SOFT CONTACT LENSES AND SOLUTIONS IN CANADA

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Abstract

Factual background information is provided on hydrophylic lens polymers and the changes in lens parameters when a change is made in the temperature, tonicity or pH of the solution they are immersed in. Cleaning and disinfection are discussed under three headings. 1) Cleaning: a) surfactants b) oxidizing agents c) enzyme cleaners; 2) Heat disinfection: 3) Chemical disinfection: a) antimicrobial substances b) oxidative substances. Tables list details of the available lenses, the systems, the salines, the surfactants, the chemical disinfectants, the extra cleaners and the ocular lubricants.

Abrégé

Ce travail discute des caractéristiques de polymères utilisés dans la confection de lentilles hydrophiles et des variantes dans leurs spécifications dues à des changements de la température, de la tonicité et du pH des solutions dans lesquelles elles sont immersées. Le nettoyage et la désinfection sont abordés sous les entêtes; 1) Nettoyage: a) détergents de surface b) agents d'oxydation c) les enzymes; 2) Désinfection thermale; 3) Désinfection chimique; a) substances microbicides b) substances oxydantes. Les tables présentent les détails des différentes lentilles disponibles, des systèmes d'hygiène, des solutions salines, des détergents de surface, des microbicides chimiques, de nettoyeurs spécifiques et des substances lubrifiantes.

The purpose of this paper is to provide a list of soft (hydrophilic) contact lenses available in Canada, along with the manufacturer's suggested disinfection systems. Hopefully, practitioners will be able to refer to the following tables to gain information on the many new contact lenses and solutions that are now available

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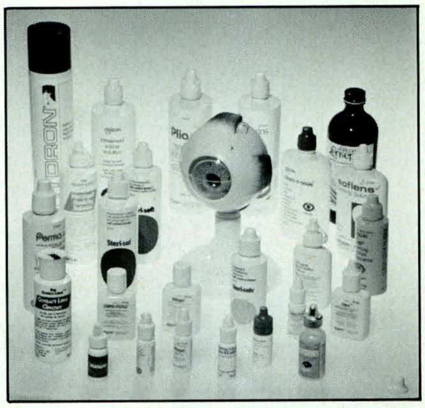

An effort has been made to include all the lenses and solutions available at the present time, however some might have been missed for which I apologize to the manufacturer. I plan to write a follow-up paper at a later date and would appreciate receiving information on any products that have been left out and on new products as they are developed.

The first part of this paper is provided as background information on the polymers from which contact lenses are made, and how their dimensions can vary with the properties of the solutions they are immersed in. The second section of the paper deals with the disinfection of contact lenses and the problems that can arise when using contact lens solutions. For an in depth study of the subject the reader is referred to the reference material listed at the end of the paper.

Polymers

Polymers are possible because of the ability of certain atoms to bond together to form stable covalent bonds. The polymers we are concerned with fall within the area of organic chemistry, or the chemistry of carbon compounds. This is due to the ability of the carbon atom (C) to link together with four other atoms of its own kind or with other atoms such as hydrogen (H), oxygen (O), nitrogen (N), sulphur (S), or chlorine (Cl). Thus long polymer chains are formed from monomers as the name (Poly-mer) suggests (from the Greek root meaning "many parts"). The name of the polymer comes from the chemical group repeating itself in th chain, eg. — Poly(ethylene), Poly(vinyl chloride), Poly(methyl methacrylate).

Individual polymer chains can be made to become entangled with their neighbours and also to "cross link" at intervals, forming a network. The frequency at which the cross linkages occur can be varied by the manufacturing technique and is called the "cross-link density". A large number of cross links will restrict deformability of the plastic. For good elastic behaviour a polymer chain must be mobile enough to change positions when a deforming force is applied to a piece of the plastic material and yet it must have enough restraining cross links to return to its original position when the force is removed.

By changing the chemical constituents and arrangements in a polymer chain the mobility of the chains can be changed to obtain flexible, or at the other extreme, hard glassy behaviour. Also as the temperature is raised the kinetic energy of the systems increases and the chains obtain greater mobility becoming rubbery at what is known as the "glass-rubber" transition temperature (Tg).[1]

Another way to separate the polymer chains, allowing them to move more freely is to add a mobile component, usually an organic liquid having a high boiling point to act as a plasticiser.[2] When water is used as a plasticiser it behaves as an "internal lubricant" allowing the chains to move more freely.

Materials Used in Hydrophilic Contact Lenses

The polymers used in the manufacture of hydrophilic lenses have been divided into three groups by Cordrey.[3]

Group A: Those materials derived from HEMA. Examples: B & L Soflens®, and Hydron®.

Group B.: Those materials derived from copolymerization using HEMA as one comonomer. Examples: Hydrocurve® and Softcon®.
Group C: Those materials containing the pyrrolidone ring, not HEMA, as a major hydrophilic unit. Example: Sauflon®.

Hathaway and Lowther (1978) state that lenses in group A, made of HEMA, attract and hold not only water but also charged organic molecules and ions such as protein, lipids, calcium and iron, which may lead to deposit build up.[4]

In Group B another monomer is mixed with HEMA and many of the original reactive sites may become occupied by the different monomers present, so that fewer sites are available for binding with tear components. Lenses in Group B are therefore less prone to deposit formation.

The lenses in Group C have as their major hydrophilic unit the pyrrolidone ring, not HEMA, and the side groups of that pyrrolidone ring may serve to block the reactive sites prone to binding organic tear constituents, and so deposits on this type of material are not common.

Three classes of hydrophilic contact lens materials classified according to their water content have been suggested by Pedley and Tighe.[5]

Class 1: HEMA plus a small amount of a non-hydrophilic monomer, giving lenses with a water content below 40%.

Class 2: HEMA (as above, but with a difference in the type and extent of the cross-linking and the technique of polymerization). These behave in substantially the same manner, the main differences being a question of lens design.

Class 3: Major hydrophilic unit not HEMA — usually vinyl pyrollidone, which is more hydrophilic than HEMA, to give a water content higher than 40%.

Water Content of Hydrophilic Contact Lenses

With polyhydroxyethylmethacrylate (HEMA) the plastic is made more hydrophilic by the presence of hydroxyl groups (OH). The majority of these OH groups are not bound, so that HEMA has a high water uptake, but it also shows a high polarity and chemical reactivity. This is a drawback when other reactive substances such as tear components come into contact with it. Deposits tend to accumulate on the surface of this plastic and become incorporated into its molecular structure.[6] With HEMA contact lenses these deposits must be removed or ocular irritation will occur.

According to Johnson, Nygren and Sjogren (1978) the water content of the material can be divided into two categories:[7]
Category 1: Water strongly bound to the polymer. In order for this water to leave the polar OH locals, high heat and a vacuum are required.
Category 2: Free water which is located in the space between the bound water and the polymer structure.

Johnson, Nygren and Sjogren state that substances dissolved in the free water can diffuse through the plastic and, if the correct charging conditions exist, can become bound to the polymer. They also state that while pores of up to 35 Å do occur in HEMA material, the pore size is normally 5-10 Å which limits the diffusion of substances to a certain size.

Holly and Refojo (1972) have shown that the higher the water content of a polymer the higher the oxygen permeability.[8] However as a contact lens becomes more hydrophilic and more flexible it also becomes more susceptible to tearing for a given thickness due to a lower modulus of elasticity. This occurs because water acts as a plasticiser, separating the polymer chains and reducing their cohesion.[9]

Depending on their chemical construction, the water content of hydrophilic lenses varies with the temperature, tonicity and pH of the hydrating solution they are immersed in.

Temperature

As the temperature of the hydrating solution is raised from a room temperature of 22 degrees centigrade to 40-50 degrees centigrade, the water content of a hydrophylic lens can decrease by as much as 20%; this is then followed by an increase in water content.[9a] High water content lenses can therefore decrease in water content by as much as 20% when taken from the storage solution at room temperature and are placed on the eye at a body temperature of around 35.7 degrees centigrade.

Tonicity

The addition of sodium chloride to water reduces the bonding and the water content is reduced. The normal osmotic pressure of tears is equivalent to that of 0.9% sodium chloride, about the same as Plasma, or intravenous saline.[10] A hypotonic solution has less sodium chloride and a hypertonic solution has more sodium chloride. As the concentration of sodium chloride increases in a hydrophilic lens, (hypertonic) the water content drops and the lens changes in dimension, becoming smaller.[11] Lenses are larger in a hypotonic solution and smaller in a hypertonic solution, as compared to an isotonic solution.[11a] There is a significant increase in the water content of a lens when it is changed from an isotonic saline solution and placed in a hypotonic distilled water solution, and as shown above, the lens swells, becoming larger. This can aid in purging a lens when it is being cleaned. Also a lens can become larger and tighter on the eye when swimming in fresh water pools. A lens rinsed in tap water will also be larger and tighter than normal.

pH

The hydrogen ion concentration is called pH. A pH of 7.0 is neutral, a pH greater than 7.0 is basic and a pH less than 7.0 is acidic. Seiderman (1972) stated that there is a greater degree of swelling of a lens in a basic solution and a lesser degree of swelling in an acidic solution.[12] If a lens is in a solution which has a pH of less than 7.0 then it is smaller in diameter and shorter in radius and higher in power, and on the other hand if the solution has a pH of more than 7.0 the lens will be larger in diameter, longer in radius and lower in power. When the parameters of a lens are being measured or stated, we must know the pH and tonicity and temperature of the solution the lens is being stored in.

It is important to keep lenses in a solution that has the same approximate pH (and tonicity) as a patient's tears, so that there is less equilibrating for the lens to do in the first few minutes on the eye. Carney and Hill found tears to be mildly alkaline with an average pH of 7.4.[13] Lenses therefore should be kept in a solution with a pH of 7.4, however R.M. Hill found an "acidward drift" in the solutions of stored lenses.[14] He felt that this could be one cause of a stinging or burning sensation when some new lenses are placed on the eye. In practice it may be wise to change overaged solutions when necessary. Dr. Hill felt that the pH level could also be brought back nearly to the level of tears by heating the capped vials to drive out the carbon dioxide, which had permeated in through the silicone stopper.

R.A. Koetting, Craig Andrews and R.R. Koetting found an alkaline shift in the tears of hydrogel lens wearers in a period from two to 24 months.[15] (Hard lenses produced the opposite effect.) As shown previously, an alkaline shift causes a lens to be larger in diameter and therefore to fit tighter than previously. Lenses therefore can tighten over a period of months due to a change in the tears and so the fit should be monitored at regular intervals.

Hydrophilic Lens in Solution

Hypertonic Solution and/or **pH less than 7.0**	**Hypotonic Solution** and/or **pH greater than 7.0**
Smaller Diameter	Larger Diameter
Shorter Radius	Longer Radius
Higher Power	Lower Power

Cleaning and Disinfection of Contact Lenses

This will be discussed under three headings:

(1) Cleaning (a) surfactants (b) oxidizing agents (c) enzyme cleaners.
(2) Heat disinfection
(3) Chemical disinfection: (a) Antimicrobial substances (b) Oxidative substances

(1) Cleaning
(a) Surfactants

The purpose of a surfactant cleaner is to mobilize, emulsify and remove proteins and other material from the lens surface. Its daily use is prophylactic, that is to prevent deposit formation rather than, as an after-the-fact cleaner, to remove built up deposits. The cleaning properties of a surfactant depend on its ability to lower the surface tension of the oil-water or solid-water interface.[16] Usually it is of a medium viscosity to protect the lens surface from rubbing frictional forces.[4a] It also should be of a high molecular weight to prevent molecules from entering the pores of the lens.[4b]

Some solutions, such as Steri-soft, are made slightly hypertonic in the hope that any contaminants which have been absorbed will be drawn out by the osmotic pressure differential.[17] Also solutions may be made somewhat alkaline so as to maximize protein removal.[17a] Softmate® and Pliagel® are well known examples of surfactant cleaners.

A new surfactant cleaner called Miraflow, has recently been introduced by Cooper Pharmaceuticals. It contains the same high molecular detergents as Pliagel (poloxamer 407). In addition, it also contains a solvent, isopropyl alcohol, which acts as an additional cleaner to take off the highly lipid and proteinaceous deposits, and therefore, the cleaning action is said to be better than using Pliagel alone.[18] The Miraflow cleaner can be used for any type of lens currently on the market: hard, soft, extended wear, CAB, and silicone lenses.[18a] With soft lenses, however, the alcohol enters the plastic and after cleaning with Miraflow, the solution must be thoroughly washed off and the soft contact lens left in a saline such as Pliasol so that all of the isopropyl alcohol will come out of the lens.[18b]

(b) Oxidizing Agents

These agents are for removing previously formed deposits and they act by oxidizing the structure of the accumulated protein deposits.[4c] They work most efficiently when used in conjunction with heat, but the cleaning must be controlled at a safe level to prevent destructive changes from occuring in the lens polymer. The lens must be made non-toxic after cleaning and the manufacturers directions should be followed carefully.

A recent addition is Liprofin, which is an intensive cleaner to be used only by the contact lens practitioner. At a temperature of 60°C it releases oxygen that is chemically highly reactive and which breaks down organic deposits by oxidation. Kreiner (1978) stated that Liprofin is able to remove lipids and mucins from hydrophilic lenses as well as having a very strong antimicrobial effect.[19]

(c) Enzyme Cleaners

Papain (as used in meat tenderizers) is the enzyme usually used in this type of cleaner. It acts by hydrolyzing the peptide linkages of the denatured protein on the lens surface,[4d] Unfortunately, it has little or no action against lipids, waxes, and cosmetic contaminants, etc.[17b]

A great drawback to this cleaner is the danger of ocular sensitization to the papain with potentially injurious effects. Phillips states that it should be used only once every seven days and the instructions for overnight cleaning and rinsing must be carefully observed.[17c] However, Hathaway and Lowther quote a study by Rudko which showed no sensitizing effects with the enzyme used in the Allergan Enzyme cleaning system.[4e]

Studies by Hathaway and Lowther showed that both (b) (Ren-O-Gel oxidizing agent) and (c) (Allergan enzyme) had about equal ability to remove deposits, but that the Allergan "at home" system was easier to use and took less time than the "in office" Ren-O-Gel system.[20] They also stated that the enzyme cleaner has been shown to have no deleterious effects on the lens polymer, whereas the oxidizing agents like those in Ren-O-Gel may react with the basic polymeric chain, with the introduction of pH sensitive molecular groups. They quote Erickson who found that protein deposition is often enhanced by the oxidative system, thus increasing the rate of further deposition subsequent to the initial cleaning.[4f] Ren-O-Gel is properly viewed as a last resort approach to thorough cleaning when nothing else works.

(2) Heat Disinfection

A number of heating units are available in which the temperature reached inside the lens case is typically around 96°C.[21] The temperature is held there for 20 minutes, and then the case containing the lenses in saline, is allowed to cool off.

Phillip states that the physical requirement for disinfection is 80°C for 10 minutes and that total sterility is only achieved by autoclaving for 15 minutes at 120°C and 15 lbs. per. sq. in. pressure.[21a] He lists a number of disadvantages to heat disinfection which I have summarized as follows:

(1) There is a fairly high risk of micro-organism build up if the procedure is not carried out daily and fresh saline prepared daily (Brown, Bloomfield, Pearce and Tragakis, 1974).

(2) Certain bacterial spores may survive and cause lens damage if the heating is not carried out daily to destroy vegetative forms of the organism.

(3) Some units use saline which does not contain a preservative, so there is a slight risk of micro--organisms being transferred on to the lens from the fingers.

(4) Repeated heating may cause slow degradation of the polymer structure, reducing lens life, and this may be more noticeable with one lens material than with another.

(5) Micro-proteins on the lens surface become coagulated or denatured and the film thus formed may cause lens discomfort, and loss of transparency. There may be loss of acuity and a conjunctival injection and possibly a change in lens fitting. Lens porosity may be reduced, aiding in the formation of corneal edema.

Callender and Lutzi (1978) compared the clinical findings of Soflens® wearers using thermal and cold disinfecting procedures, and they found that more patients developed problems using the thermal disinfection method.[22]

(3) Chemical Disinfection

There are two groups of preparations with a bacteriocidal effect used to disinfect contact lenses, (a) Antimicrobial Agents and (b) Oxidative Agents.

(a) Antimicrobial Agents (Preservatives)

The term "preservative" refers to a compound which is incorporated into a solution to prevent contamination by micro-organisms. It is said to have "cidal" action if the organism is killed and "static" action if the growth of organisms is prevented. A prefix is used to denote a specific effect on bacteria, fungi or yeast. If a preservative is effective in killing bacteria but only inhibits the growth of fungi, it is said to be bactericidal and fungistatic in action.[23] Bacteriostatic agents by themselves cannot disinfect, but are used in contact lens solutions for disinfection by combining with other antibacterials. The most common combinations are chlorhexidine, thimerosal, and EDTA. Chlorhexidine is the more effective of these but has poor fungicidal activity, whereas thimerosal is slower acting but is more effective as an anti-fungal agent. EDTA (ethylene diamine tetra acetic acid) enhances the bactericidal effect, and may also prevent calcium salts from forming lens deposits. Its own antibacterial effect is minimal but it acts by chelating-forming complexes with certain metals, notably calcium.[24]

While these substances are effective in disinfecting the lens, they have some less desirable effects. Some of the disinfectant molecules diffuse into the contact lens due to the pores of the lens, the water content, and the charge of the lens material.[25] Callender and Lutzi (1979) stated that early papers mentioned possible hazards of ocular irritation from the slow release of bound chemicals concentrated in the gel material. However they state that studies have shown that the concentrations of antimicrobial agents in commercially available solutions are safe. They also say that there is no agreement amongst clinical investigators on the incidence of adverse reactions to some formulations of chemical disinfectants for soft lenses.

Johnsson, Nygren and Sjogren (1978) stated that the storing of thiomersal reaches equilibrum after the lens has been in the solution for one hour, but that chlorhexidine continues to be stored up even after 24 hours and at a constantly increasing concentration.[7] They quote a study by Sibley and Young (1973) that showed that Thiomersal is not actively bound to the lens material and so it leaves the lens, which rests on the eye in contact with the tear liquid, just as rapidly as it was stored up. They quote a study by Refojo (1976) which said that Chlorhexidine leaks very slowly from the lens and thereby exposes the tissues of the eye to a certain influence (although at a sinking concentration) during the time that elapses until the next disinfection.

Due to electrostatic forces, chlorhexidine becomes weakly bound to a clean lens surface (Sibley, 1973).[26] However, it binds very effectively to protein deposits on the lens surface, and this increased concentration of preservatives can cause ocular discomfort, as the contaminants build up (Hind and Goyan, 1947).[27] Lens surfaces should therefore be kept as clean as possible.

While the nature of hydrophilic lenses is to absorb aqueous solutions, there may also be an adhesion of molecules to the lens surface, known as adsorption (from the Latin *ad + sorbere* — to suck in). Soft lens solutions should not contain preservatives that adsorb or complex with molecules on the lens surface, as they will then be concentrated on the surface and in these higher concentrations can cause damage to the corneal epithelial cells. Many hard lens solutions contain preservatives that bind strongly to hydrogel lenses and this is why they should not be used with soft lenses. An example is Benzalkonium Chloride which is widely used in ophthalmic solutions but is harmful to eye tissues when concentrated in soft lens materials.

While the lens is on the eye, the mucin in the tear fluid is adsorbed onto the surface of the lens in the same way that it is adsorbed on to the corneal epithelium. Phillips (1977) states that mucin and other tear proteins such as lysozyme remain in their natural state when attached to the soft lens surface in the eye, and there is not an excessive protein build-up.[28] However, daily removal of the lens results, in time, with the denaturing of adsorbed proteins. This occurs slowly with certain cold sterilizing solutions and more rapidly with boiling. Lipid secretions from the meibomian glands can also bind to the lens surface forming a hard to remove lipo-protein film which may serve as a growth medium for bacteria and fungus. Other contaminants may be present in either the ad-or absorbed state such as environmental pollutants, chemical vapours, cosmetic ingredients, nicotine, and oil and dirt from the fingers.[29] Storage cases must be kept clean and storage solution volume must be sufficient to allow adequate diffusion and dilution of contaminants into the solution. Also daily changing of the solution is a must.

A study by Johnson, Nygren and Sjogren showed a significant effect on lysozyme by chlorhexidine in a concentration of 0.005%.[7] Thimerosal at a concentration of 0.001% left the lysozyme enzyme intact. They were unable to prove the significance of these results as the level of lysozyme in the tear fluid varies from one person to another and also the concentration of the disinfectant discharged from the lens into the tear layer may vary.

The question arises as to whether a lens leaching a disinfectant against the eye can upset the natural protective mechanism of the eye, due to a change in the normal eye flora, and from disturbed lysozyme activity. The eye's own defense mechanism against infection may be affected, and a number of functions important to the eye may be influenced.

(b) Oxidative Agents

These must be inactivated after the disinfection is concluded and before the lens is worn on the eye:

(1) Hydrogen Peroxide 3% was the first method of chemical disinfection, being introduced by Isen in 1972.[30] Originally lenses were soaked for five minutes in 3% peroxide and the resulting high acidity was then neutralized by soaking the lenses for 15 minutes in a mixture of 0.5% sodium bicarbonate (tablet) dissolved in a 0.9% sodium chloride solution.[31] Lenses were stored overnight in isotonic saline. Janoff states that this is very effective as a method of disinfection.[32] Tregakis, Brown and Pearce reported in 1973 that the procedure killed a variety of organisms on lenses including the fungus aspergillus fumagatus.[33] Inns presented details of studies done in the Warner-Lambert microbiology laboratory showing a high kill rate on lenses purposely contaminated with pathogens specified by the F.D.A. (U.S.A.).[34] In the original method, problems arose because all of the sodium bicarbonate tablet did not dissolve, leaving residual particulate material on the lens. Also much of the rinsing sodium chloride solution was not sterile, being made by the patient or the local pharmacy. The hydrogen peroxide was said to be ineffective if kept in plastic containers or if exposed to light or to the atmosphere (Charles, 1975).[35] Another problem was the danger of omitting the sodium bicarbonate neutralizing procedure. The Septicon System manufactured by Warner-Lambert has eliminated the above mentioned problems.[36] Highly controlled manufacturing procedures produce a relatively stable 3% peroxide, named Lensept®. Dark brown glass bottles eliminate the "exposure to light" problem. After soaking for 10 minutes in the Lensept solution the hydrophilic contact lenses are transferred to the Lensrins (sterile buffered saline) cup. This cup contains a Septicon disc—a catalyst which decomposes the Lensept (peroxide) to water and oxygen in approximately six hours. The Lensrins quality is highly controlled to give a sterile buffered saline with a pH to match that of the tears. Besides killing organisms on the surface of the lens, the peroxide also cleans the lens surface, due to the physical expansion of the lens while in Lensept. As the surface expands anything adhering to the surface tends to be flaked off. The lens returns back to the correct size when placed back in the Lensrins saline. This flexing action keeps the lens pliable and soft. Lenses do not yellow as peroxide is a bleach. An important feature is that residues of the disinfection system do not build up in or on the soft lens, as the peroxide is reduced to water and oxygen.

Lensrins however contains thimerosal and so for those patients who may be sensitive to it, a substitute may be made by using Pliasol®. This does not contain thimerosal or chlorhexidine and so is relatively free of a sensitization potential. Fresh unpreserved buffered saline such as that by Hydron or Unisol would also be an adequate equilibration medium after peroxide exposure except that sterility is compromised. In this case, the Lensrins cup containing the catalyst should be periodically rinsed with hydrogen peroxide, to prevent the growth of bacteria, and it should not be used for intermittent storage during the day with the unpreserved saline.

(2) Iodine is prepared in the form of an iodophor, in an isotonic polymeric vehicle, in order to stabilize the free iodine. (Pliacide®—Nutraflow® Kit). The addition of the neutralizing medium which itself has been preserved with sorbic acid, EDTA and sodium borate, reduces the iodine to the iodine ion. Neutralization takes about two hours and the solution becomes colourless which indicates that the lenses can now be worn. Phillips (1977) reported that there appears to be no binding effect of the preservative, although he quotes Stone (1976) as reporting stinging if the product is used on old and probably contaminated lenses.[37] Although the system is not as convenient as other systems, it does offer flexibility, excellent disinfectant action and a colour indicator which tells the patient when the lenses have been disinfected.

Other Additives to Contact Lens Solutions

1. EDTA to increase the effect of antibacterial substances.
2. Buffer systems to bring the pH of the solution close to that of the tears.
3. Water soluable Polyvinyl alcohol to increase the wetting capacity and consistency of the solution.
4. Salts to make the solution Isotonic.

Acknowledgment

I wish to thank Dr. Scott MacKenzie, for his assistance in the preparation of the tables of solutions and lenses.

TABLE 1: THE LENSES

Lens Name	Manufacturer	Polymer	Polymer Name	Production Method	Hydration	Recommended* Cleaner	Recommended* Disinfection	Recommended* Storage	Compatible With Enzymatic Cleaners
Soflens	Bausch & Lomb	HEMA	Polymacon	Spin cast	38.6%	Surfactant (Soflens soaking solution)	Heat: B&L Aseptron Chemical: Hydrocare or Soflens Cleaning & Soaking Solution)	Saline (Soflens soaking solution)	Yes
Aquaflex	Union Optics	HEMA/ NVP/ MMA	Tetra- (filcon) A	Lathed	42.5%	Surfactant (Preflex)	Heat/ Chemical (Flexsol)	Saline Flexsol)	No
AO-Soft	American Optical	HEMA/ NVP/ MMA	Tetra- filcon A	Lathed	42.5%	Surfactant (Preflex)	Heat/ Chemical (Flexsol)	Saline (Flexsol)	No
A1-47 (Alden)	Alden Labs	HEMA/ MA NVP	NA	Lathed	36.5%	Surfactant	Heat or Chemical	Saline	Yes
Durasoft**	Wessley-Jensen	HEMA/ Compoly-mer	Phemecol	Lathed	30.0%	Surfactant	Heat or Chemical	Saline Chemical	Yes
Hydron**	National Patent	HEMA	Polymacon	Lathed	38.6%	Surfactant	Heat or Chemical	Saline	
Softcon	American Optical	HEMA/ PVP	Vifilcon A	Lathed	57.5%	Surfactant (Softcon Lens Cleaner)	Chemical: Lensept (Hydrogen Peroxide)	Saline (Lensrins)	Yes
Sauflon-70**	Medical Optics	NVP/ MMA	Lidofilcon A	Lathed	70.0%	Surfactant (Sterisolv)	Heat or chemical	Saline (Sterisoft, Sterisal)	Yes
Sauflon PW	Medical Optics	NVP/ MMA	Lidofilcon A	Lathed	79.0%	Surfactant (Sterisolv)	Chemical	Saline (Sterisal, Sterisoft)	Yes
Hydrocurve II	Soft Lenses Inc.	HEMA/ acrylamide	Bufilcon A	Lathed	46.0%	Surfactant (Preflex)	Heat or Chemical (Flexsol)	Saline (Flexsol)	Yes
Naturvue**	Milton Roy (now B&L)	HEMA/ NVP	Hefilcon A	Lathed	46.0%	Sufactant (Preflex)	Heat or Chemical (Flexsol)	Saline (Flexsol)	Yes
Permalens	Cooper	HEMA/ NVP MA/NVP	Perfilcon A	Lathed	71.0%	Surfactant (Pliagel-Miraflow)	Chemical	Saline (Permasol-Pliasol)	Yes (Lipofrin)
Ultrathin	Bausch & Lomb	HEMA	Polymacon	Spin cast	38.6%	Surfactant (Soflens soaking solution)	Heat: Aseptron Chemical (Soflens complete care system)	Saline (Soflens soaking solution)	Yes
N & N #515**	N & N Optical	HEMA polymer	NA (Material by Toyo)	Lathed	35.6%	Surfactant (Preflex-Pliagel)	Heat or Chemical	Saline (Flexsol)	Yes
N & N #1500**	N & N Optical	HEMA polymer	NA (Material by Toyo)	Lathed	29.0%	Surfactant (Preflex-Pliagel)	Heat or Chemical	Saline (Flexsol)	Yes
M-79**	N & N Optical	HEMA polymer	NA (Material by Toyo)	Lathed	37.0%	Surfactant (Preflex-Pliagel)	Heat or Chemical	Saline (Flexsol)	Yes

* Manufacturer's recommendation
* *Available in toric lenses

TABLE 1: THE LENSES

Lens Name	Manufacturer	Polymer	Polymer Name	Production Method	Hydration	Recommended* Cleaner	Recommended* Disinfection	Recommended* Storage	Compatible With Enzymatic Cleaners
Weicon** ***	P.C.L.	pHEMA	NA	Lathed	40.0%	Surfactant	Heat or Chemical	Saline	Yes
TC-75	Kelvin Contact Lenses	poly-HEMA	None as yet	Lathed	70-80%	Surfactant (Hydroclean)	Chemical	Saline (Hydrosoak)	No
TC-50	Kelvin Contact	poly-HEMA	None as yet	Lathed	50%	Surfactant (Hydroclean)	Chemical	Saline (Hydrosoak)	No
Freflex 60** ***	Freflex Canada	HEMA/ MA	None?	Lathed	60%	Surfactant	Chemical	Septicon System or any soft lens solution	Yes
Contaflex	Canadian Contact Lens Company	Random Copoly-mer (HEMAR EDTA)	None as yet	Lathed	42%	Hydrosoak Autoclaving Boiling or any soft lens solution	Any soft lens cleaner	Any soft lens solution	Yes
Contaflex	Canadian Contact Lens Company	Random Copolymer (HEMAR EDTA)	None as yet	Lathed	75%	As above except do not boil on a regular basis	Any soft lens cleaner	Any soft lens solution	Yes
Veragel	Veracon Incorporated	515 Toyo	Polyama	Lathed	34.6%	Any soft lens cleaner	Any soft lens soaking solution or thermal disinfection	Any soft lens solution	Yes
Veragel	Veracon Incorporated	1500 Toyo	Polyama	Lathed	29%	Any soft lens cleaner	Any soft lens soaking solution or thermal disinfection	Any soft lens solution	Yes
Optiflex	Opti Contact	Burton Parsons Material		Lathed	43%	Preflex and Enzyme Tablets	Flexcare or Flexsol/ Normol or any other soft lens solution or boiling	Flexcare or flexsol	Yes
Membrana	Viscon Contact Lens Manu-facturing	HEMA		Lathed	78%	Any soft lens solution	Any soft lens cleaner	Any soft lens solution	No
Viscoflex	Viscon Contact Lens Manu-facturing	HEMA		Lathed	43%	Any soft lens solution	Any soft lens cleaner	Any soft lens solution	Yes
Dominion**	Dominion Contact Lens	poly-HEMA	None as yet	Lathed	35%	Surfactant	Heat or Chemical	Heat or any soft lens solution	Yes
Dominion**	Dominion Contact Lens	poly-HEMA	None as yet	Lathed	50%	Surfactant	Heat or Chemical	Any soft lens solution	Yes

*Manufacturers recommendation
** Available in Toric Lenses
***Tinted lenses available

TABLE 2: THE SYSTEMS

Manufacturer	System Name	Details of Use	Additional Details
Burton-Parsons	Burton-Parsons Cold System	Lenses cleaned with Preflex, rinsed with Normol, stored overnight in Flexsol.	Flexsol is Normol with addition of Adsorbobase lubricant.
Burton-Parsons	Flex-Care System	Lenses cleaned with Preflex then rinsed and stored with Flex-care.	Flexcare is the same as Normol, is used for both rinsing and storage, is now said to be compatible with enzymatic cleaners containing Papain.
Softcon(AO)	Septicon System	Lens cleaned with Softcon Lens Cleaner, soaked in Hydrogn Peroxide (3%) for 10 minutes, then 6 hours minimum in saline plus Septicon disc.	H_2O_2 is neutralized by Septicon disc in #2 case.
Cooper-Flow	I-Septic System	Pliacide is mixed with Nutra-flow in Porta Flow unit. Iodine solution is neutralized in about 15 minutes and lens remains in a clear isotonic saline overnight.	Solution initially coloured. Colour will dissipate indicating disinfection is complete. Lens is not removed from Porta Flow unit until following morning. Not used with lenses that contain PVP.
Cooper-Flow	Mira-Flow System	Lens is cleaned with Mira-flow for 60 seconds then stored (after rinsing) in Mira-soak overnight.	Mira-flow is essentially Pliagel plus isopropyl alcohol. Mira-soak may be replaced by Pliasol, particularly for patients reactive to chlorhexidine or thimerosal.
Barnes-Hind	B-H Cold System	Lens is mechanically cleaned with B-H cleaning, rinsed, then stored overnight in B-H rinsing and soaking solution.	Can be augmented by B-H weekly cleaning system for periodic cleaning.
Wessley-Jessen	Durasoft Autoclave	Lens is cleaned with surfactant, placed in autoclave for 15 minutes, stored overnight in saline (preserved).	Utilizes low pressure steam at 120°C for 15 minutes.
Medical Optics Centre	Sauflon Cold System	Lens is placed in 4-5 drops of Sterisolv for 2-3 minutes, stored overnight in either Steri-sal or Steri-soft (after rinsing),	Sterisal is preserved with thimerosal 0.002% and 0.001% chlorhexidrine, Steri-soft has neither of these, rather disodium EDTA 0.1% and nipastat 0.1%.
Cooper-Flow	Perma-Therm	Lens is cleaned with surfactant (Pliagel or Miraflow), rinsed, then boiled in Permasol for 20 minutes, then store in Permasol.	For use with Permalenses. Frequent use not advised. Chemical disinfection recommended. (Miraflow, Pliagel — Permasol, Pliasol)
Bausch & Lomb	B & L Aseptron	Lenses are precleaned with surfactant (Soflens soaking solution) then heated at 90°C for 60-75 minutes - has automatic shut-off.	Recommended disinfector for B & L Soflens (polymacon). Lenses stored in B & L Soflens soaking solution.
Contactosol Ltd.	Soft Lens Care System-Generic	Lens is cleaned with Hydro-clean and stored in Hydrosoak.	Manufactured by U.K. company. Kelvin lenses are stored in Hydrosoak and they recommend this system for their lenses. (To ensure correct pH)
Bausch & Lomb	Soflens Complete Care System	Lens is gently rubbed in Soflens soaking solution, rinsed and stored overnight (6-8 hours) in same solution. Use Soflens cleaning tablets weekly. Saline may be used for rinsing.	Soflens soaking solution has incorporated surfactants, antimicrobials, buffers, preservatives and cushioning agents. Soflens cleaning tablets are for surface deposit.

TABLE 3: THE SALINES

Product Name	Manufacturer	Purpose	Details of Use	Preservative and Composition
Normol	Burton-Parsons	Rinsing	Rinse lens (after cleaning with Preflex) and before storing in Flexsol or Flexcare.	Sodium phosphate, sodium biphosphate, NaCI 0.9% and preserved: Thimerosal 0.001%.
Flexsol	Burton-Parsons	Storage	Lenses stored in Flexsol when not used.	NaCI 0.9%, disodium edetate 0.1%, absorbase. Preserved: Thimerosal 0.001%.
Flexcare	Burton-Parsons	Storage, rinsing	Latest addition to B-P system. Combines the functions of Normol and Flexsol.	NaCI, sodium borate and boric acid. Do **not** use with enzymatic cleaners (papain eg. Hydrocare). Preserved: disodium edetate 0.1%, Thimerosal 0.001%, and chlorhexidine 0.005%.
Boil 'N Soak	Burton-Parsons	Boiling, storage	Boiling and storage medium.	Boric acid, sodium borate, NaCI 0.7% Preserved: Thimerosal 0.001%, disodium edetate 0.1%.
Lensrins	Softcon(AO)	Rinsing, storage	Used with Septicon disc to neutralize hydrogen peroxide 6 hour minimum (Lensept=3% H_2O_2).	NaCI 0.85%, buffering agents, disodium edetate 0.1%. Preserved: Thimerosol 0.001%.
Pliasol	Cooper-Flow	Rinsing, boiling, storage	Used to rinse either Pliagel or Miraflow. Lens stored in Pliasol.	Balanced NaCI (0.9%), purified H_2O. Preserved: sodium edetate 0.2%, Sorbic acid 0.1% and EDTA 0.1%.
Permasol	Cooper-Flow	Rinsing, storage, irrigating	For use with Cooper Permalens	Buffered balanced NaCI, poloxamer 407, sodium borate. Preserved: Thimerosal 0.001%, disodium edetate and sorbic acid 0.1%.
Mira-soak	Cooper-Flow	Rinsing, storage	Lens cleaned with Mira-flow, stored in Mira-soak overnight.	Balanced NaCI (0.9%), purified H_2O, disodium edetate 0.1%. Preserved: chlorhexidine 0.008%.
Nutra-Flow	Cooper-Flow	Neutralizing, diluting solution	Neutralize and dilute Pliacide (Iodine) to provide daily storage medium.	Isotonic. Same as Pliasol plus KC1.
Soft Lens Storage and Rinsing Solution	Barnes-Hind	Rinsing, storage	Rinse lenses after mechanical cleaning. Store overnight.	Buffered, isotonic NaCI. Preserved: Thimerosal 0.001%, disodium edetate 0.1%.
Preserved Saline	Allergan	Rinsing, storage, soaking.	To use whenever normal saline required.	Buffered saline (NaCI). Preserved: Thimersal 0.001%, disodium edetate 0.1%.
Durasoft Solution	P.C.L.	Rinsing	Rinse lenses after Durasoft cleaner to prepare for autoclave.	Normal saline.
Steri-sal, Steri-soft	Medical Optics Centre	Rinsing, storage, soaking	Lens is mechanically cleaned (Steri-solv), stored either in Steri-sal or Steri-soft for further disinfection.	Steri-sal: 0.9% NaCI, 0.1% disodium EDTA, 0.01% Nipastat (preservative). Steri-soft: 0.9% NaCI BP, 0.1% disodium edetate, 0.001% Thimerosal, 0.001% chlorhexidine. Both in buffered aqueous polymer complex base.
Salette	Medical Optics Centre	Boiling medium	For use with Monoclens cleaner	Packaged in 10 ml pouches — sterile. Buffered 0.9% NaCI — no preservative.
Hydrosoak	Contactosol Ltd.	Rinsing, soaking	Lens precleaned with Hydro-clean and stored in Hydro-soak.	Preserved: 0.001% Thimerosal, 0.001% chlorhexidine.
Soflens soaking solution	Allergan for Bausch and Lomb	Rinsing, soaking, disinfecting	Use a few drops and rub gently for surfactant action then soak for 6-8 hours for disinfecting.	Provides complete surfactant plus disinfective properties. Contains: polysorbate 80 U.S.P., alkyl triethanol ammonium chloride, propylene glycol U.S.P. Na thimerosal, dialized hydron polymer, +3 buffers.
Hydron Non-Preserved Saline	Hydron	Soaking in heat disinfection unit	Rinse,lens with saline, fill lens case with fresh saline and heat in lens disinfector.	0.9% naCI in pressurized 250 ml container.
Unisol Non-Preserved	Burton-Parsons	Rinsing & storage	mix with distilled water and boil lens.	15 ml (MINUMS) for use in place of preserved solutions.
Salt Tablets (Non-Buffered)	B & L	Removal of lens deposits and to equilibrate the lens.	mix with distilled water and boil lens.	NaCI only.

TABLE 4: THE SURFACTANTS AND CHEMICAL DISINFECTANTS

Product Name	Manufacturer	Purpose	Details of Use	Additonal Details
Pliagel	Cooper-Flow	Prevent proteins, oils and remove cations.	Spread small amount on lens surface. Rub gently. Rinse before disinfection.	Contains Poloxamer 407, 15% non-detergent, isotonic vehicle, sorbic acid 0.1%, trisodium edetate 0.5%.
Softcon Lens Cleaner	Softcon	Remove protein and lens residue.	Same as Pliagel.	Isotonic cleaning solution. Thimerosal 0.004%.
Softmate (Softlens Cleaning Solution)	Barnes-Hind	Remove surface residues and protein.	Same as Pliagel.	Contains octylphenoxy ethanol. Hydroxyethyl cellulose. Tyloxapol 1/4%.
Preflex	Burton-Parsons	Removes tear residue and deposits.	Same as Pliagel. (Rinse with Normol or Flex-Care).	Thimerosal 0.002%, disodium ehtylene, diamino-trocetate 0.1%.
Pliacide	Cooper-Flow	Disinfection	Daily disinfection is neutralized by Nutra-flow in Porta-flow unit (2 hours). When colour is gone process is complete.	Contains 0.1% Iodine in isotonic vehicle. Not to be used with NVP or PVP containing lenses.
Mira-flow	Cooper-Flow	Surface solvent cleaning.	Lens is covered and gently rubbed for 60 seconds. Stored in Mira-soak overnight.	One detergent component same as Pliagel and another added. Contains: Isopropyl alcohol - solvent - for disinfecting and cleaning lenses.
Lensept	Softcon	Disinfection	Used daily - patient soaks lenses for 10 minutes. Stored overnight in Lensrins plus Septicon disc.	Is 3% hydrogen peroxide. Requires 6 hour minimum storage in Lensrins, plus disc, for complete neutralization.
Steri-solv	Medical Optics Centre	Disinfection	Lens soaked in 4-5 drops of Steri-solv for 2-3 minutes then placed in steri-sal or Steri-soft overnight.	NaCl BP 2.5%, Hyromellose disodium edetate 0.1%, Thimerosal 0.004%, buffered polymer base (aqueous).
Hydroclean	Contactosol Ltd.	Disinfection, Surface cleaning	Hydroclean is a mechanically utilized cleaner and disinfector. Lens stored after rinsing in Hydrosoak.	Thimerosal 0.001%.

TABLE 5: THE EXTRA CLEANERS

Product Name	Manufacturer	Purpose	Details of Use	Additional Details
Hydrocare	Allergan	Removes protein	1 Hydrocare tabled mixed with distilled water or saline. Lens deposited for 6 hours. Disinfected normal system.	Weekly use is often enough. Used by patient at home.
Soflens Cleaning Tablets.	Bausch & Lomb	Removal of surface deposits.	1 tablet with distilled water. New lens requires 2 hours in solution, older lens up to but not to exceed 12 hours. Rinsed and stored in Soflens soaking solution.	Do not use tablet if discoloured. Also compatible with B & L Aceptron system (boiling). Same as Hydrocare above).
Salt Tablets (Non-Buffered)	Bausch & Lomb	Removal of lens deposits & to equilibrate the lens.	Mix with distilled water and boil lens.	NaC1.
Barnes-Hind Weekly Cleaner	Barnes-Hind	Removal of surface deposits	Lens deposited in premixed solution for 2 hours, then disinfected with normal system.	Patient use, weekly.
Buffered Salt Tablets Tablets	Barnes-Hind	Removal of lens deposits.	Mix with distilled water and boil lens.	NaC1, sodium bicarbonate, disodium edetate, chelating agents.
Ren-O-Gel 1	Cooper-Flow	Remove protein and oily deposits.	Lens boiled in solution, cleaned with Pliagel, rinsed with distilled cold water. Disinfect before insterting.	Office use only. Frequent use will damage lens. Incompatible with PVP lenses. Lenses must be equilibrated in 10 ml isotonic solution for 2 hours at room temperature to remove residuals which can cause ocular irritation.
Ren-O-Gel 2	Cooper-Flow	Remove inorganic salts.	LKens boiled in solution for 5-15 minutes. Clean with Pliagel, rinse with distilled cold water. Disinfect before inserting.	Same as above.
Monoclens	Medical Optics Centre	Surface Cleaning, restoration	Lens boiled in solution, disinfected with Steri-solv, stored in either Steri-sal or Steri-soft.	Professional use only. Periodic cleaning of trial lenses (Sauflon) recommended.
Lipofrin	Burton-Parsons	Surface deposits and restoration	Lens precleaned with Preflex, rinsed with Normol. Lens heated in solution for 2-4 hours at 50°C, again rinsed with Normol, cleaned with Preflex, rinsed with Normol and is ready for Flexsol. (uses a magnetic stirrer)	Is an inorganic electrolyte with oxygen releasing action. Professional use only. Inns variation for P.W. lenses - 1/6 of a packet in 120 ml. of distilled water and boil lens in basket for 10 minutes then let stand 1-1/2 hours. Back in Permasol etc. 2 hours before wearing.

TABLE 6: THE OCULAR LUBRICANTS (WHILE LENS IS ON)

Product Name	Manufacturer	Purpose	Details of Use	Composition
Clerz	Cooper-Flow	Lubricating, cleaning, hydrating, re-wetting.	While lens is worn, 1 or 2 drops as required to enhance vision and to lubricate.	Poloxamer 407, sorbic acid 0.1%, disodium edetate 0.1%, sodium borate 0.2% in a neutral isotonic solution.
Adaptettes	Burton-Parsons	Cleaning, Re-wetting	While lens is worn, 1 drop 3-4 times daily as required.	Absorbase in a buffered isotonic solution. Thimerosal 0.004%, disodium edetate 0.05%.
Comfort Drops	Barnes-Hind	Re-wets, hydrates, cleans	1 or 2 drops as required while lens is being worn.	Nonionic surfactant in buffered isotonic solution. Thimerosal 0.004%, disodium edetate 0.1%.
Sterilette	Medical Optics Centre	Cleaning, re-wetting.	Insert few drops while lens is worn.	NaCl BP 0.9%, disodium EDTA 0.1%, Thimerosal 0.002% in aqueous polymer buffer solution.
Hydro-sol	Contactosol Ltd.	Lubrication, comfort.	Used on insertion for comfort.	Simple formulation for lubrication. Thimerosal 0.001%.

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