

AMERICAN ACADEMY  
of OPTOMETRY

## Controversies in contact lens care

A clinical perspective to define the best system

- Dr Langis Michaud, O.D. M.Sc. FAAO (Dipl)  
Associate Professor – Université de Montréal

ACADEMY 2012  
PHOENIX

Please silence all mobile devices.  
Unauthorized recording of this  
session is prohibited.

## Disclosure– Dr Michaud

- ▶ Speaker fees (2011–12)
  - Bausch & Lomb pharma – Allergan
  - Genzyme Canada – Cooper Vision
  - Alcon /Ciba Vision – PRN Canada
- ▶ Research funding (U de Montréal)
  - Laboratoires Blanchard – Johnson & Johnson
  - Genzyme Canada – Canadian Opto. Ass.
  - AMO /Abbott – Alcon / Ciba

## Introduction

- ▶ Contact lens care systems have evolved with 3 new products launched in the market in 2011–2012.
- ▶ BUT
- ▶ We are still seeing problems related with comfort and ocular health
- ▶ What defines the best care system to avoid negative impacts on contact lens wear and ocular health ?

## Contact lens care market 2011–12



Source: Contact Lens Spectrum annual survey, January 2012.

## Contact lens care market highlights

- ▶ Chemical (77%) exceeds Hydrogene peroxyde (23%)
  - $H_2O_2$  is still on the rise (16% in 2010)
- ▶ Top 3 players



## New players in town

- ▶ B&L Biotrue
- ▶ AMO Revitalens Ocutec
- ▶ Alcon Opti-Free Moist

## B&L Biotrue Specific Features

- ▶ Matches pH of healthy tears
  - to promote comfort upon insertion
  - pH level provides optimal activation of the dual disinfectants in Biotrue (antimicrobial efficacy)
- ▶ Utilizes a lubricant found in eyes
  - Hyaluronan (HA)
  - Long lasting effect which improves comfort
- ▶ Company claims that it keeps certain beneficial tear proteins active<sup>1</sup>
  - Lysozymes and Lactoferrin
  - Data non conclusive in that regard<sup>2</sup>

1-Barniak et al. Contact Lens Ant Eye 2010 33(1) 57-11  
2-Barniak et al. Contact Lens Ant Eye 2010 33(1) 57-11

## AMO Revitalens Ocutec

- ▶ Enhanced disinfection with the combination of Alexidine (biguanide family) and PQ-1
  - In addition: EDTA
- ▶ Kill rate equal or superior to hydrogen peroxide
  - With the convenience of MPS
  - Combined action of Alexidine and PQ-1
- ▶ Boric acid, sodium borate

## PHMB is not a bad thing

- ▶ Proven efficacy against pathogens, fungi and acanthamoeba
  - Widely used in the last 20 years by many companies
- ▶ Alexidine is part of the biguanides family
  - 2/3 of the newest solutions incorporate such elements
- ▶ Modes of action similar to PQ-1
  - Action on cell membrane
  - Larger molecular size : reduced % of biocide needed for clinical action

## PHMB

- ▶ Performance influenced by pH
  - Tears pH : 7.10 – 8.06<sup>1</sup>
  - Contact lens solutions: 7.23 – 7.88<sup>2</sup>
  - Revitalens 7.8 ; Biotrue 7.5
    - PHMB is more active at 7.8
- ▶ Heavily adsorbed during soaking
  - Disinfection in the case is reduced
  - Addition of PQ-1 to PHMB or Alexidine helps to increase pathogens disinfection in the case

1- Curr Eye Research 1997 16(5):482-6  
2- Dalton et al. Optom Vis Sci 2008, 85(2): 122-8

## Alcon's Pure Moist

- ▶ Improved contact lens wetting technology (Hydraglyde®)
  - EO- polyoxyethylene attracts moisture
  - BO- polyoxybutylene targets silicone
  - In theory, helps comfort.
    - No published data support this claim
  - Reduces lipid deposition
- ▶ Higher disinfection profile
  - Addition of a chelating agent (EDTA)
  - Enhances anti-microbial activity

## Dreams vs reality

Clinical requirements	Professional behaviour
<ol style="list-style-type: none"> <li>1. Disinfection</li> <li>2. Cleaning</li> <li>3. Eye-solution biocompatibility</li> <li>4. Material-solution compatibility</li> <li>5. Help to restore lens surface/comfort</li> <li>6. Compliance (easy to use)</li> <li>7. Affordable</li> </ol>	<p>90% ODs recommend solutions based on:</p> <ol style="list-style-type: none"> <li>1. Material-solution compatibility (34%)</li> <li>2. Potential impact on comfort (25%)</li> <li>3. Disinfectant efficacy (23%)</li> <li>4. Cleaning efficacy (12%)</li> <li>5. Convenience (6%)</li> <li>6. Cost: not an issue</li> </ol>

Nichols, J.J. CL Spectrum, Jan 20

Looking at evidence-based science for clinical recommendations

## Impacts of lens wear and lens care on the ocular health

## Factors to consider

- ▶ Impacts of contact lens wear
  - Mechanical
  - Immunological
- ▶ Deposits
  - Bioburden
- ▶ Chemicals of the care regimen
  - Uptake and release
  - Efficacy
- ▶ Corneal Staining

## Impacts of the lens on the tear film

- ▶ Reduces tear film thickness in front of the lens in the first 30 minutes of wear, more with particular care regimen<sup>1</sup>
- ▶ This leads to tear film instability<sup>2</sup>
  - Vision reduced
  - Discomfort felt at the end of the day
  - TBUT is reduced by 5 sec compared to non wearers
- ▶ Increases tear film osmolarity
  - Linked with increased ocular dryness
  - Increases likelihood of deposits on the surface of the lens

Nichols JJ, King-Smith PE. The impact of hydrogel lens settling on the thickness of the tears and contact lens. *Invest Ophthalmol Vis Sci*. 2004 Aug;45(8):2549-54.

Tutt R, Bradley A, Bradley C, Thibos LN. Optical and visual impact of tear break-up in human eyes. *Invest Ophthalmol Vis Sci*. 2000 Dec;41(13):4117-23.

Miller WL, Dougherty MJ, Narayanan S, et al. Tien A, Gaume AL, Bergmanson JP. A comparison of tear volume (by tear meniscus height and phenol red thread test) and tear fluid osmolarity measures in non-lens wearers and contact lens wearers. *Eye Contact Lens*. 2004 Jul;30(3):132-7.

## Contact lens deposits

- ▶ Related to tear film composition and environmental conditions<sup>1</sup>
  - Proteins, carbohydrates, lipids, mucin
  - Bacteria and trapped exotoxins
- ▶ Nature and quantity of deposits vary from wearer to wearer, based on individual factors
- ▶ Deposits trigger mechanical and immune responses and increase patient discomfort<sup>2</sup>

Bowers RW, White BJ. Studies of the ocular compatibility of hydrogels. A review of the clinical manifestations of spoilage. *Biomaterials*. 1987 Mar;8(2):83-8.

Zhao Z, Nadioukh T, Fakhry M, et al. Contact lens deposits, adverse responses, and clinical ocular surface parameters. *Optom Vis Sci*. 2010 Sep;87(9):669-77.

## Mechanical response

- ▶ Giant Papillary Conjunctivitis (GPC)
- ▶ Seen with all types of contact lenses
  - Hydrogels, SiHy, RGPs, Hybrid
- ▶ Associated with lens discomfort
- ▶ Treatment according to algorithms

Photo © Dr Langis Michaud OD

## Immune response related to deposits<sup>1-2</sup>

- ▶ Deposits modify the immune composition of the tear film
  - Increased potential for ocular infection to develop
- ▶ Deposits favour the development of a biofilm on the lens
  - Bacterial endotoxins on c.l. are hypothesized to be the principle causes of sterile infiltrates
  - Microbial keratitis develop if there is
    - Enough pathogens
    - Sufficient time exposure to the cornea
    - An epithelial break

1. Chalmers RL, Kely L, et al. Multicenter. *Optom Vis Sci*. 2012; 89(3): p. 316-25.

2. Radford CF, Minassian D, Dart JH, et al. Verma S. Risk. *Ophthalmology*. 2009; 116(3): p. 385-92.

## Bioburden

- On the back surface of the lens, deposits and pathogens are not exposed to the blinking process
- A tight lens on the eye, with reduced movement upon blinking, allow the pathogen to be exposed enough long to invade the cornea<sup>1</sup>
- Pathogens endotoxins are released and remain trapped under a tight lens.
  - Immune system reacts. This leads to sterile infiltrative keratitis. **Bioburden = risk factor #1**

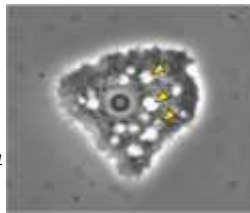
Qizhan J, Mandathara P, Krishna P, Sankaridurg V, Willcox MD, Holden B. Optom Vis Sci. 2010 Nov;87(11):847-53.

## Pathogens

- Contamination comes from water sources and through airborne transportation
  - Bathroom is the worst location to store cases and lenses
  - Pseudomonase, Achromobacter, Stenotrophomonase et Delftia*
- Dirty cases become colonized with pathogens
- Non compliance help to grow pathogens and to develop biofilm
  - Some elements, such as PG, can serve as a carbon source of nutrition for pathogens
  - Top-off reduces the concentration of biocide, making it ineffective

## Pathogenic Microbes

- Acanthamoeba*
- "Real-world" *Fusarium* strains
- MRSA, MRSE, MDR pathogens
- Stenotrophomonas maltophilia*<sup>1</sup>
  - Variety of *Pseudomonas*
  - Reported with increasing frequency
  - Supports the growth and replication of *Acanthamoeba*
  - Commonly found in contact lens cases<sup>3</sup>



A trophozoite containing food vacuoles with phagocytised *S. maltophilia* (arrows)<sup>2</sup>

1. Ambica KL, Mitali CM, James P, et al. Microbiology of contact lens cases: contamination rates, prevalent organisms, resistance to eye products and growth of *Acanthamoeba* in vivo. *Optom Vis Sci*. 2002; 79: 2482. 2. Willcox M, Khongkorn C, Choo K, et al. Survival and growth of *Stenotrophomonas maltophilia* on multiple contact lens solutions. Poster presentation, British Contact Lens Association Meeting, May 2010. 3. Wilson M, Carritt D, et al. Contact Lens Case Contamination During Daily Wear of Silicone Hydrogels. VOL 87, NO 7, OPTOMETRY AND VISION SCIENCE. 2010; 87(7): 500-504. 4. Chalmers RL, et al. American Academy of Ophthalmology.

2012.02.01-CN615

## Factors associated with increased risk of ocular infection<sup>1-2</sup>

<ul style="list-style-type: none"> <li>Contact lens materials               <ul style="list-style-type: none"> <li>Hydrogels vs SiHy</li> </ul> </li> <li>Mode of wear               <ul style="list-style-type: none"> <li>Conventional &gt; disposable</li> <li>3 months &gt; 1 month</li> </ul> </li> <li>Contact lens fitting               <ul style="list-style-type: none"> <li>tight lens, reduced movement on the eye</li> </ul> </li> <li>Power of the lens               <ul style="list-style-type: none"> <li>High ametropia</li> </ul> </li> <li>Care system               <ul style="list-style-type: none"> <li>MPS vs Peroxyde</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Extended wear</li> <li>Hygiene / Compliance</li> <li>Contact lens experience (&gt;6months)</li> <li>Age (&lt; 25 y.o.)</li> <li>Smoking</li> <li>Sex (H &gt; F)</li> <li>Internet purchase</li> </ul>
Related to the lens	Related to the wearer

Chalmers RL, W.H., Mitchell GL, Lam DY, Kinoshita BT, et al. Invest Ophthalmol Vis Sci. 2011; 52(10): p. 5690-6.  
4. Chalmers RL, Kopy L, Long B, Bergmiller P, Giles T, Bullimore MA. Optom Vis Sci. 2010; 87(10): p. 727-35.

## Clinical implications

- Deposits occur a few minutes after lens insertion. Their accumulation leads to immune reactions
- Pathogens should be eliminated
  - Solutions can be inefficient to eradicate pathogens trapped into deposits or adsorbed on the lens surface
  - Lens case is the weakest link to look at
- Lens should be replaced often to minimize risk factors to develop infections
  - Daily disposable lenses represent the safest option

Uptake and release

## ALL MPS Solutions Contain Preservative Agents...<sup>1</sup>

MPS	Preservative
Aquify <sup>®</sup>	PHMB
Biotrue <sup>®</sup>	PHMB, PQ-1
Complete Easy Rub <sup>®</sup>	PHMB
Opti-Free Evermoist (UK)/Puremoist (USA)	PQ-1, MAPD
Opti-Free Express	PQ-1, MAPD
Opti-Free Replenish	PQ-1, MAPD
renu fresh <sup>®</sup>	PHMB
renu sensitive <sup>®</sup>	PHMB
Revitalens OcuTec <sup>®</sup>	Alexidine, PQ-1

...and ALL preservatives are adsorbed to some degree by the soft contact lens during soaking<sup>2,3</sup>

MAPD = myristamidopropyl dimethylamine; PHMB = polyhexamethylene biguanide; PQ-1 = polyquaternium-1.

Trademark of "Ciba Vision," Bausch & Lomb, Inc., VAND, and Alcon.

1. Product information for: Aquify (Ciba Vision); Biotrue, renu fresh, renu sensitive (Bausch + Lomb); Complete Easy Rub, Revitalens OcuTec (AMO); Opti-Free Evermoist Puremoist, Opti-Free Express, Opti-Free Replenish (Alcon). 2. Dassanayake N et al. *Invest Ophthalmol Vis Sci*. 2005;46:E-Abstract 915. 3. Powell CH et al. *Cont Lens Anterior Eye*. 2010;33:9.

## Amount and Rate of Preservative Uptake Is Influenced by Several Factors



1. Powell CH et al. *Cont Lens Anterior Eye*. 2010;33:9. 2. Dassanayake N et al. *Invest Ophthalmol Vis Sci*. 2005;46:E-Abstract 915. 3. Sentell KB, et al. *Invest Ophthalmol Vis Sci*. 2004;45:E-Abstract 1573.

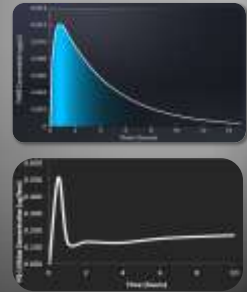
## Biocide uptake

- ▶ The Alexidine- and PHMB-based multipurpose solutions tested showed significant uptake of preservative into group IV lenses,
  - decrease in the residual activity of the storage solution.
- ▶ MAPD uptake and release produces corneal staining
- ▶ OFX and OFR MPS maintained fungicidal efficacy after storage of lenses.
  - PQ-1 properly formulated does not bind to contact lenses

Rosenthal RA, Doss S, Schmitz NL, Schlitzler RL, Schlech BA, Meadows DL, Stone RP. *Eye Contact Lens*. 2006;32(6):262-6.

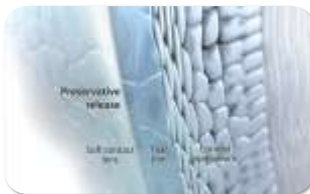
## Uptake vs material

- ▶ PHMB
  - Higher adsorption by ionic and non-SiHy lenses
  - Slower desorption ( $t(1/2) = 120$  min.)
- ▶ Aldox
  - Uptake capacity much higher with all SiHy lenses<sup>1</sup>.
  - Faster desorption ( $t(1/2) = 20$  min.)
- ▶ This difference can trigger clinical signs seen after 30 min vs 2h00 post-insertion



Powell CH, Lally JM, Hoong LD, Muth SW. *Cont Lens Anterior Eye*. 2010;33(1):9-18.

## Adsorbed MPS Preservatives Are Released by the Lens Into the Tear Film Upon Application Onto the Eye



- ▶ The release rate is dependent on the preservative and lens material combination<sup>1,2</sup>
- ▶ Released preservatives are dissipated by normal tear flow<sup>1</sup>

1. Powell CH et al. *Cont Lens Anterior Eye*. 2010;33:9-18. 2. Wilcox MDP et al. *Optom Vis Sci*. 2010;87:839.

## Uptake and release of biocides

- ▶ There are differences in the preferential adsorption/release profile of certain compounds<sup>1</sup>.
- ▶ Can lead to clinical side effects:
  - Expected increase in cytotoxicity with borate-based MPS (ex: OFR, Biotrue, Revitalens) solutions in vitro when compared with both phosphate-buffered saline (ex: Renu Fresh, Sauflon, Complete MPS) and borate-exposed lenses
  - Some exceptions can apply

Tanti NC, Jones L, Corbett MB, et al. *Optom Vis Sci*. 2011 Apr;88(4):483-92.

## Biocide release and discomfort

- Lens care products can change corneal staining and comfort responses during wear.
- These changes may be associated with release of material soaked into lenses or changes to the lens surface composition<sup>1</sup>.
- Could be related to time of desorption

Willcox MD, Phillips TJ, Gokkan J, Jalbert I, Meagher L, Gengenbach T, Holden B, Papas E. Optom Vis Sci. 2010 Nov;87(11):430-46.



## Andrasko, IER and others

- Lens/ solution interaction theory
- Had been linked to increased discomfort
- Had been described as
  - An alteration of the epithelial membrane permeability
  - A sign of cytotoxicity
  - A triggering factor for inflammation and infection

## Epithelial barrier function

- Its disruption is a known risk factor to develop MK
- Could be altered by hypoxia and mechanical impact of the lens on the eye
- Antimicrobial agents in the lens care solutions are intended to breach the cell walls of microbes and have the potential for cell membrane toxicity in the corneal epithelial cells
- Cell damage results in a loss of metabolic function and cell viability.

## Epithelial barrier function

- The current marketed contact lens MPS may have negative effects on human corneal epithelial viability and barrier function.
- Among 4 MPS studied, MPS A (AMO – Complete) maintains the cell viability and barrier function significantly better than other 3 marketed products (Alcon OFX, OFR and B&L Renu)<sup>1</sup>

Chuang ET, Chen Y, Chen F, Zheng X, Pflugfelder SC. Eye Contact Lens. 2008 Sep;34(5):281-6.

## Staining or cytotoxicity

- Cytotoxicity = alteration of the cell viability
- Translates an attack to cell membrane integrity
- Agents known with cytotoxic potential effects:
  - benzalkonium chloride, berberine chloride, and chlorhexidine<sup>1</sup>
- Solutions potential to induce cytotoxicity
  - SoloCare = Complete Comfort Plus < ReNu < OFX with Aldox<sup>2</sup>.
  - Does not match with Andrasko and IER results
- SOLUTION INDUCED STAINING SHOULD BE DIFFERENTIATED FROM CELL TOXICITY

1- Tabuchi N, Hattori T, Kato M, Koide M, Yamazaki H. J Toxicol Sci. 2012;37(3):639-43.  
2- Wright A, Mowrey-McKee R. J Ocul Toxicol. 2005;24(1):53-64.

## Cytotoxicity

Table 1: ETP is cytotoxicity direct contact test results

Rank	Material	Description of the Ranking Test
1	None	No toxicity observed in cells present
2	ETP	Low toxicity observed in cells present
3	ETP	Low toxicity observed in cells present
4	ETP	Low toxicity observed in cells present
5	ETP	Low toxicity observed in cells present

Figure 1. Effect of MPS-cycled Silly Contact Lenses on Cell Viability by direct contact assay

Solution	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Material	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

1. Bright FV et al. Poster presented at: The 6th Biennial Scientific Symposium of the Contact Lens Association of Ophthalmologists Education & Research Foundation, September 23-25, 2010, Las Vegas, NV. 2. Garafalo RJ et al. Eye Contact Lens. 2005;31:166. 3. Jones L et al. Optom Vis Sci. 2002;79:753. 4. Ward KW. Optom Vis Sci. 2008;85:8. 5. Andrasko QJ, Ryan KA. Rev Cornea Contact Lenses. March 2007;36. 6. Kisan J. Optometry. 2008;79:69. 7. Garafalo RJ et al. Cont Lens Anterior Eye. 2010;33:199. 8. FDA Ophthalmic Devices Panel meeting, June 10, 2008. Available at: <http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfAdvisory/details.cfm?msg=6699>. 9. Snyder C. Clin Refract Optom. 2005;16:1. 10. Sweeney DF et al. Cornea. 2002;21:435. 11. Korb DR, Korb JR. J Am Optom Assoc. 1970;41:233. 12. Barr JT et al. Cornea. 2006;25:14. 13. Sweeney DF et al. Poster presented at: 11th Annual Meeting of the British Contact Lens Association; May 29-June 1, 2008; Birmingham, UK.

## PATH = Preservative associated transient hyperfluorescence

When fluorescein dye is applied to the eye, it interacts with MPS preservatives released from soft contact lenses<sup>1,2</sup>

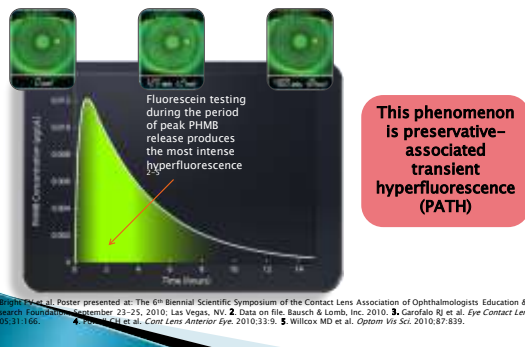
Fluorescein (negative charge) and MPS preservatives (positive charge) are attracted to one another<sup>1-8</sup>. The level of attraction depends on MPS preservative<sup>2</sup>

Fluorescein is attracted to PHMB up to 50x more strongly than to PQ-1<sup>2</sup>



MPS = multipurpose solution; PHMB = polyhexamethyl biguanide; PQ-1 = polyquaternium-1.  
1. Bright FV et al. Poster presented at: The 6th Biennial Scientific Symposium of the Contact Lens Association of Ophthalmologists Education and Research Foundation; September 23-25, 2010; Las Vegas, NV. 2. Data on file. Bausch & Lomb, Inc. 2010. 3. Blackburn RS et al. Langmuir. 2006;22:5630. 4. Daint M et al. Eur J Pharm Sci. 2008;33:138. 5. Kilvington S et al. Antimicrob Agents Chemother. 2002;46:2007. 6. Labbe A et al. J Ocular Pharmacol Ther. 2006;22:267. 7. Perez-Ruiz T et al. Chromatographia. 1998;48:263. 8. Powell CR et al. Cont Lens Anterior Eye. 2010;33:9.

## The Binding of PHMB and Fluorescein Results in a Benign, Transient Hyperfluorescence<sup>1,2</sup>



## Studies Show that Hyperfluorescence at the Time of Peak PATH is...

- NOT pathological corneal staining<sup>1,2</sup>
- NOT an indicator of cellular damage<sup>3-5</sup>
- NOT predictive of infiltrative keratitis or infection<sup>6-8</sup>
- NOT associated with future adverse events<sup>2,7,9,10</sup>
- NOT a measure of biocompatibility<sup>3-5,9</sup>



1. Garafalo RJ et al. Eye Contact Lens. 2005;31:166. 2. Ward KW. Optom Vis Sci. 2008;85:8. 3. Barrett RP et al. Invest Ophthalmol Vis Sci. 2006;45E:Abstract 5732. 4. Choy CK et al. Optom Vis Sci. 2009;86:E447. 5. Merchea MM et al. Invest Ophthalmol Vis Sci. 2008;49E:Abstract 4877. 6. Carnt N et al. Optom Vis Sci. 2007;84:309. 7. Carnt N et al. Contact Lens Spectrum. 2007;22:38. 8. Levy B, Orsborn G. Clin Refract Optom. 2006;16:165. 9. Timmons JJ. Presented at: The 2008 FDA Ophthalmic Devices Committee Meeting, June 10, 2008. 10. FDA Medical Devices Advisory Committee. Ophthalmic Devices Panel meeting, June 10, 2008. <http://www.fda.gov/ohrtm/obscet/minutes/2008-4363m1.pdf>.

## The Hyperfluorescent Activity Observed From PATH Is Different than Pathological Corneal Staining

### PATH

- Etiology likely due to benign preservative interactions<sup>1</sup>
- Generally asymptomatic<sup>2-4</sup>
- Surface phenomenon<sup>3,4</sup>
- Punctate (most commonly)<sup>1-5</sup>
- Resolution - within a few hours<sup>2,4,6</sup>
- Onset - within a few hours<sup>2,6,7</sup>
- Not associated with future complications<sup>4,8</sup>

\*Post-lens insertion

### Corneal Staining

- Etiology due to epithelial damage<sup>9</sup>
- Commonly symptomatic<sup>4,10</sup>
- Depth varies<sup>9</sup>
- Punctate to coalesced<sup>10</sup>
- Resolution - dependent on treatment and epithelial turnover rate; commonly several days<sup>11</sup>
- May or may not be associated with future complications<sup>12,13</sup>

\*Rarely micropunctate in pathological situations

## BUT....

- Hyperfluorescence theory can not explain why staining observed is not uniform across the corneal surface
- Does not explain why we can see altered epithelial cells without fluorescein
- Does not take in account the reduced tear flow under most of the lenses fitted.

1. Bright FV et al. Poster presented at: The 6th Biennial Scientific Symposium of the Contact Lens Association of Ophthalmologists Education & Research Foundation, September 23-25, 2010, Las Vegas, NV. 2. Garafalo RJ et al. Eye Contact Lens. 2005;31:166. 3. Jones L et al. Optom Vis Sci. 2002;79:753. 4. Ward KW. Optom Vis Sci. 2008;85:8. 5. Andrasko QJ, Ryan KA. Rev Cornea Contact Lenses. March 2007;36. 6. Kisan J. Optometry. 2008;79:69. 7. Garafalo RJ et al. Cont Lens Anterior Eye. 2010;33:199. 8. FDA Ophthalmic Devices Panel meeting, June 10, 2008. Available at: <http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfAdvisory/details.cfm?msg=6699>. 9. Snyder C. Clin Refract Optom. 2005;16:1. 10. Sweeney DF et al. Cornea. 2002;21:435. 11. Korb DR, Korb JR. J Am Optom Assoc. 1970;41:233. 12. Barr JT et al. Cornea. 2006;25:14. 13. Sweeney DF et al. Poster presented at: 11th Annual Meeting of the British Contact Lens Association; May 29-June 1, 2008; Birmingham, UK.



## Summary

- ▶ Andrasko grid / IER matrix observations are real but the significance and the meaning are still research questions
  - Not a true validation of lens/solution interaction
- ▶ Staining observed is not a sign of toxicity
- ▶ Staining observed is not hyperfluorescence
- ▶ Staining observed is not associated with mechanical causes neither hypoxia

What are we seeing on the cornea ?

## Corneal staining: a definition

- ▶ Pooling of fluoresceine visible under slit lamp
- ▶ Associated with a lack of surface integrity / break in the cells structure.
- ▶ Potential causes in contact lens wear:
  - Hypoxia
  - Trauma / Injury
  - Ocular Dryness
  - Infectious process (ex: viruses, bacterial ulcers)
  - Chronic Inflammation

Photo © Dr Langlois Michaud OD

## Solution induced corneal staining (SICS)<sup>1</sup>

- ▶ Recent studies show that corneal staining associated with contact lens solution is, in fact, penetration of fluoresceine within the epithelial cells membrane
- ▶ Associated with an epithelial cells apoptosis, NOT an epithelial loss, break or alterations of their tight junctions
- ▶ Its nature translates a challenge of the epithelial cells secondary to chronic exposure to chemicals.

Luermans D, Moxzzi A, Petropoulos C, Form D. Optom Vis Sci 2012 Jun;89(6):668-74.

## SICS

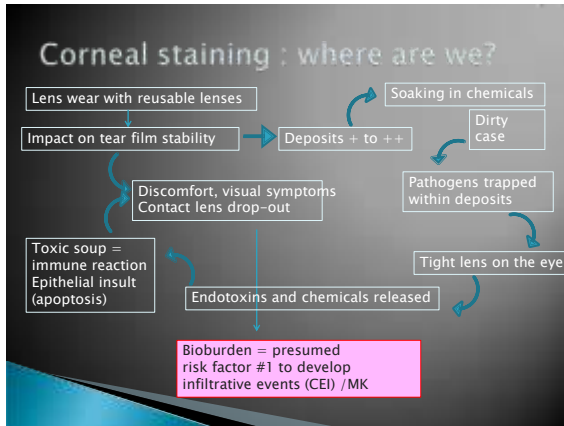
- ▶ This clinical occurrence IS NOT associated with the development of infiltrative keratitis (sterile)
- ▶ Its presence is not considered a risk factor for the development of further infections (MK)<sup>1</sup>
- ▶ Contact lens comfort IS linked with SICS presence<sup>2</sup> and CIE (infiltrates) occurrence
  - For certain combinations, not all.
    - PHMB-induced SICS does not produce high discomfort

1-Szczotka-Hyatt et al. Sathi A, Debanne S, Benetz BA, et al. Invest Ophthalmol Vis Sci. 2010 Nov;51(11):5421-30.  
2-Duc J, Evans VL, Tink J, et al. Hirst BH, Lazon de la Jara. Eye Contact Lens. 2012 Jan;38(1):2-6.

## SICS

- ▶ Corneal staining may facilitate endotoxin-tissue interactions and cytokine transportation through the tissue
- ▶ This mechanism amplifies endotoxin response leading to infiltrates
- ▶ SICS alone, in the absence of bacteria and endotoxins, is NOT associated with the development of sterile infiltrates





## Clinical implications

### ► To reduce SICS severity or its transient presence

- Reduce exposure to contact lens solutions
  - Switch to daily disposable
- OR
- Rub and rinse the lens before soaking <sup>1</sup>
- OR
- Switch solutions for hydrogen peroxide

Peterson RC, Form D. *Optom*. 2010 Dec;87(12):1030-6.



## Contact Lens-Associated Infiltrative Keratitis (CLAIK) and Multipurpose Solutions

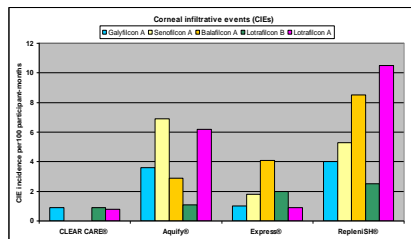
- Association between SiHy lens materials and infiltrates <sup>1</sup> or other adverse events <sup>2</sup>
- CLAIK presents as sterile with small, superficial, granular infiltrates and may or may not be accompanied by symptoms



Source: CL Spectrum -4/1/2011

1- Kislán, 2010; Szczotka-Flynn, 2007b  
2- Holden, 2001; Jalbert, 2001; Morgan, 2005b

Carnt NA et al. Contact Lens-Related Adverse Events and the Silicone Hydrogel Lenses and Daily Wear Care System Used. *Arch Ophthalmol*. 2009; 127 (12): 1616-1623<sup>1</sup>



Galyfilcon A = Advance; Senofilcon A = Clear; Balafilcon A = Purevision; Lotrafilcon B = O2Optix; Lotrafilcon A = Focus Night N Day

OPTI-FREE® Replenish® MPDS users had on average a 6% incidence per patient-month of CIEs. A hydrogen-peroxide-based solution, CLEAR CARE® Contact Lens Cleaning and Disinfecting Solution, had the lowest incidence of CIEs.

2012.02.01-CN615

## CLAIK

- Found with many lens/solution combinations
  - Senofilcon A / OFR (Sacco, 2011, Carnt, 2009; Diez, 2009; Hine, 2008; Kislán, 2010; Reeder, 2011)
  - Balafilcon A, Lotrafilcon B, Comfilcon A / OFR
  - Anecdotal cases implying OFX, Renu, private labels (Sacco, 2011)
- Not known before 2007
  - Cases increased with a wider use of SiHy
  - 2007 coincides with the launch of OFR
  - Market share of products do not explain association with SiHy
- Not related to staining nor hypoxia

DDX	First Experience with Contact Lens-associated Infection (CLAI) Infection Susceptibility (S.I.A.S.)	Traditional Cases of Infection Susceptibility (S.I.)	AE Substances
Age involvement	>80% bilateral	5% to 10% bilateral	Stasis, 1988; Smith, 1988; Condon, 1988; O'Neil, 1988; Manning, 1988
Number of infections	100% multiple, diffuse infections (some with high infection)	0% to 10% with multiple infections	Stasis, 1988; Smith, 1988; Condon, 1988; O'Neil, 1988; Manning, 1988
Appearance of infections	Conjunctiva, conjunctivitis, and grey opacities	Round, grey or white, subconjunctival, grey, white, cloudy, or amorphous opacities	Condon, 1988; Condon, 1988; Manning, 1988
Location of infections	>80% central or paracentral (some)	0% to 10% central periphery to 10% periphery	Stasis, 1988; Smith, 1988; Condon, 1988; O'Neil, 1988; Manning, 1988
Severity with regard to location	Severity independent of location	Lower severity toward periphery	Stasis, 1988
Significance	High to moderate (even for conjunctivitis in some cases)	High to moderate	Stasis, 1988; Manning, 1988; Manning, 1988
Course	Recurrent	Continuously present	Condon, 1988; Condon, 1988; Manning, 1988
Itching	Absent to >80% of cases	Absent to about 50%	Stasis, 1988; Manning, 1988
Duration	Only seen in all but a few cases	More common in advanced cases and also observed in early wear	Stasis, 1988; Smith, 1988; Condon, 1988; O'Neil, 1988; Manning, 1988; Manning, 1988
Also associated	Ulcerative keratitis (very low rates in hypergel lenses)	Hydrogel, silicone hydrogel	Stasis, 1988; Manning, 1988; Manning, 1988
Also seen (even with daily wear)	Multiple sub-epithelial keratitis	Multiple keratitis and other keratitis presentations	Stasis, 1988; Manning, 1988; Manning, 1988

Source: Sacco, A.J. CL Spectrum, Jan 21



## Essential elements

- ▶ To fit a lens that moves
- ▶ To eliminate bioburdens
- ▶ To minimize chemical exposure
- ▶ To allow oxygen permeability
- ▶ To favour user friendly products and a better compliance

## Daily disposable as the ultimate solution for contact lens wear

- ▶ Easiest and more convenient way to wear contact lenses
- ▶ Less associated with adverse effects or infections
  - No bacterial colonization
  - No deposits
  - No chemicals released in the eye every day
- ▶ Associated with higher compliance
- ▶ High DK (Si Hy, omafilconA, new hypergel-nesofilcon A) and UV protection available

## Conclusion

- ▶ The best solution is probably.... no solution !
  - At least for more susceptible and at risk wearers
  - If the cost is not an issue
- ▶ For others:
  - High profile of disinfection and efficacy
  - With a reduced level of uptake/release to maintain in case disinfection efficacy
  - Favours compliance (lens + case)
- + Lenses fitted have to move on the eye.