1. Contact Lens Solutions
2. Dry Eye Syndrome and Artificial Tears

Dr. Mehdi Alai
Optometrist
Winnipeg
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Disclosure Information

1. Contact Lens Solutions
2. Dry Eye Syndrome and Artificial Tears.

I have no conflict of interest to declare or financial relationships to disclose.

A couple of slides were provided by Alcon representative in Manitoba.
Contact Lens Solution History:

• First contact lens was made from glass in 1880
• Dr. Harry William Hind, an American pharmacist, invented the first contact lens solution right after the first corneal CL was made in 1940
Contact Lens Care Solutions:

Brief History:

- Contact lens care 20 years ago
- System was a multistep process requiring separate:
  - Disinfecting and storing solutions
  - Saline for rinsing off the cleaner or disinfecting agent
  - Enzyme tablets to remove proteins
Statistical Review:

- In the United States, approximately 50% of the population is using some form of correction for their refractive errors.
- Among them, ¼ are using CL.
- Among the young population, an even higher percentage are using CL.
- Majority of CL users wear contact lenses more than 6 hours a day.
Why Contact Lenses?

- Mostly because they provide a better quality of vision than glasses
- Cosmetic reasons:
  - Young population
  - Colored CL
  - Easier to carry than glasses
Types of Contact Lenses:

Generally we have two types of contact lenses.

1. Soft Contact Lenses
   - They are made of materials like silicon and HEMA
   - They have a different amount of water content.
   - They are the most popular type of CL and can be used in patients with mild to moderate astigmatism.
2. RGP Contact Lens

- Rigid Gas Permeable Contact Lenses are made of durable plastic material (PMMA, Silicon acrylate) with no water content and their oxygen permeability is higher than soft contact lenses.
- These lenses are also called RGP or GP, which are usually used for patients who have high astigmatism or other corneal pathology like Keratoconus.
But what are the downsides for CL?

1. Contact lenses are FB on the corneal surface
2. They need a special, complicated care system
3. There is always a possible risk of
   - Corneal abrasion
   - Corneal infection
   - Corneal hypoxia
   - Corneal neovascularization and opacity
   - Allergic reactions
   - Cytotoxic reactions
   - CL intolerance
By using CL, we are facing two major problems:

• Risk of serious corneal infection:
  ➢ So we need a special care system to eliminate contamination

• Long term use of contact lenses and their care systems increases the risk of cytotoxic and allergic reactions
How can we decrease the risk of these important complications?

In different ways:

• CL manufacturing:
  ➢ Permeability
  ➢ Material
  ➢ Design
  ➢ Daily versus other types
  OR

• New and complete contact lens care solution formulations
Characteristics of an ideal CL care solutions system:

Be able to provide…

• Cleaning
• Disinfecting
• Wetting
• Soaking and storing facilities to the CL in a fast and simple-to-follow process
The most important part of the CL care system is CL disinfection.

We have several disinfecting methods:
1. Chemicals
2. UV exposure
3. Hydrogen peroxide
4. Heat
Chemical care systems

We have two main chemical CL care systems:

Old system:
• Complicated and multistep
• Time consuming
• Most patients did not follow the steps
• Includes the first generation of disinfecting agents
• More chance of complications
• Expensive

This system is progressively being replaced by the new chemical contact lens care system
What is the new CL care system?

• It provides cleaning, disinfecting, rinsing and storing of the lens in one or two steps
• Less complicated
• Contains second generation of disinfecting agents
• More convenient for the patients; that’s why it is the most popular one today.
FDA approval

CL solutions, like other medical devices, need FDA approval (Class II devices)

• Each product test includes
  ➢ Chemistry
  ➢ Microbiology
  ➢ Toxicology
  ➢ Clinical evaluations
FDA approval Cont’d

Chemistry
• Investigate uptake and release of preservatives by lens materials
• Cleaning effectiveness
• Solution compatibility to the lens material

Microbiology
• Test the ability of the product to eliminate specific microorganisms

Toxicology
• Evaluate the adverse effect of the product on living tissue (the eye)

Clinical Evaluation
• The final step for looking at the safety and efficacy of new solution.
Today's modern care systems

1) Multipurpose solutions (MPS)
   - With preservatives
   - Unpreserved

2) Hydrogen peroxide system
   - Daily cleaner
   - Enzymatic cleaner
   - Saline solutions
1) Multipurpose Solutions

• They provide cleaning, disinfecting, rinsing and storing of the CLs
• The most popular solutions
  ➢ More convenient
• Their components
  ➢ Preservatives
  ➢ Surfactant
  ➢ Wetting agents
  ➢ Protein removers
  ➢ Buffers and electrolytes…. 
Basic Differences between currently available MPS solutions

- The important factor is the type and the amount of preservatives
- The ease and steps of use
- The type of CL material
- General conditions of each patients’ eyes

- Each MPS could be:
  - Preserved
  - Or
  - Unpreserved
Composition of MPS

• Preservatives
• Surfactants
• Wetting agents and lubricants
• Protein removers
• Other components: e.g. Electrolyte, buffers and chelating agents
Preservatives

We have two different types:

1. First generation
   a. Thimerosal
   b. Benzalkonium Chloride
   c. Chlorhexidine

2. Second generation
   a. Polyaminopropyl biguanide
   b. Polyhexamethylene biguanide (PHMB)
   c. Polyhexamidine hydrochloride
      (Chlorhexidine derivatives)
   d. Polyquaterium (Polyquad)
   e. Myristamidopropyl dimethylamine (Aldox)
Why not first generation?

• They have low molecular weight V.S. high molecular weight of the second generation
• They are easily absorbed by contact lens materials
• High rate of allergic and cytotoxic reactions
• Increased rate of CL degradations

Because of above disadvantages, they are usually replaced by second generation
Buffers, Electrolytes and Chelating Agents

**Buffers:** e.g. Sodium Phosphate, Sodium borate, Boric acid, Sodium citrate

- They make solutions resistant to change in pH.

**Electrolyte and chelating agents:** e.g. KCl, NaCl, EDTA, Taurine, Propylene glycol, Sorbitol

- These agents work as moisturizing or conditioning factors in the solution.
2) Hydrogen Peroxide System

It is categorized as:
1. Two step products
   a. Hydrogen peroxide for disinfection
   b. Saline for rinsing CL and washing out H₂O₂
2. One step products
   a. This system allows H₂O₂ to react completely → converts to pure water → more eye friendly and does not need rinsing with saline.
Hydrogen Peroxide System Cont’d

• Has the distinct advantage of being preservative free.
  ➢ Good choice for patients allergic to preservatives
• Has very good cleaning and disinfecting efficacy
Hydrogen Peroxide System Cont’d

• Expensive?
• Some of them need separate cleaners, neutralizers and enzyme tablets.
• But now, one step care products are available
Rewetting solutions (drops)

• They are saline solutions packed in smaller bottles
• Some of them have additional lubricants
• They should be packed in 30mL bottles to decrease the risk of contaminations.
Saline Solutions

• They are isotonic salt solutions
• Generally used for rinsing
• But sometimes with heat disinfecting system, they are used for CL storage.
• There are two types
  ➢ With preservatives
  ➢ Unpreserved
• Before marketing they will be tested for microorganism stasis capability.
• May be less reactive in patients that experience adverse reactions with preservatives.
RGP care solutions

• Some solutions are used only for RGP lenses
• Solutions used for both RGP and soft contact lenses are also available.
Summary

CL care solutions:
- Multistep solution system
  - One step or single bottle MPS
- H$_2$O$_2$ solution system
Summary cont’d

What is a good MPS CL care solution?

• To achieve all goals of CL care, the solution may have:
  ➢ Disinfecting agents
  ➢ Surfactant
  ➢ Lubricant and wetting materials
  ➢ Buffers
  ➢ Ionic agents

• With all of these components, the solution must be friendly to the eye.
Summary cont’d

How can we choose the right solution for the patient in today’s market?

First of all:

• We should never change the solution that has been recommended by an eye care practitioner.

• All of us, as healthcare practitioners, must strongly encourage our patients to follow the manufacturer's instructions before using the solution.

• We can choose solution based on the type of CL (Soft V.S. RGP)

• The most important factor is the patient.
Summary cont’d

Generally we have two different groups of patients:
1. Patients who have
   • No history of allergies
   • No medications that can interfere with eye tear physiology
   • Normal tear film physiology
   • No ocular surface diseases
   • Well oriented and educated
   • Do not have sensitive eyes
   • Not using contact lenses on a regular conventional basis
   • Young healthy patients who do not have specific recommendations from their eye doctor.

Maybe we can offer anyone well known MPS or hydrogen peroxide systems.
Summary cont’d

2. Patients with any or some of following problems
   • History of allergies
   • Systemic, local or any atopic conditions
   • History of having some stages of DES
   • Medications or medical conditions that interfere with normal eye tear physiology
   • Eye infections or inflammations
   • History of toxicity reactions to some previously used solutions
   • History of red eye
   • Elderly patients
Summary cont’d

In this group we must:
• Ask the patient to consult an eye doctor before using any solution.
• Use solutions that are known to have minimal adverse reactions.
• If there is no underlying risk of inflammation or infection, maybe this patient can use preservative-free solutions.
• We should encourage these patients to rinse the CLs before insertion regardless of the type of solution they are using.
• Maybe we can ask the patient to decrease the wearing time of the contact lens, if possible.
• If the patient has mild dry eye symptoms, we may suggest using solutions that better moisturize the CL along with wetting drops.
• These patients should be assessed for treatment of any possible underlying eye diseases.
Dry Eye Disorder,
Dry Eye Syndrome,
Dysfunctional Tear Syndrome
Or
Kerato Conjunctivitis Sicca (KCS)
**Xerophthalmia**

- Indicates a dry eye associated with vitamin A deficiency
- Usually observed in individuals with a history of GI disturbances, including malabsorption syndromes or with a history of malnutrition or measles.
Dry eye definition:

1- DE occurs when there is insufficient tear production or function resulting in dryness of our eye.

OR

2- DE is a disorder of the normal tear film due to lower tear production or excessive tear evaporation which may lead to the damage of external eye tissues.

Dry eye (2007)

- DE is a multifunctional disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbances, and tear film instability with potential damage to the ocular surface;
- It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface.
What does it mean?

1. Your body simply does not make enough tears
   OR

2. Your own tears are unstable and evaporate too quickly, leaving the surface of your eye dry.
Anatomy of tear production:

The **large lacrimal glands** produce “reflex tears” as a response to emotion, injury or irritation.

The **accessory lacrimal glands** secrete “constant tears” which ward off infection and lubricate the eye.

The **punctum** serves as the “drain” for tears.

The **lacrimal sac** is the “drainage system” through which tears flow from the eye into the nose.
Tear Physiology and Function:
Normal tear film has 3 layers:

1. Lipid layer
2. Aqueous layer
3. Mucin Layer
Tear Physiology Continued:

Functions:

1. It is the outermost refractive surface of the eye.
2. It keeps osmotic gradient across cornea.
3. It acts as a normal lubricant; provides comfort and clarity.
4. Washes and flushes away debris.
5. The primary source of O₂ for the cornea
6. Nourish the surface cells of our eye
7. Flush away bacteria and other debris, protecting the eye from infection
8. It contains important immune system components like IgG, lysozyme, secretory IgA
Tear film physiology and function continued:

Healthy tear film:

pH: 7.0-7.5
300-310 mOs
Pathophysiology of the dry eye

- Tear hyperosmolarity
- Tear film instability
- Any Inflammation
Prevalence and incidence

• 30-40% of the adult population suffers from dry eye. In reality, there is a significant number of people that have some degree of dry eye (subclinical or asymptomatic).
• Affects women more commonly than men
• More common in older individuals (45 and older)
Dry Eye in Canada

• In 1994, a 13-point questionnaire (The Canada Dry Eye Epidemiology Study, CANDEES) was mailed to all optometric practices in Canada.

• About 28.7% of respondents reported dry eye symptoms.

• The prevalence of patients reporting any level of symptoms of dry eyes was approximately 1 in 4; severe symptoms were reported by 1 in 225 patients.
Increase in dry eye cases

- Aging

Canadian population aged 55+ from 2001 to 2026

<table>
<thead>
<tr>
<th>Year</th>
<th>Population '000</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>8,000</td>
</tr>
<tr>
<td>2006</td>
<td>9,000</td>
</tr>
<tr>
<td>2011</td>
<td>10,000</td>
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<tr>
<td>2016</td>
<td>11,000</td>
</tr>
<tr>
<td>2021</td>
<td>12,000</td>
</tr>
<tr>
<td>2026</td>
<td>14,000</td>
</tr>
</tbody>
</table>
Why should we worry about dry eye?

Ocular surface damage

- Can lead to serious infection
- Can become irritated and uncomfortable
- Decreased clarity/unstable vision
- Difficult to wear contact lenses
- Difficulty with computer work, reading or extended TV viewing
- Decreased quality of life
Why should we worry about dry eye? Cont’d

- Contact lens discontinuation
- Adversely affects refractive surgery outcomes
- May be associated with increased risk of infection with ocular surgery
Classification of dry eye syndrome

1. Aqueous layer deficiency
   - Sjogren Syndrome
   - Non-Sjogren

2. Evaporative
   1) MGD: primary or secondary
   2) Exposure (Bell’s palsy, anatomical lid disorders...)
   3) Defective blinking (Parkinsonism....)
   4) Contact lens associated (chronic inflammation....)
   5) Environmental
Causes of dry eye:

1. Systemic conditions, inflammatory and collagen-vascular disorders: Rheumatoid Arthritis, SLE, Sjogren syndrome, inflammatory bowel diseases
2. Lacrimal disease or obstruction
3. Decrease in reflex tearing
4. Decreased function of corneal nerves
5. Age
6. Hormones
7. Medications
8. Contact Lens wear
9. Visual tasking (e.g. Computer use)
10. Foods/Drink (e.g. Alcohol)
Risk factors for DE

- **Age**: decreased tear production
- **Hormone levels**: menopause
- Systemic diseases, allergies, DM, RA, Rosacea
- Systemic medications neuroleptics, antidepressants, diuretics, antihistamines
- Refractive surgery
- Topical medications, Glaucoma medications, toxicity
- Contact lens use
- Ocular anatomy
  - Incomplete lid closure, Bell’s palsy
- Environment
  - Heaters, Fans, Smoke, Humidity
Dry eye is a chronic **condition** that can be exacerbated by a combination of these factors.
## Signs and Symptoms of Dry Eye

<table>
<thead>
<tr>
<th>Patient Symptoms</th>
<th>Clinical Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryness</td>
<td>Reduced tear film break-up time</td>
</tr>
<tr>
<td>Itchiness or scratchiness</td>
<td>Corneal surface staining</td>
</tr>
<tr>
<td>Burning or stinging</td>
<td>Conjunctival staining</td>
</tr>
<tr>
<td>Foreign body sensation</td>
<td>Low tear meniscus</td>
</tr>
<tr>
<td>Grittiness</td>
<td>Tear debris</td>
</tr>
<tr>
<td>Fluctuating visual acuity</td>
<td>Hyperemia</td>
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<tr>
<td>Tired eyes</td>
<td></td>
</tr>
<tr>
<td>General discomfort</td>
<td></td>
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<tr>
<td>Photophobia</td>
<td></td>
</tr>
<tr>
<td>Contact lens intolerance</td>
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</tbody>
</table>
Diagnostic Tools

- Tear Film Break-Up Time
- Injection
- Lissamine Green Staining
- Rose Bengal Staining
- Fluorescein Staining
- Blink Rate
- Schirmer Testing
- Osmolarity
Is Blinking important?

YES!!!

- Each blink acts to squeeze oil from the oil glands onto the tear film. Oil helps prevent evaporation of the tears.
- Each blink spreads the tear film smoothly across the surface of the eye, keeping it moist.
- Each blink flushes away debris from the surface of the eye.
- Activities involving prolonged staring can reduce the blink rate to about half the normal rate, thus allowing the surface to dry out.
Dry Eye Treatment & Management

In order to decide on the best treatment for the patient, you must first decide if the dry eye is:

- MILD
- MODERATE
- SEVERE

Plan the treatment accordingly.

Compliance is critical to the success of the treatment.
Dry Eye Treatment & Management

- Environmental
- Topical
- Punctal occlusion
- Diet
Dry Eye Treatment & Management

Environmental
- Consider a humidifier
- Avoid drafts, direct fans and heaters
- Take “eye breaks” from tasks such a computer, reading or TV
- BLINK  BLINK  BLINK
- Position computer monitors 18 - 30 inches from your eyes
- Position top of computer screen lower than eye level, therefore looking down and eyes more closed
- Make sure your glasses have the right correction for the computer/ TV/reading material

Topical
- Artificial tears - multi-dose
- Artificial tears - single dose
- Lubricating ointments

Punctal Occlusion
- Temporary: silicone plugs
- Permanent: cautery
Qualities of an Ideal Dry Eye Product

- Minimal blur
- Comfort upon instillation*
- Ability of product to spread evenly over the cornea quickly and efficiently
- Prolonged retention time for extended efficacy*
- Objective and subjective improvement in patient signs and symptoms
Qualities of an Ideal Dry Eye Product Cont’d

- Mimic the tear film as closely as possible
- Assist in maintenance of normal ocular epithelium (skin)
- Assist in recovery of normal epithelial structure and function
- Achieve a lengthening of tear film breakup time, while being comfortable in the eye
- Long retention time in the eye
Dry Eye Treatment & Management

Topical

• Artificial Tears - multi-dose/preserved
  ➢ Convenient, cost effective
  ➢ Mild/moderate dry eyes
  ➢ 4-6 times / day
• Artificial Tears - single dose/preservative free
  ➢ Moderate to severe dry eyes
  ➢ Every 1-2 hours
  ➢ Post-lasik

Lubricating Gels / Ointments

➢ Severe dry eye
➢ Night time use
➢ Longer contact time
Artificial Tears

Active Ingredients:

- Wetting agents
  - Cellulose
  - Hydroxy propyl cellulose
  - Polyvinyle Alcohol
  - Carboxy methyle cellulose
  - Hydroxy methyle cellulose
  - Methyl cellulose
  - Hydroxy propyl methyl cellulose HPMC
Polyvinyle Alcohol (PVA) alone or combined with:
- Povidone or Dextrose and PEG-400

Glycerin alone or combined with:
• Polysorbate 80
• HPMC
PEG-400
Dextran 70

HPMC alone or combined with:
• Glycerine
• Dextran 70
• PEG 400
• Or combination of all

PolyCarophil combined with:
• Dextran 70
• PEG 400

Polyethylene glycol with PEG-400
HPMC with dextran 70
Viscosity of Artificial Tears

Depends on the concentration of the wetting agent
- Example: Carboxy Methyl Cellulose (CMC) can be used in 0.25%, 0.5%, and 1% solutions.

The more severe the dry eye the higher viscosity
Artificial tears
- HPMC, PVA, Hydroxy propyl guar. (HP-Guar), glycerin
Castrol oil, mineral oil are among other ingredients that produce viscosity.
Preservatives

Multidose artificial tears contain preservatives:

- Methylparaben
- Benzalkonium Chloride
- Polyquad
- Propylparaben
- Potassium Sorbate
- Sodium Perborate
- Purite
- Sorbic Acid
- Polyhexamethylene biguanide (PHMIS)
Buffer and stabilizers in Artificial Tears:

- Phosphate
- Bicarbonate
- Borate
- Metabisulfate
- Sodium Bisulfate

Are used to balance pH, prevent drug degradation and maintain proper osmolality.
More Toxic Preservatives:

1- Thimerosal
2- Benzalkonium Chloride (BAK)
Eye reactions to preservatives in general depends on:

- Specific type of preservative employed
- Concentration of preservatives
- How frequently is used
- The integrity and physiology of the ocular surface
- Intact corneal epithelium
- Lacrimal drainage system, severity of dry eye
- Age of the patient
Mechanisms and types of ocular toxicity

1- Type I  IgE mediated hypersensitivity

2- Type II  Delayed reaction
Dry Eye Treatment: punctal occlusion

The large lacrimal glands produce “reflex tears” as a response to emotion, injury or irritation.

The accessory lacrimal glands secrete “constant tears” which ward off infection and lubricate the eye.

The punctum serves as the “drain” for tears.

The lacrimal sac is the “drainage system” through which tears flow from the eye into the nose.
Dry Eye Treatment & Management

Punctal Occlusion
Increases contact time of tears/artificial tears

- Collagen: temporary
- Silicone: semi-permanent
- Cautery: permanent
Dry Eye Treatment & Management

• Dietary Supplements
  - Omega-3 fatty acids such as fish oil, flaxseed oil or evening primrose oil

• Increase water, more than 8-10 glasses/day
Severity of Dry Eye Syndrome (DES)

1- Mild

2- Moderate

3- Sever
Systemic medications associated with symptoms of Dry Eye

- Beta-Blockers
- Diuretics
- Anti Parkinsonism
- Antiarrhythmics
- Sex hormones
- All classes of antidepressants
- Antihistamines
- Retinoids
- Antispasmodics (all anticholinergics)
- Antipsychotics (Neuroleptics)
- Chemotherapy
Summary:

- DES is a chronic and common disease with different clinical presentation and severity from mild to severe.
- It can affect all ages but more common in elderly patients and people with specific systemic conditions.
- The main treatment for almost all types of dry eye is topical artificial tears.
- Essentially we can classify the patients with dry eye as follows:
Summary Cont’d

1. Patients with no underlying systemic or local eye diseases who are suffering from mild to moderate DES.
   - We can offer any brand of multi dose preserved artificial tears 4-6 times a day
   - With severe DE unpreserved artificial tears
Summary Cont’d

2. Patients with no systemic or eye diseases who are conventional contact lens users.

- In these patients beside using non-preserved contact care lens solutions, maybe we can suggest topical wetting drops along with preserved or non-preserved single dosed artificial tears.
Summary Cont’d

3. Patients with any inflammatory ocular or systemic disorders.
   - We have to refer this group of patients to their eye or medical doctor for any possible treatment of underlying diseases.
   - If underlying eye or systemic condition is well controlled, maybe any unpreserved or preserved artificial tears can be offered for mild to moderate DES.
Summary Cont’d

4. Final group of patients who are suffering from severe dry eye.
   - As a rule, they should be under close observation of an optometrist or ophthalmologist to manage the disease and possible severe visual or ocular surface complications.
   - For relief of some symptoms, single-dosed, non-preserved artificial tears may be used as part of their treatment.
Thank you