

Importance of Oxygen & Silicon Hydrogels

Session 1.7: Objectives

- To understand the importance of **oxygen** for healthy contact lens wear
- To understand the **patient response** to high levels of oxygen
- To understand the **ocular response** to varying levels of oxygen



Importance of Oxygen

- Areas to observe and engage with patient:

Redness

Discomfort

Poor Vision

Why the renewed interest in oxygen and corneal health?

- **A mounting body of scientific evidence demonstrates...**

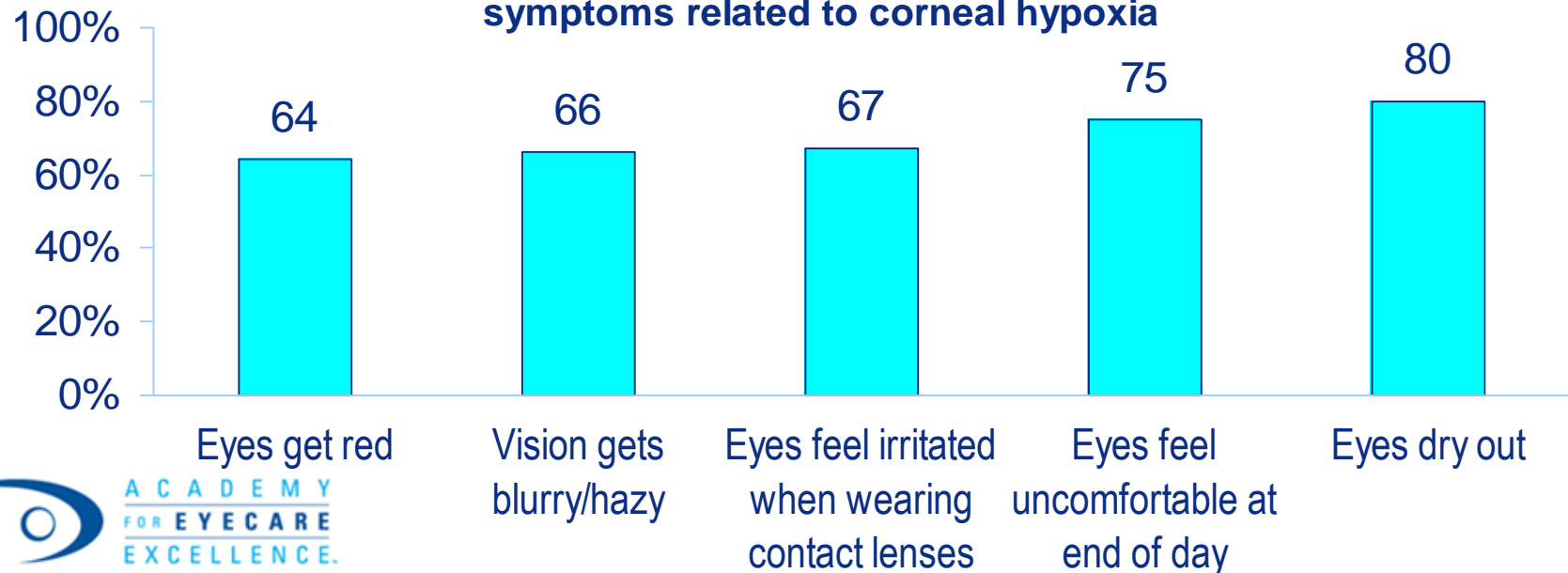
1. Sweeney, D.F. *Silicone Hydrogels: The Rebirth of Continuous Wear Contact Lenses*. Butterworth-Heinemann, 2000.
2. Ostrem E, Fink B, Hill R. A hypoxic response line model for the human cornea. *Br J Optom Disp*. 1996;4:53-55.

- A healthy cornea requires sufficient oxygen¹
- When the cornea is not sufficiently oxygenated, it can respond as if it were under severe hypoxic stress²
- Traditional low Dk/t soft contact lenses inhibit flow of oxygen and do not meet the oxygen requirements for healthy daily wear
- Provision of oxygen remains the driving force behind the development of new soft contact lens polymers
- New silicone hydrogel materials for daily wear are now available, setting a higher standard for all lens wear modalities

Corneal Oxygen Deficiency

- Insufficient oxygen can create a **cumulative stress** on the cornea
- 64-80% of patients report **symptoms** related to corneal oxygen deficiency*
- 94% of all patients report experiencing **one or more** of these symptoms*

Percentage of 1-2 week lens patients reporting symptoms related to corneal hypoxia

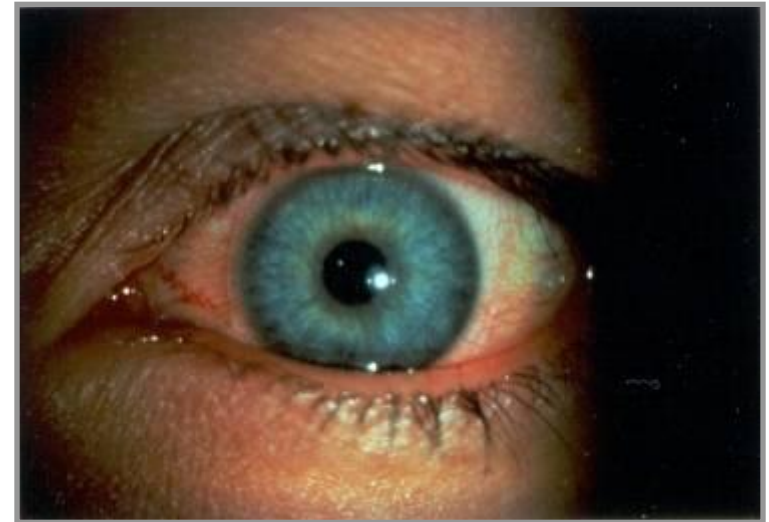


Clinical signs of corneal oxygen deficiency

Common signs include:

- Corneal edema
- Corneal staining
- Conjunctival injection, neovascularization
- Refractive error (0.50D or more myopic shift)
- Endothelial polymegathism, pleomorphism and decreased cell density

Eyes suffering from corneal oxygen deficiency



Dk/t = 125: The Magic Number?

- EW - corneal swelling equivalent to no lens¹
- EW - to avoid corneal anoxia²
- DW/EW - to avoid an increase in limbal hyperemia³
 - Implications for limbal stem cells
- DW/EW - to reduce bacterial binding⁴

1. Sweeney D (Editor). *Silicone Hydrogels*, 2000, page 93.
2. Harvitt DM, Bonanno JA. (1999): Re-evaluation of the oxygen diffusion model for predicting minimum contact lens Dk/t values to avoid corneal anoxia. *Optometry and Vision Science* 76(10):713-719.
3. Papas, E. On the relationship between soft contact lens oxygen transmissibility and induced limbal hyperemia. (1998) *Exp Eye Res* 67(2):125-131.
4. Ghormley R. (2005). How much oxygen is enough for safe lens wear? *Contact Lens Spectrum* March:19 2005-10-0547.

Oxygen: How Much is Enough?

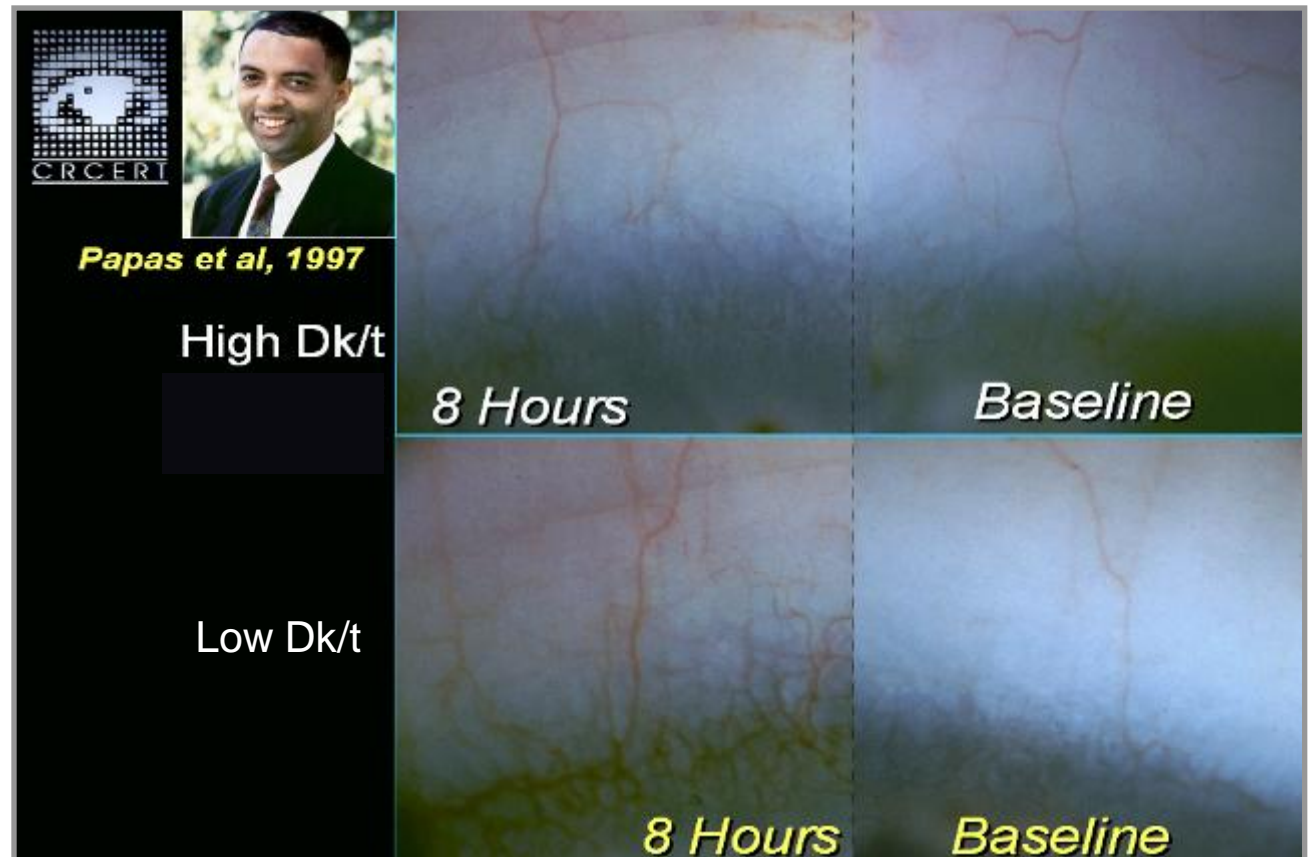
- Holden & Mertz¹ (1984)
 - Assuming 4.0% edema, min. Dk/t = **87** for EW
- Sweeney² (2003)
 - Assuming 3.2% edema, min. Dk/t = **125** for EW
- Harvitt & Bonanno³ (1998)
 - No stromal anoxia, min. Dk/t = **125** for EW

1. Holden BA. Mertz G. Critical oxygen levels to avoid corneal edema for daily wear and extended wear contact lenses. *Invest Ophthalmol Vis Sci* 1984;25:1161-7.
2. Sweeney DF. Clinical signs of hypoxia with high Dk soft lens extended wear: Is the cornea convinced? *Eye & Contact Lens* 2003;29(1S) S22-S25.
3. Harvitt DM. Bonanno JA. Re-Evaluation of the Oxygen Diffusion Model for Predicting Minimum Contact Lens Dk/t Values Needed to Avoid Corneal Anoxia. *Optometry and Vision Science* 1999;6:712-9.

Minimum Dk/t Guidelines: Limbal Hyperemia

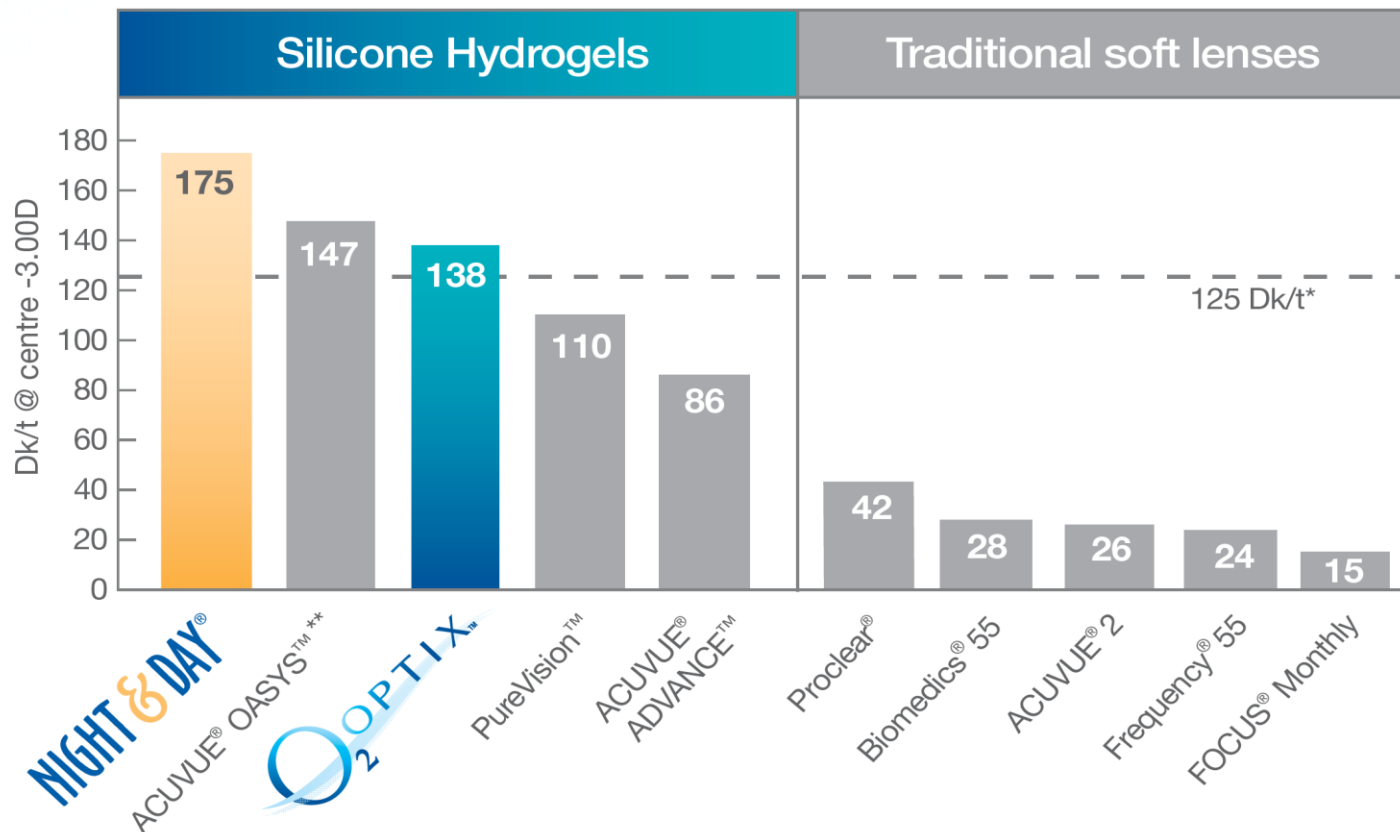
- **Papas** determined for DW and EW that a minimum Dk/t of **125** was needed to avoid **limbal hyperemia** which is a potential precursor to corneal neovascularization
 - Papas's work points out that the limbus is the only source of **stem cells** in the eye – with implications for the long term corneal health, growth and repair
- Papas, E. On the Relationship Between Soft Contact Lens Oxygen Transmissibility and Induced Limbal Hyperaemia. *Exp. Eye Res.*: 1998; 67:125-131.
 - Cavanagh, H.D., Ladage, P. Yamamoto, L. Li, S.L., Petroll, W.M., Jester, J.V. *Eye and Contact Lens*: 2003;29(1S):S14-S16.
 - Mueller, N. C., Caroline, P., Smythe, J., Mai-Le, K. and Bergenske, P. *Optometry and Vision Science*: 2001; 78(12S):199.

Limbal Redness in Daily Wear Low Dk: Precursor to Neovascularisation



A healthy cornea requires oxygen, lots of it.

- O₂OPTIX offers high oxygen transmissibility to help protect patients from the signs and symptoms of corneal oxygen deficiency, for whiter, healthy-looking eyes.
- Up to 5x more oxygen transmissibility than traditional daily wear soft lenses.¹



*A Dk/t level of 125 has been indicated by 4 independent researchers to be an important value for overnight wear.^{2,3,4,5} Not all lenses shown are approved for overnight wear.

**JJVC report Dk/t measured at -4.00D for OASYS™.

*CIBA VISION Data on file. 2005

What is Dk/t?

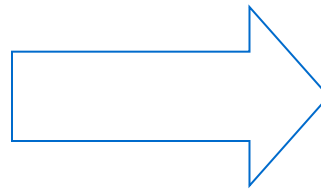
- Dk/t is the ISO (International Standards Organisation) approved measure to describe the **oxygen transmissibility** of contact lenses
- Dk/t is the only measure that has been correlated with real **clinical changes** (oedema, redness, pH shift, bacterial binding)
- Dk/t is a **practical** way to discriminate between lens oxygen performance in optometric practice

Remember the POINT:

Powers	Dk/t is at centre of -3.00 lens. Higher powers reduce Dk/t. Must fit high Dk lens material to stay above the minimum thresholds for oxygen transmissibility
Overwear	Many patients wear lenses 7 days a week for long hours
Individuals	... require different amounts of oxygen. No simple clinical test for oxygen requirement. Must fit above the minimum to cater for all patients
Napping	84% of contact lens wearers do it! DW patients frequently need EW levels of transmissibility
Thickness	... varies across a lens leading to lower Dk/t in the periphery than in the centre of a minus lens

Our Challenge

- The challenge that remains is for optometrists to embrace **silicone hydrogel** contact lenses and offer a growing base of wearers a healthy future



How do you currently treat signs and symptoms of chronic hypoxia and lens overwear?

“Take out your lenses earlier”
“Take a day off”
“Reduce you wearing time”



“It doesn’t fit with my lifestyle.”
“It’s a hassle!”
“I don’t want to”



Discontinue?



Non-compliance?

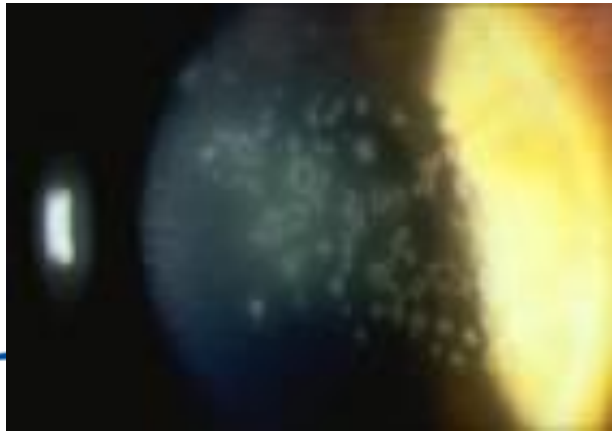
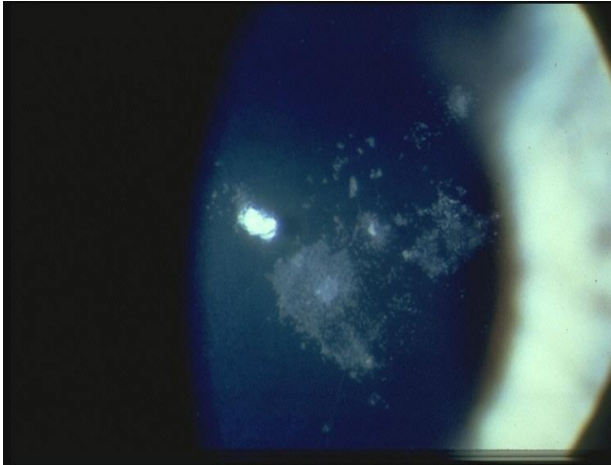
Corneal Insurance

- A lens with **increased oxygen transmissibility** - not a change in lens wearing schedule and/or water content - is the most effective means of dealing with oxygen-related issues!

Patients may not always show immediate, clinically visible signs of hypoxic stress, but practitioners *“must strive for long-term cornea insurance”* Hill, 1998

Ten Reasons to Fit Silicone Hydrogel Contact Lenses

Ten Reasons to Fit Silicone Hydrogel Contact Lenses



Complications in DW lenses is due to two large reasons

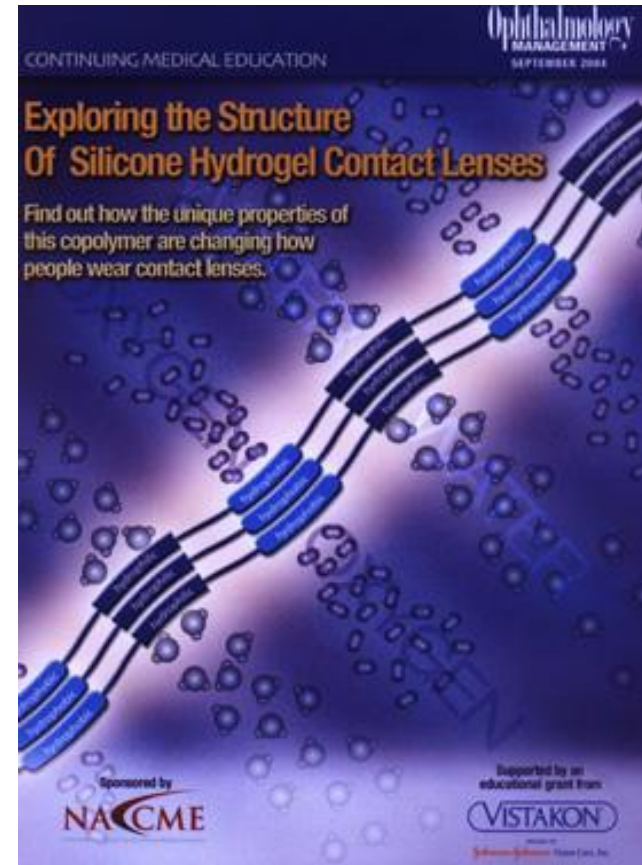
- Deposit Related-Non Compliance
- Hypoxia Related

Hypoxia

- Non Compliance- issues were taken care by frequent replacement
- Hypoxia-
 - Water Content
 - ↑ Oxygen in silicone hydrogels is silicone driven

REASON 1: THE PRESENT AND THE FUTURE

- Commitment of Companies towards silicone hydrogels to keep up with future
- 1970s

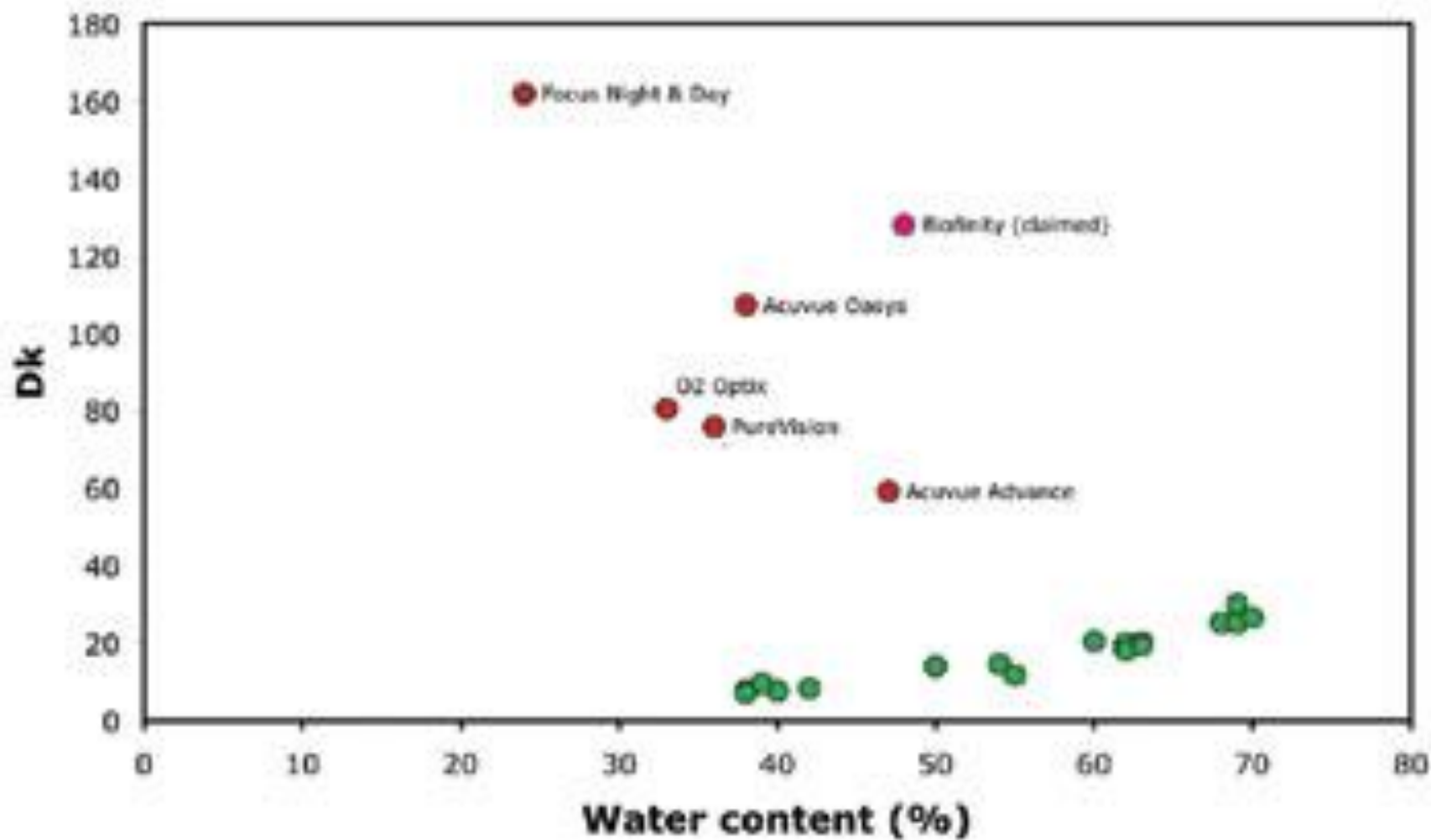


EDUCATION WITH VISION™

REASON 2: HIGHER DK VALUES

- Six times more oxygen than hydrogels
- Conventional materials rely on water content to increase Dk levels
- Increasing the water content in conventional or mid-water contact lenses increases the resultant Dk/t.
- Silicone hydrogel lenses, Dk/t climbs significantly as the silicone content
- The highest Dk/t material available is

lotrafilcon A



REASON 3: UNIQUE CORNEAS

- One cornea different from another is the amount of oxygen that it needs
- Some corneas surely do fine with Dks in the 20s or 30s
- Corneas with greater needs, however, don't fare as well.
- Patients with Corneal Exhaustion syndrome

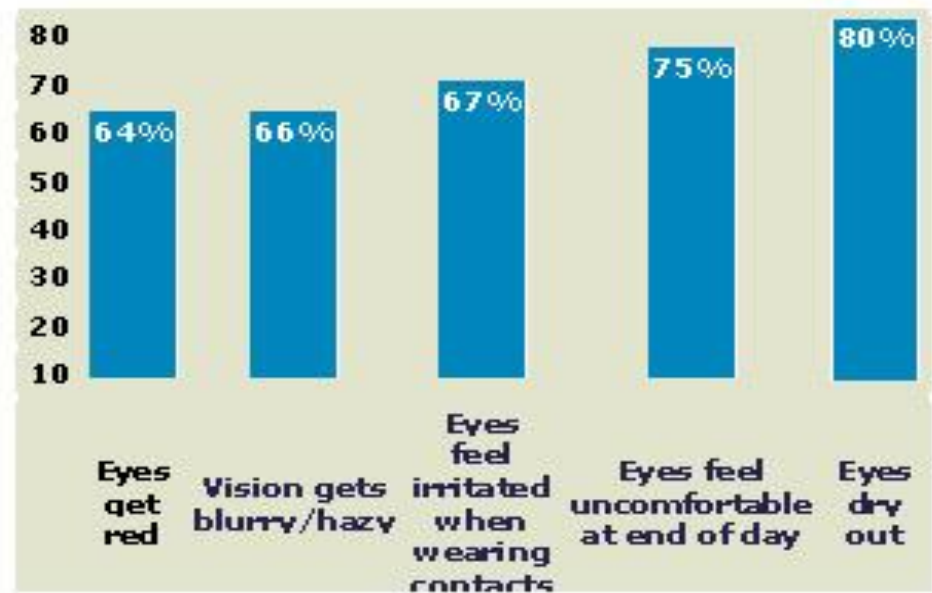


Figure 1. Symptoms related to corneal hypoxia and percentage of patients who experience them.

REASON 4: DK/t CONTROVERSY

- For lenses that have Dk/t of 50 or more, a law of diminishing returns applies.
- there is not much difference in terms of oxygenation between the two silicone hydrogel lenses [Night & Day and Pure Vision]." Although there is a 60% difference in Dk/t between lotrafilcon A and balafilcon (175 vs. 110), it only results in a 1% advantage in terms of corneal oxygen consumption.

REASON 5: SLEEPING IN LENSES

- According to a market data, 84% of soft contact lens wearers nap in their lenses, and one-third admit to doing so frequently or all the time.
- Twenty-five percent of patients wearing one- to two-week disposable-type lenses with low oxygen transmissibility occasionally or routinely sleep in their lenses overnight.
- Seventy-two percent of soft contact lens wearers said they prefer a schedule that includes overnight wear at least occasionally

REASON 6: WEARABILITY

- To make the surfaces of silicone hydrogel lens materials hydrophilic, techniques incorporating plasma into the surface processing of the lens have been developed
- The surfaces of Night & Day and O2Optix lenses are permanently modified in a gas plasma reactive chamber to create a permanent, ultrathin (25 nm), high-refractive index, continuous hydrophilic surface.

REASON 6: WEARABILITY *cont..*

- The Acuvue Advance lens material is the first non surface-treated silicone hydrogel and uses an internal wetting agent based on poly vinyl pyrrolidone (PVP).
- It's designed to provide a hydrophilic layer at the surface of the material to "shield" the silicone at the material interface, thereby reducing the degree of hydrophobicity typically seen at the surface of silicone hydrogels.



REASON 7: LESS DEPOSITION

- Historically, protein deposition has been a problem with contact lenses. Three major variables affect the development of deposits:
 1. Length of wear
 2. Individual tear chemistry
 3. Lens material.

REASON 8: LIFESTYLES

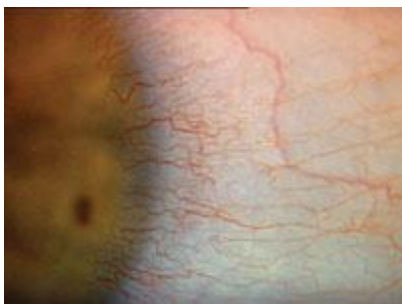
- Silicone hydrogels offer benefits that conventional lenses don't.
- Continuous wear contact lenses can prove especially useful for certain vocations or professions.
- Members of the emergency work force (medical personnel, fire fighters and the police) often work unpredictable hours and schedules.
- They may benefit from immediate clear vision on waking. Other shift workers may appreciate similar advantages.

REASON 9: DRYNESS PROBLEMS

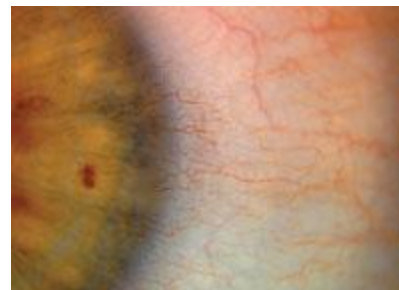
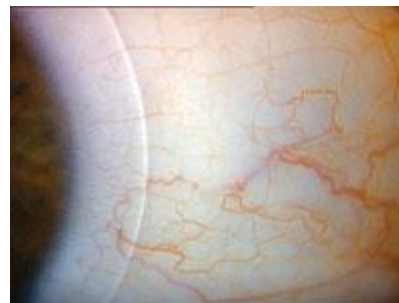
- End-of-day symptoms of discomfort and dryness often reported by mid-water lens wearers are significantly reduced for silicone hydrogels.
- In a recent study, Chalmers found that more than 30% of daily wear soft lens patients reported moderate to severe end-of-day dryness with their low-Dk lenses.
- After one week in silicone hydrogel lenses, only 13% reported that degree of end-of-day dryness.



With Hydrogels



Refitted with Silicone Hydrogels



REASON 10: IMPROVEMENTS

- More and more companies plan to jump into the silicone hydrogel fray, making increasing options available.
- Contact lens companies are looking at developing innovative silicone-based hydrogels, and the foreseeable future for this segment of lens materials looks promising.

Conclusion

- Corneal physiology and long-term eye health are paramount particularly with respect to busy lifestyles and the desire to wear contact lenses for longer periods during the day.
- Disposable option with Silicone Hydrogels and high oxygen transmission with the surface quality of PMMA is a dream come true for Contact lens practitioners

A Closer Look at THE AQUA MOISTURE SYSTEM



Introducing New AIR OPTIX™ AQUA

An advanced combination of:



OXYGEN

MOISTURE

*A New Level of Comfort^{†1}:
On Contact, All Day, Every Day
For a Healthy, Natural Feeling*



[†] Compared with AIR OPTIX™.
1. CIBA VISION, data on file, 2007.

Product specifications



Material:	lotrafilcon B
Water content:	33%
Handling tint:	light blue
Powers:	-1.00 to -6.00, 0.25D steps -6.50 to -10.00, 0.50D steps
Replacement schedule:	4 weeks
Diameter (mm):	14.2
Base curve (mm):	8.6
Center thickness (mm):	0.08@ -3.00D
Dk/t:	138@ -3.00D
Wearing schedule:	daily wear or up to 6 nights extended wear
Fitting:	no refit required for existing wearers of O2OPTIX™

Thank You