PREDICTABILITY OF DAILY DISPOSABLE CONTACT LENS ‘SUCCESS’ – A PRACTITIONER’S GUIDE

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INTRODUCTION

A group of experienced eye care practitioners was recently asked ‘what do practitioners expect from daily disposable contact lenses?’ The collective answer included specific lens features and benefits such as comfort, clear vision, positive effects on eye health, a handling tint, and easy-to-use packaging, amongst others. The question put back to the group was, ‘what do these features and benefits (which control to the patient’s experience of their contact lenses) provide to the practitioner?’ The unanimous response was ‘predictability’ (CIBA VISION, Practice Academy Consultant meeting, November 2010).

This article describes how developments in daily disposable contact lenses have lead to increasing success and predictability of performance.

Over the past decade, there has been a significant increase in the fitting of daily disposable contact lenses in the UK.1 Daily disposable contact lenses offer wearers increased convenience and reduced risk of complications associated with deposition and solution-related reactions. However, symptoms of ocular discomfort and ‘end of day’ dryness are still common, affecting around 70% of wearers,2 and are also associated with a greater likelihood of dissatisfaction and drop-out from lens wear.3 ‘Comfort enhanced’ daily disposable lenses have been designed to minimise the prevalence of dryness and discomfort amongst wearers and should also provide practitioners with the ability to ‘predict’ the likelihood of a successful outcome based upon the lens characteristics.

For eye care practitioners, choosing to prescribe a daily disposable contact lens is largely driven by the convenience offered for the patient, often in combination with various health and compliance considerations.1 4 In addition, the predictability of whether the patient is likely to succeed with a given lens type and modality of wear is something which is largely guided by the professional’s own previous experiences of the various lenses. As an example, amongst UK practitioners, daily disposable contact lenses are the preferred choice for teenage patients4 perhaps in part because it is easier to predict good compliance (no solutions or cleaning required) and the lower overall risk of complications.1 Additionally, the daily disposable modality typically helps alleviate concerns from parents too, with approximately 50% of parents expressing significant concerns regarding their child’s potential ability to follow instructions in taking care of the lenses and the potential for eye damage.5
The ‘success’ of a patient’s first experience of contact lens wear is governed by several important factors, including; ease of first insertion, whether or not they are nervous/anxious, initial impressions of comfort, stabilisation of vision, the patient’s ability to handle their lenses, and end of day comfort, to name just a few. To ensure the best possible outcome for patients, it is important for practitioners to understand a new wearer’s expectation of their contact lenses. This information, combined with clinical experience and knowledge of lens characteristics, should allow practitioners to make an initial lens selection that best predicts a patient’s likelihood to succeed with their lenses.

**What do patients expect from their contact lenses?**

Amongst non-contact lens wearers, fear of discomfort with contact lenses is the leading reason for staying with their spectacles only. It is not surprising that the most common reason for dropping out of contact lens wear is also discomfort, although dry eyes and reduced visual acuity (VA) are also common reasons.

In terms of predictability, and based on consumer market research, patients are most concerned that their contact lenses provide them with ‘crisp, clear vision’, a ‘comfortable and natural feeling’ and ‘good ocular health’ (Figure 1). This is in stark contrast with ‘ultraviolet protection’ and ‘overnight use’, which ranked lowest in terms of patients’ requirements from contact lenses.

With symptoms of discomfort affecting a significant proportion of all contact lens wearers, it is important for practitioners to be aware of the comfort characteristics of a given contact lens at the initial lens fitting stage and to effectively identify symptoms of dryness, discomfort and reduced wearer satisfaction during aftercare appointments.

**Is it possible to predict successful contact lens wear?**

Many investigators have attempted to identify clinical signs and symptoms that predispose patients to contact lens induced symptoms of discomfort.

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**Figure 1. Consumer requirements of their daily disposable contact lenses**

- Provides crisp, clear vision
- Feels comfortable and natural on your eyes
- Being healthy for your eyes
- Letting oxygen through to your eyes
- Helps to retain your eyes natural moisture
- Being easy to remove
- Being good value for money
- Helps you feel as if you don’t need a correction
- Easy to handle
- Is a trustworthy brand
- Resistant to deposit build-up
- Being low-priced
- Not requiring cleaning
- Ultraviolet (UV) protection
- Overnight use

Scale of importance (100% = High importance, 0% = Low importance)
and dry eye (CLIDE).\textsuperscript{8,10} A recent study, published by the Contact Lens and Anterior Eye Research (CLAER) Unit, Cardiff University, identified a novel method to predict CLIDE by combining specific ocular signs with subjective grading of symptoms.\textsuperscript{9} In particular, the appearance of lid parallel conjunctival folds (LPCOF) and decreased non-invasive tear break-up time (NIBUT) in combination with an abnormal score based on the ocular surface disease index (OSDI)\textsuperscript{©} questionnaire, was reported to provide a positive predictive value of 87\% and accuracy of 91\% for predicting dry eye / discomfort symptoms amongst new wearers.\textsuperscript{9}

Given the inter-individual differences in susceptibility to dryness / discomfort symptoms during contact lens wear, a one-size fits all approach to contact lens prescribing is unlikely to provide the best outcome to the greatest number of patients.

### What do practitioners think about dry eyes and contact lenses?

In a survey of European eye care practitioners, 92\% of respondents felt that, relative to spectacles, the contact lens wear experience should be like wearing no correction at all;\textsuperscript{4} the expectation of lens performance on the eye therefore appears to be understandably high. However, surprisingly more of the practitioners who took part in survey felt that ‘end of day comfort’ was more important for spectacles (33\%) than for contact lenses (26\%).\textsuperscript{4}

As highlighted by Riley et al.,\textsuperscript{11} practitioners should be aware of the disparity which exists (of approximately 1 to 1.5 hours) between the average duration of comfortable lens wear and the reported average total duration of contact lens wear (13 to 14 hours).\textsuperscript{2,11} In real terms, this disparity means that the majority of contact lens wearers will experience symptoms of discomfort towards the end of their wearing schedule and increases their likelihood of ceasing contact lens wear.\textsuperscript{3}

### The ocular surface and its mechanisms to prevent dryness symptoms

In the normal healthy cornea the epithelial cell layer has an uneven ‘rolling’ hill’ appearance when viewed under high magnification. Attached to this uneven surface are a group of large molecular mucins referred to as a glycocalyx (the ‘slime’ covering a fish is also a form of glycocalyx). The glycocalyx makes the surface of the cornea more wettable and allows the tears to spread more smoothly over the surface of the cornea. A second group of larger mucin molecules is secreted by the conjunctival goblet cells and dissolves in the tear film. The soluble mucin molecules interact with the epithelium bound glycocalyx to collect dust and debris, which enters onto the ocular surface from the surrounding atmosphere. The blink reflex serves an important role in mechanically sweeping large mucin molecules along with ocular debris away from the ocular surface. Following each blink, the ocular balance...
of the tear film is restored by the release of further soluble mucin molecules into the tear film. Thus, the ‘blink activated’ renewable surface of the cornea is vital for maintaining normal tear layer and ocular function.

The presence of a contact lens on the eye significantly disrupts the normal tear layer function due to the physical barrier created between the corneal epithelium and the eyelids. It is for this reason that symptoms and ocular signs of dry eye are a relatively common manifestation amongst contact lens wearers.2 Producing a contact lens materials which behaves in the same way as the natural corneal surface (biomimetic) has been the challenge of academia and the contact lens industry since contact lenses were first developed.

More recently the effectiveness of the ‘comfort enhancing’ contact lenses has been the subject of much research.12-15 Several of the large contact lens manufacturers (CIBA VISION, Duluth GA, Johnson & Johnson Vision Care, Inc, Markham, ON, Bausch & Lomb, Rochester NY) currently manufacture commercially available daily disposable contact lenses with claimed ‘enhanced comfort’. Interestingly, and in support of their claim, such ‘comfort enhanced’ daily disposable contact lenses have demonstrated effectiveness in reducing symptoms and biomicroscopic signs of dry eye amongst previously symptomatic re-usable daily lens wearers (replacement frequency of 1 to 4 weeks).16

Mechanisms of action of comfort enhancing daily disposable contact lenses

Four of the commercially available ‘comfort enhanced’ daily disposable contact lenses can be broadly categorised into three groups based upon their mechanism of action. The first group are poly-HEMA materials, which contain bound co-polymers specifically designed to retain water. For example, the 1-Day Acuvue Moist contact lens (Etafilcon A; Vistakon, Johnson and Johnson) uses polyvinyl pyrrolidone (PVP), which is permanently embedded within the Etafilcon A material to act as a ‘water holding’ agent and limiting the rate of lens dehydration during wear. The second group of comfort enhancing lenses are also poly-HEMA materials, but instead of embedding water retaining molecules within the lens, these materials are coated in lubricating additives that are found in the packaging saline in which they are stored. The SofLens daily disposable (Hilafilcon B, Bausch and Lomb) is one such example, and uses
a high water content material packaged in a saline solution that contains poloxamine; the lens surface becomes coated with poloxamine molecules, which are then gradually released into the tear film from the moment of lens application onto the eye.

The third group of contact lens materials are those that are made from polyvinyl alcohol (PVA). PVA is a water-soluble non-toxic (biocompatible) polymer, which is widely found in eye drops and contact lens solutions owing to its lubricating properties. Lenses that utilise PVA include Focus DAILIES All Day Comfort (Nelficon A, CIBA VISION) and Focus DAILIES Aqua Comfort Plus (Nelficon A Plus, CIBA VISION).

During the manufacturing process, not all of the PVA in the lens undergoes polymerisation, leaving some un-bound PVA within the lens matrix. Through the action of blinking, the un-bound PVA slowly releases from the lens into the tear film during lens wear, in a ‘timed release’ fashion. The comfort enhancing properties of Focus DAILIES Aqua Comfort Plus lenses are further enhanced by the addition of hydroxypropylmethylcellulose (HPMC), which is present in the packaging saline, and polyethylene glycol (PEG), which binds to the PVA prolonging its release. Both of these substances are ocular lubricants that are commonly found in artificial tear supplements.

**Method of manufacture – does it matter?**

To further understand the concept of ‘comfort enhanced’ contact lenses it is important to consider the method of manufacture of different contact lens types. Poly-HEMA materials are most commonly manufactured using a double-sided cast mould or spin casting process. During these processes a liquid HEMA monomer, along with cross-linkers and, in some cases, solvents, are placed into a mould of the desired lens geometry. The lens shape and geometry is created either by placing a ‘male’ mould on top of the chemical mixture, forcing the solution to spread between the two moulds to occupy all of the available space, or alternatively by attaching the ‘female’ mould to a spindle that rotates to create the lens geometry by virtue of centrifugal forces. Exposure of the mould contents to chemical polymerising agents causes the HEMA monomers to form cross-linkages and the liquid monomer is converted into a solid polymer. However, during the polymerisation process not all of the HEMA monomers are converted into a polymerised state. Since unpolymerized HEMA monomers are hazardous and potentially toxic to the ocular surface it is necessary to extract these toxic chemicals and solvents before the lens is packaged and ready for use.

Lenses that are made from PVA similarly undergo a process of polymerization using a cast moulding technique, but...
rather than using a chemical polymerizing agent, PVA undergoes polymerization when exposed to ultraviolet (UV) light. Transparent quartz moulds (Figure 2) allow UV light to pass through the moulds, converting the PVA into its polymerised form. Unlike HEMA, PVA both in its monomer and polymer form is biocompatible and hence there are no toxic by-products or solvents to extract from the lenses. Negating the need for an ‘extraction step’ during manufacture is a fortuitous characteristic of PVA due to the ocular lubricating properties of the unbound PVA monomers. These unique properties of PVA have led to the development of a unique and patented method of contact lens manufacture called Lightstream™ Technology (CIBA VISION Corporation, Duluth, GA).

Objective clinical performance of comfort enhanced daily disposable contact lenses

The subjective clinical performance of comfort enhanced daily disposable contact lenses continues to be a popular area of research; however, to date no single study has compared the performance of all of the currently available comfort enhancing daily disposable lenses. A limitation of subjective methods to assess lens performance is that the outcomes may be influenced by other characteristics of the lenses which don’t specifically relate to lens comfort, such as ease of handling, osmolarity of the packaging saline and the influence of brand awareness, amongst others. The objective performance of comfort enhanced daily disposable lenses was recently investigated by Wolffsohn et al.15 (see Optometry Today, 10th December 2010) who found that following intervals of wear of 8, 12 and 16 hours there was no difference in ocular surface temperature or bulbar redness between the aforementioned four lens types over the course of the 16hr wearing schedule.14 However, pre-lens tear break-up time was significantly and consistently more stable at the end of the day and throughout the day when patients wore lenses made of Nelficon A Plus (DAILIES AquaComfort Plus) and Nelficon A (Focus Dailies All Day Comfort).15

Conclusion

In real terms, the clinical performance of the currently available ‘comfort enhanced’ daily disposable contact lenses varies by manufacturer, intended mechanism of action, and method of manufacture.15 In order to maximise patient satisfaction, to better predict successful outcomes, and to establish preferences for initial lens selection, eye care practitioners should be aware of the differences in lens characteristics and manufacturing method, as well as the objective clinical performance of various daily disposable lenses.

About The Author

Dr Cameron Hudson is the Professional Services Manager for CIBA VISION, UK.
DAILIES AquaComfort Plus® offers superior tear film stability¹

Help your patients enjoy whatever the day brings

Blink-activated moisture release technology

© CIBA VISION (UK) Ltd, a Novartis company, 2011. 1. Wolffsohn J., Hunt O., Chowdhury A, Objective clinical performance of ‘comfort-enhanced’ daily disposable soft contact lenses, Contact Lens & Anterior Eye, 2010. Focus, DAILIES, AquaComfort Plus, PLUS, CIBA VISION, the DAILIES logo and the CIBA VISION logo are trademarks of Novartis AG. ACUVUE is a trademark of Johnson & Johnson Vision Care, Inc. SoFlo is a registered trademark of Bausch & Lomb. * DAILIES PLUS is the abbreviated name for DAILIES AquaComfort Plus
References


1. Which of the following combination of tests/clinical show 91% predictive accuracy for dry eye/discomfort symptoms amongst new wearers:
   a. Non-invasive tear break up time, ocular surface disease index and lid parallel conjunctival folds.
   b. Non-invasive tear break up time, Schirmer test and ocular surface disease index
   c. Schirmer test, ocular surface disease index and tear meniscus height
   d. Lid parallel conjunctival folds, non-invasive tear break up time and Schirmer test

2. According to market research which of the following are the three characteristics of contact lenses ranked by wearers as being most important?
   a. Providing clear vision, are comfortable and are healthy for the eye
   b. Are good value for money, easy to handle and provide clear vision
   c. Are low-priced, easy to handle and are comfortable
   d. Provide ultra-violet (UV) protection, are good value for money and healthy for the eye

3. Which of the following lubricating agents are utilised by Nelfilon A contact lenses
   a. Polyvinyl pyrrolidone (PVP)
   b. Polyethylene Glycol (PEG)
   c. Polyvinyl alcohol (PVA)
   d. Poloxamine

4. Which if the following statements about polyvinyl alcohol (PVA) is not true
   a. Contact lenses which incorporate unbound PVA exhibit sustained release of the moisturising agent during the lens wear lifetime
   b. PVA is biocompatible both in its monomer and polymer form
   c. PVA is used in many dry eye therapies due to its lubricating properties
   d. Unpolymerised PVA monomers must be extracted from the lens following polymerization

5. Which of the following lenses showed the least stable pre-lens tear break up time at the end of the day and throughout the day?
   a. Nelfilon A Plus
   b. Nelfilon A
   c. Etafilcon A
   d. Hilafilcon B

6. What proportion of existing contact lens wearers are reported to exhibit symptoms of discomfort during their wearing schedule?
   a. 20%
   b. 50%
   c. 70%
   d. 90%
# PREDICTABILITY OF DAILY DISPOSABLE CONTACT LENS ‘SUCCESS’

## MULTIPLE CHOICE ANSWERS

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