



## Original Research Article

# Antibacterial Effects of Soft Contact Lens Disinfectant Solutions

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## ABSTRACT

Contact lens wearers are at great risk of developing microbial keratitis because of incorrect usages and unhygienic maintenance of contact lenses. Therefore, the present study was planned to provide data that will be helpful in selecting the solution to remove microbial contaminations. One hundred bacterial isolates from contact lenses wearer were isolated, identified and subjected to in vitro antibiotic sensitivity. *In vitro* sensitivity testing was done by Kirby-Bauer disc diffusion method. Multi drug resistant strains of pathogenic, as well as opportunistic microorganisms may be isolated during the study. Our study demonstrated that during asymptomatic wear lenses are colonized by low levels of bacteria with gram-positive bacteria, such as coagulate negative staphylococci, predominating. Gram-negative bacteria are frequently the causative agents of adverse responses during contact lens wear. Measuring the adhesion of different strains and/or species of bacteria to different contact lens materials demonstrated considerable differences. In particular, *Pseudomonas aeruginosa* strains adhered in larger numbers to the highly oxygen permeable contact lens. Pure cultures are isolated & their morphology is studied by Grams staining and Kirby bauer disc diffusion test is used to determine the resistance/sensitivity of strains to specific chemicals. Gram positive & gram negative cultures with different zones shows different sensitivity pattern. Cultures with <10 mm diameter shows resistant towards solution that is used in Disc diffusion method and with 11-19 mm diameter shows intermediate & sensitive towards solution. X solution contains the active component, chlorhexidine gluconate 0.005 %. But in Y solution it is dymed (polyamino propyle biguanid) 0.0001 %. From our comparison, it is noted that both gram positive and gram negative bacteria have shown resistance towards solution Y (may be due to drug resistance) and solution Y is found to be ineffective in controlling contact lens bacterial isolates. However solution X has shown effectiveness against gram positive and to a intermediate effectiveness against gram negative bacteria. Hence solution X is better than solution Y in controlling contact lens isolates.

## Keywords

Contact lens,  
Kirby-Bauer  
method,  
*Pseudomonas  
aeruginosa*,  
*Staphylococci*

## Introduction

A contact lens, or simply contact, is a lens placed on the eye. Contact lenses are considered medical devices and can be worn to correct vision, for cosmetic or therapeutic

reasons. People choose to wear contact lenses for many reasons. Aesthetics and cosmetics are often motivating factors for people who would like to avoid wearing

glasses or would like to change the appearance of their eyes. Other people wear contacts for more visual reasons. When compared with spectacles, contact lenses typically provide better peripheral vision, and do not collect moisture such as rain, snow, condensation, or sweat. This makes them ideal for sports and other outdoor activities. Additionally, there are conditions such as keratoconus and aniseikonia that are typically corrected better by contacts than by glasses.

### **Types of contact lenses**

#### **Corrective contact lenses**

Corrective contact lenses are designed to improve vision, most commonly by correcting refractive error. This is done by directly focusing the light so that it enters the eye with the proper power for clear vision. Recently, there has been renewed interest in orthokeratology, the correction of myopia by deliberate overnight flattening of the corneal epithelium, leaving the eye without a refractive error during the day.

#### **Cosmetic contact lenses**

A cosmetic contact lens is designed to change the appearance of the eye. These lenses may also correct refractive error. All individuals who would like to wear cosmetic lenses should have a contact lens examination with an eye doctor prior to first use, and if used long-term, regular aftercare examinations, in order to avoid potentially blinding complications.

#### **Therapeutic contact lenses**

Soft lenses are often used in the treatment and management of non-refractive disorders of the eye. A bandage contact lens protects an injured or diseased cornea from the

constant rubbing of blinking eyelids thereby allowing it to heal. They are used in the treatment of conditions including bullous keratopathy, dry eyes, corneal abrasions and erosion, keratitis, corneal edema, descemetocoele, corneal ectasis, Mooren's ulcer, anterior corneal dystrophy, and neurotrophic keratoconjunctivitis. Contact lenses that deliver drugs to the eye have also been developed.

### **Rigid lenses**

Glass lenses were never comfortable enough to gain widespread popularity. The first lenses to do so were lenses made from polymethyl methacrylate (PMMA or Perspex/Plexiglas). PMMA lenses are commonly referred to as "hard" lenses. A disadvantage of these lenses is that they do not allow oxygen to pass through to the cornea, which can cause a number of adverse clinical events.

Starting in the late 1970s, improved rigid materials which were oxygen-permeable were developed. Lenses made from these materials are called rigid gas permeable or 'RGP' lenses. A rigid lens is able to replace the natural shape of the cornea with a new refracting surface. This means that a spherical rigid contact lens can correct for astigmatism.

Rigid lenses can also be made as a front-toric, back-toric, or bitoric. This is different from a spherical lens in that one or both surfaces of the lens deliver a toric correction. Rigid lenses can also correct for corneal irregularities, such as keratoconus. In most cases, patients with keratoconus see better through rigid contact lenses than through glasses. Rigid lenses are more chemically inert, allowing them to be worn in more challenging environments than soft lenses.

## **Soft lenses**

Soft lenses are immediately comfortable, while rigid lenses require a period of adaptation before full comfort is achieved. The biggest improvements to soft lens polymers have been increasing oxygen permeability, lens wettability, and overall comfort.

Disadvantages of silicone hydro gels are that they are slightly stiffer and the lens surface can be hydrophobic and less "wetttable." These factors can influence the comfort of the lens.

## **Lens case to store contact lens**

Lens case varies depending on material and wear schedule. Daily disposable lenses are discarded after a single use and thus require no cleaning. Other lenses require regular cleaning and disinfecting to prevent surface coating and infections.

There are many ways to clean and care for contact lenses, typically called care systems or lens solutions:

## **Solutions**

Multi-purpose lens care solutions are the simplest and most convenient method for cleaning, disinfecting, and storing soft contact lenses. Protein deposits have traditionally been the targets of lens care solutions; however, some tear film proteins, when maintained in their active state, have antimicrobial properties that may prove valuable to keeping contact lenses clean.

Differences in solution formulations among the commercially available lens care products can result in varying levels of patient comfort and lens disinfection, as well as maintenance of certain tear film proteins.

It should be noted that effective removal of denatured proteins continues to be Important to lens care because they bind to lenses and are opaque, which reduces visual acuity. Denatured proteins can also impact patient ocular health and comfort with contact lens use. Patient compliance with recommended lens cleaning protocols is essential for minimizing complications with contact lenses. However, compliance with all aspects of contact lens care is low. Eye care specialists can play an important role in ensuring optimal patient compliance with lens care regimens through.

## **Saline solution**

Sterile saline is used for rinsing the lens after cleaning and preparing it for insertion. Saline solutions do not disinfect, so it must be used in conjunction with some type of disinfection system. One advantage to saline is that it cannot cause an allergic response, so it is well suited for individuals with sensitive eyes and/or strong allergies.

## **Hydrogen peroxide systems**

Hydrogen peroxide can be used to disinfect contact lenses. Care should be taken not to get hydrogen peroxide in the eye because it is very painful and irritating. With "two-step" products, the hydrogen peroxide must be rinsed away with saline before the lenses may be worn. "One-step" systems allow the hydrogen peroxide to react completely, becoming pure water. Thus "one-step" hydrogen peroxide systems do not require the lenses to be rinsed prior to insertion, provided the solution has been given enough time to react.

Enzymatic cleaner – Used for cleaning protein deposits off lenses, usually weekly, if the daily cleaner is not sufficient. Typically, this cleaner is in tablet form.

Ultraviolet, vibration, or ultrasonic devices – Used to both disinfect and clean contact lenses. The lenses are inserted inside the portable device (running on batteries and/or plug-in) for 2 to 6 minutes during which both the microorganisms and protein build-up are thoroughly cleaned. These devices are not usually available in optic retailers but are in some electro-domestic stores.

### **Disinfecting Agents**

Contact lens solutions utilize antimicrobial biocides to disinfect lenses, so that they may be safely inserted into the eye, typically following an overnight soak. Three terms frequently used when discussing antimicrobials are sterilization, preservation, and disinfection.

- Sterilization is the process by which all organisms, including spores, are killed with no possibility for microbial growth. It is important to note that lens care solutions are sterile, but they do not sterilize contact lenses.
- Preservation refers to components of lens care solutions intended to prevent the growth of micro-organisms while in the bottle. Some contact lens wearers may be sensitive to the preservatives in a contact lens solution. Symptoms of preservative sensitivity include dryness, grittiness, burning, reduced wearing time, and itching.
- Disinfection is the chemical process by which the number of viable micro-organisms on a contact lens is reduced neither to a level which is neither harmful to ocular health nor to the quality of contact lenses and accessories. Disinfection occurs in the lens case with contact lenses.

Lens care solution formulas are optimized to provide preservation and disinfection.

Disinfectants are able to kill bacteria, fungi, and amoeba without killing human cells because human cells have greater stability due to their high cholesterol content (up to 25%) and proportion of saturated fatty acids. Several different disinfectant biocides are used in contact lens solutions, including PHMB (polyhexamethylene biguanide/polyaminopropyl biguanide), PQ-1 (poly quaternium-1), myristamidopropyl dimethylamine ([MAPD], an amid amine), and Alexidine dihydrochloride. These disinfectants have varying levels of efficacy in killing bacteria, fungi, and amoeba. Their efficacy is also impacted by the overall formulation of the contact lens solution within which they are included.

### **Material and Methods**

1. Processing of contact lens which is medically graded.
2. Isolation of bacteria from the lens.
3. Identification of contaminants.
4. Antimicrobial testing.
5. Comparison of contact lens solutions.
6. To draw the comparison results via graph.

The samples were taken from both used and unused contact lenses using cotton swabs. Each swab obtained was inoculated into separate tubes with nutrient broth and incubated at 37°C for 24 h. Bacterial isolation was conducted by obtaining inoculums from the incubated nutrient broth and gently streaking it on nutrient agar. To separate individual cells, streaking of bacterial culture on nutrient agar plate was used. These plates were incubated at 37°C for 12 h. Pure cultures were further confirmed by performing Gram's staining and by studying the morphology of these isolated colonies.

**Antibiotic sensitivity testing**

The Kirby-Bauer test for antibiotic susceptibility, called the disc diffusion test, is a standard that has been used for years. First developed in the 1950s, it was refined and by W. Kirby and A. Bauer, then standardized by the World Health Organization in 1961. It has been superseded in clinical labs by automated tests. But the K-B is still used in some labs, or used with certain bacteria that automation does not work well with. This test is used to determine the resistance or sensitivity of aerobes or facultative anaerobes to specific chemicals, which can then be used by the clinician for treatment of patients with bacterial infections. The presence or absence of an inhibitory area around the disc identifies the bacterial sensitivity to the drug.

The basics are easy: The bacterium is swabbed on the agar and the antibiotic discs are placed on top. The antibiotic diffuses from the disc into the agar in decreasing amounts the further it is away from the disc. If the organism is killed or inhibited by the concentration of the antibiotic, there will be NO growth in the immediate area around the disc: This is called the zone of inhibition. The zone sizes are looked up on a standardized chart to give a result of sensitive, resistant, or intermediate. Many charts have a corresponding column that also gives the MIC (minimal inhibitory concentration) for that drug. The MIC is currently the Standard test run for antibiotic sensitivity testing because it produces more pertinent information on minimal dosages.

The Mueller-Hinton medium being used for the Kirby-Bauer test is very high in protein. Steps:

1. Antibiotic discs prepared using what man filter paper No.1

2. Sterilized by dry heating in hot air oven (160° for 1 hr)
3. Discs impregnated with solutions X and Y.
4. Agar plates inoculated with Gram positive and Gram negative bacteria separately by swabbing.
5. Antibiotic Discs placed on inoculated agar plates and pressed gently.
6. Plates incubated for 24-48 hrs.
7. After incubation plates checked for sensitivity zones and resistively zones measured.

Two types of cleaning solutions are used in disc diffusion method to determine the sensitivity of the bacteria. These solutions, 1) X-solution and 2) Y-solution, are completely different in their compositions.

The contents are,

<b>Contents in X-solution</b>	<b>Contents in Y solution</b>
A sterile isotonic solution contains hydronate, boric acid, edentate disodium, poloxamine, sodium boride, sodium chloride preserved with dymed 0.0001%.	Solution contains chlorhexidine gluconate solution 0.005%, edentate disodium 0.1%, pH and isotonicity is adjusted to lachrymal fluid.
pH value : 7	pH value : 6

**Disc diffusion method**

After completely swabbing the plate, turn it 90 and repeat the swabbing process. Rein the swab around the circumference of the plate before discarding it in the discard bag.

**Placing the antibiotic disc**

Then using a dispenser such as the one pictured antibiotic impregnated disks are

placed onto the agar surface. As the bacteria on the lawn grow, they are inhibited to varying degrees by the antibiotic diffusion from the disk.

**Sensitivity pattern**

It has been determined that zones of inhibition of a certain diameter (varies for antibiotic and to a lesser extent, bacterial species) correlate with sensitivity or resistance to the antibiotic tested.

The zones sizes are looked up on a standardized chart to give a result of sensitive, resistant, or intermediate. Many charts have a corresponding column that also gives the MIC (minimal inhibitory concentration) for that drug.

**Interpretation**

Zone diameter is reported in millimeters looked up on the chart, and result reported as S (Sensitive), R (Resistive), I (Intermediate).

**Results and Discussion**

Both mediums (Nutrient broth and Nutrient agar) are prepared successfully. Are the mediums which are used to growth the individual bacterial colonies. Isolation and identification of pathogens from contact lenses may suggest an appropriate chemotherapy. Hence, for the present discussion from contact lens wearer were screened for the presence of bacteria. Isolates are separated and these plates were incubated at 37°C for 12 h.

Examine the slide under the light microscope. Gram-positive bacteria appear purple as stained by crystal violet, which is trapped within their thick cell walls. Gram-negative bacteria appear pink as stained by

the safranin counter stain, as their thin cell walls allow the crystals violet to wash out during decolonization. Finally the Gram-positive staphylococci (Gram-positive rods in chains, violet color) and Gram-negative *Pseudomonas auregenosa* (Gram-negative single rods, pink in color) were identified by biochemical tests.

**Table.1** General interpretation

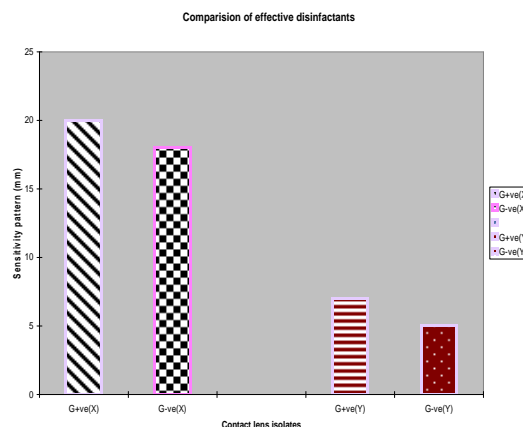
Diameter of zone (mm)	Sensitivity pattern
< 10	Resistant
11-19	Intermediate
> 20	Sensitive

After identification we also determined culture sensitivity. Results are depicted in table:

**Table.2** Sensitivity measurement

Type of bacteria	Zone Diameter with X-solution (mm)	Zone Diameter with Y-solution (mm)
Gram positive	20 (sensitive)	7 (resistant)
Gram negative	18 (intermediate)	5 (resistant)

**Graphical representation:**





## Comparison

X solution contains the active component, chlorhexidine gluconate 0.005 %. But in Y solution it is dymed (polyamino propyle biguanid) 0.0001 %. From our comparison, it is noted that both gram positive and gram negative bacteria have shown resistance towards solution Y (may be due to drug resistance) and solution Y is found to be ineffective in controlling contact lens bacterial isolates. However solution X has shown effectiveness against gram positive and to an intermediate effectiveness against gram negative bacteria. Hence solution X is better than solution Y in controlling contact lens isolates.

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