



**W**hen Professor Otto Wichterle produced the first wearable soft contact lenses in 1961 using a Meccano set and the generator from his son's bicycle, he had already considered how long each lens would last and how often it should be replaced. Asked what should be done with the lenses when they were dirty, Wichterle would simply say throw them away.<sup>1</sup> Fifty years later, contact lens manufacturing and materials may be a world away from those early days of soft lenses, but the optimum replacement interval for Wichterle's pioneering invention still provokes debate.

The original soft lenses were replaced when damaged, lost or spoiled such that they became uncomfortable and vision deteriorated. Depending on the patient, disinfection system and lens material, replacement intervals could be as long as two to three years although, as soft lenses became more widely prescribed, some practitioners began to introduce their own replacement schemes based on their clinical experiences of lens life.<sup>1</sup>

The industry's concept of planned or frequent replacement for soft contact lenses first emerged in 1985 with a three-monthly replacement scheme. It was in 1988, when the Acuvue lens was first introduced to the UK, for weekly replacement, that 'disposable' became the accepted term for these lenses. In the late 1980s, more two-weekly and weekly options emerged, whether for daily or extended wear.

With a variety of replacement schedules available, researchers studied the relative merits from a clinical standpoint. Literature reports of the benefits of frequent replacement and disposability over unplanned replacement are extensive, and centre primarily around the influence on lens deposits and their impact on clinical performance.

Several early studies demonstrated the clinical benefits of replacing lenses at least monthly. With high water content hydrogel lenses, front surface wettability is better maintained and lens deposits decrease if lenses are replaced monthly rather than every three months.<sup>2</sup> Replacing lenses every month or more frequently maintains performance throughout the period of use, whereas increasing the replacement interval to three months leads to a significant loss of performance.<sup>3</sup>

Other studies also support the choice of two-weekly over monthly replacement for clinical reasons. As

# The long and the short of soft CL replacement

The optimum replacement interval for soft contact lenses has been debated since the first hydrogel lenses emerged almost 50 years ago. **Anna Sulley** and **Sheila Hickson-Curran** review the background to this debate and the latest research findings



Garlo/Phanie/Rex Features

Replacement frequency also appears to be a factor in developing papillary changes. Patients on a one-day to three-week replacement cycle with hydrogel lenses had a significantly lower risk of developing contact lens associated papillary conjunctivitis (CLPC) than patients who replaced their lenses at longer intervals.<sup>8</sup>

That 'fresher is better' when it comes to soft lens replacement interval was therefore evident from the early days of planned replacement and disposability. And although some specialist lenses were still replaced less frequently, the most commonly prescribed hydrogel lenses came to be replaced at intervals of one month or less.

## Daily disposables debut

In 1995, the introduction of the first daily disposable lens offered the simplicity and convenience of contact lens wear free from cleaning and disinfection and led to comparisons of clinical performance with other modalities.

When re-fitted with a daily disposable lens, conventional daily wear users showed improved vision, comfort, symptoms, slit-lamp findings and overall satisfaction.<sup>9</sup> The incidence of corneal complications with lenses replaced daily was lower than with other lens types, including gas-permeable lenses.<sup>10</sup> Daily disposables were shown to have the lowest overall complication rate of soft daily wear modalities and the complication rate to rise as the replacement interval increased.<sup>11,12</sup>

More recently, the relative incidence of more serious complications with different modalities has been the subject of further research. In the UK, a study in Manchester showed that daily disposable users had the lowest incidence of non-severe keratitis of all soft lens types.<sup>13</sup>

Other studies by Stapleton and Dart<sup>14,15</sup> did not find a lower risk of microbial keratitis (MK) compared to other soft daily wear lenses. However,

## How often should wearers replace their contact lenses?

early as 1980, it was suggested that disposing of lenses either weekly or two-weekly could help to minimise lens deposits that adversely affect patient comfort.<sup>4</sup> Later, protein and lipid deposits on Group II lenses were shown to increase progressively over four weeks' wear.<sup>5</sup>

A survey of more than 1,000 soft lens wearers found fewer dryness symptoms and end-of-day discomfort with two-weekly replacement lenses than with monthly lenses.<sup>6</sup> Comfort at replacement was the same with daily disposable and two-weekly lenses and both were significantly more comfortable at replacement than monthly lenses. Other authors showed that two-weekly replacement lenses, when combined with a multi-purpose solution, provide better patient comfort and satisfaction than other, monthly replacement lenses.<sup>7</sup>



of those daily disposable users presenting with MK, about half (52 per cent) admitted to at least occasional overnight wear,<sup>14</sup> a major risk factor for MK. Also, the daily disposable modality seemed to be associated with the lowest risk of severe MK, although there was a difference in relative risk noted between brands.<sup>15</sup>

From the clinical standpoint, numerous studies have therefore supported the contention that 'fresher is better' for soft lens replacement.

One study looked at the effect on comfort of replacing hydrogel lenses more often than daily, and although replacing lenses midway through the wearing day led to an initial improvement in comfort with the new lenses, there was no difference in end-of-day comfort scores.<sup>16</sup>

Many of the large-scale studies comparing clinical performance with different replacement frequencies were conducted in the 1990s with hydrogel lenses. Over the past decade not only have new designs emerged to correct a wider range of patients but silicone hydrogels (SiHs) have overtaken hydrogels as the materials of choice in most markets across the world. Further studies with currently available lenses have therefore shed more light on the arguments for and against each replacement frequency.

## The advent of silicone hydrogels

In 1999, the introduction of the first SiH lenses marked a major step forward in contact lens technology. But the clinical performance of the first generation of SiHs and the reluctance of practitioners to embrace extended wear initially caused relatively low uptake. Today, SiHs have

become the most commonly prescribed materials in the UK, accounting for half of all new fits and two in every three refits.<sup>17</sup> Only a small minority of lenses (5 per cent) are prescribed for extended wear.

With an increasing number of prescribing options, soft lens replacement interval has continued to be debated. The first generation of SiHs were recommended for monthly replacement and up to 30 nights' continuous wear. Two-weekly SiH options emerged in 2004 with Acuvue Advance with Hydraclear and, the following year, Acuvue Oasys with Hydraclear Plus, the first of a new generation of SiH lenses with low modulus of elasticity and coefficient of friction, and wettability achieved without the need for a surface coating.

In 2008 came the world's first daily disposable SiH lens, 1-Day Acuvue TruEye, which meant that SiH lenses were now available in all three of the most commonly prescribed replacement frequencies. Almost all new lenses fitted in the UK today are for replacement at intervals of one month or less (99 per cent) and almost half (45 per cent) are for daily replacement.<sup>17</sup>

The frequency of lens replacement continues to vary greatly among markets.<sup>18</sup> Daily disposable lenses, for example, are prescribed for 6 per cent of fits in Croatia and for 75 per cent of fits in Hong Kong. However, North America remains below the global average for the proportion of daily disposables fitted (30 per cent). The US and Japan markets have the highest overall contact lens penetration (16 per cent and 22 per cent respectively)<sup>19</sup> where two-weekly lenses are the most commonly dispensed reusable lens types.<sup>20</sup>

Several studies have investigated the influence of replacement frequency on the performance of modern lenses. A survey in 2007 to investigate monthly soft lens wearers' experience with their contact lenses asked wearers using a variety of monthly lens brands – traditional hydrogel and SiH – about their attitudes to their current lens performance.<sup>21</sup>

More than two-thirds of monthly lens wearers (68 per cent) noticed a decrease in wearing comfort over the course of a month and the sensation of growing discomfort was experienced almost equally by wearers of hydrogel and SiH lenses, with no significant difference between the two lens types.

Asked which week of the month, in general, these wearers started to notice that their lenses were uncomfortable, more than nine out of 10 (95 per cent) said that they became aware of discomfort in weeks three and four. Monthly SiH lens wearers who experienced discomfort tended to notice it earlier in the lens cycle than hydrogel wearers.

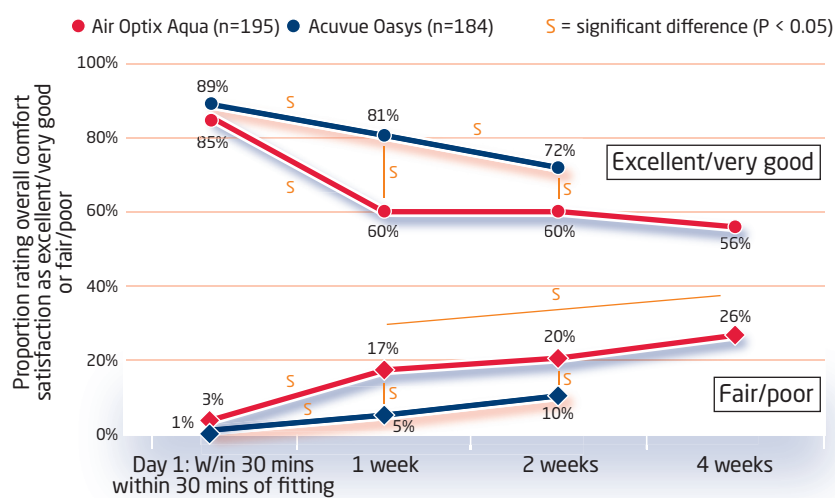
For over half of wearers, subjective perceptions of vision and ocular health also worsened over the course of a month's wear. Around two thirds (64 per cent) felt their vision was less clear at the end of the month compared to the first day they put the lenses in, and just over half (53 per cent) felt the lenses were less healthy for their eyes. Again these perceptions were shared by SiH and hydrogel wearers alike.

There was also evidence that some monthly wearers replaced their lenses more often than once a month in order to maintain comfort, regardless of lens type. About one in three (34 per cent) felt they had to replace them before the end of the month due to discomfort and this was the case for both hydrogel and SiH wearers.

Other authors have found a decline in lens performance with lens age. A recent study investigated patient wearing experience (comfort, symptoms and comfortable hours of wear) with two daily wear SiH lenses, the two-weekly Acuvue Oasys with Hydraclear Plus and monthly replacement Air Optix Aqua lenses.<sup>22,23</sup>

Both lenses showed performance declined across their recommended life, in some cases in the first week of wear. With the two-weekly replacement lens, comfort slowly declined across the wearing schedule (Figure 1). In contrast, the monthly lens showed a sharp drop in the proportion of patients who were satisfied with overall comfort during the first week of wear (85 per cent to 60 per

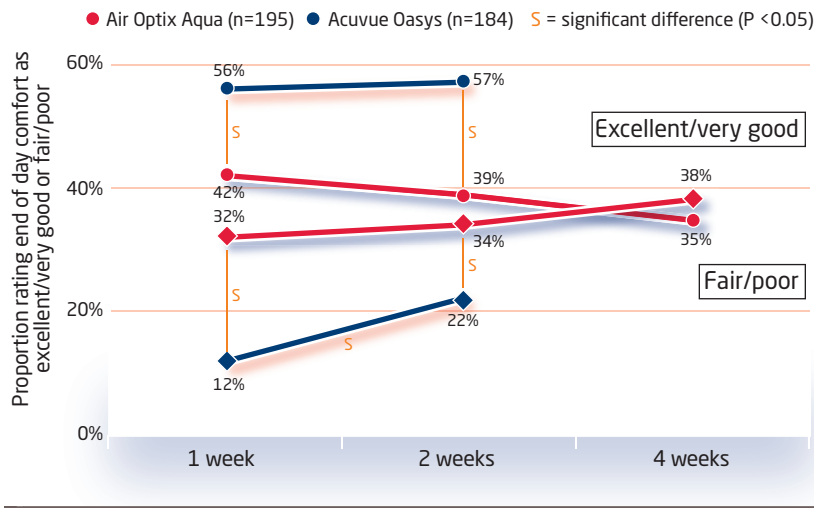
**Figure 1** Overall comfort satisfaction during a randomised, parallel group, 2-4 week, subject masked, daily-wear study<sup>22</sup>



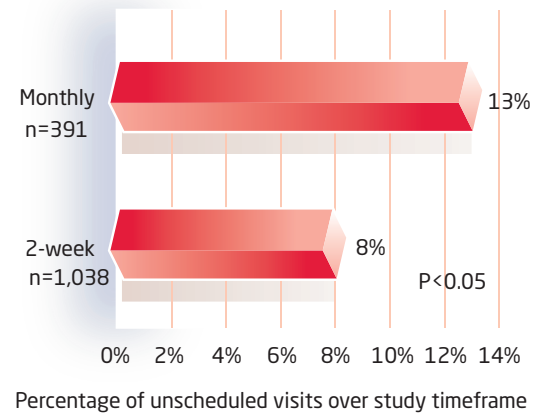


## Contact Lens Monthly

**Figure 2** End of day comfort satisfaction during a randomised, parallel group, 2-4 week, subject masked, daily wear study<sup>22</sup>



**Figure 3** Percentage of patients returning for a contact lens-related unscheduled visit<sup>24</sup>



cent), and the proportion of patients who were dissatisfied with comfort increased over the remaining three weeks (26 per cent at the end of the monthly lens wear cycle compared to 10 per cent at the end of the two-weekly lens wear cycle).

Results for end-of-day comfort (Figure 2) showed a similar distribution, and, for the monthly lens wearers, uncomfortable hours of wear continued to increase over the four-week life of the lens (2.2 hours average increase in uncomfortable wear from two to four weeks, a statistically significant difference). Clinical evaluations of deposits, wettability, corneal staining and limbal redness also showed a decline in performance over time, which may partly explain the decrease in comfort and increase in dryness symptoms.

Researchers have also looked at the impact of replacement frequency on scheduled and unscheduled visits in SiH wearers.<sup>24</sup> The median return for an annual visit for two-weekly and monthly prescribed lens wearers was the same, at 13 months. But significantly more monthly wearers returned for an unscheduled visit due to clinical complaints related to their contact lenses than two-weekly lens wearers (13 per cent vs 8 per cent, Figure 3). Complaints included irritation, discomfort and blurred vision. Return visits for medical reasons were not different in this study.

For patient satisfaction and practice efficiency, practitioners should consider these findings when deciding on optimal replacement frequency for SiH lenses, the authors conclude.

However, some studies of soft lens wearers (SiH and hydrogel) have revealed no differences in other clinical findings between replacement

schedules. The Contact Lens and Dry Eye study<sup>25</sup> found no significant difference in the frequency of contact lens-related dry eye between different modalities. More recently, lens factors other than replacement schedule, such as water content, material, wearing time and deposition, have shown an association with corneal staining.<sup>26</sup>

### Compliance with replacement interval

If 'fresher is better' for clinical reasons, is it also better for patient compliance? The overwhelming consensus is that daily disposable wearers are the most compliant group, despite initial concerns when these lenses first became available that patients might re-use them. Jones *et al*<sup>6</sup> were among the first to report that wearers of daily disposable lenses were more likely to be compliant with the prescribed wearing schedule than other disposable and frequent replacement lens wearers (98 per cent vs 89 per cent).

Recent consumer surveys have supported this finding. In the US, a survey of wearers with recommended replacement intervals up to six months found that daily disposable wearers were the most compliant; 94 per cent of wearers told to replace their lenses every day complied, less than 6 per cent discarded lenses every two days and 0.5 per cent waited up to a week before replacing their lenses.<sup>27</sup>

A study by Donshik *et al*<sup>28</sup> found good correlation between the prescribed lens replacement schedule and patients' actual replacement, and that the recommended schedule was followed less as the replacement interval increased.

Morgan<sup>29</sup> reported very high levels

of compliance among daily disposable users in the UK, with as many as 97 per cent of wearers discarding their lenses on a daily basis, compared with 81 per cent of two-weekly wearers and 82 per cent of monthly wearers who replaced their lenses within the recommended period. This author also noted very wide differences in compliance rates between countries.

Other authors support the view that compliance with lens replacement in the UK is similar with two-weekly and four-weekly lenses. Jones *et al*<sup>6</sup> found equal levels of compliance with these modalities (89 per cent), and a maximum replacement interval of 28 days for two-weekly lenses and 50 days for four-weekly lenses.

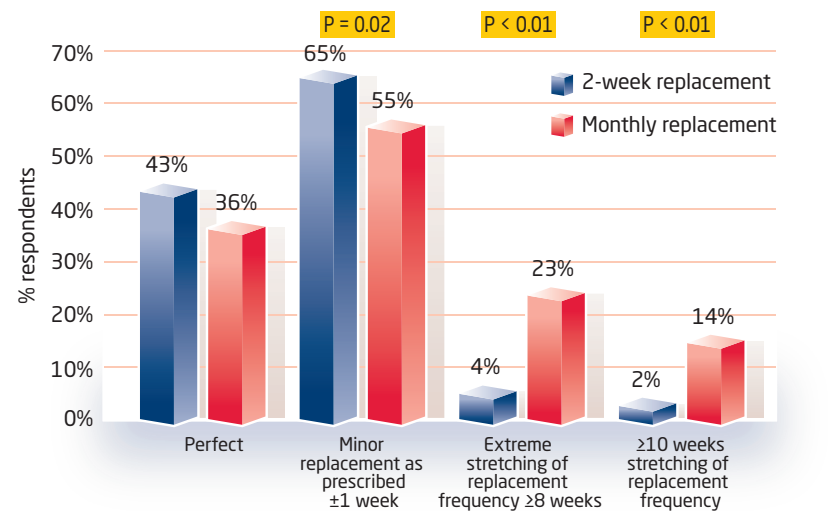
Recent studies have added further to the compliance debate. Dumbleton and co-workers have published a series of papers based on surveys conducted in North America about replacement frequency of soft lenses, patient and practitioner compliance with these recommendations and reasons for patient noncompliance.

A survey of SiH and daily disposable wearers was conducted through eye care practices in the US that included lens wearer distribution of 16 per cent daily disposable, 45 per cent two-weekly SiH, and 39 per cent monthly SiH.<sup>30</sup> One per cent of monthly lens wearers, 4 per cent of daily disposable wearers, and 18 per cent of two-weekly wearers were given instructions that did not conform to the manufacturers' recommended replacement frequency (MRRF). Four per cent of patients reported that their practitioner gave no recommendation on replacement frequency.

Four in 10 patients completing the survey exceeded the MRRF. Asked



**Figure 4** 'Stretching' of lens replacement interval from survey of 645 frequent replacement contact lens wearers



after how many days or months they replaced their lenses, 15 per cent of daily disposable wearers said they replaced their lenses after more than a day, 29 per cent of four-weekly lens wearers after more than 31 days, and 59 per cent of two-weekly wearers after more than 17 days. The most frequent reasons given were 'forgetting which day to replace lenses' (51 per cent) and

'to save money' (26 per cent).

A study in Canada and the US by the same group showed similar results although prescribing rates differed.<sup>31</sup> Non-compliance rates for actual replacement frequencies reported by patients were lowest for daily disposables, followed by monthly lenses (33 per cent Canada, 28 per cent US) and two-weekly lenses (50 per

cent Canada, 52 per cent US).

However, recent findings support the view that the problem of 'stretching' replacement interval is worse among patients wearing a monthly lens than in those with a two-weekly replacement schedule.<sup>32</sup> An online survey was conducted among randomly selected US consumers who were unaware that the information was being sought by a contact lens manufacturer.

The results showed that only 43 per cent of patients who were prescribed a two-weekly replacement lens and only 36 per cent of patients prescribed a monthly replacement lens were complying perfectly with the prescribed schedule.

'Minor stretching' (up to one week) was identified among 65 per cent in the two-weekly replacement group and 55 per cent of those in the monthly replacement group. But only 4 per cent of patients in the two-weekly group displayed 'extreme stretching' (eight weeks or more) compared to 23 per cent in the monthly group (Figure 4). Monthly wearers were therefore more prone to extreme over-wear, potentially leading to problems with comfort and/or vision.

For the authors of this work,<sup>32</sup> it was counterintuitive that patients who





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were noncompliant with a two-week replacement schedule would be more adherent to instructions if allowed to wait four weeks to change their lenses. When noncompliance with frequent replacement was an issue, switching to daily disposable lenses was probably a better alternative, they suggested.

The importance of compliance to comfort and vision in SiH lens wearers has been highlighted in another recent study in the US.<sup>33</sup> Patients wearing either two-weekly or one-monthly replacement SiH lenses rated their comfort and vision in the morning, at the end of the day, when lenses were new and when they needed replacing.

Compliant patients had better comfort and vision at end of day and when the lenses needed replacing than non-compliant patients, and this was the case regardless of replacement modality. However, a potential limitation was that the samples used in this study differed, with more toric lens wearers in the two-weekly group than the monthly group, which may have influenced the results.

These authors observe that some lens materials may be optimally replaced every two weeks, whereas other materials could be comfortably worn for a month. In fact multiple lens attributes can impact contact lens comfort, including material properties such as modulus, smoothness, wettability and wetting agents. Comfort also depends on how proteins, lipids and allergens deposits on the surface over time.<sup>34</sup>

Arguments for and against prescribing a particular replacement frequency from the compliance viewpoint may therefore be misplaced. It may be more appropriate to select the best combination of lens attributes for a given patient and the way the lens is to be worn.

A new US study sheds more light on the relationship between contact lens-related ocular complications and compliance with soft lens replacement schedule.<sup>35</sup> Patients who 'stretched' their lens life more than three times the recommended interval were found to have significantly more complications than compliant patients.

Interestingly, this study found that compliance varied not just with replacement frequency but with lens type. Compared with patients wearing SiH lenses, those using conventional hydrogels tended to over-wear their lenses 3-4 times longer on average beyond the recommended replacement frequency (44.8 average days' over-wear for noncompliant patients wearing hydrogels compared to 16 days with SiHs).

**TABLE 1**

### Tips to improve patient compliance with replacement frequency

- Reinforce compliance advice at every opportunity
- Use open questions to identify patients who are non-compliant
- Explain the comfort, vision and ocular health benefits of replacing lenses as recommended with illustrations of the potential consequences of over-wear (eg using grading scales)
- Use memorable analogies to reinforce lens replacement
- Track order patterns to identify patients using fewer than expected lenses
- Use direct to patient shipments to aid compliance with replacement schedule
- Ensure practice supply, delivery and pricing aspects aid compliance; a care plan including aftercare allows regular monitoring of patients
- Suggest the 1st and 15th of the month as replacement days to aid compliance with two-weekly replacement lenses
- Use electronic reminder systems to prompt patients when to change their lenses
- Remind patients always to have an adequate supply of lenses to aid replacement compliance and a back-up pair of spectacles

that their replacement frequency can therefore be extended. In some cases replacement more frequent than the MRRF was recommended; this occurred only for 1 per cent of two-weekly lenses but for 18 per cent of monthly lenses.

### Reinforcing compliance

If the debate continues on the optimum replacement frequency, there is general agreement that, for reusable lenses, perfect compliance levels overall are low. Practice procedures should therefore be directed at identifying those who are noncompliant and encouraging compliance at every opportunity.<sup>36</sup> Examples of ways to improve compliance are summarised in Table 1.

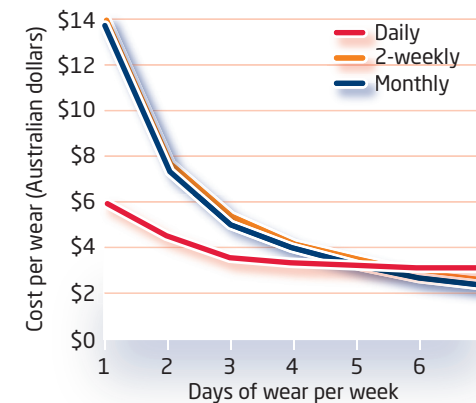
Carefully question the patient using open questions to elicit non-compliant behaviours, such as 'How often do you replace your lenses?' rather than 'Are you replacing your lenses every two weeks?'. Empathise with the patient so that they feel more able to admit to stretching, while emphasising that comfort and vision will not be optimal unless lenses are replaced as recommended and, at worst, they could be putting the health of the eyes at risk. Explain that wearing lenses longer than recommended may be associated with a higher risk of contact lens-related complications.<sup>30,35</sup>

However, it is worth remembering that compliance is about much more than just replacement schedule. In fact only 2 per cent of contact lens wearers are thought to be fully compliant with their contact lens wear and care regime.<sup>29</sup>

Try employing a memorable analogy for reinforcing lens replacement; in the case of daily disposables, re-using a wet wipe or paper tissue could be a useful analogy. Reinforce your advice at every visit and track order patterns to identify those who are using fewer than expected lenses; a direct to patient shipment method can also aid compliance with a replacement schedule. Supply, delivery and pricing considerations can also be used to aid compliance, and offer a care plan that includes aftercare for all lens types so that you can monitor your patients regularly. For two-weekly replacement lenses, suggesting the first and 15th of the month as replacement days may aid compliance.

Use the Acuminder electronic reminder system or a device such as the Lens Alert case to remind patients when to change their lenses, since more than half of those not replacing lenses when recommended report that they simply forgot which day to replace

**Figure 5** Cost per wear for daily, two-weekly and monthly replacement spherical lenses



After Efron<sup>37</sup> with permission from *Clin Exp Optom*

These authors argue that although compliance is important, the number of days that the patient exceeds the recommended schedule is also a key factor. They observe that even patients who are not fully compliant can still reduce their rate of complications by reducing the number of days they over-wear their lenses.

A further issue which has received attention is that of practitioners prescribing replacement that differs from MRRF.<sup>30</sup> Possible reasons cited include the perception that some lens types do not degrade in performance when worn for longer periods and



them.<sup>30</sup> In this study 53 per cent of wearers believed that a reminder system would aid compliance, the most popular methods being a mobile phone reminder or text message (29 per cent) and a nominated day each week or month (26 per cent).

Remind patients always to have an adequate supply of lenses on hand as an aid to replacement compliance. Make sure that patients also have a back-up pair of spectacles, since a higher proportion of those non-compliant with replacement frequency do not have an up-to-date spectacle prescription.<sup>30</sup>

The good news is that better communication has been shown to facilitate greater compliance with replacement frequency. Discussion between practitioner and patient is more extensive for patients who are compliant. Moreover most wearers (78 per cent) acknowledge that it is extremely important or important to replace lenses on schedule.

### Cost, convenience and replacement frequency

Clinical factors are not the only determinants when choosing a replacement schedule for a particular individual; other patient factors also come into play. The decision is often based on lifestyle and leisure pursuits, and this is particularly the case with daily disposable lenses which are a convenient option for occasional or part-time wear, for social use, sports and travel.

Cost is another important issue that is often neglected in the literature. A model developed recently in Australia introduces the concept of 'cost-per-wear' to allow direct comparison of the cost of different lens replacement frequencies.<sup>37</sup>

Cost-per-wear is the total cost incurred by a patient over 12 months, taking into account professional fees and the cost of lenses and solutions, and dividing this by the number of times the lenses are worn over that period.

The model shows that cost-per-wear for spherical lenses is almost identical for two-weekly and for monthly replacement but decreases with increasing frequency of wear. For daily replacement it is lower than for reusable lenses when worn 1-4 days per week but higher when worn 6-7 days per week. The cross-over point is at five days' wear a week, when cost-per-wear is virtually the same for all three commonly prescribed lens replacement frequencies (Figure 5).

A similar but higher cost pattern is observed for toric lenses, with cross-over at 3-4 days' wear per week. Multifocal lenses have cross-over points for daily versus two-weekly lenses at 4-5 days' wear per week and for daily versus monthly lenses at three days per week. The authors conclude that daily disposable lenses are more cost-effective for part-time wear, with reusable lenses being more cost-effective for full-time wear.

The model can be applied to the cost of contact lens wear in different countries and the relative costs of different forms of lens wear are unlikely to vary. The cross-over point will vary depending on the cost of individual lens brands being compared. Practitioners could apply this principle to examine the impact of different cost inputs and assumptions in their own practices. Cost-per-wear can also be used to aid compliance by demonstrating to patients the cost-effectiveness of their replacement regime and wearing schedule.

#### KEY POINTS

- Many clinical studies and patient satisfaction surveys support the contention that 'fresher is better' for soft contact lens replacement, especially when replaced daily
- Soft lens performance generally declines with lens age
- Almost all soft lenses fitted today are for replacement at intervals of one month or less
- In the US and Japan two-weekly lenses are the most commonly dispensed reusable lens types, markets with the highest contact lens penetration rates
- Compliance with lens replacement varies between countries
- Daily disposable wearers are most likely to comply with lens replacement
- Extreme 'stretching' is more likely among monthly than two-weekly replacement lens wearers
- Failure to replace lenses at the recommended interval is associated with discomfort and complications
- Monthly wearers are more likely to make unscheduled visits for clinical complaints than two-weekly wearers
- Practitioners need practice strategies to reinforce compliance with lens replacement
- 'Cost-per-wear' for spherical and toric lenses is similar for two-weekly and for monthly replacement



These authors also observe that the most frequent reason given by daily replacement lens wearers for noncompliance is 'to save money', showing that cost can also be a clinical issue, although compliance with replacing daily disposables is generally high across markets.<sup>28</sup>

### Conclusions

The key to success with an individual patient is the ability to select the lens (material and design), replacement frequency and wearing modality that best meets his or her individual needs. That decision will be based on a variety of factors: clinical, most likely to comply, practical considerations such as wearing patterns and lifestyle, and cost. This will help deliver not only optimal physiological response and vision, but also comfort performance, the main reason for lapsing from lens wear.

While the optimum replacement interval for soft lenses will continue to be debated, the contention that 'fresher is better' from the clinical standpoint is supported by many studies over the past 30 years.

There are conflicting findings on compliance with different replacement frequencies. However, a better approach might be to acknowledge that almost all contact lens wearers are noncompliant to some degree and focus on identifying these behaviours and the reasons behind them. Encouraging compliance will help ensure that all wearers get the best from their lenses and wear them as comfortably and safely as possible. ●

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