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Sodium hypochlorite usage during COVID-19 – reassurance or a menace

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Abstract

Sodium hypochlorite (NaOCl) is a highly essential chemical compound used regularly under numerous circumstances. It is a clear, yellowish liquid that is inflammable and a strong oxidant. It is used since many years and is recommended as the disinfectant of choice to avoid the spread of infection and cross infection between health care professionals and the patients. The current COVID pandemic has forced its use in abundance not only in health care units, but as well as in public places. It is like a double-edged sword that requires careful follow up of a set of protocols and precautions during its use to avoid its side effects and health problems among health care workers and the public.

Keywords: SARS-CoV-2; Sodium Hypochlorite; Disinfection; Microorganisms

1. Introduction

Coronavirus disease 2019 (COVID-19) is a respiratory infection caused by SARS-CoV-2 (COVID-19 virus). It is transmitted mainly through respiratory droplets and spreads with close physical contact. Corona in Latin means crown which belongs to the family Coronaviridae. They are large, enveloped, single stranded RNA viruses with the genomes packed inside a helical capsid of nucleocapsid protein (N) and surrounded by fragile lipid envelope associated with three structural proteins - the membrane protein (M), envelope protein (E) and spike protein (S) which mediate virus entry into host cells. Some also have envelope-associated hemagglutinin-esterase protein (HE) [1].

At 21-23°C and 40% humidity, the life span and survival rate of coronavirus depends upon the materials on which it thrives upon, such as paper and tissue paper (3hr), air (3hr), copper (4hr), cardboard (24hrs), wood (2days), cloth (2days), stainless steel (2-3days), polypropylene plastic (3days), glass (4days), paper money (4days) and outside of surgical mask (7days). Survival rate of virus on metal, glass or plastic can increase up to 9 days [2]. One of the best ways to control the spread of this infection that has caused the pandemic is to sanitise and disinfect the areas regularly.

Disinfection is a process which eliminates all or many pathogenic microorganisms on objects but not the bacterial endospores [3]. Disinfectants are used to prevent the spread of disease and reduce the potential risk of contamination. Ideally disinfectants should have broad antimicrobial spectrum, rapid bactericidal action, nontoxic to living beings and environment, lack poisonous residues, have deodorizer, be colourless, non-flammable, non-staining and cost effective [4].

Factors affecting disinfection are organic load, level of microbial contamination, nature of objects, temperature and pH of disinfectants. Depending on these factors they are subdivided into chemical sterilant (disinfectants which kill endospores after long exposure 6-10hr), high level disinfectant (kill all microorganism except some bacterial endospores after less exposure, 45min), intermediate disinfectant (kills tubercle bacilli, vegetative bacteria, most viruses and fungi but not endospores), low level disinfectant (kill vegetative bacteria, some fungi and few viruses at less

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exposure, 10 min). Disinfection with 62% to 71% ethanol, 0.5% hydrogen peroxide or 1% sodium hypochlorite (commonly used), can kill the viruses within a minute [5].

With their efficiency to inhibit acquaintance and spread of COVID virus, disinfectants have emerged as one of the great combatants against COVID-19. Disinfectants such as quaternary ammonium, sodium hypochlorite, accelerated hydrogen peroxide, phenolic and per acetic acid are used in health care units. Sodium hypochlorite is one of the key disinfectants used routinely at present [6].

2. Sodium hypochlorite

During World War I, Dakin introduced sodium hypochlorite solution for antisepsis of the infected wounds. It is called as Dakin solution, Dakin fluid or Carrel-Dakin fluid. It consists of mixture of sodium peroxide (NaO) and hydrochloric acid (HCl) which produces sodium hypochlorite. This dilute sodium hypochlorite (NaOCl) is known as bleach. It is a clear, pale yellowish liquid with chlorine odour, containing 1 to 18% chlorine [7]. It can cause burns and should be stored carefully to prevent deterioration [8]. It is inexpensive and has a relatively short shelf life of 3 months. The shelf life is dependent on factors such as sunlight, temperature, vibration and the starting concentration at the time of preparation [9]. Sodium hypochlorite is effective against bacteria, viruses and fungi and disinfects the same way as chlorine does [10].

2.1. Preparation of sodium hypochlorite

Sodium hypochlorite preparation can be done by dissolving the salt in softened water to form concentrated solution. This will electrolyse in water and forms sodium hypochlorite solution. 150g of active chlorine will be present per litre. During this process caution to be taken to handle the explosive hydrogen gas that will also be formed. Another way of preparation of NaOCl is by adding chlorine gas (Cl_2) to caustic soda (NaOH). One of the end products would be oxygen and the other being hypochlorous acid (HOCl). These two substances play a role in oxidation and the disinfection processes respectively, by acting on the proteins of the biological molecules. The disinfection ability increases with the lowering of the pH by the release of the acid [9].

2.2. Storage of sodium hypochlorite

Storage of NaOCl solution has to fulfil criteria such as storage life, requirements, tank materials and temperature. It is stored in an anticorrosive container which will also manage the instability of the solution. As sodium hypochlorite undergoes decomposition, the effectiveness decreases since there will be slow breakdown of the solution and thereby the reduction in its oxidative and corrosive effects. NaOCl is best stored at 60°F (15°C) in a cool room, away from direct sunlight exposure, as it decomposes under UV radiation and heat. Tank material in which NaOCl is stored are HDPE, fiberglass reinforced plastic, PVC, titanium bolts, PTFE, PVDF, FKM, tantalum and chlorobutyl rubber lined steel. Specific gravity of this solution is 1.9. If the solution has to be kept outside, then the tank material should consist of insulation, mastic coatings, and heat tracing. Vent should be double the size of the inlet pipe diameter of the tank to prevent oxygen accumulation. If it is not stored properly oxygen gas accumulation causes hazardous pressure and will be dangerous [11].

If the initial concentration of NaOCl is high it breaks the chemical faster and further reaction with water will be slowed. Hence optimal concentrations should be maintained [12].

2.3. Mechanism of Action

When sodium hypochlorite disinfectant comes in contact with the contaminated surface, the HOCl penetrates into the microbial cells via the cell membrane and inhibits enzyme activities and damages the DNA and cell membrane. Full penetration of solution generates oxidative stress that in turn damages the cellular components of microbial cells. Study has showed that cell structures of few microorganisms like mycobacteria and corynebacteria are protected by hydrophobic lipid bilayer which prevents the penetration of HOCL [12].

2.4. General principles of using a hospital disinfectant

Equipment or surfaces should be completely clean from dust and other items which interfere with the action of the disinfectant. Disinfectant should be used for equipment which have the potential to spread the infection. They are categorised into groups like critical, semi-critical and non-critical items. Critical items are those in direct contact with tissues or vascular system and definitely need sterilisation. Semi critical items contact the mucous membrane or non-intact skin for which high level disinfectants are necessary and non-critical items are those where in the surface contact needs cleaning [13].

Depending on the needs, different concentrations of NaOCl are prepared such as cloths and mops - 0.006 % NaOCl solution; work surfaces, floors, crockery, cutlery etc. 0.01 % NaOCl solution. General disinfection is done using 0.1% solution to sanitize walls, bathrooms and also other surfaces like laboratory work surfaces, sink, pierre jars and 0.25 % solution is used on blood spillage areas [14].

3. Prevention and Control guidelines in using NaOCl disinfectant in health care units: NCDC (National Center for Disease Control) & WHO Guidelines [15]

The floor, toilet floor, bed screen, shower screen, railings of the clinical hospital areas are disinfected first by using three buckets, where one bucket uses plain water, second uses detergent solution to remove the dust and other particles and finally one more uses 1% sodium hypochlorite after drying the area. Disinfectant should be used as per the manufacturer's instructions with respect to dilution and contact time. Objects which are contaminated with blood, other body fluids, secretions or excretions are cleaned first after wearing the personal protective equipment (PPE kit) and then disinfected using freshly prepared 1% sodium hypochlorite. The solution should be in contact with the surface for 20 minutes. All the sample containing containers should be disinfected before transportation with 1% sodium hypochlorite. Spraying of sodium hypochlorite should be avoided as it has less disease control ability and is also dangerous to the health care workers.

Ceiling, wall, doors and door knobs can be disinfected by hot water, followed by detergent and then by 1% NaOCl solution. The surfaces should be touched only after it dries.

Clinical areas, laboratories, spill areas can be disinfected using 1% sodium hypochlorite, including rag piece, absorbent paper, gloves, Spill care kit, Mop and Hot water. Gloves should be worn always. If the spill areas are large, cover it with absorbent paper/ rag piece. The broken glass and sharps should be removed using a pair of forceps carefully and disposed in the puncture proof sharps container. Let the sodium hypochlorite (1%) stay for 10–20 minutes on the spill areas. Then clean the area and discard the cleaning material into infectious waste bin. Mop the area again with soap and hot water followed by 1% sodium hypochlorite.

White cloth, Mattress/ pillow with rexin cover must be washed using 1% NaOCl for 20 minutes with PPE kit being worn.

3.1. Concentration of sodium hypochlorite and its efficiency against different microrganisms [16]

1% and 2% sodium hypochlorite are microbial resistant to MRSA (Methicillin-resistant Staphylococcus aureus) isolates from surface, environment and ICU equipment.

0.5% of sodium hypochlorite inactivates the C. Difficile spore and vegetative spore. 0.5%, 1% and 2% of sodium hypochlorite inactivates the MRSA, P. Aeruginosa, K. Methicillin Resistant Pneumoniae, S. Aureus, S. Epidermidis, S. Haemolyticus, S. Marcescens, E. Cloacae, E. Coli and P. Mirabilis. 0.1% of sodium hypochlorite inactivates virus which are present for long time on dry surfaces, but the protective action of NaOCl will reduce when it is rehydrated.

5.25% of NaOCl inactivates the growth of albicans, tropicalis, lusitaniae, parapsilosis, kefyr, labrata (clinical isolates) after 30 seconds of contact.

The disinfected surface will be safe until the next person touches it. Hence, the surface has to be disinfected after each use to maintain safety. When a single bacterium occupies the surface, it reproduces into 2.4 million in about 6 hours.

3.1.1. Disadvantages

Sodium hypochlorite releases toxic chlorine gas when heated above 35°C. The chlorinated compounds emitted while cleaning is carcinogenic to humans. They can cause irritation or injury to mucous membranes, conjunctiva, respiratory tract, or gastrointestinal tract. It can also cause necrosis depending on period of exposure. Bronchospasm, skin damage, acute respiratory distress syndrome (ARDS) and severe necrosis have also been reported [17].

High concentrations are known to cause breakdown of muscle tissue. This rhabdomyolysis releases a protein called myoglobin into the blood which affects the kidneys causing acute kidney injury. Hemolysis of RBCs takes place when HOCl are inhaled directly. When HOCl reacts with the proteins and lipids it generates free radicals like superoxide and OH radicals. These are also known to severely damage the renal epithelial cells causing renal diseases [18].

Viruses can show resistance to disinfection due to their cellular property. They are always attached to materials like host cells, cell debris, soil or aerosols. These are called as viral clumping protective factors, which reduces the penetration of the disinfectants. Therefore prior to the use of disinfectants, cleaning of the surfaces or materials using soap or detergent is necessary [19]. NaOCl solutions are less hazardous at 1% concentration than the standard supplied solution of 14% concentration [20].

Sodium hypochlorite is unstable. Chlorine evaporates at a rate of 0.75 gram per day from solution. Sodium hypochlorite disintegrates when heated or if it contacts acids, sunlight, certain metals, and poisonous and corrosive gases, including chlorine gas. It is a flammable strong oxidant that reacts with flammable compounds and reducing agents. These characteristics must be kept in mind during transport, storage, and use [9].

3.1.2. Handling care and tips for use of NaOCl

Do not mix it with strong acids, amines and ammonia. Wear protective gloves, glasses and PPE kit while using it. Hands should be washed properly with soap after its use. It should be preserved in tightly packed containers in a cool area away from sunlight. It should be kept away from children. If it irritates eyes and skin, wash the area immediately with water [21].

4. Conclusion

The use of sodium hypochlorite has increased drastically and has been a boon in controlling the COVID 19 pandemic. It is used abundantly in the public spaces, crowded areas and in the presence of humans and other creatures. Although it is an economical and highly effective disinfectant, due considerations need to be taken while using this disinfectant and the harmful effects associated with it should deter it`s use in abundance.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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