

# CHEMICAL

Hospital Disinfectants



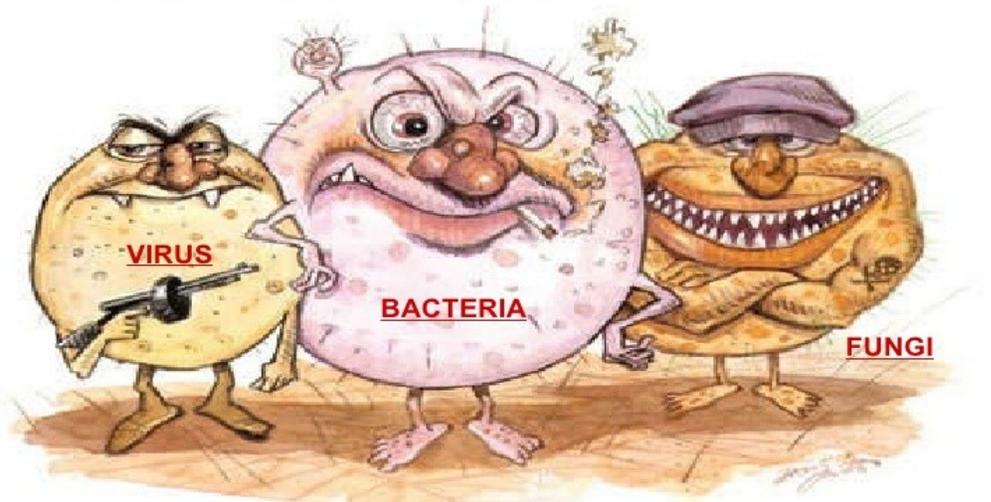
  
Natural remedies



## A COMPARITIVE STUDY FOR SAFER HOSPITAL DISINFECTION



## AGENTS OF NOSOCOMIAL INFECTIONS



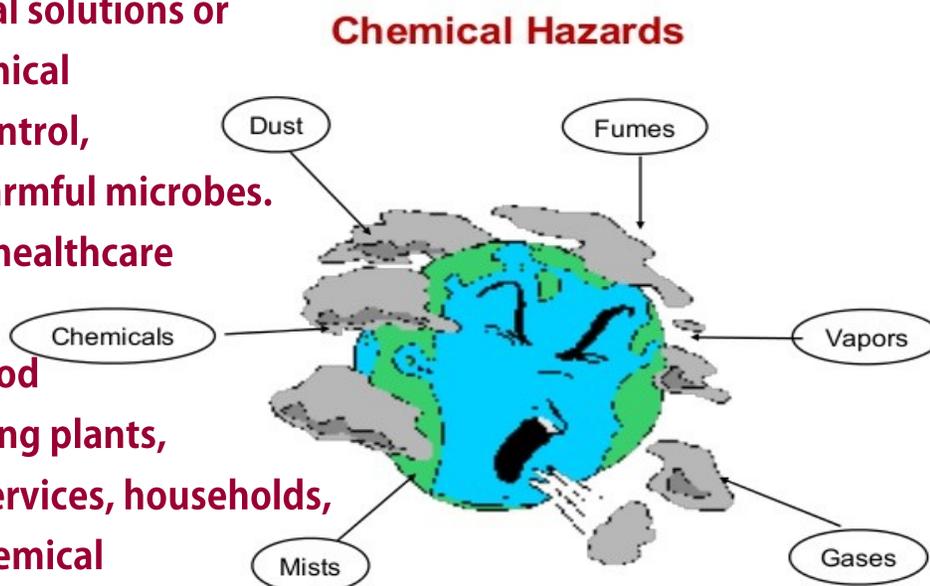
## GESCO HEALTHCARE PVT.LTD.

Old no. 73, New No. 2, S - Block, 18th Street, Anna Nagar, Chennai- 600 040,  
Tamil Nadu, INDIA. Phone: 91 44 26202607  
Mail: [info@gesconaturals.com](mailto:info@gesconaturals.com) / [www.gesconaturals.com](http://www.gesconaturals.com)

## CAUTION on Chemical Disinfectants:

Chemical antimicrobial solutions or disinfectants are chemical substances used to control, prevent, or destroy harmful microbes.

Workers in hospitals, healthcare facilities, poultry facilities, abattoirs, food products manufacturing plants, sanitary and similar services, households, etc. frequently use chemical disinfectants to eradicate the diseases causing microbes.



- Chemical antimicrobial solutions or disinfectants could be hazardous to all.
- Some of the chemical disinfectants are flammable and explosive.
- They may react with incompatible chemicals violently and generate toxic gases.
- All chemical antimicrobial solutions or disinfectants are, by their very nature, potentially harmful or toxic.
- Like other toxic substances, the chemical antimicrobial solutions or disinfectants could be harmful to humans and the environment.
- Some of the chemical antimicrobial solutions or disinfectants are irritating to the skin, eyes, and respiratory system.
- The highly corrosive chemical antimicrobial solutions or disinfectants could inflict serious damage if they come into contact with the skin or eyes.
- The airborne chemical antimicrobial solutions or disinfectants would also cause respiratory problems.

**CAUTION on Chemical Disinfectants:**

- Flammability is one of the potential dangers when chemical antimicrobial solutions or disinfectants are used.
- Alcohols are flammable liquids that could be ignited if used near a flame, spark or any ignition source particularly when the alcohols are applied by spraying as mist.
- Ethylene oxide is a highly flammable and explosive gas that has an explosive concentration range of 3% to 100% by volume.
- Formaldehyde gas, which is given off by either liquid formalin or paraformaldehyde powder, has a characteristic pungent odor and is highly flammable. It forms explosive mixtures with air and the explosive concentrations range from 7% to 73% by volume.
- Hydrogen peroxide possesses strong oxidizing properties and spilling high concentration peroxide solutions on flammable substance can cause an immediate fire.
- Sodium hypochlorite in aqueous solutions is not explosive but the anhydrous sodium hypochlorite becomes an explosive substance.
- Calcium hypochlorite is not flammable. However, it acts as an oxidizer with combustible materials.
- Mixing chemical antimicrobial solutions or disinfectants with other chemical substances could be hazardous.
- Chlorine, which is a toxic gas, is rapidly released from sodium hypochlorite solutions (bleaching solutions) if mixed with acids for example, the acidic cleaning agents. In such circumstances, workers would be exposed to high concentrations of chlorine that could be fatal.
- Calcium hypochlorite decomposes readily in water or when heated, releasing oxygen and toxic chlorine. It may react explosively with ammonia, amines, or reducing agents.

**CAUTION on Chemical Disinfectants:**

- When formaldehyde is mixed with strong oxidizers, violent reactions could occur. Mixing formaldehyde solution (formalin) with potassium permanganate could cause an explosion.

Health hazards involved in using chemical antimicrobial solutions or disinfectants.

- Formaldehyde is an effective disinfectant. It is a toxic and carcinogenic chemical and can cause eye irritation, cough, shortness of breath, skin irritation, chronic bronchitis and exacerbation of asthma. It can also react with chlorine to form another carcinogen.
- Ethylene oxide is toxic by inhalation. It is also an irritant to the skin, eyes, and the respiratory tract. Ethylene oxide may damage the nervous system, and the chemical is also a carcinogen.
- Glutaraldehyde is a strong irritant to the skin, eyes, and respiratory system. Contact with the chemical can cause skin sensitisation, leading to allergic contact dermatitis. Exposure to the chemical may exacerbate asthma.
- High concentrations of hypochlorite are irritating to the mucous membranes, eyes and skin.
- Concentrated hydrogen peroxide solution is corrosive and the domestic-strength peroxide solutions could cause local burns, irritation of the mucous membranes, eyes and the skin.
- Quaternary ammonium compounds might cause mild to severe irritation of the skin and mucous membranes depending on the chemical properties and the concentration.
- Allergic reactions can occur to workers handling iodine solutions and iodophors. Concentrated iodine compounds can be irritating to skin.

### CAUTION on Chemical Disinfectants:

- Phenols disinfectants may cause irritation of the skin, local burns, headache, vomiting, diarrhoea, and damage to the kidneys in severe cases.
- Alcohol disinfectants can be irritating to the injured skin. Inhalation of concentrated alcohol vapour may cause irritation of the respiratory tract and have effects on the central nervous system.

Many factors can influence the risk of hazards associated with use of chemical antimicrobial solutions or disinfectants. These include physical, chemical and toxic properties of the substances used in their preparation, usage protocols and practices, the nature and duration of the exposure, the effects of combined exposures, the routes of entry into the human body, and the susceptibility of the worker.

It should be noted that many of the chemical antimicrobial solutions or disinfectants are proprietary prepared formulations and their chemical components may not be shown in detail on the containers.

There are occasions where a hazardous chemical antimicrobial solutions or disinfectants could be substituted by using other less or non-harmful chemical antimicrobial solutions or disinfectants to minimize or eliminate risks, for example, ortho-phthalaldehyde (OPA) has been used as glutaraldehyde alternative.

In addition, the one and only best alternative to chemical antimicrobial solutions or disinfectants, is our 100% natural and organic antimicrobial solution used to reduce or eliminate microbes.

It is also very important to note that, when chemical antimicrobial solutions or disinfectants are used, researchers have found that they actually make certain microorganisms stronger and resistant to antibiotic treatment. This is true even in hospital settings.

**While building up antibiotic-resistance and thereby contributing to the creation of superbugs, chemical antimicrobial solutions or disinfectants disrupt the balance of bacteria, both good and bad, making it much easier for the bad bacteria to flourish.**

Some of the common chemical disinfectants and their characteristics are described in the following paragraphs. Each of the chemical disinfectants has its characteristics, hazards and efficacy against various microorganisms.

#### 1. Ammonium hydroxide:

Ammonium hydroxide is a colourless liquid that is commonly found as household ammonia. It has a strong irritating odour and is corrosive at high concentrations. Ammonium hydroxide is an alkali. Alkalis have been used as disinfectant against a wide range of pathogens including most bacteria and viruses. The disinfection activity of alkalis is slow but increases with higher temperature. Alkalis are ineffective against the non-enveloped viruses and bacterial spores.

#### 2. Benzalkonium chloride:

Benzalkonium chloride and cetylpyridinium chloride are quaternary ammonium compounds that are widely used as disinfectants. They are cationic detergents. Benzalkonium chloride and cetylpyridinium chloride are reported non-toxic at use-dilution concentrations. However, prolonged contact with the disinfectants at high concentrations can irritate the skin. They are effective against bacteria, fungi and enveloped viruses. The disinfectants have residual effect, keeping surfaces bacteriostatic for a brief time. Benzalkonium chloride and cetylpyridinium chloride are the active ingredients in disinfectants for homes, farms, hospitals, offices, etc. The compounds are considered stable in storage but are easily inactivated by organic matters, anionic detergents, soaps and hard water.

#### 3. Calcium hypochlorite:

Calcium hypochlorite is a widely used chlorine compound that is highly effective against bacteria, algae, fungi and other microorganisms. Calcium hypochlorite is adopted primarily to chlorinate swimming pool and to treat water supplies and sewage. It is also frequently used as a bleaching agent and sanitizer in industrial applications. Calcium hypochlorite disinfectant usually contains 65% available chlorine. As calcium hypochlorite is a strong oxidant, there are fire and explosion risks on contact with acids, combustible substances and reducing agents. It reacts violently with many other substances including ammonia, amines, nitrogen compounds, etc. causing explosion hazard.

#### 4. Calcium oxide:

Calcium oxide ( $\text{CaO}$ ) commonly known as lime or quicklime, is a white caustic solid. It is soluble in water, forming calcium hydroxide and generating heat. Contact with water or moisture may generate enough heat to ignite nearby combustible materials. Calcium oxide reacts violently with acids and halogens. Dissolved in water, calcium oxide forms a medium strong alkali that has biocidal effect on some bacteria and viruses. The chemical is often used to disinfect animal carcasses. Solutions of slaked lime (i.e. calcium hydroxide) are used to disinfect premises. Calcium oxide is corrosive and can severely irritate and burn the skin and eyes on contact. Inhalation of calcium oxide dust will cause respiratory discomfort.

#### 5. Chlorhexidine:

Chlorhexidine is one of the biguanide disinfectants that destroy microorganisms by damaging the cell membrane permeability. It is reported non-irritating and, while considered a bactericidal, virucidal and fungicidal, is less effective against these agents than many other disinfectants. Chlorhexidine could maintain effectiveness in the presence of organic matters.

#### 6. Cresol and hexachlorophene:

Cresol and hexachlorophene are phenol disinfectants. The phenols are broad-spectrum disinfectants. They are ideal for destroying many bacteria but less effective against viruses. They are not active against bacterial spores. The disinfectants are applicable in situations where a heavy load of organic materials is present. Phenol compounds are the active ingredients in most bottles of "household disinfectant". The compounds are commonly found in scrub soaps and surface disinfectants. Phenol compounds can be irritating to the skin and eyes and have a distinct odour. When phenol compounds are breathed, ingested, or applied to the skin at high concentrations, they can be very harmful. Ingestion of phenol compounds may cause vomiting, circulatory collapse, paralysis, convulsions, and coma.

#### 7. Ethyl alcohol:

Ethyl alcohol, also known as ethanol, a colourless, volatile, highly flammable liquid with characteristic odour. Ethanol is an effective disinfectant that is commonly available. Its rapid killing action and lack of chemical residue make chemical ideal for disinfection for many medical items. The activity of ethanol drops sharply when diluted to below 50% in concentration, with the optimal concentration range being 60-90% solutions with water (volume/volume). Ethanol and solutions containing more than 50% ethanol are flammable and easily ignited. Excessive exposure to ethanol could pose health hazards.

#### 8. Ethylene oxide:

Ethylene oxide is used primarily as a means of sterilizing heat-sensitive materials such as medical preparations and instruments. It is active against a wide variety of bacteria, fungi, and viruses. Ethylene oxide is a colourless and odourless gas. It is highly toxic, flammable and explosive. Ethylene oxide has an explosion concentration range of 3-100% in air by volume. It is an irritant to the skin, eyes and respiratory system. Ethylene oxide may damage the nervous system. It is a carcinogen.

#### 9. Formaldehyde:

Formaldehyde is a toxic and colourless gas with pungent and suffocating odour at room temperature. Formaldehyde is a carcinogen. The chemical is readily soluble in water. Commercial formaldehyde chemical is produced and sold as an aqueous solution (formalin) containing 37-50% formaldehyde by weight. Aqueous formaldehyde could be used as a disinfectant or preservative. Besides being a liquid disinfectant, formaldehyde may be used as a fumigant to disinfect objects surface and air.

#### 10. Glutaraldehyde:

Glutaraldehyde (1,5-pentanedial) is an effective disinfectant against bacteria, fungi and viruses. Glutaraldehyde is widely used as an antimicrobial agent in a variety of applications such as in cooling water systems, paper-pulp industry, poultry industry, cosmetic field, microbiological field, food industry and medical area. The extensive use of this biocide is due to being non-corrosive to metals, stainless steel, rubber, etc. Glutaraldehyde is soluble in water and organic solvents and the solutions are stable for long periods of time. Its efficacy is highly dependant on pH and temperature. Glutaraldehyde works best at a pH greater than 7 and high temperatures. It is considered more efficacious than formaldehyde in the presence of organic matters, soap and hard water. Exposure to glutaraldehyde liquid or vapour may cause health problems including skin sensitisation, exacerbation of asthma and leading to allergic contact dermatitis, etc.

#### 11. Hydrogen peroxide:

Hydrogen peroxide is a colourless liquid at ambient conditions. It is a common oxidizing and bleaching agent. The chemical is widely used in deodorants, water and sewage treatment or as rocket fuels and disinfectants. A preparation containing hydrogen peroxide at 15- 20% concentration is considered bactericidal, virucidal and fungicidal. At high concentrations, it is a sporicidal. Diluted forms of hydrogen peroxide are often used as cleansers for human cuts and scrapes. Concentrated hydrogen peroxide solution is reactive and explosive. It is also corrosive and on contact, the concentrated hydrogen peroxide solutions may cause chemical burn of the skin and eyes.

#### 12. Iodine compounds:

Iodine compounds are broad spectrum and considered effective for a variety of bacteria, fungi and viruses. Iodines are often formulated with soaps and considered to be relatively safe. Concentrated iodine compounds can be irritating to the skin, stain clothes or damage rubber and metals. Tincture of iodine has been used as an antiseptic for skin cuts and scrapes. Iodine agents are inactivated by quaternary ammonium compounds and organic debris.

#### 13. Iodophors:

Iodophors are preparations containing elemental iodine complex with a polymer carrier (i.e. the complexing agent) of high molecular weight. The resulting complex provides a sustained -release of iodine in aqueous solution. Iodophors' bactericidal activity is relatively slow. Iodophors are general use disinfectants, which are less readily inactivated by organic matter than elemental iodine. Povidone-iodine (PVI) is a commonly available iodophor, usually prepared as a 7.5-10% solution. Formulations with lower concentrations have good antimicrobial activity because dilution can increase iodine concentrations. As the amount of free iodine increases, the degree of skin irritation also may increase.

#### 14. Isopropyl alcohol:

Isopropyl alcohol, also known as isopropanol, is a highly flammable colourless liquid with an odour reminiscent of ethanol or acetone. Isopropyl alcohol is found in alcohol sponges, cleaning agents, and rubbing alcohol. The rubbing alcohol generally contains 70% isopropyl alcohol. Isopropyl alcohol is an irritant of the eyes and mucous membranes. Prolonged skin contact with isopropyl alcohol may cause eczema.

#### 15. Ortho-phthalaldehyde:

Ortho-phthalaldehyde (OPA) is a light yellow solid and is chemically related to glutaraldehyde. Like glutaraldehyde, high pH may make the chemical more active against microorganisms. OPA is widely used as glutaraldehyde alternative. It is a potential skin and respiratory sensitiser and thus can aggravate pre-existing asthma or dermatitis. OPA is non-flammable and is stable at a wide pH range.

#### 16. Paraformaldehyde:

Paraformaldehyde is a white powder with the odour of formaldehyde. Paraformaldehyde has been used as a fumigant for over 30 years to decontaminate laboratory facilities and to disinfect sick rooms, clothing, linen, and sickroom utensils. When heated, paraformaldehyde releases formaldehyde gas, an effective disinfectant. Paraformaldehyde is an irritant to the skin, eyes and the respiratory system. High concentrations exposures to paraformaldehyde could lead to pulmonary edema.

#### 17. Peracetic acid:

Peracetic acid (or peroxyacetic acid) is a colourless liquid with a strong vinegary odour. Peracetic acid is an irritant and it decomposes to acetic acid, oxygen and water and therefore does not pose an environmental hazard. Peracetic acid is a strong oxidizing agent that rapidly kills a wide range of microorganisms. A concentration of 0.2% peracetic acid is active against all microorganisms including bacterial spores, and is effective in the presence of organic matter at low temperature. It is usually applied as a spray, or as a mop-on solution. Peracetic acid can corrode metals and it can also cause materials discolouration.

#### 18. Sodium hypochlorite:

Sodium hypochlorite is the active ingredient in common bleach and is effective against bacteria, viruses and fungi. It is one of the most widely used of the chlorine containing disinfectants used. Sodium hypochlorite solution is used on a large scale for surface purification, bleaching, odour removal and water disinfection. Liquid chlorine bleach usually contains 5.25% solution of sodium hypochlorite as disinfectant. Diluted hypochlorite solutions lose potency quickly and therefore it should be made freshly prepared before use. Sodium hypochlorite is corrosive to metal surfaces at high concentrations.

When the hypochlorite solution come in contact with formaldehyde, bis-chloromethyl ether, a known carcinogen, is produced. Mixing hypochlorite solution with an acid would rapidly release chlorine, a toxic gas. Bleached articles should not be autoclaved without removing the hypochlorite residue by reduction with sodium thiosulphate or sodium bisulphate.

### **THERE ARE MANY DISADVANTAGES IN USING CHEMICAL DISINFECTANTS:**

- **DISCOLORATION OF METAL ITEMS, WHICH OCCURS WHEN CALCIUM (NOT SODIUM) HYPOCHLORITE POWDERS ARE USED, OFTEN IS CONFUSED WITH CORROSION (RUSTING).**
- **CARE MUST BE TAKEN TO PROTECT BOTH STAFF AND PATIENTS FROM THE FUMES WHEN MIXING AND USING**
- **WHEN USING FORMALDEHYDE SOLUTIONS, CANNOT DILUTE WITH CHLORINATED WATER AS A DANGEROUS GAS (BIS-CHLOROMETHYL-ETHER) CAN BE PRODUCED.**
- **STAFF SHOULD WEAR GLOVES TO AVOID SKIN CONTACT, PROTECT EYES FROM SPLASHES, LIMIT EXPOSURE TIME AND USE THESE SOLUTIONS ONLY IN A WELL-VENTILATED AREA.**
- **CHEMICALS USED TO KILL MICRO ORGANISMS COULD BE MAKING THEM STRONGER.**
- **LOW LEVELS OF BIOCIDES, WHICH ARE USED IN DISINFECTANTS AND ANTI-SEPTICS TO KILL MICROBES, CAN MAKE THE POTENTIALLY LETHAL BACTERIUM STAPHYLOCOCCUS AUREUS**
- **BIOCIDES ARE COMMONLY USED IN CLEANING HOSPITALS AND HOME ENVIRONMENTS, STERILIZING MEDICAL EQUIPMENT AND DECONTAMINATING SKIN BEFORE SURGERY.**
- **BUT, THE BACTERIA CAN SURVIVE AND BECOME RESISTANT TO TREATMENT.**
- **OVER TIME, THEY BUILD UP ANTIBIOTIC-RESISTANCE AND THEREBY CONTRIBUTING TO THE CREATION OF SUPERBUGS.**
- **CHEMICAL DISINFECTANTS DISRUPT THE BALANCE OF BACTERIA, BOTH GOOD AND BAD, MAKING IT MUCH EASIER FOR THE BAD BACTERIA TO FLOURISH.**
- **THE CHEMICALS THEMSELVES ARE TOXIC IN THEIR OWN RIGHT.**
- **CAUSE DAMAGE TO RESPIRATORY AND CIRCULATORY SYSTEMS, HEART, LIVER, KIDNEYS AND EYES**

- **NONYL PHENOL ETHOXYLATE, A COMMON INGREDIENT IN LAUNDRY DETERGENTS AND ALL-PURPOSE CLEANERS, IS BANNED IN EUROPE, AS IT BIODEGRADES SLOWLY INTO EVEN MORE TOXIC COMPOUNDS**
- **PETROLEUM SOLVENTS USED IN FLOOR CLEANERS MAY DAMAGE MUCOUS MEMBRANES**
- **BUTYL CELLOSOLVE, FOUND IN MANY ALL-PURPOSE AND WINDOW CLEANERS, MAY DAMAGE YOUR KIDNEYS, BONE MARROW, LIVER AND NERVOUS SYSTEM**
- **TRICLOSAN, THE ACTIVE INGREDIENT IN MOST ANTIBACTERIAL PRODUCTS, NOT ONLY KILLS BACTERIA, IT ALSO HAS BEEN SHOWN TO KILL HUMAN CELLS**

### **ARE WE DISINFECTING OUR WAY TO POOR HEALTH?**

**IN AN IRONIC TWIST, WHILE WE ARE DISINFECTING TO KEEP OUR ENVIRONMENT, PATIENTS, CO WORKERS AND FAMILY SAFE, WE MAY ACTUALLY BE CAUSING THEM HARM.**

**THIS THEORY, KNOWN AS **THE HYGIENE HYPOTHESIS**, IS LIKELY ONE REASON WHY MANY **ALLERGIES AND IMMUNE-SYSTEM DISEASES** HAVE DOUBLED, TRIPLED OR EVEN QUADRUPLED IN THE LAST FEW DECADES.**

**HOSPITALS AND OTHER HEALTH CARE INSTITUTIONS ARE ENGAGED IN ESSENTIAL AND INTENSIVE EFFORTS TO PREVENT HEALTH CARE—ASSOCIATED INFECTIONS (HAIs). HAIs ARE OF PARTICULAR CONCERN TO INFECTION PREVENTION PROFESSIONALS BECAUSE MANY OF THESE ARE CAUSED BY RAPIDLY DEVELOPING STRAINS OF MULTIDRUG-RESISTANT ORGANISMS (MDROs). THESE MDROs CAN CAUSE SERIOUS ILLNESS IN BOTH PATIENTS AND HEALTH CARE WORKERS.**

**WHILE DEMAND FOR MORE EFFECTIVE CLEANING AND DISINFECTING IS GROWING, THERE IS ALSO INCREASING EVIDENCE THAT EXPOSURE TO CLEANING AND DISINFECTING CAN RESULT IN ACUTE AND CHRONIC HEALTH EFFECTS, PARTICULARLY RESPIRATORY ILLNESS.**

**IN RESPONSE, MORE & MORE HOSPITALS ARE SEEKING LESS TOXIC, NATURAL & ORGANIC DISINFECTING PRODUCTS.**

**IN MANY COUNTRIES MOST CHEMICAL DISINFECTANTS HAVE BEEN WITHDRAWN FROM USE.**

Although disinfection is important in hospitals, it is essential in the health care industry for environmental surface management and infection prevention and control.

The Centers for Disease Control and Prevention (CDC) and Healthcare Infection Control Practices Advisory Committee recommend that all health care settings, regardless of the level of care provided, make infection prevention a priority and that standard precautions, including environmental disinfection, be used as a means to reduce infection transmission.

Antimicrobial products are substances or mixtures of chemicals used to destroy or suppress the growth of harmful microorganisms, whether bacteria, viruses, or fungi, on inanimate objects and surfaces. These products contain about 275 different active ingredients and are marketed in several formulations: sprays, liquids, concentrated powders, and gases.

And most of these are very harmful and not fit for use in any setting, in any form.

The surfaces that require disinfection, are classified according to their potential to transmit an infection at the time of use.

Transmission of infectious agents from environment and surfaces:

HAIs are a serious risk to patients, doctors, staff and all others who come into any Healthcare facility. The infectious agents that cause HAIs in patients also pose a risk of infection to health care workers. A number of factors contribute to HAIs among patients and other personal in hospitals. Environmental or surface contaminations in the health care setting is one factor in the transfer of infectious agents that contributes to HAIs in patients and others.

Pathogens may be transmitted, from patients or health care workers to environmental surfaces, where they can persist or proliferate if proper disinfection is not performed. Depending on the organism, microbes can persist in the environment for hours, in case of some enveloped viruses, days or weeks, in case of most vegetative bacteria and fungi, or months, in case of bacterial spores and fungal spores.

Common surfaces in the rooms of patients colonized or infected with the bacteria methicillin-resistant *S aureus* or vancomycin-resistant enterococci (VRE) may become contaminated and touched by health care workers. Prior room occupants colonized or infected with VRE, methicillin-resistant *S aureus*, or *Clostridium difficile* also increase the risk of colonization or infection for the next occupant.

Infectious agents can also be transferred to patients and health care workers after contact with a contaminated surface. One study has also found that environmental surface contamination is a determinant of transmission of MDROs to the protective clothing of health care workers.

### Role of environmental and surface disinfecting in preventing infections:

A recent review of intervention studies suggests that improvements in environmental disinfection may prevent the transmission of infectious agents and reduce HAIs.

Improved environmental disinfection resulted in decreased contamination and infection, as shown in a study of the spread of VRE in a 21-bed medical intensive care unit with high-level endemicity.

In a study of *C difficile* in a Veterans Administration hospital, increased disinfection of high-touch surfaces led to decreased contamination on surfaces.

Recent publications also emphasize the importance of a thorough disinfection, of the room of an infected patient after discharge.

### Chemical respiratory hazards in disinfecting:

Although the demand for more effective disinfecting agents is growing, there is also increasing evidence that exposures to chemicals can cause acute and chronic health effects, particularly respiratory illness.

Conventional disinfecting products are a very complex mixture of chemical ingredients, some of which are associated with adverse human health effects, including dermal and respiratory sensitization, dermal and respiratory irritation, work-related asthma, chronic bronchitis, and sensitization. Potentially harmful occupational exposures during disinfection are a function of multiple factors, including (1) the chemical characteristics of the disinfecting product, (2) the physical characteristics (aerosols vs liquids), (3) the methods of product application (spraying vs wiping), and (4) the characteristics of the built environment (ventilation, room size).

Health care workers account for approximately 15% of work-related asthma in the only in the United States. The workers may be exposed to a complex mixture of volatile chemical compounds, and the use of chemical disinfecting products contributes to this exposure. There are a number of chemicals present in disinfecting products that can cause or exacerbate asthma because of their irritant or allergenic properties.

Chemical disinfecting products include, but are not limited to, chlorine, ammonia, ethanalamine, 2-butoxyethanol, and quaternary ammonium compounds.

Bello et al, provides a review of potentially hazardous chemicals in disinfecting products used in health care.

Environmental and surface disinfection chemicals are also routinely applied in other settings outside the health care industry, particularly in commercial buildings, schools, food service, and hotels.

The tasks and products used in these settings are often similar to those used for environmental and surface disinfection in health care.

Studies and reviews in the last decade documented an increased risk of asthma, chronic bronchitis, wheezing and other respiratory symptoms, and dermatitis among janitors and other workers with regular exposure to chemical agents during their daily activities.

Respiratory health effects are a major concern world over today, due to the hazardous nature of all chemical disinfectants. There are numerous case reports on work-related asthma associated with exposure to chemical disinfectants. Surveillance systems in different countries have observed an increased incidence of work-related asthma among both cleaners and health care workers, and these notifications were associated with exposure to chemicals. Several studies have reported that chemicals associated with respiratory disorders, were also associated with skin disorders, in particular hand dermatitis.

Epidemiologic studies based on general population samples have observed an increased incidence or prevalence of asthma or respiratory symptoms in cleaners and also in nurses or other health care professionals. In population-based studies using job exposure matrices, exposure to cleaning agents across different occupations was associated with asthma and severe or uncontrolled asthma in several studies with different designs. In workforce-based studies, specifically designed questionnaires for the respective sectors have been used and have consistently shown associations between the use of chemical products and asthma among cleaners and health care professionals.

There is an on-going search world-wide for less toxic disinfecting agents, such as natural and organic agents, also called green disinfectants and cleansers.

The occupational hygiene model for hazard prevention and control recognizes elimination or substitution of hazards with safer alternatives as most effective compared with engineering and administrative controls, and it considers personal protective equipment (PPE) as the last resort.

With the introduction of green chemistry initiatives, green or natural and organic cleansers and disinfecting products with less or no hazardous formulations, are being developed and brought into the market place. The major criteria in these product developments, is to prohibit disinfection and cleansing in Healthcare or institutional or industrial or domestic use from containing chemicals causing skin corrosion or serious eye damage and ingredients known to be carcinogens, mutagens, reproductive toxins, asthma, skin allergy or other health related hazards.

Chemical disinfectants, which are classified as antimicrobial pesticides, are registered with the U.S. Environmental Protection Agency (EPA) in accordance with the Federal Insecticide, Fungicide and Rodenticide Act. Likewise, each country has its own regulatory requirements for chemical disinfectants and all products have to be registered.

More than 5,000 antimicrobial products are registered with the EPA and sold in the marketplace. Out of these, more than 60% of antimicrobial products are registered to control infectious microorganisms in hospitals and other health care environments.

Disinfectants are biocidal chemicals used to control contamination by microorganisms. Disinfectants are classified as hazardous substances. Although disinfectants used in the healthcare facilities are especially selected so that potential residues left on surfaces etc. do not taint the surface or environment or are harmful to person, still many of them affect the person using them or coming in contact with them, either during or after use.

Human health risks from chemical disinfectants depend on both the hazards of the chemical and the amount of exposure a person has. It is important to understand that the exposure limits mentioned in product labels / MSDS sheets etc., are only appropriate as a cautionary warning and do not promote any healthy or a safe environment.

However new, nonchemical-based technologies are emerging which could meet definitions of green, made of ingredients with antimicrobial properties.

Currently, there are a very few systematic evaluations of green cleaning and disinfecting products, new technologies, and application methods for effective infection prevention or for occupational health and safety.

It is time for all to consider the use of natural disinfectants. Recent studies have shown that **40% of cleansers and disinfectants sold in stores are ineffective** against germs and bacteria!

Germs are forever increasing and mutating, making them harder to eliminate and protect against. Fully killing bacteria and viruses before they spread is crucial in hospitals in order to prevent infection, which could lead to sepsis and possible death.

Hospitals must use disinfectants. But the abundance of antibacterial *everything* – from hand sanitizers to laundry detergent to air fresheners, is causing far more harm than good in our health care environments.

## **What is the Alternative?**

After this long study on the effects of all the possible harm and disadvantages in using Chemical based Disinfectants, what other alternate would be ideal in this situation. Almost all the hospitals and every health care facility use or recommend one or the other Disinfectant that is currently available in the market, as there has not been a better alternative till date.

Hence all the scientists and clinicians have seemingly done their studies and tests on the Chemical based disinfectants available and have based their conclusions and findings on the least harm that could be done to the health care environment and the workers, by any brand of Chemical based disinfectant available in the market, taking into consideration the different alternative combinations of chemical ingredients that are used in any of the Disinfectants.

The Disinfectants meant for use in any healthcare facility or environment must be free from the following chemicals:

- Hydrogen peroxide
- Peracetic acid
- Acetic acid
- Ortho-phthalaldehyde
- Formaldehyde
- Glutaraldehyde
- Alcohol or Isopropyl alcohol
- Phenol
- Peroxygen-base
- Hypochlorites
- Chlorine dioxide
- Chlorine solutions
- Mercury compounds
- Antiseptics

The most ideal Disinfectant meant for use in any healthcare facility must be active in disinfecting, all kinds and types of micro organisms. It must be anti bacterial, anti fungal and anti viral.

The other benefits could include:

- **100% Natural and Organic**
- **Non-toxic**
- **Hypoallergenic**
- **Non-carcinogenic**
- **Non-mutagenic**
- **Non-teratogenic**
- **Eco-friendly**
- **Kills 99.999% of germs**
- **Non-staining**
- **Non-oily**
- **Fully bio-degradable**
- **Odourless**
- **Non-corrosive**
- **A new standard of care in infection prevention and control or management**
- **Specially formulated to allow fast, thorough and gentle cleansing, washing, rinsing, irrigation and decontamination of all areas in any health care facility.**
- **Eliminates the potential for any microbial contamination**
- **Is free from all known drugs, preservatives and chemicals**
- **The only natural and organic alternative to all chemical based cleansers**
- **Cleanses, washes, rinses, irrigates and decontaminates, even when surfaces are difficult to access**
- **Does not promote bacterial resistance or mutation**
- **Possesses rapid kill time**
- **Very effective against all moulds, yeasts, fungi, bacteria and viruses**
- **Non-sterile, preserved for multiple use**
- **pH balanced / works between a broad range of pH of 2 - 12**
- **Contains active anti microbial ingredients**
- **Contains no detergents**
- **No additional irrigation is necessary**
- **Home care friendly**
- **Managed care friendly**
- **Simple and easy to use**
- **Has no side effects**
- **Prevents bio-film formation**
- **Suitable for repeated, long-term use**
- **Easy to store**
- **Long residual effect.**
- **Stable at temperatures up to 130° c**

## SUMMARY &amp; COMPARISON TABLE ON LIQUID CHEMICAL DISINFECTANTS

Class	Recommended use	How They Work	Advantages	Disadvantages	Comments & Hazards
Formaldehyde	<ul style="list-style-type: none"> <li>• Bactericidal</li> <li>• Virucidal</li> <li>• Fungicidal</li> <li>• Sporicidal</li> </ul>	<ul style="list-style-type: none"> <li>• Formaldehyde Inactivates micro-organisms by alkylating the amino and sulfhydryl groups of proteins and ring nitrogen atoms of purine bases.</li> </ul>	<ul style="list-style-type: none"> <li>• Inexpensive</li> <li>• Kills a wide range of organisms</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable only for closed rooms</li> <li>• Pungent odor</li> <li>• Highly toxic</li> <li>• Corrosive</li> <li>• Carcinogenic</li> <li>• Health hazard</li> <li>• Exposure Time - 24 Hours.</li> </ul>	<ul style="list-style-type: none"> <li>• Irritant to eyes &amp; respiratory tract</li> </ul> <p>Deleted from the list of CDC in 1981. Many countries stopped using it.</p>
Hydrogen Peroxide	<ul style="list-style-type: none"> <li>• Bactericidal</li> <li>• Virucidal</li> <li>• Fungicidal</li> <li>• Sporicidal</li> </ul>	<ul style="list-style-type: none"> <li>• Hydrogen peroxide works by producing destructive hydroxyl free radicals that can attack membrane lipids, DNA, and other essential cell components.</li> </ul>	<ul style="list-style-type: none"> <li>• Expensive</li> <li>• Kills a wide range of organisms</li> </ul>	<ul style="list-style-type: none"> <li>• Highly corrosive</li> <li>• Toxic</li> <li>• Incompatible with the equipment. Discoloration of black anodized metal finishes and functional changes in endoscopes.</li> </ul>	<ul style="list-style-type: none"> <li>• Seizures</li> <li>• Cerebral infarction</li> <li>• Permanent Neurological deficits</li> </ul>
Glutaraldehyde	<ul style="list-style-type: none"> <li>• Bactericidal - good</li> <li>• Fungicidal - good</li> <li>• Tuberculocidal - excellent</li> <li>• Virucidal - good</li> <li>• Sporicidal - good</li> </ul>	<ul style="list-style-type: none"> <li>• Coagulates cellular proteins</li> </ul>	<ul style="list-style-type: none"> <li>• Non-staining, relatively Non corrosive</li> <li>• Useable as a sterilant on plastics, rubber, lenses, stainless steel and other items that can't be autoclaved</li> </ul>	<ul style="list-style-type: none"> <li>• Not stable in solution</li> <li>• Has to be in alkaline solution</li> <li>• Inactivated by Organic material</li> </ul>	<ul style="list-style-type: none"> <li>• Eye, skin and respiratory irritant</li> <li>• Sensitizer</li> <li>• Toxic</li> </ul>

## SUMMARY &amp; COMPARISON TABLE ON LIQUID CHEMICAL DISINFECTANTS

Class	Recommended use	How They Work	Advantages	Disadvantages	Comments & Hazards
70% Isopropyl Alcohol Solution	<ul style="list-style-type: none"> <li>Cleaning some instruments</li> <li>Cleaning skin</li> </ul>	<ul style="list-style-type: none"> <li>Changes protein structure of microorganism</li> <li>Presence of water assists with killing action</li> </ul>	<ul style="list-style-type: none"> <li>Fairly inexpensive</li> </ul>	<ul style="list-style-type: none"> <li>&lt;50% solution not very effective</li> <li>Not active when organic matter present</li> <li>Not active against certain types of viruses</li> <li>Evaporates quickly</li> <li>Contact time not sufficient for killing</li> </ul>	<ul style="list-style-type: none"> <li>Flammable</li> <li>Eye irritant</li> <li>Toxic</li> </ul>
Chlorine Compounds	<ul style="list-style-type: none"> <li>Spills of human body fluids</li> <li>Bactericidal - good</li> <li>Fungicidal - good</li> <li>Sporicidal - good at &gt;1000 ppm Sodium Hypochlorite</li> </ul>	<ul style="list-style-type: none"> <li>Free available chlorine combines with contents within microorganism, reaction by products cause its death</li> <li>Need 500 to 5000 ppm</li> <li>Produce chemical combination with cell substances</li> <li>Depends upon release of Hypochlorous acid</li> </ul>	<ul style="list-style-type: none"> <li>Kills hardy viruses (e.g., hepatitis)</li> <li>Kills a wide range of organisms</li> <li>Inexpensive</li> <li>Penetrates well</li> <li>Relatively quick microbial kill</li> <li>May be used on food prep surfaces</li> </ul>	<ul style="list-style-type: none"> <li>Corrodes metals such as stainless, aluminum</li> <li>Organics may reduce activity</li> <li>Increase in alkalinity decreases bactericidal property</li> <li>Unpleasant taste and odor</li> <li>Tuberculocidal, with extended contact time</li> </ul>	<ul style="list-style-type: none"> <li>Follow spill procedure and dilution instructions</li> <li>Make fresh solutions before use</li> <li>Eye, skin and respiratory irritant</li> <li>Corrosive</li> <li>Toxic</li> </ul>

### SUMMARY & COMPARISON TABLE ON LIQUID CHEMICAL DISINFECTANTS

Class	Recommended use	How They Work	Advantages	Disadvantages	Comments & Hazards
Iodophors (Iodine with carrier)	<ul style="list-style-type: none"> <li>Disinfecting some semi-critical medical equipment</li> <li>Bactericidal - very good</li> <li>Fungicidal - excellent</li> <li>Virucidal - excellent</li> </ul>	<ul style="list-style-type: none"> <li>Free iodine enters Microorganism and binds with cellular components</li> <li>Carrier helps penetrate soil/fat</li> <li>Need 30 to 50 ppm</li> <li>Probably by disorder of protein synthesis due to hindrance and / or blocking of hydrogen bonding</li> </ul>	<ul style="list-style-type: none"> <li>Kills broad range of organisms</li> <li>Highly reactive</li> <li>Low tissue toxicity</li> <li>Kills immediately rather than by prolonged period of stasis</li> <li>Not affected by hard water</li> <li>May be used on food prep surfaces</li> </ul>	<ul style="list-style-type: none"> <li>May stain plastics or corrode metal</li> <li>May stain skin/ Laundry</li> <li>Stains most materials</li> <li>Odor</li> <li>Some organic and inorganic substances neutralize effect</li> <li>Tuberculocidal, with extended contact time</li> <li>Sporicidal, some</li> </ul>	<ul style="list-style-type: none"> <li>Dilution critical</li> <li>Follow Directions !</li> <li>Use only EPA registered hard surface iodophor Disinfectants</li> <li>Don't confuse skin antiseptic iodophors for disinfectants</li> <li>Skin and eye irritant</li> <li>Corrosive</li> <li>Toxic</li> </ul>
Phenolic Compounds	<ul style="list-style-type: none"> <li>Bactericidal - excellent</li> <li>Fungicidal - excellent</li> <li>Tuberculocidal - excellent</li> <li>Virucidal - excellent</li> </ul>	<ul style="list-style-type: none"> <li>Gross protoplasmic poison</li> <li>Disrupts cell walls</li> <li>Precipitates cell proteins</li> <li>Low concentrations - inactivate essential enzyme systems</li> </ul>	<ul style="list-style-type: none"> <li>Nonspecific concerning bactericidal and fungicidal action</li> <li>When boiling water would cause rusting, the presence of phenolic substances produces an antirusting effect</li> </ul>	<ul style="list-style-type: none"> <li>Unpleasant odor</li> <li>Some areas have disposal restrictions</li> <li>Effectiveness reduced by alkaline pH, natural soap or organic Material</li> <li>Sporicidal, no</li> </ul>	<ul style="list-style-type: none"> <li>Skin and eye irritant</li> <li>Sensitizer</li> <li>Corrosive</li> <li>Toxic</li> </ul>

## SUMMARY &amp; COMPARISON TABLE ON LIQUID CHEMICAL DISINFECTANTS

Class	Recommended use	How They Work	Advantages	Disadvantages	Comments & Hazards
Quaternary Ammonium Compounds (QUATS)	<ul style="list-style-type: none"> <li>• Ordinary housekeeping (e.g., floors, furniture, walls)</li> <li>• Bactericidal – excellent</li> <li>• Fungicidal – good</li> <li>• Virucidal – good (not as effective as phenols)</li> </ul>	<ul style="list-style-type: none"> <li>• Affects proteins and cell membrane of Micro organism</li> <li>• Releases nitrogen and Phosphorous from cells</li> </ul>	<ul style="list-style-type: none"> <li>• Contains a detergent to help loosen soil</li> <li>• Rapid action</li> <li>• Colorless, odorless</li> <li>• Non-toxic</li> <li>• Less corrosive</li> <li>• Highly stable</li> <li>• May be used on food prep surfaces</li> </ul>	<ul style="list-style-type: none"> <li>• Does not eliminate spores, TB bacteria, some viruses</li> <li>• Effectiveness influenced by hard water</li> <li>• Layer of soap interferes with action</li> </ul>	<ul style="list-style-type: none"> <li>• Select from EPA list of hospital disinfectants</li> <li>• Skin and eye irritant</li> <li>• Toxic</li> </ul>
ZITRITIDE Bitter orange extract (Bioflavonoid complex)	<ul style="list-style-type: none"> <li>• Bactericidal</li> <li>• Virucidal</li> <li>• Fungicidal</li> <li>• Sporicidal</li> </ul>	<ul style="list-style-type: none"> <li>• Organic Acids reduce the Ph of bacteria cells, forcing them to divert their metabolic activity towards balancing Ph. This will result in a reduction of essential metabolic activity, resulting in killing the organism.</li> <li>• Works within a pH range of 2 to 12 and is stable at temperatures up to 130° C.</li> </ul>	<ul style="list-style-type: none"> <li>• Natural / Organic</li> <li>• Non-corrosive</li> <li>• Non-toxic</li> <li>• Non-irritant</li> <li>• Non-rinse</li> <li>• Biodegradable</li> <li>• Food safe</li> <li>• Ecofriendly - Safe for people, surfaces and environment</li> <li>• User friendly</li> <li>• Easy to use</li> <li>• Multipurpose</li> </ul>	<ul style="list-style-type: none"> <li>• NONE</li> </ul>	<ul style="list-style-type: none"> <li>• Natural / Organic</li> <li>• Multiple uses. One product for critical &amp; non critical areas.</li> </ul>

- The antiviral effect of the product is at the level of transcription as it has been proven to stop the replication of negatively stranded RNA viruses (reverse transcriptase) into virulent positive strands.