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Nathan Efron AC

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EDITORIAL

Thirtieth anniversary of daily disposable contact lenses

This year marks the thirtieth anniversary of the introduction of daily disposable contact lenses, which means that – for the majority of optometrists world-wide – daily disposable lenses have been available ever since they graduated to practice. This editorial will briefly recount the history of the development of daily disposable lenses as a background to celebrating the thirtieth anniversary of this popular lens wearing modality.

Why did we need to develop daily disposable lenses?

Prior to the introduction of daily disposable lenses in the mid-1990s, all soft lenses were reusable and required daily maintenance with a chemistry set of solutions to remove intrinsic deposits such as protein, lipids, calcium and mucus, and extrinsic deposits such as iron particles, tobacco smoke and eye cosmetics.¹ As well, reusable lenses needed to be stored overnight in a small plastic case.¹ The gradual build-up of long-term deposits, and toxic elements in the care solutions, caused high rates of ocular complications such as conjunctival hyperaemia, corneal staining and papillary conjunctivitis.² We needed something better.

The possibility of developing regularly replaced lenses appears to have been first recognised by the inventor of soft contact lenses – Otto Wichterle. During the 1980 conference of the International Society for Contact Lens Research, Wichterle was asked to comment about the problems of solutions and lens spoilage. He replied as follows:

Is it worth investing a great deal of research on this problem? There is one solution that would eliminate all the problems of deposition – once deposits occur, we could reject the lens and take a new one! I believe we are now very close to the development of technology which will cause a dramatic drop in the selling price of lenses. Once you are able to buy a lens for one dollar or less, lens spoilage won't play a role. If a lens is spoiled, it will be cheaper to buy a new lens than to buy expensive solutions and waste time with cleaning.³

Although Wichterle did not specifically mention the possibility of daily disposability, this modality is a logical extension of his pronouncement, which was even made prior to the introduction of regular replacement lenses.

A major *scientific* driving force for the development of daily disposable lenses was the celebrated 'Gothenburg Study' published in 1985,⁴ which is one of the most highly-cited papers in the contact lens literature. This study examined long term adverse physiological effects of contact lens wear on the anterior eye, and offered compelling evidence to demonstrate that these effects would be minimised by fitting contact lenses that are more oxygen permeable (subsequently resolved with the introduction of silicone hydrogel materials around year 2000) and more regularly replaced. Rapid advances in cast moulding technology facilitated the introduction daily disposable lenses in the mid-1990s.

Is 2024 the true anniversary year?

As to whether 2024 is the correct thirtieth anniversary year of the introduction of daily disposable lenses is open to conjecture. Johnson & Johnson Vision Care made the 1-Day Acuvue lens available to a restricted number of practitioners in Omaha and Las Vegas, USA, in June 1993, in what appears to have been a pre-market trial. This was followed by launches in Western USA in August 1994, and then nationwide launches in Canada, Japan, UK and USA in February 1995.⁵ A UK company – Award Technology (subsequently acquired by Bausch & Lomb) – launched the Premier lens in the UK in November 1995.⁵ Thus, there was a gradual release of daily disposable lenses from regional to national to global markets over the period 1993–1995.

In conventional scientific parlance, the true date of the availability of a medical device on the market is when it is formally reported in the scientific literature. In that regard, the first published report of daily disposable lenses was that of Hamano et al.⁶ in 1994. In their article describing complications of contact lens wear, Hamano et al.⁶ reported reviewing the charts relating to 893 eyes of patients wearing daily disposable lenses, and finding a complication rate of 2.5%, which was the lowest of the seven lens types assessed. The following year I published the first report of a clinical trial with daily disposable lenses, conducted on 29 subjects, and noted good comfort, vision and ocular response after one month of lens wear.^{7,8}

Considering all of the above historical markers, it would seem reasonable to nominate the year 1994 as the starting point for daily disposable contact lenses; hence my proposed 30-year anniversary celebration this year.

A remarkable evolution

We have certainly come a long way since contact lenses were first introduced in the early 1970s. The original soft lenses distributed by Bausch & Lomb – the 'Soflens' – were manufactured from hydroxymethyl methacrylate (HEMA) and had a low water content (38%).⁹ These lenses were very expensive – perhaps as much as AUD400.00 a pair in today's values (i.e., AUD200.00 per lens); the current unit cost of a daily disposable lens is less than one dollar, as correctly predicted 44 years ago by Otto Wichterle.³

The original HEMA soft lenses were intended to last 'indefinitely' – only to be discarded when they (a) became damaged or lost; (b) were heavily covered in irremovable deposits making them too uncomfortable to wear; (c) resulted in a noticeable deterioration of vision¹⁰; or (d) induced ocular pathology that was either self-diagnosed or detected during an eye examination. Patients would wear the same pair of lenses for many years, with one report of the same pair of lenses being used for 4 years.¹⁰

The primary advantage of daily disposable lenses (compared with reusable lenses) is that they offer wearer

convenience.¹¹ Daily disposable lenses can be discarded at any time of day and are amenable to flexible wearing schedules (e.g., lenses may be worn for just a few days per week). Lens cleaning, maintenance and overnight storage is obviated. Long-term deposits do not accumulate on the lens surface, thus preserving good comfort and optimal vision.¹⁰

Daily disposable lenses also offer certain challenges and benefits to contact lens practitioners. The primary challenge is the allocation of enough space for a sizeable inventory of various brands of lenses in a suitable range of parameters. However, a well-maintained inventory of lenses facilitates timely and accurate lens fitting as well as the immediate dispensing of lenses for short-term wearing trials, prior to offering an ongoing lens supply. Streamlined payment systems can be set up, with lens supply matching the recommended frequency of aftercare visits.¹¹

There are potential disadvantages of daily disposable lenses. They are generally more expensive than reusable lenses when worn on a full-time basis,¹² although I would argue that the convenience and ocular health benefits of this modality justifies this extra expense. Daily disposable lenses are less expensive when worn on a part-time basis.¹² The greater expense of daily disposable lenses when worn on a full-time basis has resulted in lower prescribing rates of this lens type in less affluent countries.¹³

Another concern of daily disposable lenses is the environmental impact of discarding billions of non-biodegradable lenses, and associated packaging, each year. This concern is mitigated to some degree by recycling programmes offered to lens wearers by most of the major contact lens companies, and by lens manufacturers taking measures to reduce the carbon footprint of lens production.^{14,15}

How successful have daily disposable lenses been?

Together with Professor Philip Morgan at the University of Manchester, UK, I have been tracking the uptake of all contact lens types, including daily disposable lenses, world-wide since 2000, by undertaking annual national surveys of contact lens

prescribing.¹⁶ Figure 1 shows trend data relating to the prescribing of daily disposable lenses – as a proportion of all soft lens fits – between 2000 and 2023, inclusive. Data are presented as three-year moving averages for 17 key markets that have generated data consistently over the 24-year survey period. The black dotted line is the mean prescribing data for all countries.

It is evident from Figure 1 that there has been a steady rise in daily disposable lens fitting, increasing from around 18% of all soft lens fits in 2000 to 48% in 2023. Some markets (notably Australia and the United Kingdom) see over 60% of fits as daily disposables whereas this value is much lower in the Netherlands, Spain and Bulgaria. Differences between countries in the extent of daily disposable lens prescribing relates to a variety of factors which have been discussed in detail elsewhere;¹⁶ these factors include national differences in regulatory approval mechanisms, extent of industry product advertising; government and private insurance reimbursement policies, national affluence, and influence of the predominant prescribing profession (optometry, ophthalmology and dispensing).

When daily disposable lenses entered the market around 1994, they were only available in spherical form. As their popularity grew and manufacturing processes improved, daily disposable lenses began to be introduced in a variety of materials and designs. At the present time in Australia, 41 daily disposable lens types are available; specifically, 15 spherical, 11 toric, 11 spherical multifocal, 3 myopia control, and 1 cosmetic tinted.¹⁷

Conclusion

The two major innovations that have impacted the contact lens field since the invention of soft lenses over half a century ago are daily disposability and silicone hydrogel materials. There has been a confluence of these two innovations over the past decade in that a majority of daily disposable lenses are now manufactured from silicone hydrogel materials, adding yet another layer of safety and ocular well-being for contact lens wearers. Despite these innovations, a significant minority of lens wearers still use reusable lenses

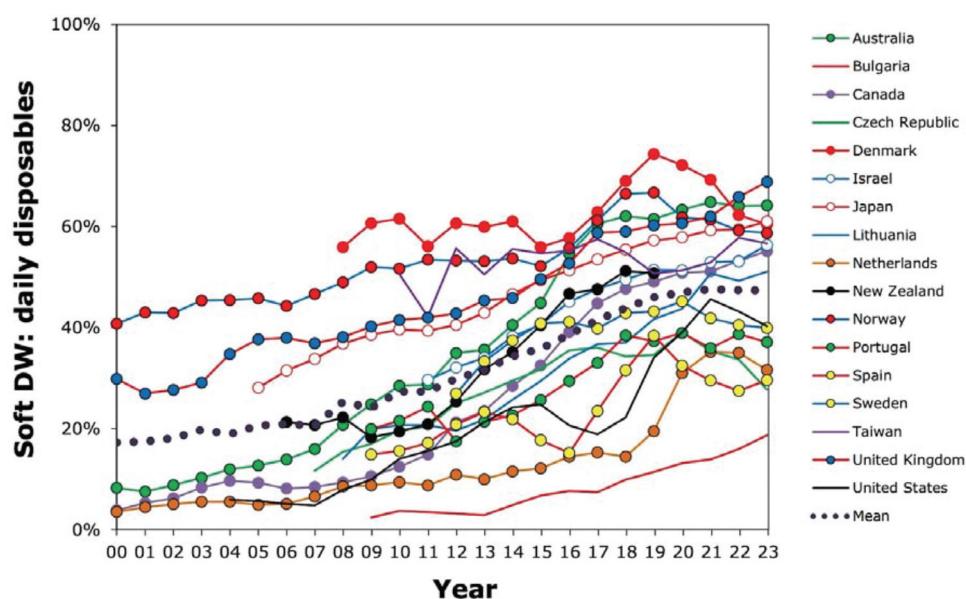



Figure 1. Trends in prescribing daily disposable contact lenses as a percentage of all soft lenses in 17 nations between 2000 and 2023. Data are shown as three-year moving averages. $N = 247,575$ lens fits.

today, although the use of reusable lenses is likely to continue to decrease over time.

Without doubt, this thirtieth year anniversary of the introduction of daily disposable lenses is a milestone that the contact lens industry, contact lens practitioners, and contact lens wearers can jointly celebrate.

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Nathan Efron AC
Optometry and Vision Science, Queensland University of
Technology, Kelvin Grove, Australia
 n.efron@qut.edu.au