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Body and Surface Sanitization | Do's and Don'ts

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Suddenly the world surrendered to an unexpected creature unknown to its overly anticipated future plans. Predictions, anticipations, models, and discussions on the possible nuclear war, environmental disasters, ocean pollution, industry 4.0, or the digitalized world were kept on hold, and everyone was concerned about one thing: Surviving Corona. SARS- CoV-2.

Originated in Wuhan, China, it quickly spread across Asia, Europe, and America creating mayhem in every country. As this article is being written, over three million known infections and 260,000 plus deaths have been reported worldwide.

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-Cov-2) is identified as the virus responsible for the debacle occurring all around in different scales. This is also called as COVID-19 in public health communications. Some countries handle it carefully, and some have become a total disaster zone during its peak depending on the efficiency of the operations management. While all the scientists are working around the clock to beat the virus and to find a cure for COVID-19, still the solution is beyond the horizon with a lot of unanswered questions on the table. Social distancing seems to be the most effective way to mitigate the spreading of the virus, while individual hygienic behavior contributes immensely to hold the virus entering the body.

Generally, transmission of a virus similar to SARS-CoV-2 occurs via respiratory droplets released by coughs and sneezes within a range of six feet, which comes in contact with another person's mouth or nose, seldom through eyes. It mainly enters human cells by binding to the receptor angiotensin-converting enzyme 2 (ACE2). Generally, a person touches his/her face over 12 times an hour unintentionally. The SARS-CoV-2 virus is known to survive on different surfaces with a life span ranging from hours to days. Preliminary research indicates that the virus may remain viable on plastic and steel for up to three days, but does not survive on cardboard for more than one day. People touch these surfaces multiple times during their daily activities. An infected person can easily leave his/her footprint on the surfaces and the rest of the work is in the hands of others in the area. People are never isolated in their daily life, and a mix of healthy, sick and silent carriers roam around in the society undetected. Therefore, the threat of contracting the virus at any given point is extremely high, and owing to the uncertain pattern of deaths and the cure still being unknown, prevention remains to be the best option at this time.

Prevention can be done by isolation, quarantine, or lock-down of suspected spreading areas. All these methods also affect other areas, especially the Economy. In order to maintain daily life and to run daily activities, even at a very minimal level, people's movement and involvement is a must. Essential services, as well as relief works, need to be continued to run the system at a bare level of normalcy. Although work-from-home is operating in many service-oriented sectors, the necessity of in-person activities is also important to operate the functions smoothly.

Many organizations have taken measures to operate at a minimal level with a high degree of sanitization of the premises and the people involved in the operation. Unfortunately, the people involved may not be tracked well, or they may not reveal the truth of their movements due to fear of being quarantined, shame to be isolated, or other social factors: Sad situation, but this is the reality. Therefore, all the persons involved in such operations and the premises and the equipment need to be sanitized properly and effectively. However, society has a wide spectrum of views and opinions on sanitization.

SARS-CoV-2 is a virus belonging to the ***Coronoviridae*** family which takes a spherical shape, with an image reminiscent of a Solar Corona due to decorations with about 20 nm long petal-shaped surface projections called "peplomers" or "spikes". The virus has a single-strand RNA with a viral genome of 26-32 kilobases in length. The cell wall of the virus is a lipid bilayer and the spikes come out of the bilayer to form the corona structure.

Best is Soap and Water

The best sanitization method recommended by experts and the WHO is using soap and running water. Soap is a bipolar molecule that consists of a polar end of a nonpolar long-chain hydrocarbon tail and a head. The hydrophobic non-polar head and long-chain binds to the organic parts of dirt, oil, lipid, fat, or protein, whereas the hydrophilic polar end which usually consists of a carboxylic or sulphonic acid end with Na+ or K+ ions, dissolves in water and sometimes makes micelles to take dirt/oil out.

The non-Polar head and tail of the soap molecules bind to the lipid bilayer, break it apart, and dissolve in water. This opens up the virus and exposes the genetic material inside, thus destroying the virus. This mechanism generally takes place in a time span of 20 s. Therefore, an effective hand wash needs to be used with a thorough rubbing and cleaning over 20 seconds.

Alcohol? With or Without Soda?

Apart from soap, a quick and instant method for hand sanitization is widely known as a 70% alcohol solution. Generally, it's a 70% Isopropyl/ethanol mixture solution in water with additives such as hydrogen peroxide, glycerin, and other skin-smoothing agents. Moreover, it can be made to a gel form with Carbopol. Whichever the method, it needs over 70% alcohol strength for effective antimicrobial action.

The mechanism of alcohol on the virus is more or less the same as soap. Alcohol is effective in destroying the viruses having both protein and lipid layers. Proteins are denatured by ethanol and lipid layers also get dissolved in the alcohol, disrupting the membrane exposing the genetic material. To have an effective sanitization, a minimum of 65% alcohol strength is recommended. However, most of the alcohol-based sanitizers in the current market do not fulfill the minimum standards, and it's a big question awaiting regulation.

Although hands can be sanitized by either of the above methods, other surfaces are prone to be contaminated by saliva and mucous droplets from uncovered sneezing by patients or carriers. Generally, a sneeze can carry the droplets over 6 feet and a normal saliva droplet can travel about 3 feet while a person is just talking to another. These droplets deposit on the nearest surface, and they can live between 3 hours to many days depending on the surface. These surfaces also need to be cleaned, but with a suitable sanitizing agent that would be effective and safe on that surface as well. The surfaces are not just flat surfaces at the micro-level. They have microscopic grooves, pits, and cavities where Viruses can live for days. If not properly sanitized with an effective sanitizer that would kill the virus, there is a probability of the virus spreading through the surface.

Bleach to Wash out Everything

There are several surface sanitizers in the market with different properties and effectiveness. Also, it depends upon the place and purpose. The most common disinfectant, Bleach, is NaOCl (Liquid Bleach) or $Ca(OCl)_2$ (Bleaching Powder). Depending on the requirement, the solution can be diluted and applied. However, the Bleach solution has a relatively short lifespan and it needs to be prepared frequently.

Industrially, Bleach is prepared by the absorption of gaseous chlorine into NaOH.

Chlorine-based compounds are effective against a wide variety of microorganisms including bacterial spores. They are listed by the World Health Organization as essential medicines in any health system. They are easy to use, widely available, and very cheap. The principal ingredients of a concentrated sodium hypochlorite solution are hypochlorite and sodium hydroxide. Normally sodium hypochlorite is a strong basic solution (pH: 12.5 to 13.5) containing 5 to 12% of available chlorine (AC), but now the pH is adjusted to make it neutral. NaCl formed in eq. 1 is eliminated adequately from the NaOCl product.

This makes metal and other surfaces to be damaged in prolonged use inside buildings and factories. Although the concentration of bleach is less than 1%, the long-term effect is far more damaging.

The Ozone Hole in the Arctic is Closed, But….

Ozone, although it doesn't form naturally, it can be generated mechanically for sanitization purposes. When reacted with water, it forms hydrogen peroxy (HO_2) and hydroxyl (OH) free radicals which have greater oxidizing capacity than Ozone itself and plays an active role in the disinfection process. Ozone is a short-lived unstable molecule, and it needs to be generated on-site.

It is generally believed that the bacteria are destroyed because of protoplasmic oxidation resulting in cell wall disintegration (cell lysis). The effectiveness of disinfection depends on the susceptibility of the target organisms, the contact time, and the concentration of the ozone. Thus, the effectiveness of Ozone disinfection always depends upon many factors. Furthermore, the effectiveness of the Ozonated water depends upon the pH of the solution. Higher pH facilitates ozone decomposition due to increased hydroxyl radical formation; whereas lower pH (less than 7.0) slows down ozone decomposition resulting in higher concentrations of molecular ozone. The rate of ozone decomposition increases significantly (due to •OH formation) when the pH is greater than 8.0. Ozone residuals are difficult to maintain at pH levels greater than 9.0. More basic solutions that have a higher concentration of hydroxyl radicals possess a greater potential of disinfection.

Ozone is a very strong oxidant and virucide. The mechanisms of disinfection using ozone include:

- Direct oxidation/destruction of the cell wall with leakage of cellular constituents outside of the cell.
- Reactions with radical by-products of ozone decomposition.
- Damage to the constituents of the nucleic acids (purines and pyrimidines).
- Breakage of carbon-nitrogen bonds leading to depolymerization.

The generation of Ozone is a very high energy-intensive process. Generally, it's carried out using ambient air with 21% Oxygen or Pure Oxygen of 95% purity. The two main principles of Ozone generation are Corona-Discharge and UV-light. Corona-Discharge, which has no connection with Covid-19, is the primary method with greater sustainability of the unit and higher Ozone production at a low price.

However, in current Ozone Chambers, ambient air is used where purity and the yield of Ozone generated can be lower.

Quaternary Ammonium Compounds (QACs)

Quaternary ammonium compounds are a family of low-level disinfectants primarily derived from benzalkonium. QACs are reacted to provide a variety of chain lengths and molecular structures so that the mix of QACs used in the disinfectant provides a wider range of efficacy than a single chain. QACs are generally used to disinfect countertops, toilets, and other high touch environmental surfaces and floors. They are of low cost and used in many applications. QACs are cationic detergents (surfactants or surface-active agents). They reduce surface tension and form micelles, allowing dispersion in a liquid. The negatively charged anion portion is usually chlorine or bromine and is linked to the nitrogen to form the QAC salt. QACs are further classified based on the nature of the R groups, which can include the number of nitrogen atoms, branching of the carbon chain, and the presence of aromatic groups. These variations can affect the antimicrobial activity of the QAC in terms of dose and action against different groups of microorganisms.

QACs are membrane-active agents that interact with the cytoplasmic membrane of bacteria and the plasma membrane of yeast. 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 and spores, depending on the product formulation. At low concentrations (0.5 to 5 mg/liter), they are algistatic, bacteriostatic, tuberculostatic, sporostatic, and fungistatic. At concentrations of 10 to 50 mg/liter, they are microbicidal for these same groups, depending upon the specific organism and formulation. Thus, QACs can be modulated to be more effective against specific targets and safer to humans.

In conclusion, it's extremely vital to recognize the role of a particular disinfectant with the occasion. Considering the chemical and microbiological effects of the disinfectant alone, will not yield expected results as many other factors govern the antimicrobial functions. Every disinfectant has its advantages and disadvantages for a particular situation. Selecting a suitable disinfectant for the application is crucial. Effects of disinfectants on the skin upon prolonged usage need to be carefully analyzed. Applying Chemical Knowledge along with some dosage of common sense is advisable at this point where different opinions galore.

At the end of the day, it's not who's right, but what's best for the society. Once the crisis is over, we need to stand up as one human race who successfully survived a global terror. It doesn't count who contributed more, or less, it ultimately boils down to who survived or not.

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Fate and Transport of Viruses in Groundwater Environments

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Groundwater contamination

Groundwater is widely used as drinking water supplies around the world, specifically in the developing economies. About 96 percent of all usable freshwater is found as groundwater, which globally provides 25 to 40 percent of the world's drinking water. Aquifers are the source of groundwater that is located subsurfaceis often connected with surface water systems and mostly recharge through rainwater infiltration and percolation and may discharge to surface water sources such as streams and lakes. Contamination of groundwater depends on the risk factors: 1) sensitive aquifers; aquifers in which viruses may travel faster and further than bacteria (e.g. limestone, lateritic or coastal plain sand aquifers, which are high in permeability; 2) shallow unconfined aquifers; 3) aquifers with thin or absent soil cover;4) close to surface water bodies; and 5) high population density areas.

Contamination of groundwater via chemical and pathogenic contaminants is a severe environmental problem that poses a significant threat to human health. Among the pathogenic contaminants such as viruses, bacteria, and protozoa, viruses are readily transported through soils, due to their smaller size compared to bacteria and protozoa. Studies have reported on the fate and transport of viruses in soils and aquifers are necessary to determine the vulnerability of groundwater to pathogenic contamination and to secure safe drinking water sources. However, only a handful of literature reports on the capacity of transport of viruses into groundwater.[1,2] Major processes that govern the subsurface transport of viruses are their rate of