Minimizing Hospital Acquired Infections with OHAir® systems with Odorox® technology.

Hospital acquired infections (HAI's) – also called nosocomial infections - are caused by viral, bacterial, and fungal pathogens. The most common types are bloodstream infections, pneumonia, urinary tract infections, and surgical site infections.

HAI's result from incorrect or lax hygiene and are transmitted via contaminated surfaces or airborne pathogens and are increasingly difficult to treat because many strains of bacteria have become resistant to antibiotic treatment. Increased use of outpatient treatment centers in recent decades means that a greater percentage of people who are hospitalized today are likely to be seriously ill with more weakened immune systems and more susceptible to infection. Infection can be rapidly spread by medical staff when they move from patient to patient unless they practice scrupulous sanitation procedures.

Surface transmission

There are many ways to contaminate surfaces, but the most common modes are by the settling of airborne microorganisms and by the transfer of microorganisms from contaminated hands or materials. People touch contaminated surfaces and contaminate themselves and others. Infection can occur by contact with the eyes, mouth, nose and any open wound – however minor. That is why hand washing is so important before touching and treating each patient.

Airborne transmission

Airborne transmission occurs when droplets or aerosols containing microbes from the infected person are propelled through the air and deposited on a host's body or are inhaled. Aerosols are generated from the infected source person mainly by coughing, sneezing, talking, and during the performance of hospital procedures. Aerosols can stay suspended in air for extended periods and are hard to sanitize. They can combine with dust and be carried by convection and throughout heating ventilation and air conditioning

systems to contaminate surfaces and be inhaled remote from the infective source. Microorganisms transmitted by airborne transmission include Legionella, Mycobacterium Tuberculosis, Rubella, Varicella, and Ebola Virus.

The US Centers for Disease Control (CDC) estimates that 5 percent of all hospital admissions result in infections that patients acquire during their stay while receiving treatment for other conditions, culminating in 1.7 million infections and 99,000 deaths each year as well as $28–$33 billion in excess costs.

The Odorox® and OHAir® Advantage

Conventional chemical sterilants must be hand or mechanically applied – often throughout the day and more thoroughly at the end of the day. They cannot keep up with the many dynamic avenues of contamination and cannot sanitize air. OHAir® devices provide a more effective approach by generating powerful airborne oxidants called hydroxyls (•OH) that safely and effectively sanitize air and surfaces.

Hydroxyls are well studied and known as nature's sanitizer[i]. The sun's ultraviolet light reacts with water vapor and oxygen to generate over 2 million hydroxyl radicals in each cubic centimeter of outdoor air. Hydroxyls react so effectively with volatile organic compounds and microorganisms that they do not exist more than a few seconds indoors. Odorox® technology reestablishes the balance of nature indoors by maintaining a natural level of hydroxyl radicals which rapidly minimizes airborne and surface pathogens. OHAir® systems can be safely deployed 24 hours a day to sanitize occupied spaces.

How Odorox® Technology Works

The mode of action of hydroxyls and other radical oxidants against bacteria, viruses and mold are well understood based on extensive atmospheric chemical studies.[2] The radicals are powerful oxidants that readily regain the electron they lack by means of abstracting a hydrogen atom (H·) from the lipids, proteins, carbohydrates etc. that constitute the membranes and cell walls of microorganisms. Stable HOH water molecule is regenerated, and the cell walls of the microorganisms are irreparably breached. Third party laboratory tests have proven that the technology kills bacteria, viruses, and fungi on both hard and soft surfaces [2]

Hydroxyl radicals react with the biochemical in the cell walls of a broad range of microorganisms

resulting in cell death. When this technology was tested against a 'Super-Bug', Carbapenem-resistant enterobacteriaceae (CRE), high kill rates in the order of 3-4 log_{10} reductions of pathogen on surfaces were observed. This result is consistent with kill rates for many other bacteria as well.

This mode of attack utilizes very high energy and is non-selective. All bacteria tested showed high kill rates within hours; most showed kill rates of 3-4 log_{10} reductions, including the medically important Methicillin-Resistant Staphylococcus Aureus (MRSA) organism[3].

OHAir® devices utilizing Odorox® technology safely generate the same concentration of hydroxyls found outdoors, re-establishing nature's fresh air conditions indoors without causing harm to people, plants or pets. Based on the literature and scientific studies conducted on behalf of HGI Industries Inc., the Odorox® technology would greatly benefit medical environments.

New and Emerging Infections

Based on extensive published data[4], the free radical mode of action of the Odorox® technology should be effective against all microorganisms. Some microorganisms take longer to mitigate, but they respond to treatment.

There is no natural defense that an organism can mount to this type of attack. Consequently, OHAir® systems utilizing Odorox® technology should be effective mitigating nearly all microorganisms; even scourges like Ebola, Marburg, West Nile virus, etc. The organisms may change the particular features on their cell membranes to protect themselves against assault from the immune system and various types of drugs like antibiotics and anti-viral agents, however they will still be vulnerable to free radical assault from hydroxyls.

Background Information

The mechanism by which nature controls microorganisms in the air and on surfaces has been studied by atmospheric scientists since the 1970's and is well summarized by D. E. Heard in his comprehensive study of atmospheric chemistry entitled "Analytical Techniques for Atmospheric Measurements, Editor D. E. Heard, Blackwell Publishing,

Scientists confirmed that the Sun generates a steady state concentration of about 2 million hydroxyls molecules per cubic centimeter. These radicals are such powerful oxidizing agents that they react with chemicals in the air and are consumed usually within 20-50 milliseconds.

Hydroxyls effectively sanitize the Earth's troposphere by reacting with and decomposing nearly all volatile organic chemicals and many inorganic gases. They also sanitize the air and surfaces outdoors by killing nearly all bacteria, viruses and mold species. Microorganisms persist in nature in areas inaccessible to direct ultra violet radiation and/or hydroxyl rich air and within infected plants and animals.

The hydroxyl radical is generated when a molecule of water reacts with reactive oxygen species generated by powerful ultraviolet light. The net result is:

$$H_2O \longrightarrow HO\cdot + H\cdot$$

The hydrogen radical is stripped away by the reactive oxygen species. The resulting HO· free radical has a very unstable, unpaired electron and aggressively removes the missing hydrogen from nearly any other organic chemical it comes in contact with, including all of the biochemicals on the surface of microorganisms. The hydroxyl is itself reduced – the species it attacks is oxidized. Next to atomic fluorine, there is no more powerful oxidant. Hydroxyls are thousands of times more powerful than ozone or bleach and react one million times faster than ozone.

Footnotes

1. Studies conducted at Leeds University and published by Professor D. E. Heard during the 1970's.
2. D. E. Heard, "Analytical Techniques for Atmospheric Measurement", Blackwell Publishing, 2006.
3. R. Atkinson, "Kinetics and Mechanisms of the Gas-Phase Reactions of the Hydroxyl radials with Organic Compounds", Journal of Physical and Chemical Reference Data, Monograph No.1, 1989.
4. A. T. Hodgson, D. P. Sullivan and W. J. Fisk, "Evaluation of Ultraviolet Photocatalytic Oxidation for Indoor Air Applications - Conversion of Volatile Organic Compounds at Low PPB Concentrations", LBNL-58936, 2008.

HGI Industries Incorporated, 2055 High Ridge Road, Boynton Beach, Florida 33426, (www.hgiind.com) manufactures and distributes advanced technology solutions utilizing Odorox® hydroxyls for some of the most challenging air and surface contamination problems in industry.