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The Characteristic Study of Peroxy Compound with Respect to Their Pharmaceutical Application

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ABSTRACT

Hospital infections are one of the major causes of morbidity and mortality worldwide, and their treatment becomes increasingly difficult due to increased bacterial resistance. The cleaning chemicals for hospitals are formulated to not only clean and disinfect, but to counteract Health care- Associated Infection (HAI)-causing pathogens and other emerging threats. They also are formulated to balance efficiency and surface compatibility. Disinfectants are widely used in hospitals and other health care centers to control the growth of microbes on both living tissues and inanimate objects. Different disinfectant formulations have different applications. Many disinfectants are used alone or in combinations (e.g., hydrogen peroxide and peracetic acid) in the health-care setting. To minimize the spread of these microorganisms in hospitals, they proposed various forms of disinfection, however diversity and effectiveness of these methods are varied. Thus, this study aimed to understand the associations of microorganisms controlled by disinfectants in the hospital environment. They are effective even in disinfecting the outer clothing/body in an effective manner. The outbreak of coronavirus (COVID-19) has led to broad use of chemical disinfectants in order to sterilize public spaces and prevent contamination.

INTRODUCTION

The recent widespread coronavirus (SARS-CoV-2) pandemic situation worldwide stimulated a mass effort by governments, local authorities, and public health institutes to conduct disinfection campaigns of public facilities and community-shared spaces. This led to the development of chemical disinfectants used for sterilizing surfaces and medical devices that can be contaminated by COVID-19 virus.[1] Disinfection for the SARS- Covid-19 virus is usually done using a solution of sodium hypochlorite, commonly known as bleach. Solution of sodium hypochlorite is unstable and quickly breaks down to release chlorine (Chlorine can have several harmful effects). The combination product gives hospitals a potential alternative to sodium hypochlorite and also it is environment friendly and leaving no harmful residue.[2] Appropriate disinfection procedures are a must for control of hospital-acquired infection, as failure can result in many hospital-acquired infections thus leading to increased cost, morbidity and mortality.[3-4] According to estimates from the Centers for Disease Control and Prevention, Healthcare-Associated Infections (HAIs) kill more people each year globally than car accidents, breast cancer or Aids. The most common HAIs are central line-associated bloodstream infections, Methicillin-Resistant Staphylococcus Aureus (MRSA), vancomycin resistant Enterococci bloodstream infections, Clostridium difficile, Surgical Site Infections (SSIs).[5] Stringent disinfection reduces the risk of HAIs.[6] To disinfect is to cleanse so as to destroy or prevent the growth of disease carrying microorganisms.[7]

According to USP, a disinfectant is a chemical or physical agent that destroys or removes the vegetative forms of harmful microorganisms when applied to a surface.[8] Disinfection is defined as destruction of pathogenic microorganisms or their toxins or vectors by direct exposure to chemical or physical agents. [9] Disinfection occurs at the molecular level. It requires electrons for oxidation, acidification, and coagulation. Oxidation and reduction are two important mechanisms in disinfectants.[10] In disinfectant, the points to be considered include; selection of chemical agents, challenge organisms, surface types, contact time, neutralizer and laboratory.[11] The antimicrobial activity of disinfectant performs in two different ways: growth inhibition (e.g. bacteriostatic, fungistatic) and lethal action (sporicidal, bactericidal, fungicidal, and virucidal effects).[18]

Efficacy of Disinfectant

According to the meta-analysis published by Agency For healthcare research and quality, an effective disinfection protocol considers factors including, targeted microbes, surface type, disinfectant compatibility with surfaces and materials, cost and ease of use, safety to staff and patients. For a disinfectant to be effective, it needs to sit wet on a surface for a certain length of time. This ensures that the disinfectant is in contact with the microorganism long enough to kill it.[12] Factors that affect the efficacy of disinfection include prior cleaning of the object; organic and inorganic load present; type and level of microbial contamination; concentration of and exposure time to the germicide; physical nature of the object (e.g., crevices, hinges, and lumens); presence of biofilms; temperature and pH.[3][13-14]

Ideally, the perfect disinfectant should possess a complete antimicrobial spectrum, act rapidly and persistently, lack toxicity to humans and the environment, be compatible with the material to treat, noncorrosive, nonirritating, be chemically stable, and be economical and easy to use.

Actually, no product meets all these requirements; therefore, we need to find the best possible compromise to achieve the ideal result, minimizing the disadvantages related to their use.[15][16-17] When applying the surface disinfectant on the target surface, the approaches can be generally divided into two groups:

i) without mechanical action, e.g. total immersion and directly spraying, and

ii) with mechanical action, e.g. spray & wiping, dipping & wiping, and soaking & wiping.

The most prominent method is ready-to-use disinfecting wipes.[18][3] In health-care settings, objects usually are disinfected by liquid chemicals or wet pasteurization.[13] Complete disinfecting protocol includes four steps: Pre-cleaning, disinfecting (dwell time), wiping clean and rinsing with water. [19] In general, disinfectants have three mechanism of action or ways that they affect or kill an organism: Cross-linking, coagulating, clumping; structure and function disruption; and oxidizing.[20]

Uses of disinfectant:

Disinfectants are widely used in medicine, veterinary medicine, and the food processing industry. Broad-scale use of disinfectants may have detrimental ecological consequences, for instance the development of antimicrobial resistance (Antibiotic resistance and disinfectant resistance may be stabilized and maintained even in the absence of a direct selective pressure).[21-22] Disinfectants may also be used to chemically treat infectious hospital waste, especially disposable plastic and microbiological wastes.[3] It is also a form of decontamination and can be defined as the process whereby physical or chemical methods are used to reduce the amount of pathogenic microorganisms on a surface.[17]

Standard test of disinfectant:

The standard tests to check disinfection efficiency include Rideal-Walker phenol Coefficient (R.W.C) test, Chick-Martin and Garrod's test, Kelsey and Maurer's in-use tests and surface disinfection tests capacity use dilution test (Kelsey and Sykes, 1969), modified by Kelsey and Maurer, 1974, various other microbial time kill assays and standard carrier tests such as EN 13697, ASTM E2197, etc. And to measure MICs of disinfectant against microbial species use the micro broth dilution testing (by agar dilution method).[23][3][17] According to USP, to demonstrate the efficacy of a disinfectant within a pharmaceutical manufacturing environment, it may be deemed necessary to conduct the following tests: Use-dilution tests, Surface challenge tests, statistical comparison of the frequency of isolation and numbers of microorganisms isolated prior to and after the implementation of a new disinfectant.[8]

The EPA has divided disinfectant products into mainly two major types:

1. Hospital type disinfectants are critical to infection control and are used on-medical and dental instruments, floors, toilet seats and other surfaces;

2. General use disinfectants are the major source of products in-households, swimming pools and water purifiers.[8]

Methods of Disinfection: [5][6][13][15][17]

Chemical disinfectants:

1. High level disinfectant: High-level disinfectants kill all organisms, except high levels of bacterial spores.

Chemical characteristics	Hydrogen peroxide (7.5%)	Peracetic acid (0.2 %)	Glutaraldehyde (less than equal to 2.0%)	OPA(0.55%)	Hydrogen peroxide/PAA (7.35% /0.23%)
High-level disinfectant claim	30 minutes @ 20°C	Not Applicable	20-90 minutes @ 20⁰-25°C	12 minutes @ 20°C, 5 minutes @ 25°C in AER	15 minutes @ 20°C
Sterilization Claim	6 hours @ 20°C	12 minutes @ 50-56°C	10 hours @ 20⁰ 25°C	None	3 h @ 20°C
Activation	No	No	Yes (alkaline glutaraldehyde)	No	No
Reuse life (number of days a product can be reused as determined by re-use protocol)	21 days	Single use	14-30 days	14 days	14 days
Shelf life stability (time a product can remain in storage (unused))	2 years	6 months	2 years	2 years	2 years
Disposal Restrictions	None	None	Local (no U.S. EPA regulations exist but some states and local authorities have disposal restrictions)	Local (no U.S. EPA regulation s exist but some states and local authorities have disposal restrictions)	None

Formaldehyde Glutaraldehyde Hydrogen peroxide

Ortho-phthalaldehyde (OPA)

Peracetic acid

Peracetic acid and

Hydrogen peroxide

2. Intermediate level disinfectant: Intermediate-level disinfectants might be cidal for mycobacteria, vegetative bacteria, most viruses, and most fungi but do not necessarily kill bacterial spores.

Chlorine and chlorine compounds Iodophors

3. Low level disinfectant: Low-level disinfectants can kill most vegetative bacteria, some fungi, and some viruses in a practical period of time (≤10 minutes).

Alcohol

Phenol

Quaternary ammonium compounds

Miscellaneous Inactivating Agents

Other germicides Metals as microbicides Ultraviolet radiation Pasteurization Flushing- and washer-disinfectors

In disinfectants, the Oxidizing agents are Sodium hypochlorite (NaClO), Povidone-iodine, Hydrogen peroxide and Peracetic acid. And Non- oxidant (coagulant) are Alcohol (ethanol), Chlorhexidine, Quaternary Ammonium Compound (QAC), Glutaraldehyde and ortho-phthalaldehyde (OPA)[10]. The Natural disinfectants are Rubbing alcohol, White Vinegar, Lemons, Steam and Hot Water, Essential oils, Borax.[24]

Materials Compatibility	Good	Good	Excellent	Excellent	No data
Monitor MEC of solution	Yes (6%)	No	Yes (1.5% or higher)	Yes (0.3% OPA)	No
Safety	Serious eye irritant (safety glasses)	Serious eye and skin irritant (concentrated solution)	Respiratory irritant	Eye irritant, stains skin	Eye irritant
Processing	Manual or automated	Automated	Manual or automated	Manual or automated	Manual
Organic material resistance	Yes	Yes	Yes	Yes	Yes
OSHA exposure limit	1 ppm TWA	None	None (The ceiling limit recommended by the American Conference of Governmental Industrial Hygienists is 0.05 ppm.)	None	Hydrogen Peroxide -1 ppm (time-weighted average for a conventional 8-hour workday)
Cost profile (per cycle)	+ (manual) ++ (automated)	+++++ (automated)	+ (manual) ++ (automated)	++ (manual)	++ (manual)

Abbreviations and Footnotes:

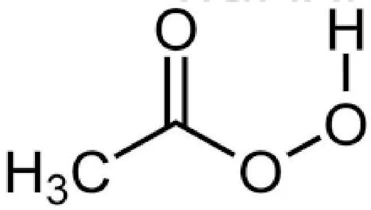
OPA ortho-phthalaldehyde

AER Automated Endoscope Reprocessor

MEC minimum effective concentration is the lowest concentration of active ingredients at which the product is still effective + = least expensive; +++++ = most expensive

Peroxygen Compounds

PeroxyChem is one of the largest North American producers of peracetic acid and has developed a wide offering of high quality products, ranging in concentration from 5% to 35% peracetic acid in equilibrium solution.[26] Both hydrogen peroxide and peracetic acid are peroxygen compound of great importance in infection control because, unlike most disinfectants, they are unaffected by the addition of organic matter and salts. In addition, the formation of the hydroxyl radical, a highly reactive ion that occurs as peroxygen compounds encounter air, is lethal to many species of bacteria because it is a strong oxidant. Being highly reactive, the hydroxyl radical attacks essential cell components and cell membranes, causing them to collapse. Mechanism of action of peroxygen compound is oxidizing action.[27] Many other peroxygen compounds (e.g. percarbonate per lactate, per succinate per benzoate and pervalerate) have microbicidal properties, but they are generally unstable and have found little use in the disinfectant industry.[22]



Peracetic acid

Peracetic acid [PAA]

Peracetic acid was introduced in 1955.[28] PAA was first registered as a disinfectant in 1985 by the EPA.[29] Peracetic Acid, also known as (PAA), PAA is a weak organic acid but is a strong oxidizing chemical that has unique biocidal properties. It is susceptible to hydrolysis, known as dissociation.[30][31-32] PAA is a strong disinfectant with a wide spectrum of antimicrobial activity.[33]

PAA is a highly reactive and highly biocidal oxidizer that maintains its efficacy in the presence of organic soil. PAA removes surface contaminants (primarily protein) on endoscopic tubing.[34][31] However, it breaks down to acetic acid (vinegar) and water leaving no harmful residue, which makes it the chemical of choice when looking for a food-safe antimicrobial.[31][35] It is soluble in water and is completely biodegradable, breaking down to harmless products.[28] It can corrode copper, brass, bronze, plain steel, and galvanized iron but these effects can be reduced by additives and pH modifications. It is considered unstable, particularly when diluted; for example, a 1% solution loses half its strength through hydrolysis in 6 days, whereas 40% PAA loses 1%–2% of its active ingredients per month.[25] PAA has an acrid odour but kills all types of microorganisms, including spores, and is active in the presence of soiling matter. [22]

Commercially available formulations of PAA are equilibrium solutions of acetic acid, peracetic acid and a small amount of hydrogen peroxide. [30][36] Another emerging alternative to ethylene oxide and aldehyde sterilants is PAA. PAA based solutions are considered to be a more potent disinfectant than hydrogen peroxide; are sporicidal, bactericidal, virucidal and fungicidal at low concentrations; and are environment friendly. They have replaced traditional disinfectants for medical devices, endoscopes and haemodialysers.[5] PAA is more effective when the pH value is 7 than at a pH range between 8 and 9. At a temperature of 15 °C and a pH value of 7, five times more PAA is required to effectively deactivate pathogens than at a pH value of 7 and a temperature of 35 °C.[37] An automated machine using PAA to chemically sterilize medical (e.g., endoscopes, arthroscopes), surgical, and dental instruments is used in the United States.[25]

Mode of Action

Peroxygen compounds also kill spores by removing proteins from the spore coat, exposing its core to the lethal disinfectant.[27] PAA disinfects by oxidizing the outer cell membrane of bacterial cells, endospores, yeast, and mold spores, it denatures proteins, disrupts cell wall permeability, and oxidizes sulfhydryl and sulfur bonds in proteins, enzymes, and other metabolites.[32][34][36]

The oxidation mechanism consists of electron transfer. When a stronger oxidant is used, the electrons are transferred to the microorganism much faster, causing the microorganism to be deactivated rapidly.[37]

Spectrum of Kill

● Certain temperatures, pH, and concentrations affect the efficacy of PAA.

● At 3000 ppm, PAA can kill all microbial life whereas at 10 ppm, it only kills bacteria.

Environmental Profile –

● PAA readily decomposes and its primary and secondary products are all deemed non-harmful to the environment.

Cost Effectiveness –

● PAA is readily available from various manufacturers and can be found in both concentrated and ready-to-use formats.[29]

● **Advantages:**

An advantage of PAA is its lack of harmful decomposition products (i.e. acetic acid, water, oxygen, hydrogen peroxide); it enhances removal of organic material and leaves no residue. It remains effective in the presence of organic matter and is sporicidal even at low temperatures.[28]

Microbial Activity:

PAA shows fairly strong efficacy against a broad spectrum of pathogens.[29] PAA (0.26%) was effective (log_{10} reduction factor >5) against all test strains of mycobacteria (M. tuberculosis, M. avium-intracellulare, M. chelonae, and M. fortuitum) within 20–30 minutes in the presence or absence of an organic load. With bacterial spores, 500–10,000 ppm (0.05%–1%) inactivates spores in 15 seconds to 30 minutes using a spore suspension test.[25]

PAA will inactivate gram-positive and gram-negative bacteria, fungi, and yeasts in <5 minutes at <100 ppm. In the presence of organic matter, 200-500 ppm is required. For viruses, the dosage range is wide (12 -2250 ppm), with poliovirus inactivated in yeast extract in 15 minutes with 1500 to 2250 ppm. Bacterial spores in suspension are inactivated in 15 seconds to 30 minutes with 500 to 10,000 ppm (0.05 to 1%).[31] It is bactericidal at 10ppm, fungicidal at 30 ppm and virucidal at 400 ppm in a 5 minute contact time. Furthermore, it is sporicidal at concentrations of 3000 ppm.[29]

	ACUTE HAZARDS	PREVENTION	FIRE FIGHTING
FIRE & EXPLOSION	Flammable. Above 40.5°C explosive vapour/air mixtures may be formed. Explosive.	NO open flames, NO sparks and NO smoking. NO contact with flammables or hot surfaces. Above 40.5°C use a closed system, ventilation and explosion-proof electrical equipment. Do NOT expose yourself to friction or shock.	Use water spray. See Notes. In case of fire: keep drums, etc., cool by spraying with water. Combat fire from a sheltered position.

Dangers of Peracetic Acid [31][38]

PAA safety is a major concern for anyone potentially exposed because PAA is corrosive to the eyes, the skin and the respiratory tract. According to NIOSH, symptoms of acute exposure to PAA vapor include cough, labored breathing, and shortness of breath; skin redness, pain, and blisters; severe deep burns to the eyes.

PREVENT GENERATION OF MISTS!			
	SYMPTOMS	**PREVENTION**	**FIRST AID**
Inhalation	Burning sensation. Cough. Labored breathing. Shortness of breath. Sore throat. Symptoms may be delayed. See Notes.	Use ventilation, local exhaust or breathing protection.	Fresh air, rest. Half- upright position. Refer for medical attention. See Notes.
Skin	MAYBE ABSORBED! Redness. Pain. Blisters. Skin burns.	Protective gloves. Protective clothing.	First, rinse with plenty of water for at least 15 minutes, then remove contaminated clothes and rinse again. Refer for medical

			attention.
Eyes	Redness. Pain. Severe deep burns.	Wear face shield or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then refer for medical attention.
Ingestion	Abdominal pain. Burning sensation. Shock or collapse.	Do not eat, drink, or smoke during work.	Rinse mouth. Do NOT induce vomiting. Refer for medical attention.

PHYSICAL & CHEMICAL INFORMATION[38][46]	
Physical State; Appearance: Colourless liquid with characteristic odour. **Chemical dangers** Decomposes violently on contact with metals. Attacks most metals. This produces highly flammable hydrogen gas and oxygen. This generates fire and explosion hazard. Decomposes on heating and on burning. This produces toxic and corrosive gases. The substance reacts with most organic and inorganic compounds, causing fire and explosion hazard.	**Formula:** $C_2H_4O_3$ / CH_3COOOH Molecular mass: 76.1; **Viscosity:** 3.280cP **Decomposes at** >50°C **Melting point:** 0°C **Relative density** (water = 1): 1.2 **Solubility in water**: miscible Vapour pressure **kPa at 20°C:** 2.6 **Relative vapour density** (air = 1): 2.6 **Relative density of the vapour/air- mixture at 20°C (air = 1):** 1.04 **Acidity(pka):**8.2 **Flash point:** 40.5°C **Auto-ignition temperature:** 200°C **Boiling point:**105°C(221°F;378K)

According to UN GHS (Globally Harmonized System of Classification and Labelling of Chemicals.) Criteria included in labeling:

Flammable liquid and vapour heating may cause a fire fatal if inhaled or harmful if swallowed or in contact with skin causes severe skin burns and eye damage may cause respiratory irritation.

Very toxic to aquatic life

SPILLAGE DISPOSAL

Evacuate the danger area! Consult an expert! Personal protection: chemical protection suit including self-contained breathing apparatus. Do NOT let this chemical enter the environment. Do NOT wash away into the sewer. Do NOT absorb in saw-dust or other combustible absorbents. Collect leaking and spilled liquid in covered plastic containers as far as possible. Absorb remaining liquid in sand or inert absorbent. Then store and dispose of according to local regulations.

STORAGE

Fireproof. Provision to contain effluent from fire extinguishing. Separated from combustible substances and incompatible materials. See Chemical Dangers. Cool. Store only if stabilized. Store in an area without drain or sewer access.[38]

Applications of PAA

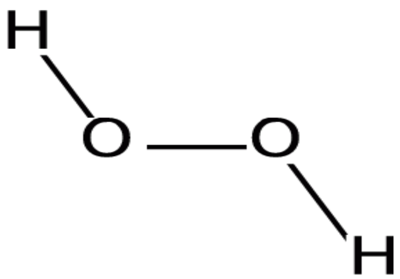
The different concentrations of PAA are used in chemical synthesis, bleaching, sanitization, disinfection and sterilization across a variety of industries, including food and beverage, environmental remediation, industrial cleaning and sanitization, and oil and gas production also used in health care settings. [26][36-37]

PAA is widely used in Europe for wastewater disinfection.[36]

PAA is used as a disinfectant against bacteria, fungi, and viruses in the food and medical industry, as a polymerization catalyst or co-catalyst, in the epoxidation of fatty acid esters, as an epoxy resin precursor, in the synthesis of other chemicals and for disinfection of endoscopes and silicones.[39-40]

Hydrogen peroxide (H_2O_2)

Hydrogen Peroxide is a peroxide and oxidizing agent with disinfectant, antiviral and antibacterial activities. It is a widely used antimicrobial chemical. It is used in both liquid and gas form for disinfection application.[41] Hydrogen peroxide (H_2O_2) is a clear, colorless liquid at room temperature with bitter taste, which is commercially available in a variety of concentrations ranging from 3 to 90%. $H_2O_2$is considered environmentally friendly because it can rapidly degrade into the innocuous products water and oxygen. Although pure solutions are generally stable, most contain stabilizers to prevent decomposition.[42]



Structure of Hydrogen peroxide

H_2O_2 is effective against bacteria, viruses, yeast and spores. It is commercially available in concentrations ranging from 3% to 90%. H_2O_2 is environmentally friendly, because it can rapidly degrade into harmless products, that is, water and oxygen. H_2O_2 acts as an oxidant by producing hydroxyl free radicals (•OH), which attack cell components, including lipids, proteins, and DNA. Proposed mechanism of action is based on its ability to target exposed sulfhydryl groups and double bonds.[11][18]

H_2O_2 is a widely used biocide for disinfection, sterilization, and antisepsis. In general, greater activity is seen against gram positive than gram-negative bacteria; however, the presence of catalase or other peroxidases in these organisms can increase tolerance in the presence of lower concentrations. Higher concentrations of H_2O_2 (10 to 30%) and longer contact times are required for sporicidal activity, although this activity is significantly increased in the gaseous phase. H_2O_2 is a very reactive material, is not very stable and is destroyed by alkalis. Once the bond is broken via the Fenton reaction, a hydroxyl radical (˙OH) is formed, and it performs sterilization. To increase stability, the pH is adjusted to approximately 5 and phosphonates are added. Hydrogen peroxide has found intensive use in sterilizing cardboard packaging used for milk.[22][40] H_2O_2 does not kill spores effectively at a low concentration

(< 2%) (Low-level disinfectant), but it acts as a high-level disinfectant or chemical sterilant if allowed sufficient time at a high concentration (7.5–30%).[40]

It's good, broad-spectrum bactericidal, virucidal, sporicidal and fungicidal properties, combined with its excellent stability and environmentally friendly characteristics have made hydrogen peroxide the disinfectant of choice for semi-critical and non-critical equipment while being an ideal surface disinfectant. [5]

Properties	
Chemical formula	H_2O_2
Molar mass	34.0147 g/mol
Appearance	Very light blue color; colorless in solution
Odor	slightly sharp
Density	1.11 g/cm^3(20 °C, 30% (w/w) solution) 1.450 g/cm^3(20 °C, pure)
Melting point	−0.43 °C (31.23 °F; 272.72 K)
Boiling point	150.2 °C (302.4 °F; 423.3 K) (decomposes)
Solubility in water	Miscible
Solubility	soluble in ether, alcohol insoluble in petroleum ether
log *P*	-0.43
Vapor pressure	5 mmHg (30 °C)
Acidity (pka)	11.75
Magnetic susceptibility (χ)	−17.7·10
Refractive index (nD)	1.4061
Viscosity	1.245 cP (20 °C

Physical and chemical properties of H_2O_2:[4]

H_2O_2 advantages include its potent and broad spectrum antimicrobial activity, flexibility in use and safety profile in comparison to other microbicides. It also has advantages with regard to its toxicity and environmental profile. However, overall, the effective and safe use of H_2O_2 depends on the way it is used. The gas form is particularly effective in comparing liquid forms and at lower concentrations.

Accelerated Hydrogen Peroxide [AHP]

AHP is a more recent breakthrough in hospital disinfectants. It is in Oxivir and Alpha HP. These products are a blend of safe, active cleaning agents with hydrogen peroxide. These compounds are safe for the cleaning staff and the environment with the lowest EPA toxicity category of IV. These one-step cleaners disinfect in the presence of organic matter and blood. They are efficient with short dwell times. AHP kills bacteria, viruses, mycobacteria, pathogenic fungi, and blood-borne pathogens.[5-6]

PAA and H_2O_2 combination

PAA, when combined with hydrogen peroxide, was found to be more effective, typically against glutaraldehyde-resistant mycobacteria.[12] It has been shown to reduce bacterial levels on surfaces to a greater degree than a quaternary ammonium disinfectant and reduced contamination by *C.difficile*, MRSA, and VRE as effectively as sodium hypochlorite in another study. The product has a smell similar to vinegar that may be of concern when it is initially introduced. The combination product gives hospitals a potential alternative to sodium hypochlorite when a sporicidal disinfectant is needed.[45]

Combinations of PAA and hydrogen peroxide further boost the efficacy profile, as this blend can prevent the formation of biofilms on hard surfaces.[7] Combining peracetic acid with hydrogen peroxide results in synergistic antimicrobial activity.[28]

CONCLUSION

Health Associated Diseases [HAIs] during hospitalization results in an increase in the risk of serious infections in patients. An effective cleaning and disinfection program is required for controlled environments used in the manufacturing of medicinal products to prevent microbial contamination and deliver quality products thus enhancing patient safety. A variety of chemical disinfectants are widely available and they provide an effective tool against SARS-CoV viruses on surfaces or in water. Other more specialized chemicals are used in medical facilities for thorough sterilization of medical devices and hard-to-reach surfaces.

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