

Health benefits of daily disposable contact lenses

Jane Veys and Dr Karen French review the literature relating to clinical response to daily disposable wear compared to other wear modalities

THE INTRODUCTION OF daily disposable contact lenses onto the market represented a significant advance in contact lens technology. Following the launch of the world's first daily disposable lens, 1-Day Acuvue, by Johnson and Johnson in 1993 several other manufacturers entered the market and daily disposable lenses have increased in popularity. Since their introduction, the rate of prescribing has continued to increase in the UK and they currently represent approximately 44 per cent of all new soft lens fits¹ in the UK.

Daily disposables are perceived as having a wide range of benefits both for patient and practitioner. This modality of contact lens wear is convenient for the patient as it eliminates the need for daily cleaning and disinfection. The daily replacement of lenses eliminates the effects of lens ageing and surface deposition and as a result the patient can be expected to benefit from improved comfort and better vision. From a practitioner's point of view, single use encourages patient compliance, fitting of daily disposables is generally straightforward, and lenses are now available in a wide range of parameters and designs including toric and progressive lenses.

But do these perceived advantages of daily disposables actually lead to superior clinical performance and are there obvious health benefits associated with the use of

daily disposable lenses? And what exactly do we mean when we say 'health benefits'? This article reviews the literature to date and outlines those factors that need to be considered when monitoring the health of a contact lens wearer.

DEFINITION OF HEALTH

The Oxford English Dictionary defines health as 'the state of being free from illness or injury' and healthy as 'having or promoting good health'. More pertinently the *Physician's Desk Reference* (PDR) medical definition of health is 'the state of the organism when it functions optimally without evidence of disease or abnormality; a state characterised by anatomical and physical integrity'. When taken in the context of wearing contact lenses these definitions of health and healthy could be used if there were no significant adverse events arising from the lens wear. Furthermore, minimising any risk of allergy, eliminating any potential solution sensitivity and providing ultra-violet protection may also be considered under the banner of health benefits.

The symptoms reported and slit lamp signs observed during the examination of a contact lens wearing patient (Table 1) can be used as health indicators and the absence of any of these signs and symptoms can be considered as a measure of health.

TABLE 1	
Symptoms and slit-lamp signs associated with soft contact lens wear that can be used as potential indicators of health	
Symptoms	Signs
Reduced/variable vision	Lens deposition
Lens awareness	Reduced lens wettability
Foreign body sensation	Conjunctival injection
Itching	Superficial punctate keratitis
Redness	Papillae
Burning	Conjunctivitis
Lacrimation	Neovascularisation
Mucus	Oedema
Photophobia	Non-staining infiltrates
Pain	Peripheral ulcers (<1mm)
	Paracentral/central lesions (>1mm)
	Anterior chamber reaction

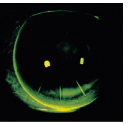
TABLE 2	
Some potential complications of soft contact lens wear	
Lens surface deposition	
Hypoxia	
Oedema	
Neovascularisation	
Superficial punctate keratitis	
Contact lens induced papillary conjunctivitis	
Corneal infiltrative events:	
Infiltrative keratitis	
Contact lens peripheral ulcer	
Microbial keratitis	

POTENTIAL ADVERSE EVENTS FROM SOFT CONTACT LENS WEAR

Potential adverse events from soft contact lenses wear are well documented² and are listed in Table 2. Some of these complications are described in more detail.

Lens surface deposition

After a period of wear, a contact lens will have different surface characteristics from those on initial insertion. It will adsorb proteins, lipids and other components from the tear film almost as soon as it is inserted into the eye. Over time denatured protein deposits and lipid contamination can accumulate on the contact lens surface. It is these deposited tear components that can affect the success or otherwise of soft contact lens wear. It has been estimated that as much as 80 per cent of the clinical problems relating to soft contact lens wear can actually be attributed to the deposition of tear-derived constituents on the surface of the lens.³ These clinical problems include reduced visual acuity, comfort and wettability and increased immunological responses such as contact lens-induced papillary conjunctivitis (CLPC) and corneal infiltrative events, such as non-severe infiltrative keratitis and severe infectious keratitis. The need to reduce the complications arising from lens spoliation has resulted in the domination of frequent replacement lenses in the current contact lens market. However even with the reduced clinical problems, increased subjective performance and fewer unscheduled aftercare visits associated with frequent lens replacement modalities it is still possible for tear-lens interactions and associated reduction in performance to be apparent.



Contact lens-induced papillary conjunctivitis (CLPC)

This condition primarily affects the upper tarsal conjunctiva and has a multifactorial aetiology. It is described as an allergy-like reaction to lens contamination, especially to protein deposition on the lens surface. Mechanical trauma has also been indicated as a causative factor. Early symptoms of CLPC include discomfort towards the end of the day during lens wear, possibly accompanied by itching. There may be an increased production of mucus, especially first thing in the morning, and the vision may be variable as a result of the mucus smearing across the front surface of the lens. In the more advanced stages the vision can become variable as a result of excessive lens movement on blinking. The discomfort and itching is more severe and the patient may have to remove the lens earlier than usual as a result of decreased tolerance. The signs of CLPC can only be observed if the upper lid is everted. Initially there may be increased roughness of the upper tarsal conjunctiva and increased hyperaemia. In severe cases papillae will be as large as 1mm in diameter and there is marked hyperaemia. There may also be conjunctival oedema and mucus strands lying in between the papillae.

Corneal infiltrative events (CIE)

The term corneal infiltrative event is used by some researchers to encompass a variety of different forms of keratitis.^{4,5} This approach covers a range of severities from non severe infiltrative keratitis to severe microbial keratitis.

Infiltrative keratitis (IK)

Infiltrative keratitis is an inflammatory reaction of the cornea, with multifactorial causes including foreign body and trauma. Many cases are reported to be due to the release of exotoxins from gram-positive bacteria found on the lid margins. Symptoms vary in severity and may include mild to moderate irritation, mild hyperaemia, lacrimation and photophobia, although the patient is often asymptomatic. Examination may reveal moderate bulbar and limbal hyperaemia and diffuse or small focal infiltrates usually in the peripheral cornea close to the limbus.

Contact lens peripheral ulcer (CLPU)

This is an inflammatory response to toxins released by gram-positive bacteria on the surface of a contact lens, resulting in the formation of an isolated peripheral infiltrate. Symptoms include mild to moderate pain, lacrimation and photophobia. Signs are typically a single circular lesion of the peripheral or mid-peripheral cornea at anterior stromal level. The infiltrate stains with fluorescein

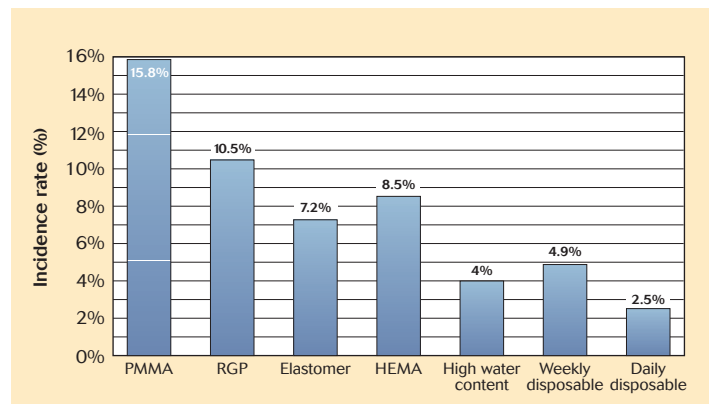


FIGURE 1.
Incidence
of clinical
complications
associated with
different lens
wear modalities
(Hamano et al
(1994))

and there is rarely any anterior chamber reaction.

Microbial keratitis (MK)

The most serious complication associated with contact lens wear is microbial keratitis. Fortunately the incidence of MK is low as a healthy ocular surface has many defence mechanisms to combat infection. However MK can arise due to direct infection by bacteria, virus, fungus or amoeba. In order for this to occur there must be some compromise to the normal ocular surface defence mechanisms. Symptoms of MK include increasing, often severe pain, excessive lacrimation and progressively increasing discharge. There will be marked conjunctival injection and possibly lid oedema. Examination reveals a central to paracentral lesion that is often irregular in shape and can be >1mm. There is staining of this lesion and its depth can reach mid-stromal level. There is characteristically flare in the anterior chamber and in severe cases there may also be hypopyon.

COMPARISONS OF DAILY DISPOSABLE CONTACT LENSES WITH OTHER LENS WEAR MODALITIES

There have been several clinical studies investigating the performance of daily disposable lenses in comparison with other lens wear modalities. Each of these studies use some or all of the health indicators presented in Table 1 as a measure of lens performance. One of the first such studies was published by Hamano *et al* (1994).⁶ They conducted a three-month study involving 23,068 patients and investigated the rate of clinical complications associated with a variety of lens wear modalities. This included conventional soft lenses, a daily disposable soft lens, an extended wear soft lens worn continuously for one week, and also PMMA and RGP lenses. The incidence rate of clinical complications was calculated for each type of lens (Figure 1). It can be seen that a significantly lower rate of clinical complications were noted for the daily disposable lens wearers than for other lens modalities. It was concluded that there was statistical

confirmation of the clinical usefulness of the daily disposable lens modality and the authors predicted this to be the most ideal modality for the reduction of corneal complications.

Nilsson and Söderqvist (1995)⁷ carried out a three-month study investigating the performance and clinical complication rate associated with daily disposable lenses. The study involved 31 myopic patients, 20 of whom had previously worn conventional soft contact lenses. The other 11 patients were new to contact lens wear. Each of these patient wore the daily disposable lens every day for a 12-week period. Among the group of 11 neophyte contact lens wearers, no new complications were noted over the 12-week period and in the 1 case where tarsal abnormalities were noted prior to fitting, these abnormalities did not change. Of the 40 patients who had previously worn conventional soft contact lenses, no new complications were noted. Pre-existing tarsal abnormalities reduced from 20 per cent to 0 per cent and conjunctival injection from 23 per cent to 0 per cent following 12 weeks of daily disposable wear. Subjective symptoms of dryness or burning reduced from 35 per cent to 5 per cent. The study concluded that daily disposable wear was an attractive modality with a reduced complication rate compared with other lens modalities. No signs of complications or ocular stress were noted in association with daily disposable wear and subjective assessment of comfort and visual acuity was good.

The results of these two early studies suggest that there are definitive health benefits associated with daily disposable lenses in comparison with conventional soft lens wear, however neither study included the now more common lens modality of frequent replacement lens wear.

Solomon *et al* (1996)⁸ carried out a three-year study comparing daily disposable lenses not only with conventional soft lenses but also with frequent replacement lenses designed to be changed at two-week, one-month or three-month intervals. A total of 229 patients completed the study and data were collected relating to the subjective performance of the lenses as well as noting

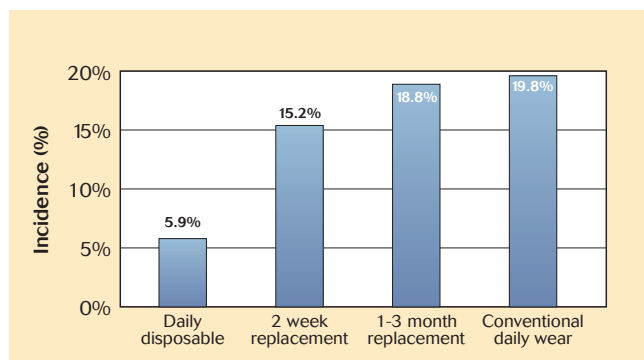
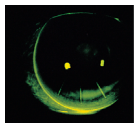


FIGURE 2a. Incidence of clinical complications associated with different lens wear modalities (Solomon et al 1996)

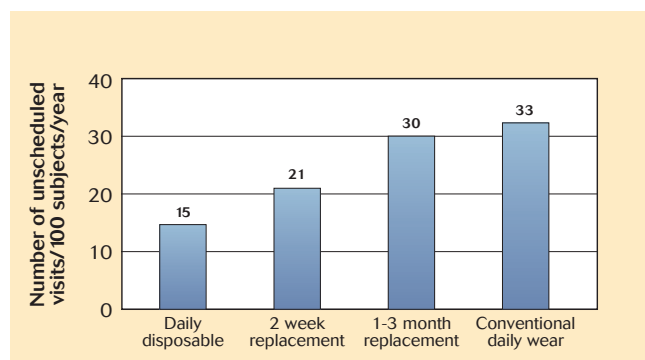


FIGURE 2b. Number of unscheduled aftercare visits per 100 subjects per year for different lens wear modalities (Solomon et al 1996)

any clinical complications. Although most of the data were collected at scheduled visits, further information was obtained about the number of unscheduled visits in each category and the complications that led to these visits. The results generally supported the hypothesis that contact lens performance improves as replacement frequency increases, with daily disposables being the ultimate modality. Figure 2a shows clearly that the complication rate associated with daily disposable lenses in this study was lower than the other modalities. Similarly the number of unscheduled visits was significantly less (Figure 2b). The authors concluded that in comparison to both conventional lens wear and frequent replacement modalities, daily disposable lens wearers:

- ◆ Reported fewer symptoms
- ◆ Reported better vision, comfort and overall satisfaction
- ◆ Had fewer surface deposits, complications and tarsal abnormalities.

They therefore suggested that daily disposable lens wear was probably the most trouble free way of wearing contact lenses.

A similar three-year study (Suchecki et al (2000)⁹ determined the incidence of contact lens related complications in a variety of soft contact lens wear modalities. One hundred and thirty-eight patients were included in the study and the rate of lens related complications was expressed as events per person per year (E/P/Y). They found that daily disposable lens wearers had the lowest E/P/Y and the lowest overall incidence of lens related complications for any of the soft lens modalities (Figure 3).

Parazinski and Donshik (1999)¹⁰ carried out a retrospective study of 47 contact lens wearers who had been wearing frequent replacement contact lenses to determine the incidence of contact lens associated papillary conjunctivitis (CLPC) and to assess the potential risk factors that may predispose a frequent replacement lens wearer to develop CLPC. They concluded that patients replacing their contact lenses at intervals of 4 weeks or greater

had an incidence of CLPC of 36 per cent, which was considerably higher than the incidence of 4.5 per cent amongst patients who replaced their lenses on a one-day to three-week basis.

Sankaridurg et al (2003)¹¹ compared the adverse events presenting among daily disposable lens wearers with a control group of spectacle wearers. Two hundred and eighty-one myopes with no previous contact lens wear experience were enrolled in the study. The adverse events were categorised as serious, significant or non-significant based on severity on presentation, level of clinical concern and potential threat to vision. They found that there were no serious events in either group. They also found that while the incidence of adverse effects was higher in the contact lens wearing group than the spectacle wearing group, the incidence of adverse events with daily disposable wear was very low. They concluded that this was extremely encouraging for the daily disposable modality of lens wear.

Allergy sufferers who wear contact lenses may show complications including conjunctival injection, corneal staining and lid roughness or papillae, as well as reduced comfort and vision. Hayes et al¹² (2003) found that slit lamp findings among this category of lens wearer improved following one month wear of a daily disposable lens in comparison with their habitual lens. Comfort was also significantly greater with the daily disposable lens. The authors concluded that the use of daily disposable lenses was an effective strategy for managing allergy-suffering contact lens wearers.

Patients who report dry, sensitive or easily irritated (DSEI) eyes are a particularly challenging group, however a study by Schnider et al¹³ reported that daily disposable lenses, in particular 1-Day Acuvue, provided an effective option for minimising the symptoms of irritation and dryness.

Microbial keratitis is a rare but significant and potentially sight threatening complication of contact lens wear. Several studies have been carried out over the last 15 years comparing the incidence of MK with different lens wear modalities. These are summarised in Table 3. Although many of these studies were carried out before the widespread popularity of the daily disposable wear modality, all studies highlighted the lower risk of MK associated with daily wear hydrogel lenses in comparison to extended wear hydrogel lenses. Morgan et al (2005)⁵ carried out a UK study of the incidence of keratitis among contact lens wearers, including daily disposable wear as a modality. They reported a lower number of corneal infiltrative events associated with daily disposable wear in comparison with other soft contact lens wear and calculated a relative risk factor of 0.8, compared with daily wear hydrogels with a relative risk of 1.0. Stapleton et al (2005)¹⁴ carried out a different study investigating the incidence of contact lens related keratitis. They found that the annual incidence of moderate to severe MK per 10,000 wearers was significantly lower for daily disposable wear than daily wear hydrogel and similarly that daily lens wear carried much lower risk than extended lens wear. It is inappropriate to draw any comparisons between any of

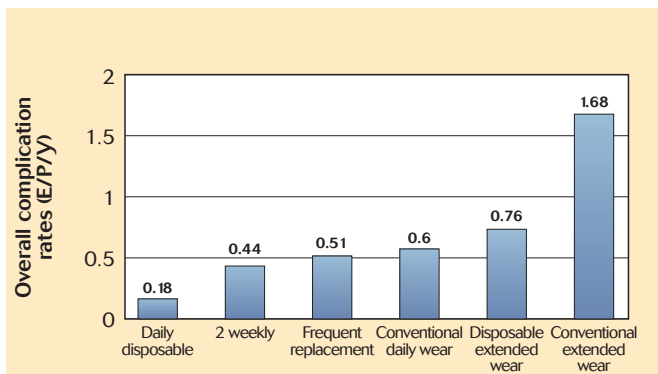


FIGURE 3. Overall complication rates associated with different lens wear modalities (E/P/Y = events per person per year (Suchecki et al 2000)

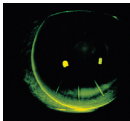


TABLE 3
Annual incidence of microbial keratitis from a range of publications highlighting the low annualised incidence of keratitis associated with daily disposable wear

Author	Year	Country	DW RGP	DW hydrogel	EW RGP	EW hydrogel	Daily disposable hydrogel
Poggio <i>et al</i> ²⁰	1989	US	4.0	4.1		20.9	
MacRae <i>et al</i> ²¹	1991	US	6.8	5.2	18.2	23.9	
Benjamin ²²	1991	US	1.1	2.1	4.2	8.8	
Nilsson ²³	1994	Sweden	1.2	0.5		3.1	
Cheng <i>et al</i> ²⁴	1999	Netherlands	1.1	3.5		20.0	
Morgan <i>et al</i> ⁵	2005	UK	2.9	6.4	0	96.4	4.9
Stapleton <i>et al</i> ¹⁴	2005	Australia		3.1		11.7	0.9

these studies due to differences in definition of keratitis and methodologies used.

It is interesting to note that in the study of Morgan *et al* (2005)^{5,3} of the patients wearing daily disposable lenses who presented with a corneal infiltrative event admitted to sleeping in their lenses prior to presenting at hospital with a problem. This raises the importance of patient compliance and the effect that this may have on complications associated with contact lens wear.

Over the last 30 years, research into non-compliance has increased, and many factors which may account for non-compliance have been proposed. Studies have shown that anywhere from 40 to 91 per cent of contact lens wearers show some level of non-compliance with their care regime.¹⁵ Sokol *et al*¹⁶ (1990) used the Health Belief Model in a study of patient compliance among contact lens wearers. This model describes how patients are more likely to be compliant if they follow certain beliefs regarding medical conditions and demonstrates that the fewer the steps in a process, the better the compliance. It is generally believed that the single use of contact lenses

promotes compliance.¹⁷ Another recent study included an evaluation of the level of compliance with different lens wear modalities.¹⁸ A survey of more than 1000 successful soft contact lens wearers found that daily disposable lens wearers were more likely to be compliant with the single use instruction (98 per cent) compared to those who replaced their lenses at two or four weekly intervals (89 per cent).

UV protection

When considering the impact of contact lens wear on ocular health it is also important to take into account any protection that may be offered by the contact lens. There is now widespread awareness of the dangers of excessive exposure to the sun and increasing evidence of the harmful effects of ultra-violet radiation (UVR) on the eye. A UV blocker incorporated into a contact lens material will cover and protect the cornea, limbus and internal ocular structures as well as protecting against peripheral and obliquely incident radiation. Several daily disposable lenses on the market today include UV blocking. The Johnson & Johnson products

have been shown to block at least 99 per cent of UVB and 86 per cent of UVA radiation.¹⁹

Table 4 summarises some of the potential health related indicators and highlights the clinical performance of daily disposable contact lenses in comparison to reusable contact lenses.

CONCLUSIONS

It is widely perceived that daily disposable lens wear offers many benefits to the contact lens wearing patient. These benefits include convenience, increased comfort and increased vision. A review of the published literature also highlights evidence that daily disposable lenses represent a healthier way to wear contact lenses. More recent technology that allows the addition of wetting agents to hydrogel materials is also allowing improvements in end of day comfort.

Studies have shown that there is a trend to reduced adverse events associated with daily disposable wear and also that there are fewer unscheduled aftercare visits. However, it is important not to neglect patient education. Daily disposable contact lens wearers should be reminded regularly of the risks of re-using daily disposable lenses and of wearing non-disinfected lenses to ensure maximum compliance and to minimise the risk of infection. Vigilance with hand washing and drying, avoiding lens wear when ill and the need for regular aftercare visits should be discussed. As with all contact lens wearers, it should never be forgotten to instil the importance of seeking professional help at the onset of any redness, marked discomfort or reduced vision.

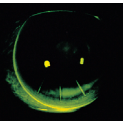
It is interesting to note that signs of hypoxia have not been observed as a significant complication of daily disposable lens wear in any of the studies reviewed. However in conventional hydrogel materials over-wear of lenses even on a daily disposable basis can potentially induce signs of hypoxia. Silicone hydrogel technology has advanced significantly over the last few years with newer products allowing both increased oxygen delivery to the cornea, as well as improved comfort compared to hydrogel lenses and first generation Silicone hydrogel lenses. With this in mind we may one day look forward to the benefits of a daily disposable lens in a silicone hydrogel material.

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TABLE 4
List of the potential health-related indicators of daily disposable contact lenses as compared to conventional and frequent replacement hydrogels

More convenient
Improved compliance
Lower incidence of overall complications
Lower incidence of unscheduled visits
Fewer deposits
Improved vision
Preferred and better comfort at end of day
Eliminates risk from potential case contamination
Lower incidence of CLPC
Improved comfort for allergy sufferers
Reduced slit lamp findings (allergy sufferers)
Improved comfort in patients with DSEI
Lower incidence of MK
Better UV protection (or equal in the case of frequent replacement)



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