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Clean. Elevated.

THE NEW WORLD OF COVID-19 AND DISINFECTION

Introducing a Revolutionary Change

An Ionogen White Paper
by
Bergein F. Overholt, MD and Chuck Jones, PhD

SETTING THE SCENE

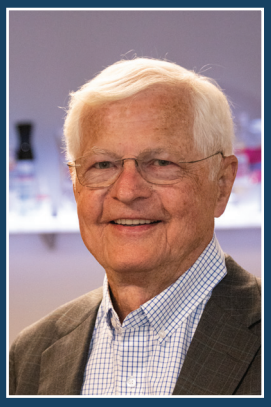
The world is facing a confluence of enormous challenges never before encountered:

- A pandemic caused by a virus that mutated and jumped from animals to humans, wreaking havoc on society.
- Superbugs that are resistant to most, if not all, antibiotics leading to enormous economic and personal losses.
- Misinformation about and misapplication of products that are being used for disinfection and sanitation leading to further human illness.

Addressing these three major societal issues will be explored in this paper. In response to the challenges they present, knowledgeable leadership and advances in technology have joined together to produce a sanitation/disinfection product that is far more effective than bleach yet is totally safe for humans, pets, and the environment.

In fact, as you will see, it also provides promise for protecting us from COVID-19.

A revolutionary answer to the challenges listed above lies within this paper. When you read it, prepare your mind for change!



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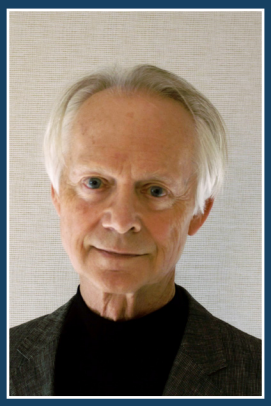
EXECUTIVE SUMMARY

This Ionogen white paper reports new research-based interventions, currently awaiting approval in the EPA queue. It presents practical, real-world solutions to a globally-threatening set of human health vulnerabilities: First, the problem of novel mutating pathogens, e.g., diseases without vaccines, like the zoonotic virus causing our current Covid-19 pandemic. Second, the growing threat of Antibiotic Microbial Resistant (AMR) "Superbugs" that have become immune to known antibiotics. Third, the grave hazards from inadequately addressed toxic side effects associated with the standard disinfectants used in our front-line defense in those two contexts and others.

This paper proposes an innovative approach to resolving all these challenges in the form of a recently engineered, patented process for producing a non-toxic, stable, pH-controlled, concentration-targeted version of Hypochlorous Acid (HOCl), a fast-acting, comprehensively effective, bio-mimicking disinfecting and sanitizing agent; the same substance employed by white blood cells to fight disease in our bodies. Recognition of HOCl's distinct advantages in addressing pathogens (viruses, bacteria, mold, fungi, prions) is not new, however Ionogen's innovations for both production and application have overcome serious prior barriers to its broad implementation.

Citing research, this paper proposes a ground-breaking model for sanitization and disinfection, both on surfaces and in the air; one that employs Ionogen's Super-HOCl in aerosolized form, requiring no wiping step, to produce results demonstrably superior to traditional disinfectants through a process that is entirely safe for people, animals, and the environment.

As one example, Ionogen's dry-fogging of a Super-HOCl solution, in a study administered by a certified, independent laboratory, quickly and successfully produced a log-10 (that is, a 99.99999999%) eradication of an EPA-approved Covid-19 surrogate virus (0C43) injected into the air at far higher concentrations than one could encounter in real life.



Chuck Jones, PhD

THE NEW WORLD OF DISINFECTION

THE BIG PROBLEMS

Ours is a challenging new world with both good and bad things happening around the globe. We are facing sectional wars, social upheaval, political turmoil, climate change, and, central to this paper, a biological catastrophe that will bring great disruption and challenges to society as we know it today.

That biological catastrophe is primarily related to a fundamental change evolving in microorganisms – namely, mutation - that has been occurring since inception but is currently occurring in a more aggressive pattern. Microorganisms, including viruses and bacteria, are, in effect, "smart". As Nature predicts, they adapt and mutate to survive and thrive in the world, often in ways highly unfavorable to humans.

Three Problematic Examples

Mutating Viruses
The COVID-19 pandemic caused by a new mutated virus that originated in animals and moved to humans. COVID-19, caused by the neovirus, SARS-CoV-2, represents only one of multiple worldwide illnesses caused by mutated pathogens.

People around the globe are facing an alarmingly changing world in which such mutations of viruses are creating human epidemics and pandemics with enormous consequences associated with human morbidity and mortality resulting in huge societal costs.

We are now dealing with zoonotic viruses that move from animals to humans, e.g. Ebola and others, and viral mutations such as the coronaviruses that include the flu virus, MERS and SARS-CoV-1 and now SARS-CoV-2, the virus causing the current COVID-19 pandemic, which itself appears to be mutating into a more contagious form as this is being written. Humans have little natural defense against these newly introduced pathogens. We are vulnerable.

Antibiotic Microbial Resistance (AMR)
Repeated exposure of bacteria to antibiotics has produced bacteria that have become resistant to antibiotics. Similarly, low levels of disinfecting biocides, inadvertently misused during efforts to sanitize the environment, can also lead to potentially lethal pathogen mutations.[1,2] The result: "superbugs" that are killing 99,000 hospitalized patients annually in the United States alone. Unless major changes are made, AMR is projected to be associated with the death of 10 million people around the globe in 2050 with a cumulative cost of over $100 trillion USD.[3] That mortality rate represents the death of one person every three seconds if we do not solve this problem.

What is happening? The cost of developing new antibiotics is so great that new antibiotics are not being developed as rapidly as is needed to address the issues of "superbugs" resistant to all current antibiotics. Unless significant changes occur, the possibility of our society entering an era of "no effective antibiotics" for some deadly infectious diseases is becoming a reality.

Toxic Exposure
Toxic exposure to humans and the environment is resulting from efforts to address these pathogens with current sanitizers and disinfectants. It turns out that many of the chemicals we are currently using in our efforts to sanitize our environment are proving poisonous to people, especially to children, to animals including our pets, and to the environment. Ironically, the effort toward cure has become a significant problem in itself. The products we use have, until now, represented the state of the art in cleaning, sanitizing and disinfecting technology but the great majority of these products contain toxic chemicals.

The threat to our society of the toxicity of the chemicals we are exposing our people and children to is likely the greatest threat of all.

Of these three issues, the threat to our society of the toxicity of the chemicals we are exposing our people and children to is likely the greatest threat of all.

The worldwide costs in terms of money and of lives lost accruing from mutating pathogenic viruses, from AMR bacteria and from toxic chemicals we use for disinfection and sanitation are staggering. And the threats they pose will increasingly become greater if we fail to find and enact effective interventions to mitigate and resolve these problems. Failing at that task ultimately means eventually even jeopardizing global society itself.

ADDRESSING THESE PROBLEMS

First, consider sanitation and disinfecting products. One recommendation to address these catastrophic diseases is to defeat the pathogens where they originate before they invade our bodies: namely, targeting surfaces of all types, especially in healthcare facilities, in food preparation, in public buildings, in wound care. Essentially everywhere. Including in homes. But doing so requires effective, safe disinfection! However, current disinfection methods and products are fraught with severe problems, including:

This report details a positive alternative approach offered through the introduction of a totally non-toxic, highly-effective sanitizer/disinfectant product powered by hypochlorous acid (HOCl).

- ineffective results
- incomplete or improper use (failure to completely follow instructions or faulty implementation of cleaning procedures)
- unintentional promotion of AMR due in part to incorrect use
- the toxic effects of cleaning products that cause serious diseases in both adults and children4-13 and harm to animals as well as toxic harm to the environment.

Most disinfectants are effective in killing bacteria and viruses if used as directed and applied according to instructions for a sufficient period of time. But too often, those directions are not - or cannot – be adequately followed. And all too often, the disinfectants contain toxic chemicals.

And, yes, we must also consider the impact of "less than full truth in advertising." We are told the products are safe, in part based on the fact they have been assigned an "EPA registered number." But reviewing the EPA "N" list (https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2) or the products' Safety Data Sheet reveals that many, if not most, of these products include chemicals that are harmful to humans, animals or to the environment - such as quaternary ammonium compounds ("QUATS"), bleach, hydrogen peroxide or ethyl alcohol. We will delve further into the issues of sanitizer, disinfectant toxicity and failures in full disclosure later in this paper.

Beyond surface disinfection, a second area for attacking pathogenic viruses is defeating them in the air we breathe. Recent medical evidence and opinion indicate that viral transmission through the air plays an important role in disease transmission.[14-21] This finding opens many new frontiers to combat viral diseases. We will also discuss this subject in greater detail later in this paper.

PROPOSING A DRAMATIC IMPROVEMENT TO DISINFECTION AND SANITATION

Instead of dwelling on the negative issues in disinfection, this report details a positive alternative approach offered through the introduction of a totally non-toxic, highly-effective sanitizer/disinfectant product powered by hypochlorous acid (HOCl) in a stabilized, near neutral pH Super Mixed Oxidant Solution (Super-HOCl).*

*Super Mixed Oxidant Solution (Super-HOCl) refers to the product produced by the Ionogen (Knoxville, TN) advanced electrolysis methodology used in producing the solution. It is composed primarily of HOCl but during and shortly after electrolytic production, it also contains measurable amounts of hydrogen peroxide, chlorine dioxide and ozone. While in fresh, active form, these oxidants are additive in enhancing the pathogen killing effect of HOCl. However, they dissipate within a few minutes of being freshly made, reverting back to a neutral state.

A BRIEF HISTORY OF HOCl

In its simplest description, HOCl is produced during the electrolysis of a saltwater solution. During electrolysis, Free Available Chlorine (FAC) is produced with the chlorine being dissolved in water. The FAC is the active agent in killing pathogens and its effectiveness is determined in great part by its concentration in solution – the higher the concentration, the greater the effectiveness.

First described by the French chemist Antoine Jérôme Balard in 1834 and then by Michael Faraday, the antibacterial effectiveness of HOCl went unrecognized for decades. Later HOCl was used successfully during WWI for wound care.[22] However, the equipment to produce the HOCl was large and cumbersome, expensive and unreliable. Furthermore, the HOCl product produced by these early machines was unstable resulting in a short shelf-life.

A renewal of interest in HOCl began about 15 years ago. Since that time, product quality has improved but has still suffered from manufacturers' inability to produce more than minimal concentrations of FAC as well a failure to establish long-term product stability. If these difficult problems had not posed such steep challenges, HOCl would have been broadly available and widely used long ago.

SIGNIFICANT TECHNOLOGICAL ADVANCES IN HOCl PRODUCTION

Ionogen has addressed these prior limitations by recently developing and patenting proprietary technology that enables production of HOCl:

- in a stable solution
- at a near-neutral pH
- with a broad range of specifically targeted FAC concentrations designed for different applications ranging from 200-2200 parts per million (ppm)

These Super-HOCl products meet or exceed the major criteria of the "ideal disinfectant" as characterized by the Center for Disease Control and Prevention (CDC)[23] in that they:

- rapidly and effectively kill offending pathogens including bacteria, viruses, fungi and molds
- are completely non-toxic to humans and pets
- are completely non-toxic to the environment

Ionogen's Super-HOCl is a disinfectant that is stable, is more effective than existing products and also is completely non-toxic to people, animals and to the environment.

In fact, Super-HOCl establishes a new industry standard for disinfection and sanitation. To reiterate and underscore, Ionogen's Super-HOCl is a disinfectant that is stable, is more effective than existing products and also is completely non-toxic to people, animals and to the environment.

MORE ON THE ISSUE OF TOXICITY OF DISINFECTANTS

As stated earlier, even with the two major issues of mutating viruses and AMR, the threat to our society of the toxicity of the chemicals we are exposing our people and especially our children to with the use of standard disinfectants may be the greatest threat to humans of all.

Consider the following:

Toxicity of Existing Products and Chemicals Used for Cleaning and Disinfection
Increasingly, recognition of the toxicity of current cleaning and disinfection products on both the environment and to adult humans is occurring, to say nothing of the amplified negative effects on children.

Examples of toxic chemicals in household and commercial cleaning and disinfecting products are numerous. Many Lysol® products such as disinfecting wipes, spray and laundry sanitizer contain QUATS, All-purpose cleaner and Kitchen Pro Antibacterial Cleaner also contain QUATS as does Clorox Everest and Disinfecting Bathroom Cleaner.

Other Clorox compounds contain sodium hypochlorite (bleach). Purell Wipes and Hand Cleaner contain Ethanol (Ethyl alcohol) which is very drying to the skin and is unsafe for young children. Add to this the recent FDA warning against using hand sanitizers imported from Mexico that are or could be contaminated with methanol or 1-propanol.

This list is simply offered as a series of examples, inviting the reader to explore further. All a consumer has to do to "check out" a product is to use the internet to review the Safety Data Sheet for the product in question.

The results are extremely concerning as most if not all commonly used household and commercial cleaning/ disinfection products contain chemicals with potential significant deleterious side effects that are often overlooked, unrecognized or unappreciated by the user. Quaternary ammonium compounds (QUATS), hypochlorite (bleach), hydrogen peroxide in high percentage, phenol compounds - all have toxicity concerns:

- irritation or injury to eyes and skin (very common)
- a strong association with development of childhood asthma[4]
- a cause of adult onset asthma[4-8]
- a cause of development of COPD (chronic obstructive pulmonary disease).[9,10] In fact, one investigator stated that "the effect of occupational cleaning (ed.: use of sprays and other cleaners) was comparable to smoking somewhat less than 20 pack-years" (ed: 1 pack year equals one pack of cigarette a day).[10]
- a cause of thyroid cancer.[11]
- a cause of "endocrine disruption" with a reduction in fertility in mice.[12]
- an increase in defects in neural tube (brain) developments in mice.[13]

All this paints a rather grim picture of the current state of sanitization and disinfection.

HOCl is naturally produced by white blood cells of all mammals for the purpose of killing invading bacteria, viruses and other pathogens.

COMPARING TOXICITY: SUPER-HOCl IS NON-TOXIC AND HAS NO ADVERSE EFFECT ON HUMANS

Hypochlorous acid (HOCl) is the main component of Super-HOCl. Because the average person is not familiar with hypochlorous acid, there is naturally some concern about its safety, especially in vaporized form such as what is produced by our Purity humidifier system. In addition to the chemical compound including the symbol "Cl", the slight "chlorine" smell of the product when vaporized might lead people to believe the system is producing noxious chlorine gas.

To unequivocally dispel this misconception, testing to determine whether chlorine gas is produced during vaporization of HOCl was performed by an independent, accredited lab over a 2-day period. The air concentrations of Chlorine (Cl^-) (ppm) for both testing days ranged from 0.085 – 0.19 ppm. These results are far below the Permissible Exposure Limit of 0.3 ppm established by California and by OSHA, hence proving that vaporized HOCl does not contain dangerous levels of chlorine gas.

HOCl is non-toxic to people. In fact, HOCl already exists in the human body, being naturally produced by white blood cells of all mammals for the purpose of killing invading bacteria, viruses and other pathogens.

Clinical observations over decades have shown no negative effects from using HOCl for wound care or for treatment of ocular disease. HOCl has been substituted for drinking water with mice which incurred no deleterious effects. Multiple studies further substantiate the non-toxicity of HOCl to humans. However, clinical observation is often anecdotal. True, scientific, peer-reviewed data is required when stating a product used in treating humans is non-toxic and not harmful.

Scientific studies at the cellular level are extremely important in evaluating toxicity to humans. Ionogen's observational cytotoxicity studies performed by an independent lab in four different studies have demonstrated no toxicity to lung cells (A549 cell line) when heavily exposed or fogged with Super-HOCl. In addition, Ionogen is currently undertaking detailed cellular metabolic toxicity studies performed by an independent, certified lab to scientifically determine if there is any acute or chronic human lung cell toxic effects from exposure to Super-HOCl. Given Ionogen's four previous studies on lung cell viability, no concerns are anticipated. Results are expected to be available by the end of 2020 and will be reported as an addendum to this paper on this website.

Furthermore, Ionogen is initiating the processes for a human clinical trial to further study the safety and effectiveness of Super-HOCl in fogging and misting of patients with and without COVID-19.

SUPER-HOCl TESTING RESULTS WITH THREE TARGET PATHOGENS: SUPERBUGS, BACTERIA, AND VIRUSES

Ionogen has engaged an approved independent laboratory to study the effectiveness of using Super-HOCl with a range of three main pathogen categories: superbugs, bacteria, and viruses.

Research Results from a Tough Challenge - A Representative Superbug

The Center for Disease Control (CDC) has identified Clostridioides difficile (C. diff) as one of its current top three superbugs. One of their press-release summaries indicates C. diff causes roughly half a million intestinal infections yearly manifested by persistent diarrhea, with almost 30,000 patients in the United States dying within 30 days of diagnosis of C. diff and with 15,000 of those being directly attributable. It has been noted as the most common microbial cause of healthcare-associated infections in U.S. hospitals with costs upwards of $4.8 billion every year in excess health care costs for acute care facilities alone.[24]

C. diff is exceptionally hard to kill as it forms spores for protection when attacked by an antibiotic. The spores can enable it to survive in the presence of air for two years. This 2020 article title says it all: Hospital disinfectants struggling to kill C. diff bacteria colonies: Clorox comes close, but none completely eliminates superbug.[25]

In tests performed by an independent, certified laboratory, Super-HOCl (Ionopure Disinfecting Spray) achieves a remarkable log-6 (99.99996%) kill of Clostridioides Difficile spores in 1 minute (table 1). Again, C. diff is the most difficult of bacteria to kill as it forms resistant spores when "attacked." No other disinfectant has achieved this level of C. diff kill in 1 minute in a safe, non-toxic and effective way.

Below is a table depicting the difference on C. diff survival between untreated surfaces and Super-HOCl-treated surfaces measured as Colony Forming Units (CFUs), which is a microbiological term referring to the number of viable cells. Moving from over a million CFUs to less than .23 CFUs is what results in that 99.99996% rate of effectiveness.

Table 1
Use of HOCl on Clostridioides Difficile

On-Site Generating (OSG) Technology & Wipe System for the Remidiation of *Claustridium difficile* (ATCC: 43958) on Stainless Steel Surface Using 2,200 ppm of Free Available Chlorine (FAC) Surfactant-Enhanced Solution				
Treatment System	**Exposure Time (Min)**	**Average recovery from untreated surface** *(avg. of 2 sq. analysis; CFU/sq.)*	**Recovery from Treated Surface (CFU/sq.)**	**Average Percent Reduction**
Ionopure Disinfecting Spray (2200 ppm)	1	1,040,000 CFUs	<0.23	>99.99996%
	2	1,050,000 CFUs	<0.23	>99.99997%
	5	1,050,000 CFUs	<0.23	>99.99997%

All testing done under ASTM GCLP standards.

A log-6 reduction of the presence of a pathogen is a difficult milestone to fathom, even when it is cast in simple numbers as a 99.9999% (six 9's) kill rate. On the following page is a graphic (figure 1) designed to make the idea more comprehensible, even if it is still challenging to grasp.

Figure 1
Log-6 Reduction

Log Reduction	Number of CFUs Remaining	% Reduction of Bacteria
0	1,000,000	0
1	100,000	90
2	10,000	99
3	1,000	99.9
4	100	99.99
5	10	99.999
6	1	99.9999

Visualizing a **Log-6 Reduction**

A stack of one million pennies reaches approximately 4,986 feet tall, or about the height of five Eiffel Towers.

A log-6 reduction of that stack would leave you with **just one penny.**

OTHER SUPER-HOCl BACTERIOLOGY / VIRAL STUDIES

Testing results against other viruses and bacteria is equally important and demonstrates a broad spectrum of pathogen kill by HOCl. Table 2 details results of the use of Super-HOCl at various concentrations on bacteria that cause many of the hospital-acquired bacterial illnesses.

Table 2

Pathogen Kill Rates Following Exposure to Aerosolized HOCl (Dry-Fogging)

Bacteria	Results
Klebsiella pneumoniae (best known for respiratory infections)	>99.99% Reduction
Staphylococcus aureus (skin infections)	>99.99% Reduction
Pseudomonas aeruginosa (common UTI/kidney infections)	>99.99% Reduction

Norovirus is another virus of particular interest. It is highly infectious and is one of the most common causes of outbreaks of gastroenteritis with vomiting and diarrhea. It is particularly notorious for rampant gastrointestinal illness on cruise ships and in schools. Transmission can be by hand to mouth but also vomiting can result in aerosolized norovirus that can "travel" across a room in the air. Once established, the virus is difficult to completely eliminate so attempts at cleaning facilities exposed to norovirus require very strong chemicals including bleach (1.5 – 7.5%) in water.

Since human norovirus cannot be grown in a laboratory environment, HOCl was previously tested against surrogate viruses for human norovirus (Bacteriophage and Murine Norovirus) and was found to readily kill those viruses on surfaces, thereby potentially slowing down and perhaps even preventing norovirus outbreaks of gastroenteritis. Further studies on the use of aerosolized Super-HOCl against norovirus surrogates are in process.

Studies of dry-fogging vaporized HOCl have shown 99.9% reductions in viral quantity in surface viral testing and a log-10 (99.99999999%) reduction in aerosolized Coronavirus 0C43 quantity in air.

Based on these results, Super-HOCl demonstrates and establishes a baseline for new industry-wide disinfection standards. And, like the ability to safely destroy the most difficult-to-kill C. diff so effectively, Super-HOCl can kill essentially any bacteria, virus, fungus or mold on surfaces in a timely manner, generally in a matter of seconds while remaining completely safe for humans.

These studies, and those described below, combined with clinical experience, provide a solid scientific foundation for treatment of and prevention strategies for human diseases with Super-HOCl, including (norovirus) gastroenteritis and, possibly, pulmonary diseases like COVID-19.

SUPER-HOCl DRY-FOGGING KILLS CORONAVIRUS BOTH IN THE AIR AND ON SURFACES

Super-HOCl solutions administered via a free-standing, portable cool-mist, ultrasonic vaporizer produces misting ("fog") to easily cover several rooms in a building or home (5000 sq ft.). The ultrasonic vaporizer produces very small aerosolized particles, 2-4 microns in size, which will remain suspended in air, creating a very slight haze, as well as effectively coating surfaces without wetting ("dry-fogging").

Studies of dry-fogging of vaporized Super-HOCl against both surface inoculated 0C43 coronavirus and against aerosolized coronavirus 0C43 (a CoV-2 surrogate virus used as an equivalent stand-in for research purposes) by an independent, certified lab, have shown 99.9% reductions in viral quantity in surface viral testing from dry-fogging alone and a log-10 (99.99999999%) reduction in aerosolized Coronavirus 0C43 quantity from dry-fogging in air (see table 3).

Table 3

Viral Reduction Rate from Dry-Fogging Super-HOCl on Both Aerosolized and Surface Coronavirus 0C43 (COVID-19 Surrogate)

Test	Results
Aerosolized Coronavirus 0C43	>99.99999999% Reduction
Surface Coronavirus 0C43	>99.9% Reduction

In more everyday language, table 3 shows that Super-HOCl dry-fogging successfully and continuously killed 99.99999999% (log-10) of the coronavirus quantity that was being continuously infused into the air of the experimental chamber at a concentration rate that was 33,000,000 times the level anyone would possibly encounter in an everyday situation - even when in the presence of infected person(s) coughing and sneezing in a room.

In the context of the pandemic health crisis, these conclusive results provide an extremely important advance in providing an effective, relative simple means to increase public safety where people - any of whom might be Coronavirus carriers - are interacting with one another.

HIGHLIGHTING A MAJOR NEW TREATMENT IMPLICATION:

- Vaporized Super-HOCl dry-fogging will attack and kill viruses both in the air and on surfaces.
- Being able to use dry-fogging with vaporized Super-HOCl to kill airborne viruses as well as those on a surface is an extremely important point for human applications, as current studies show that multiple, small drops of saliva and fluids are not only expelled during a cough or sneeze, but now the studies show that droplets are expelled even when "just" talking and could account for transmission of SARS-CoV-2 virus.[14-21]
- These droplets stay airborne for at least 5-10 minutes. Smaller, aerosol sized droplets have been shown to stay suspended for several hours and can carry viruses such as SARS-CoV-2. But vaporized Super-HOCl used in dry-fogging attacks and effectively kills viruses both in the air (droplets or aerosolized) and on surfaces within seconds to minutes.

SUPER-HOCl MISTING ALSO REDUCES BIOFILM – AND IMPROVES CLEANING AND DISINFECTION

Biofilm, also known as bioburden, is defined as a thin, microscopic layer of microorganisms, both dead and alive, that bind together and accumulate on essentially any surface, forming a mat of organic and inorganic material on that surface. This mat is primarily composed of polysaccharides and provides a material matrix for bacteria to accumulate, grow and multiply. The bacteria are also partially "protected" by the matrix, thereby becoming more difficult to access, which, in turn, provides opportunities for development of resistance to antibacterial treatments and disinfectants. These opportunities are likely enhanced if antibacterial treatments and disinfectants are applied incorrectly.

Biofilm accumulation can be indirectly determined by measuring Adenosine Triphosphate (ATP), the energy molecule found in living cells - hence providing an indirect measure of organic material and bacterial presence. ATP is determined by using sterile swabs rubbed over a surface to test for the presence of organic material. The swabs are then placed in an ATP-measuring device, resulting in a digital readout of ATP quantity. A low readout indicates a clean surface. A high readout implies dirtiness, i.e. biological contamination. A reduction in ATP scores following cleaning and disinfection, in part, reflects a reduction in the surface biofilm.

To achieve maximal cleaning and disinfection of a surface, the biofilm must be removed. Classically, any reduction in biofilm for cleaning/disinfection purposes has required two steps - both a manual wiping step with a cleaning agent followed by an application of a true disinfectant for a specified period of time (up to 4-10 minutes). This process is more challenging in practice than it sounds in theory and, therefore, it is seldom

successfully followed,[2] a cleaning implementation failure that takes us back to the concern about antimicrobial resistance.

Fortunately, new developments by Ionogen in cleaning and sanitation indicate the manual wiping step is not mandatory to achieve a significant reduction of biofilm if one is using Super-HOCl.

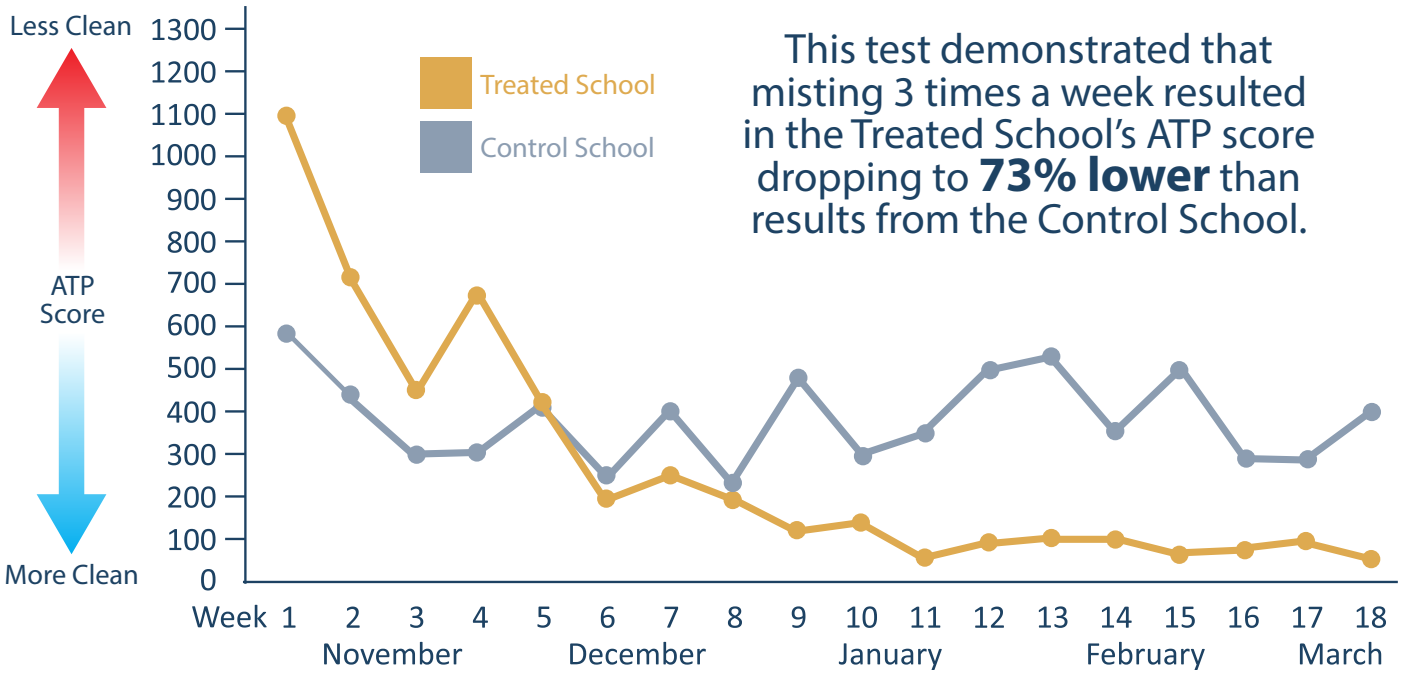
In addition to the dry-fogging technology mentioned above, Ionogen has also researched the utility of spraying its product by employing a portable, hand-held misting machine. Study results have demonstrated that its Power Misting treatment successfully creates a full cleaning step, without wiping, that significantly reduces biofilm to facilitate deep cleaning. The effectiveness and efficiency of the streamlined protocol has been demonstrated through research projects undertaken both in school buildings and in Ambulatory Surgery Centers (ASCs), each very challenging and crucial environments to clean and disinfect.

In its study of two comparable schools, one serving as a control and the other as the test school, Ionogen compared standard school cleaning methods (control school) versus standard school cleaning methods plus Super-HOCl power misting of the school (test school) with Ionopure's sanitizing solution at the end of the school day, three times weekly.

Both schools started with high ATP (hence, biological contamination) scores but, over the 5-month duration of the study, the Super-HOCl Power-Misted school's ATP scores dropped significantly and remained at substantially lower levels during the duration of the study, demonstrating a statistically significant improvement in cleaning and disinfection (figure 2). The only intervention difference was misting the Ionopure sanitizing solution 3 times weekly.

Figure 2

Adenosine Triphosphate (ATP) Readings in a Super-HOCl-Treated School vs. the Control School



Likewise, in our study of Ambulatory Surgery Centers (ASCs), we used two comparable ASCs. The control ASC underwent standard cleaning with Cavicide wipes* between procedures and a terminal cleaning with both wipes and a Lysol disinfectant* spray at the end of the day. The test ASC underwent the same cleaning process but used Super-HOCl solutions and wipes. Also an additional step of power misting of the rooms with Super-HOCl was done after the terminal cleaning at the end of the day. The misting required an additional 1-2 minutes per room.

**Both Cavicide wipes and Lysol Disinfecting Spray contain Quaternary ammonium compounds (QUATS), which are known toxic chemicals.*

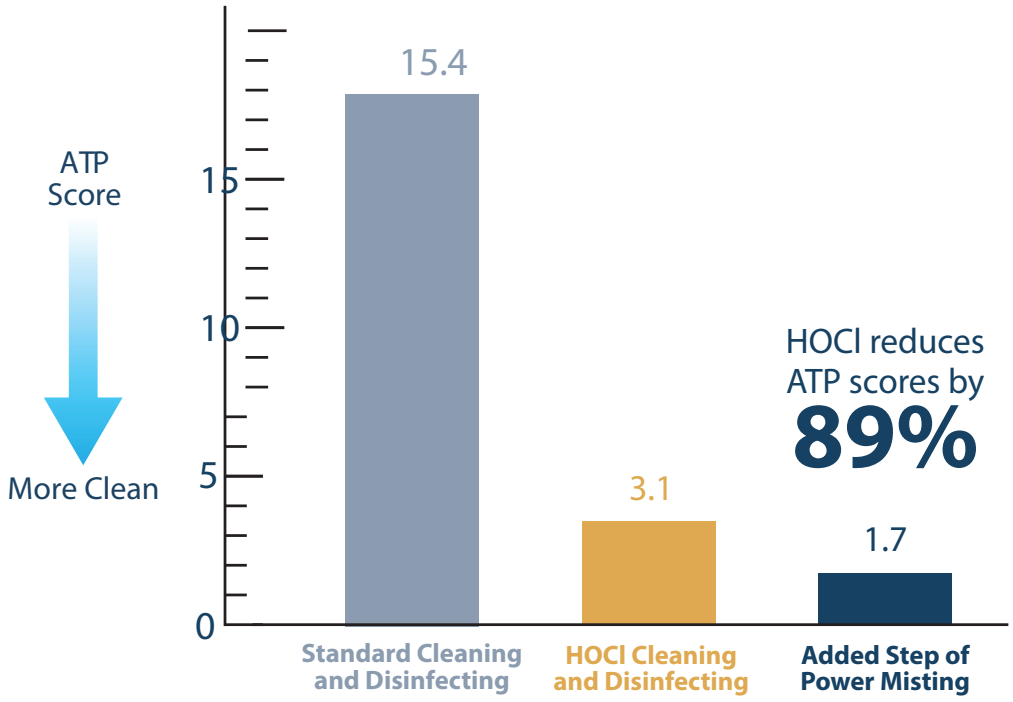
At the end of the regular terminal cleaning, the control ASC rooms were very clean, averaging an ATP score of 15.4. The HOCl-cleaned rooms were even more clean with an average ATP score of 3.1. Adding the power misting of HOCl to these rooms as a last step produced a further statistically significant drop in ATP values to 1.7 (figure 3). In the words of the non-medical bio-statistician reviewing these results, "The improvement (3.1 to 1.7) was comparable to an additional manual wiping step."

Bottom line: cleaning and sanitizing with HOCl produced significantly improved results in reducing ATP scores in endoscopic ASCs.

Figure 3

ATP Results Comparing Standard-Treated Rooms and Super-HOCl-Treated Rooms

Ambulatory Surgery Center



PROPOSING THE NEW IONOGEN CLEANING AND SANITIZING PARADIGM

- Power misting and dry-fogging with vaporized Super-HOCl reduces biofilm without manual wiping and also effectively kills bacteria and viruses, molds and fungi, quickly and thoroughly on surfaces. This remarkable finding literally changes the way we think about cleaning, sanitation and disinfection of those surfaces.
- Dry-fogging with vaporized Super-HOCl attacks and kills viruses in the air as well as on surfaces creating a new modality for treating and preventing airborne viral infections such as the common cold, flu, SARS-CoV-2 and others.
- Dry-fogging and misting with vaporized Super-HOCL provides these powerful effects safely so that sanitizing a space can occur with no ill effects while people (e.g., patients or families at home or children and teachers and administrators in schools) remain present.

SUPER-HOCl ALSO PROVIDES A MEANS TO ADDRESS BOTH "SUPERBUGS" AND MUTATING VIRUSES

One approach to addressing the daunting challenges of "superbugs" and mutating viruses is to use a non-toxic, highly effective disinfectant at the source where the pathogens exist – namely the environment.[3] In essence, the aim is to kill the pathogen before it has the opportunity to invade the human body – and to do it in a way that is both safe for humans and for the environment.

Super-HOCl does just that: it is a non-toxic product which is a highly effective sanitizer/disinfectant that kills all pathogens without producing any adverse effects on humans.

A SPECULATIVE IDEA CALLING FOR FURTHER RESEARCH

BASED ON WHAT IS KNOWN ABOUT PULMONARY MEDICINE, THE RESEARCH CITED IN THIS WHITE PAPER, ALONG WITH SUBSTANTIAL ANECDOTAL OBSERVATION, SUGGESTS THE POSSIBILITY OF IMPROVING TREATMENT OF SELECTED LUNG DISEASES BY USING AEROSOLIZED SUPER-HOCl AS AN INHALATION THERAPY. FURTHER RESEARCH IS PLANNED TO EVALUATE THIS APPROACH.

Viruses are very small particles (20-400 microns). When they invade the human body, it is typically by way of the respiratory tract: nose and mouth, throat, trachea, bronchi and with some viral particles ending in the smallest lung structures, the acinar sacs lined with alveolar cells where the transfer of oxygen and carbon dioxide occurs.

The viruses can attach anywhere along that tract, likely first in the nose, throat and trachea. From there spread can occur to the lower regions of the lung (bronchioles, alveolae) depending on multiple factors including particle size and shape, humidity and depth of inspiration. Major and serious infections such as pneumonia occur when alveolar infection occurs in a widespread manner throughout segments of the lungs. Our laboratory studies have shown that Super-HOCl can be vaporized in aerosolized-sized particles equal to or less than 2-4 microns, which are small enough to reach the alveolae. Separately, as reviewed earlier in this paper, our studies have also shown that vaporized Super-HOCl will kill coronavirus (Table 3).

As previously discussed, we demonstrated a remarkable achievement – a log-10 (99.99999999%) removal of a continuous stream of a very large amount of infused virus from the air.

Logically and plausibly, albeit speculatively, it follows that vaporized Super-HOCl could be used adjunctively to treat or even prevent lung infections such as COVID-19 pneumonia. Clinical studies are being developed to test this hypothesis. Until that time, clinical observations have shown a dramatic improvement in patients with viral sore throats or those with flu-like symptoms through simply using Super-HOCl prepared for use as a nasal spray, gargling and/or dry-fogging in a small room.

HONESTY IN DISINFECTION – HOW MUCH IS LACKING?

As a current standard practice, the proper process of manual wiping of a surface with a cleaning agent followed by application of a disinfectant and, subsequently, allowing that disinfectant time to work (typically 4 -10 min) is recommended by companies selling cleaners and disinfectants. Although effective, in everyday practice that is a process seldom followed correctly by the user.[2]

This is a well-known problem but one that is not addressed adequately either by the companies or by the end users. As pointed out previously, a serious consequence of this failure to follow the proper usage protocol is that bacteria and viruses are exposed to the disinfectants in an attenuated fashion that often proves inadequate for killing the pathogens. The result: some of the pathogens survive with limited exposure to the disinfectant, and, in the process, develop resistance to the intended killing agents. And resistance to disinfectants most likely contributes to more bacteria developing antibiotic resistance, contributing ultimately to the problem of "superbugs."

This is the not-so-secret secret, and it is neither honestly nor openly discussed.

Furthermore, as previously reviewed, most disinfectants that are used today, have toxic chemicals in them that are harmful to the environment and to humans (even more so to children and the infirm). For example, after drying on a surface, "QUATS" (quaternary ammonium compounds) can remain active as a disinfectant on a hard surface for days, a point that is proudly touted in advertisements. Children and adults who touch that surface during that time have varying degrees of transfer of the chemical to their skin – with likely at least some absorption. Over time, levels of the chemical can build up in the body and have their effect on human health.

Add to the not-so-secret secret, the clear reality that the problem of disinfectant toxicity inflicted on the environment, animals and people is also not discussed with forthcoming honesty by the companies producing and distributing these chemicals.

Is this failure to discuss problematic unintended, health-threatening effects of their products directly acknowledged by the companies that make these disinfectants? Do they take even partial responsibility for the serious problems of microbial resistance to disinfectants that is becoming more prominent? Or to the contribution to the problem of antibiotic microbial resistance? Or the enormous problem of hospital acquired infections? Or to the crisis the world will be facing in one-two decades with superbugs and who knows what else might be arising? And what about the huge issue of toxic disinfectant chemicals that remain on surfaces and expose children, adults and pets to those chemicals resulting in diseases we already know about?

Equally important is collectively determining how to address these questions now that we are realizing and acknowledging them. How do we deal with these issues? The answer requires a logical, science-based, stepwise progression toward achieving solutions. We must start with honesty and truth in recognizing the causes. Then we need to move to actions like those recommended by the World Health Organization and in the report from the United Kingdom.[3]

Ionogen's Super-HOCl solutions provide non-polar, Free Available Chlorine in precise concentrations previously unobtainable and which have demonstrated effective lethality to bacteria, viruses, molds and fungi – while being entirely safe to humans and the environment.

ONE ANSWER

One action to take in addressing this burgeoning crisis is to use a truly "ideal" disinfectant – one that is non-toxic while also being highly effective. We propose that disinfectant is Super-HOCl. Pathogens simply cannot develop resistance to free chlorine. It is too operationally efficient as a pathogen killing agent. And Ionogen's Super-HOCl solutions provide non-polar, Free Available Chlorine in precise concentrations previously unobtainable and which have demonstrated effective lethality to bacteria, viruses, molds and fungi – while being entirely safe to humans and the environment.

CONCLUSION

Our new world of pandemics and antibiotic microbial resistance, complicated by the toxicity of existing disinfectants to people and to the environment, requires new preventive measures and new medical therapies if we are to remain a vibrant, progressive society while successfully protecting our citizens from unnecessary diseases and toxicity.

The new Super-HOCl sanitizing and disinfectant products created by Ionogen provide the revolutionary solution. They are non-toxic, safe and highly effective in eliminating viruses, bacteria, fungus and mold both on surfaces and in the air. Accordingly, they provide the foundation for solving challenges emerging from the deeply concerning evolution of viruses, bacteria, and other problematic microorganisms in our world while preserving our environment and our safety from toxic chemical disinfectants.■

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