K. P., To Kelvin K. W., Cheng Vincent C. C., Woo Patrick C. Y., Yuen Kwok-Yung. Middle East Respiratory Syndrome Coronavirus: Another Zoonotic Betacoronavirus Causing SARS-Like Disease. *Clinical Microbiology Reviews*. 2015; 28(2)[DOI](#)
3. Mohd Hamzah A., Al-Tawfiq Jaffar A., Memish Ziad A.. Middle East Respiratory Syndrome Coronavirus (MERS-CoV) origin and animal reservoir. *Virology Journal*. 2016; 13(1)[DOI](#)
4. Al Hajjar Sami, Memish Ziad A., McIntosh Kenneth. Middle East Respiratory Syndrome Coronavirus (MERS-CoV): A Perpetual Challenge. *Annals of Saudi Medicine*. 2013; 33(5)[DOI](#)
5. Tan W, Zhao X, Ma X, Wang W, Niu P, Xu W, et al. A novel coronavirus genome identified in a cluster of pneumonia cases—Wuhan, China 2019– 2020. *China CDC Weekly*. 2020; 2(4):61-62.
6. Hassan SS, Rout RK, Sharma V. A Quantitative Genomic View of the Coronaviruses: SARS-COV2. 2020
7. Jin Yuefei, Yang Haiyan, Ji Wangquan, Wu Weidong, Chen Shuaiyin, Zhang Weiguo, Duan Guangcai. Virology, Epidemiology, Pathogenesis, and Control of COVID-19. *Viruses*. 2020; 12(4)[DOI](#)
8. Hui David S., I Azhar Esam, Madani Tariq A., Ntoumi Francine, Kock Richard, Dar Osman, Ippolito Giuseppe, Mchugh Timothy D., Memish Ziad A., Drosten Christian, Zumla Alimuddin, Petersen Eskild. The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health — The latest 2019 novel coronavirus outbreak in Wuhan, China. *International Journal of Infectious Diseases*. 2020; 91[DOI](#)
9. Saif LJ, Wang Q, Vlasova AN, Jung K, Xiao S. Coronaviruses. *Diseases of swine*. 2019;488-523.
10. Chen Yu, Liu Qianyun, Guo Deyin. Emerging coronaviruses: Genome structure, replication, and pathogenesis. *Journal of Medical Virology*. 2020; 92(4)[DOI](#)
11. Rodriguez-Morales AJ, Bonilla-Aldana DK, Balbin-Ramon GJ, Rabaan AA, Sah R, Paniz-Mondolfi A, et al. History is repeating itself: probable zoonotic spillover as the cause of the 2019 novel Coronavirus Epidemic. *Infez Med*. 2020; 28(1):3-5.
12. Sestak K, Saif LJ. Porcine coronaviruses. *Trends in emerging viral infections of swine*. 2008; 10:321.
13. Jin Ying-Hui, Cai Lin, Cheng Zhen-Shun, Cheng Hong, Deng Tong, Fan Yi-Pin, Fang Cheng, Huang Di, Huang Lu-Qi, Huang Qiao, Han Yong, Hu Bo, Hu Fen, Li Bing-Hui, Li Yi-Rong,

- Liang Ke, Lin Li-Kai, Luo Li-Sha, Ma Jing, Ma Lin-Lu, Peng Zhi-Yong, Pan Yun-Bao, Pan Zhen-Yu, Ren Xue-Qun, Sun Hui-Min, Wang Ying, Wang Yun-Yun, Weng Hong, Wei Chao-Jie, Wu Dong-Fang, Xia Jian, Xiong Yong, Xu Hai-Bo, Yao Xiao-Mei, Yuan Yu-Feng, Ye Tai-Sheng, Zhang Xiao-Chun, Zhang Ying-Wen, Zhang Yin-Gao, Zhang Hua-Min, Zhao Yan, Zhao Ming-Juan, Zi Hao, Zeng Xian-Tao, Wang Yong-Yan, Wang Xing-Huan. A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). *Military Medical Research*. 2020; 7(1)[DOI](#)
14. Biscayart Cristian, Angeleri Patricia, Lloveras Susana, Chaves Tânia do Socorro Souza, Schlagenhauf Patricia, Rodríguez-Morales Alfonso J.. The next big threat to global health? 2019 novel coronavirus (2019-nCoV): What advice can we give to travellers? – Interim recommendations January 2020, from the Latin-American society for Travel Medicine (SLAMVI). *Travel Medicine and Infectious Disease*. 2020; 33[DOI](#)
 15. Kruse Robert L.. Therapeutic strategies in an outbreak scenario to treat the novel coronavirus originating in Wuhan, China. *F1000Research*. 2020; 9[DOI](#)
 16. van Doremalen Neeltje, Bushmaker Trenton, Morris Dylan H., Holbrook Myndi G., Gamble Amandine, Williamson Brandi N., Tamin Azaibi, Harcourt Jennifer L., Thornburg Natalie J., Gerber Susan I., Lloyd-Smith James O., de Wit Emmie, Munster Vincent J.. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *New England Journal of Medicine*. 2020. [DOI](#)
 17. WHO. Coronavirus disease (COVID-19) technical guidance: Guidance for schools, workplaces & institutions: who; 2020 [Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/guidance-for-schools-workplaces-institutions>.
 18. Kampf G., Todt D., Pfaender S., Steinmann E.. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *Journal of Hospital Infection*. 2020; 104(3)[DOI](#)
 19. Duan S, Zhao X, Wen R, Huang J-j, Pi G, Zhang S, et al. Stability of SARS coronavirus in human specimens and environment and its sensitivity to heating and UV irradiation. *Biomedical and environmental sciences: BES*. 2003; 16(3):246-255.
 20. Sajadi MM, Habibzadeh P, Vintzileos A, Shokouhi S, Miralles-Wilhelm F, Amoroso A. Temperature and latitude analysis to predict potential spread and seasonality for covid-19. Available at SSRN 3550308. 2020.
 21. Lamarre Alain, Talbot Pierre J.. Effect of pH and temperature on the infectivity of human coronavirus 229E. *Canadian Journal of Microbiology*. 1989; 35(10)[DOI](#)
 22. Zhongdong W, Haiyan S. A Manual on Protection against COVID-19 2020.
 23. Lu Renfei, Wu Xiuming, Wan Zhenzhou, Li Yingxue, Zuo Lulu, Qin Jianru, Jin Xia, Zhang Chiyu. Development of a Novel Reverse Transcription Loop-Mediated Isothermal Amplification Method for Rapid Detection of SARS-CoV-2. *Virologica Sinica*. 2020. [DOI](#)
 24. Pratelli Annamaria. Canine coronavirus inactivation with physical and chemical agents. *The Veterinary Journal*. 2008; 177(1)[DOI](#)
 25. Rabenau H.F., Kampf G., Cinatl J., Doerr H.W.. Efficacy of various disinfectants against SARS coronavirus. *Journal of Hospital Infection*. 2005; 61(2)[DOI](#)
 26. Afhami S, Soleimani HA. Prevention and control of nosocomial infections. 4 ed: Tabib, Timurzadeh; 2007 2007.
 27. Madarsara TJ, Kudakan NA, Yari S, Saeidabadi H. Assessing respiratory exposure to harmful evaporations in a manufacturing company. *Asian Pacific Journal of Environment and Cancer*. 2019; 2(2)
 28. Association AWW. Water chlorination principles and practices: Amer Water Works Assn; 1973.
 29. Shin G-C, Cho S-M, Jeon N-B, Ku J-H. Effect of sodium hypochlorite (NaOCl) treatment on bacterial yellow blotch in oyster mushroom, *Pleurotus ostreatus*. *The Korean Journal of Mycology*. 1994; 22(2):190-195.
 30. Yari S, Saeidabadi H. Simulation the Probability of Liberalizing Chlorin Gas from Urban Water Chlorination System in Alborz: With the Cancer Approach. 2019.
 31. Fitzgerald Gerard J.. Chemical Warfare and Medical Response During World War

- I. *American Journal of Public Health*. 2008; 98(4)[DOI](#)
32. Szinicz L.. History of chemical and biological warfare agents. *Toxicology*. 2005; 214(3)[DOI](#)
33. Garner J.. Some Recollections of Porton in World War 1 Commentary. *Journal of the Royal Army Medical Corps*. 2003; 149(2)[DOI](#)
34. Racioppi F., Daskaleros P.A., Besbelli N., Borges A., Deraemaeker C., Magalini S.I., Martinez Arrifta R., Pulce C., Ruggerone M.L., Vlachos P.. Household bleaches based on sodium hypochlorite: Review of acute toxicology and poison control center experience. *Food and Chemical Toxicology*. 1994; 32(9)[DOI](#)
35. Winder Chris. The Toxicology of Chlorine. *Environmental Research*. 2001; 85(2)[DOI](#)
36. Cevik Yunsur, Onay Meral, Akmaz Ibrahim, Sezigen Sermet. Mass Casualties from Acute Inhalation of Chlorine Gas. *Southern Medical Journal*. 2009; 102(12)[DOI](#)
37. Withers R.M.J., Lees F.P.. The assessment of major hazards: The lethal toxicity of chlorine. *Journal of Hazardous Materials*. 1985; 12(3)[DOI](#)
38. Jiang X.Z., Buckley L.A., Morgan K.T.. Pathology of toxic responses to the RD50 concentration of chlorine gas in the nasal passages of rats and mice. *Toxicology and Applied Pharmacology*. 1983; 71(2)[DOI](#)
39. Becker Charles E.. Methanol poisoning. *The Journal of Emergency Medicine*. 1983; 1(1)[DOI](#)
40. Keil Frerich J.. Methanol-to-hydrocarbons: process technology. *Microporous and Mesoporous Materials*. 1999; 29(1-2)[DOI](#)
41. Waugh K. Methanol synthesis. *Catalysis Today*. 1992; 15(1):51-75.
42. Joyce R, McKusick BC. Handling and disposal of chemicals in laboratories. *Handbook of Chemistry and Physics*. 2000; 16(1):5.
43. Yi S. Methanol Tank Area Fire Risk Assessment. *Guangzhou Chemical Industry*. 2015; 5:89.
44. Shafi Humera, Imran Muhammad, Faisal Usman Hafiz, Sarwar Muhammad, Ashraf Tahir Muhammad. Eight fatalities due to drinking methanol-tainted alcohol in Pakistan: A case report. *Egyptian Journal of Forensic Sciences*. 2016; 6(4)[DOI](#)
45. Rahman GA, Adigun IA, Yusuf IF, Ofoegbu CKP. Wound dressing where there is limitation of choice. *Nigerian Journal of Surgical Research*. 2010; 8(3-4)[DOI](#)
46. Ascenzi JM. Handbook of disinfectants and antiseptics: CRC Press; 1995.
47. KAWAMOTO K, TSUJIMOTO Y. Effects of the Hydroxyl Radical and Hydrogen Peroxide on Tooth Bleaching. *Journal of Endodontics*. 2004; 30(1)[DOI](#)
48. Kim Y.-J.. Analysis of Oxide Film Formed on Type 304 Stainless Steel in 288°C Water Containing Oxygen, Hydrogen, and Hydrogen Peroxide. *CORROSION*. 1999; 55(1)[DOI](#)
49. Watt Barbara E, Proudfoot Alex T, Vale J Allister. Hydrogen Peroxide Poisoning. *Toxicological Reviews*. 2004; 23(1)[DOI](#)
50. Halliwell Barry, Clement Marie Veronique, Long Lee Hua. Hydrogen peroxide in the human body. *FEBS Letters*. 2000; 486(1)[DOI](#)