

J&J Institute

# Contact Lens Selection

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With continuing advances in technology, eye care professionals now have a larger range of contact lens products to choose from than ever before. So, how can we be sure we are prescribing our patients with the right product to meet their needs?

This article uses patient examples to explore the contact lens selection decision making process, with the aim to ensure we are making personalised contact lens recommendations for each of our patients based not only on their contact lens requirements, but also on their ocular health. In ensuring we provide patients with personalised recommendations, we hope to optimise our patient satisfaction and increase contact lens wearer retention. This practice will also ensure we are meeting the General Optical Council (GOC) Standards of Practice, treating our patients as individuals, taking into account their views and preferences when making decisions about their care.<sup>1</sup>

In creating a personalised contact lens recommendation for each patient, we need to consider the attributes of the lens we select to ensure it can provide our patient with optimum vision and comfort, whilst delivering safe and healthy wear.

The following detailed contact lens properties should always be considered; material properties, optical design, and modality. These elements, together with the patient's lifestyle, ocular health and prescription requirements will help to inform our ideal contact lens choice.

## Material Properties

The first decision to consider here is the material of the contact lens; should you fit a hydrogel (Hy) or silicone hydrogel (SiHy) soft contact lens, or would a rigid gas permeable (RGP) contact lens better meet the patient's needs?

Soft contact lenses continue to dominate most of the contact lens market, accounting for 87% of all fits worldwide.<sup>2</sup>

Options available to the practitioner continue to evolve, covering a wide range of parameters, designs and replacement frequencies. Historically, prescribing of either daily disposable (DD) or reusable (RU) Hy lenses exceeded that of SiHy lenses, however, increasing preference for SiHy led to a higher proportion of SiHy lenses being prescribed from 2015 onwards.

Whilst there is a shift towards use of SiHy lenses due to their higher oxygen permeability, hydrogel contact lenses, with their naturally hydrophilic nature, low modulus and reduced tendency to attract lipid deposits,<sup>3</sup> remain a good choice, particularly for patients who have marginal tear films and excess lipid contamination of the tears due to meibomian gland dysfunction.<sup>4</sup> Oxygen transmissibility should of course be a consideration for each patient, however, recent clinical insights show us that at a Dk/t of approximately 20 units, the central cornea receives the oxygen it requires for normal oxygen consumption in the open eye state<sup>5</sup> and many modern hydrogels fit within this range. There is also considerable evidence that market leading high-water content hydrogel lenses made of etafilcon A do not produce clinically significant levels of corneal oedema,<sup>6</sup> or show any difference in central corneal oxygen consumption compared to a SiHy material, lotrafilcon A.

**SiHy contact lenses, first introduced to market in the late 1990s, are again available in both DD and RU modalities and now make up 57% of fits worldwide and 76% of fits in the UK.<sup>2</sup>**

Incorporation of silicone into the contact lens, produces a material with significantly increased oxygen permeability, meaning oxygen consumption for SiHy lenses is 98-100%,<sup>7</sup> irrespective of make or model. When SiHy contact lenses first came to the market it was thought that greater oxygen transmissibility would also result in improved comfort levels and a reduction in adverse events, however, a comfort advantage with SiHy lenses has been hard to prove due to confounding factors<sup>8</sup> and research has shown no relationship between Dk/t and comfort.<sup>9</sup> This is likely due to the inherent hydrophobicity and stiff nature of silicone which meant that 1<sup>st</sup> generation SiHy lenses had a higher modulus and poorer wettability<sup>10</sup> compared to their hydrogel counterparts. More modern SiHy materials have dealt with these concerns, and now are available with highly desirable levels of comfort and tear film interaction.<sup>11</sup> With regards to adverse events, despite SiHy lenses causing a reduction in hypoxic events, they have not brought about a reduction in risk of microbial keratitis as was anticipated<sup>12,13</sup> and several studies have in-fact shown a nearly two-fold increase in relative risk for infiltrative

keratitis.<sup>14,15,16</sup> These challenges aside, where consideration of oxygen transmissibility is important, for example, in patients who are predisposed to vascularisation secondary to the thicker designs of some toric lenses or higher spherical refractive errors, a SiHy would be the desired material of choice.

Whilst RGP lenses only account for 10% of contact lens fits worldwide,<sup>2</sup> their value should not be forgotten. RGP contact lenses can offer practitioners a larger prescription range, correction of corneal astigmatism up to 2.50DC with a simple spherical lens and are also available in toric and multifocal designs. Due to its rigid surface, RGP contact lenses have been shown to provide patients with preferable vision compared to soft contact lenses,<sup>17,18</sup> likely due to neutralization of corneal irregularities by the pre-corneal tear lens. As such, RGP lenses are often utilised for the correction of corneal irregularity, such as keratoconus, post corneal graft and post-refractive surgery, as well as for high levels of ametropia or astigmatism. In addition to excellent vision, RGP lenses can support excellent corneal health due to incomplete corneal coverage and retro-lens tear exchange, resulting in an excellent safety record and a very low risk of microbial keratitis.<sup>18</sup> However, these benefits come at a much longer adaptation period compared to soft contact lenses,<sup>17</sup> which may account for the reduced prescribing of these lenses in mainstream practice over the last 20 years.<sup>2</sup>

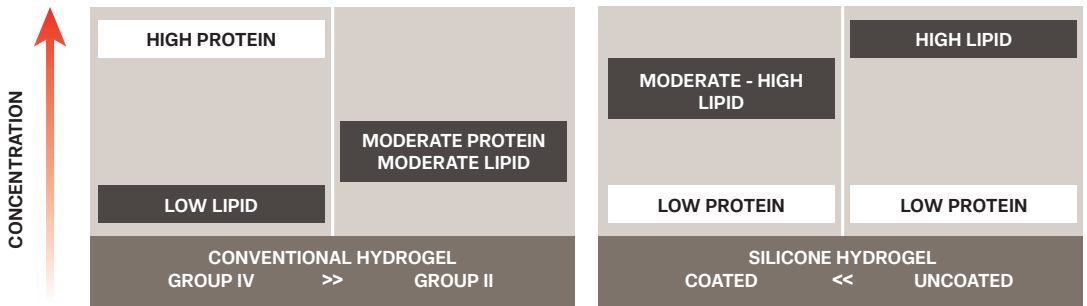
It is clear from the information above that RGP, Hy and SiHy contact lenses all have a solid place in modern contact lens

practice and practitioners should always select the best contact lens material for patients based on overall comfort, visual performance, safety and clinical need. As soft contact lenses make up 95% of contact lenses prescribed in the UK,<sup>2</sup> the rest of this chapter will concentrate on the material properties associated with soft contact lenses only.

## Deposition

Hydrogel and SiHy lenses differ in their deposition profiles, with wide variations also occurring within these lens types, depending upon the International Organisation for Standardization (ISO) classification as described in Table 1

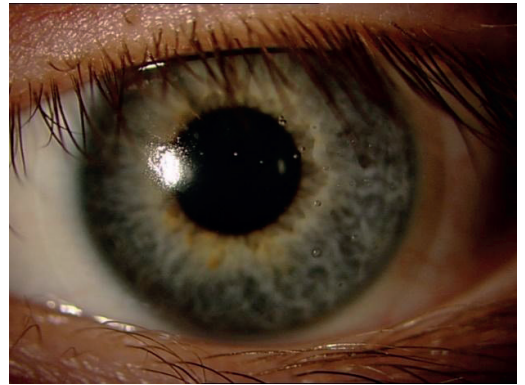
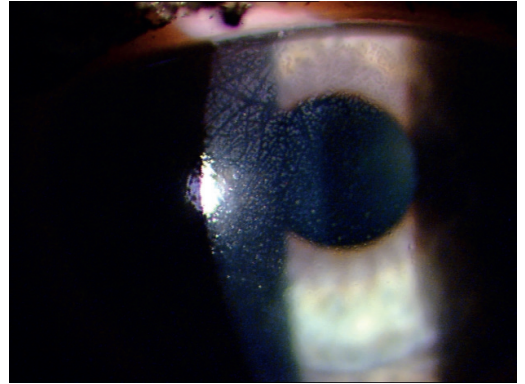
and Figure 1. Both research and clinical experience recognise that, broadly, Hy contact lenses deposit more protein (Figure 2a) compared to lipid (Figure 2b), whilst the converse is true of SiHy. Further, higher water content, ionic hydrogel materials have a tendency to attract greater amounts of protein compared to non-ionic lower water content hydrogel lenses. Once deposited on the contact lens surface, the protein can become denatured, triggering the release of inflammatory biomarkers which could result in irritation.<sup>19</sup> However, if the proteins are simply taken into the lens and not denatured, as has been demonstrated in etafilcon A, a group IV hydrogel, they can support the maintenance of low levels of inflammatory biomarkers.<sup>19</sup>



**Figure 1.** Schematic illustration of trends in lipid and protein deposits on different contact lens materials (After Mann A and Tighe B. Contact lens interactions with the tear film. Experimental Eye Research, 2013;117:88-98)

Knowledge of the differences in deposition profile can be useful when considering matching a contact lens material to a patient's ocular surface.

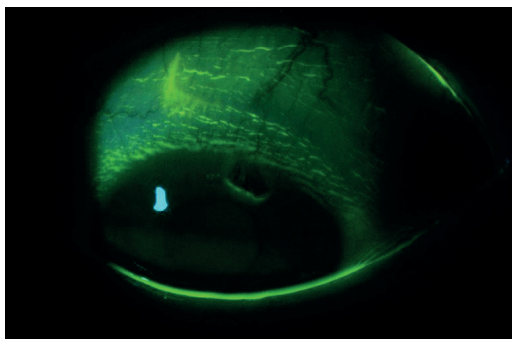
For example, a patient with meibomian gland dysfunction who is prone to exhibiting high levels of cholesterol in their tears, may benefit from being fitted with a hydrogel material where possibility of lipid deposition is lower.<sup>20</sup>



**Figure 2.** Deposition of protein (a) is more common with hydrogel lenses compared to lipid (b) with SiHy lenses.

Code Part	Code Name	Explanation	
1	Prefix	The term used to designate a specific identity of monomers and crosslinking agents. The prefix is administered by the US Adopted Names Council (USAN), with use optional for all countries outside the USA.	
2	Stem	Two stems are available; filcon, for materials that contain $\geq 10\%$ water by mass (soft lenses), or focon, for materials that contain $< 10\%$ water by mass (rigid lenses).	
3	Series Suffix	Administered by the USAN Council, to denote changes in the original ratio of monomers of an exisiting contact lens material to make a new material. A capital letter is added after the stem; A is the original (first) formulation, B the second and so on.	
4	Group Suffix	Represented by Arabic numerals, indicating the range of water content and ionic content for filcon materials and the presence or absence of silicone/fluorine for focon materials.	
		Focon (Rigid) Lenses	Filcon (Soft) Lenses
	i	Materials not containing silicone or fluorine	$< 50\%$ water content, non-ionic
	ii	Materials containing silicone but not fluorine	$\geq 50\%$ water content, non-ionic
	iii	Materials containing silicone and fluorine	$< 50\%$ water content, ionic
	iv	Materials containing fluorine but not silicone	$\geq 50\%$ water content, ionic
	v		Enhanced oxygen permeable materials (e.g. SiHy)
	VA		Ionic
	VB		$\geq 50\%$ water content, non-ionic
	VC		$< 50\%$ water content, non-ionic
5	Dk	Oxygen permeability expressed in Dk units using mmHg	
6	Water Content	Water content, expressed as the percentage of water by weight in the material	
7	Modification code	The modification code, designated by a lower case ‘m’, denoting that the contact lens (from Group i-iv) has a modified surface which has characteristics different from the bulk of the material, e.g. plasma treatment. For Group v polymers, the modification code, designated by the lower case ‘c’ or ‘w’ denotes that the contact lens has a modified surface that has characteristics different to the bulk material. The lower case ‘c’ indicates the surface has been chemically modified (e.g. plasma or bonded surface modification). The lower case ‘w’ is used for materials having releasing or internal wetting agents.	

 Table 1. ISO System of Contact Lens Materials Classification in a seven-part code<sup>21</sup>



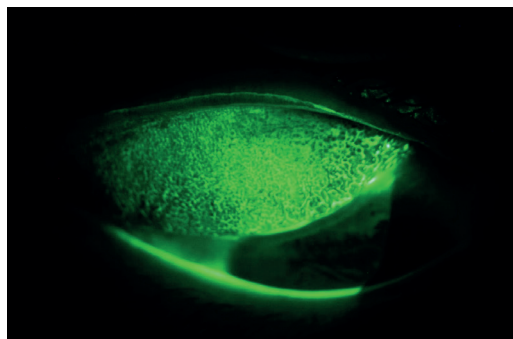
**Figure 3.** Superior Epithelial Arcuate Lesion, a mechanical complication associated with high modulus contact lenses.

## Modulus

When considering matching a contact lens to a patient, the modulus of the lens is one of the material properties that should be considered.

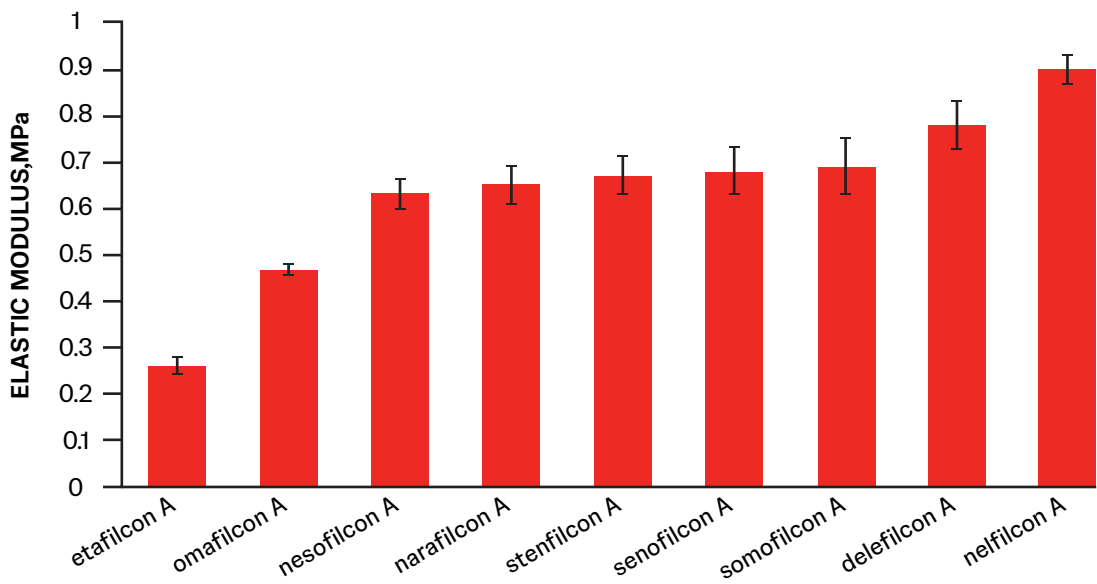
The modulus, a mechanical property of the lens, describes the tensile, or elastic, strength of the lens, and together with the lens thickness denotes how easily the lens will drape over the cornea.

Where the thickness of a lens remains constant, a reduction in the material modulus will create a lens which more easily drapes over the anterior surface. Whilst researching the effect of modulus on contact lens comfort is challenging due to confounding material factors, research

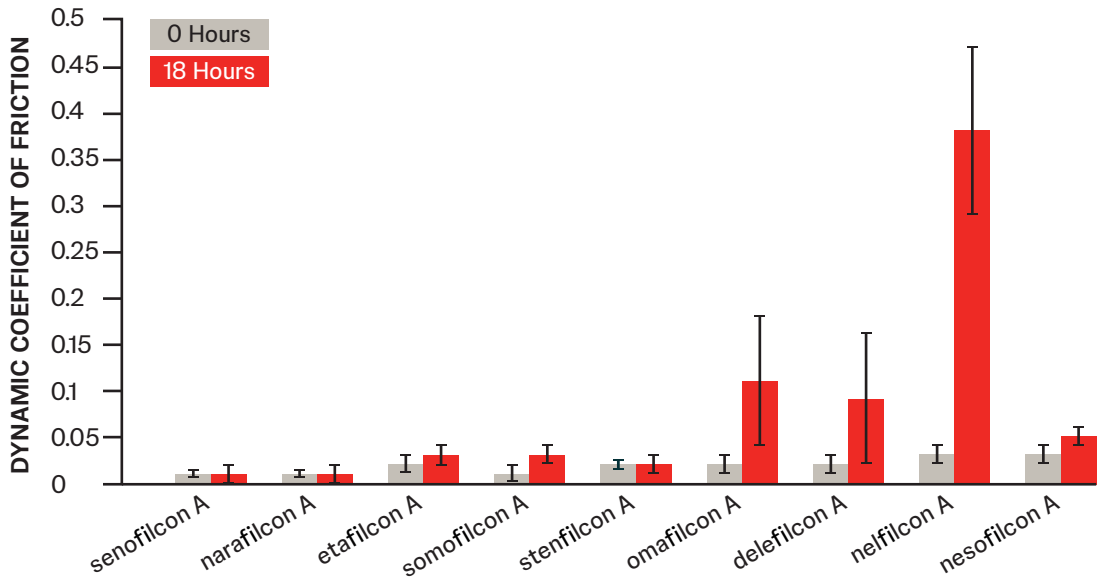


**Figure 4.** Contact lens papillary conjunctivitis (CLPC), a complication associated with high modulus contact lenses.

suggests that a negative correlation exists between modulus and patient comfort, that is, as modulus increases, patient reported comfort decreases.<sup>9</sup> This was evident when fitting patients into first generation SiHy lenses where the tensile modulus was significantly higher than typical hydrogel lenses and an adaptation time was needed.<sup>22</sup> Risk of mechanically induced ocular complications, such as Superior Epithelial Arcuate Lesion (SEAL) stain (Figure 3) or contact lens induced papillary conjunctivitis (CLPC) (Figure 4), was high in first generation SiHy lenses, a complication which is rarely seen with more modern SiHy materials where the modulus is much lower.<sup>23,24</sup> Whilst a lower modulus may have a beneficial impact on comfort, it can cause problems with handling, so could cause challenges for patients with poor dexterity. Without a standard method for calculation of modulus, the values reported through different studies cannot be directly compared. The moduli values of a range of daily disposable contact lenses are shown in Figure 5, as reported by Sulley et al, and measured using one technique.<sup>25</sup>



**Figure 5.** Mean modulus of elasticity values for a range of daily disposable contact lenses, investigated by Sulley et al.<sup>25</sup> Error bars represent the standard deviation of the mean.



**Figure 6.** Mean dynamic coefficient of friction for a range of daily disposable contact lens materials at 0 hours (grey bars) and 18 hours (blue bars) simulated wear.<sup>29,30</sup> Error bars represent the standard deviation of the mean.

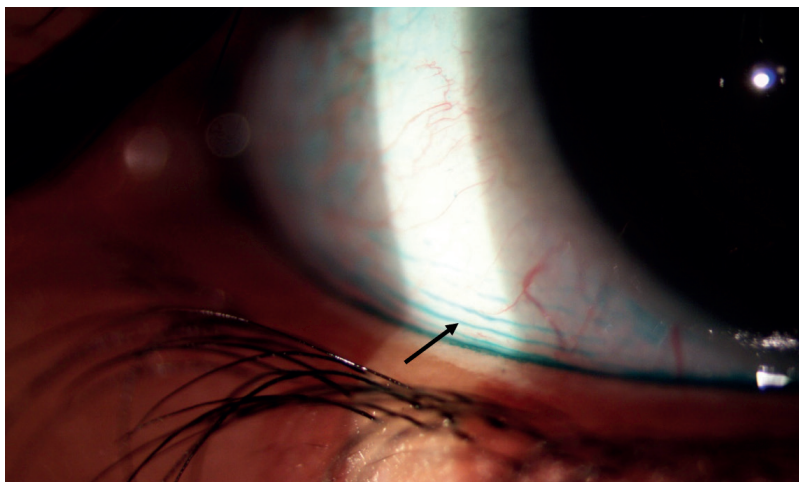
## Coefficient of Friction

The co-efficient of friction of the lens material is another vital material property to consider. Defined as the force required to move an object divided by its mass, it indicates the resistance the upper lid will experience when passing over the contact lens surface during blinking.<sup>18</sup> A low coefficient of friction (or high lubricity) relates to the ability of the eyelid to travel smoothly across the front surface of the contact lens without irritation.

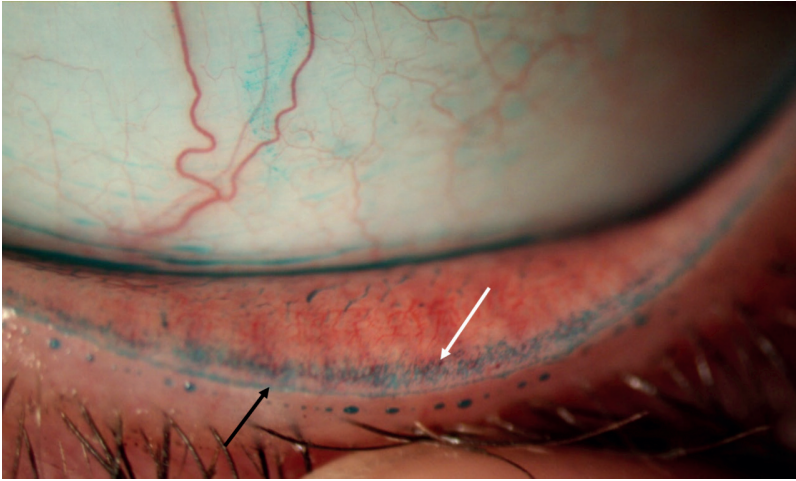
There is considerable evidence showing a strong correlation between coefficient of friction and mean comfort, where comfort increases as coefficient of friction decreases.<sup>9,26</sup>

No standard method has been developed or adopted by the industry to measure coefficient of friction, therefore contact lens companies may use different methods, yielding different results, making comparison between companies challenging. The dynamic coefficient of friction of several different contact lens materials, measured using the same technique, are shown in Figure 6.

Lid-parallel conjunctival folds (LIPCOF, Figure 7) and lid wiper epitheliopathy (LWE, Figure 8) are thought to be clinical indicators of friction and are associated with increased contact lens discomfort.<sup>27,28</sup> Examination of the ocular adnexa for signs LIPCOF and LWE is therefore advised during contact lens aftercare, with presence indicating potential need to move the patient into a more lubricious material.



**Figure 7.** Lid parallel conjunctival folds (LIPCOF), utilising Lissamine Green Dye to enhance visibility

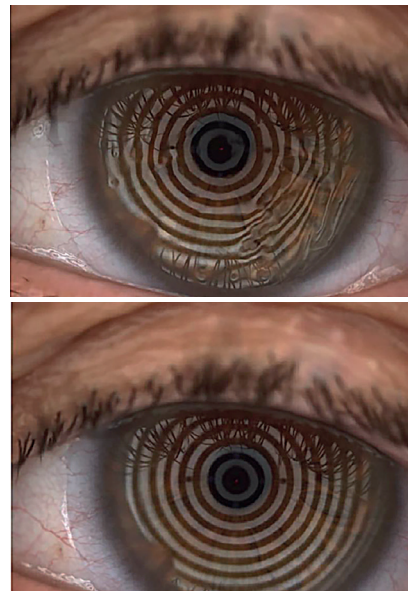


**Figure 8.** Lid wiper epitheliopathy (LWE) stained with Lissamine Green, with stain extending beyond Marx line.

## Wettability

The term ‘wettability’ describes the ability of the tear film to spread across and remain on a contact lens surface. The more wettable the contact lens material is, the better the tear film forms a cohesive film across the lens surface and does not dry or thin between blinks. Wettability is intrinsically linked to the coefficient of friction of a lens, in that as wettability reduces, coefficient of friction will increase. Traditionally, wettability has been assessed *in vitro* by measuring the contact angle of a sessile droplet of water or saline on the contact lens,<sup>31,32</sup> with a lower contact angle indicating better wetting. However, these *in vitro* measurements do not appear to show any relationship to on-eye clinical wetting, therefore are of limited value. *In vivo* wettability is perhaps more useful, though the link between *in vivo* wettability and comfort is yet to be fully understood. *In vivo* wettability has been assessed in research using a variety of simple techniques which can be translated into clinical practice, including measurement of pre-lens non-

invasive tear break up time (NITBUT)<sup>33,34</sup> and assessment using specular reflection.<sup>35</sup> Wettability can easily be assessed in practice using either of these techniques, as demonstrated in Figure 9.



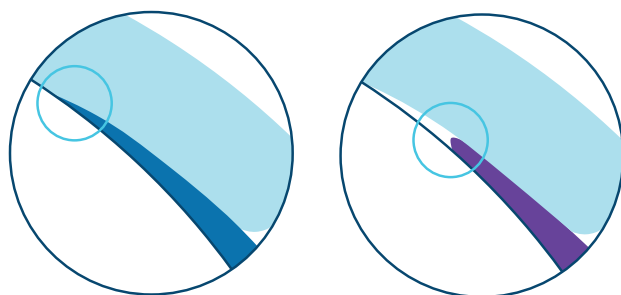
**Figure 9.** Assessment of prelens tear film break up time to provide information on contact lens wettability. Poor contact lens wetting is observed as distortion of placido rings (top), versus good wetting (bottom).

## Design

All contact lenses are designed differently, with a range of base curves, diameters and edge profiles available and it's recognised that the comfort of the lens can potentially be affected by these differing design features.<sup>22</sup> Certainly, the design of a lens can influence how the lens fits the patient and the comfort this brings. Eye care professionals who regularly fit soft contact lenses know to assess movement of the lens on eye<sup>36,37</sup> and corneal coverage<sup>38</sup> to determine the success of a fit, as both of these elements are believed to impact patient comfort. Likewise, with RGP fitting we look at how the lens edge interacts with the lids on blink to consider optimum wearer comfort. The edge profile of a lens is another design element that can have an impact on comfort and that does vary between lenses. The edge profile of a lens can be classified as either a tapered, edge-on-eye design, or as a rounded/block, edge-off-eye design (Figure 10). Studies have shown that lenses with a rounded, edge-off-eye design tend to provide poorer comfort

compared to lenses with tapered, edge-on-eye designs,<sup>39</sup> with the tapered designs providing a smoother transition between the conjunctiva and the lens surface,<sup>40</sup> with less movement.<sup>22</sup>

It is worth educating our patients to know that contact lens designs do vary. They will recognise and appreciate our clinically advised product recommendation even more if we are able to articulate to them the features and benefits of the specific lenses we are recommending. It makes sense to speak to contact lens manufacturers to obtain detailed design information regarding the products you routinely fit or have access to; having knowledge of the features and benefits of each design will again lead to more successful fitting and less potential for trial and error.



**Figure 10.** Diagrams showing a tapered, edge-on-eye design (left) and a rounded/block, edge-off-eye design (right). Images for illustrative purposes only.

## Modality

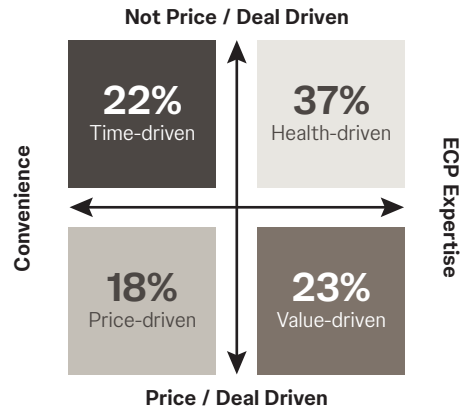
Modality, or frequency of lens replacement, also needs to be considered when selecting a lens for patients.

In the UK, practitioners now prescribe daily lenses 62% of the time,<sup>2</sup> with this shift likely driven by convenience and reduced risk of infection.<sup>41</sup>

Re-usable lenses typically offer a wider range of prescription parameters and may well be the only option for some patients, whilst also offering a more cost-effective solutions for patients who are price conscious. Whilst there is no strong evidence showing a direct link between the modality of a lens and comfort,<sup>22</sup> it is widely recognised that build-up of deposits on certain lens materials can lead to higher discomfort in wearers of some re-usable contact lens materials on the market. It should also be noted that comfort in monthly lenses is likely to reduce over the month,<sup>42</sup> so patient satisfaction should be carefully assessed at each aftercare to avoid the patient ceasing lens wear due to comfort issues.

## Cost

Once we have fully considered the patient's lifestyle needs, ocular health



**Figure 11.** Patient motivations to healthcare<sup>43</sup>

and the material properties of the lenses available, the appropriate lens should be recommended to the patient with clear reasons as to why this lens best meets their requirements. Price is shown in studies to be a secondary consideration<sup>43</sup> for most patients (Figure 11), especially when you consider cost per wear which often equates to a difference of just a few pence per day. However, once the patient is informed of the cost of the recommended lens, if it isn't suitable, then you can work together to see if a more cost-effective option is available and advise them of the loss of benefit that this contact lens option may deliver.

## Additional considerations for maximum success

Whilst it is paramount that eye care professionals stay fully up to date with new innovations in terms of design and material properties, it is the ability to apply these elements to each individual patient, that

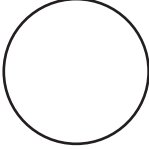
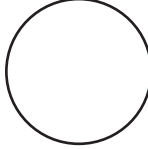
will ultimately lead to successful, long-term contact lens wear. If, for example, ocular examination revealed hyperaemia and papillae on lid eversion, and the patient reported suffering seasonal hayfever, we may wish to recommend daily disposable contact lenses. Daily disposable contact lenses would best serve the patient by minimising the build-up of both deposits and allergens, with research showing that hydrogel daily disposables provide both increased comfort and a protective element for such individuals.<sup>44,45</sup> Environmental factors and previous patient history should also be taken in to account when considering an appropriate contact lens recommendation. A patient with a history of infection would undoubtedly benefit from a daily disposable modality, where risk of infection is lower,<sup>46</sup> as would patients who smoke, due to the increased risk of corneal infiltrative events and microbial keratitis.<sup>47</sup>

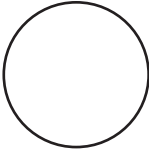
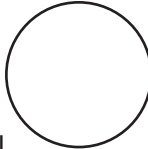
## Summary

In making tailored contact lens recommendations for patients, we must ensure we match our patients' needs and ocular health with the most appropriate contact lens, taking into account material properties and design in doing so. This personalised recommendation should then be clearly communicated with the patient, so that they are able to understand the importance of the contact lens fitting process - and indeed aftercare - in ensuring they have successful contact lens wear. The key to optimum recommendations for maximum success is to be knowledgeable about the products that are available, paired with ability to apply this knowledge when factors affecting suitability come in to play. Prescribing contact lenses is both a science and an art and can be very rewarding to both ourselves and our patients when we get it right.

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## Patient examples:

CONTACT LENS RECORD			
Name	David Wrack	Date	
Age	39	Last E/E date	
Occupation	IT Support	Rx	R -1.25 /-0.75 x 90
Current Lenses	Never worn	L	-1.50DS
		Keratometry	R 7.75@180, 7.90@90
		L	7.80@180, 7.85@90
Reason for Visit			
Wants CLs for social/sport only GH – Good, no meds or allergies OH - None Hobbies - Basketball, comp gaming			
Ocular Examination			
 <p>Right</p> <p>MGD G2</p> <p>Clear</p> <p>No stain with NaFl</p> <p>TBUT 5secs, streaky</p> <p>Tear prism 0.2mm</p>	<p>Lids / Lashes</p> <p>Conjunctiva</p> <p>Cornea Staining</p> <p>Tears</p>	<p>Left</p> <p>MGD G2</p> <p>Clear</p> <p>No stain with NaFl</p> <p>TBUT 6secs, streaky</p> <p>Tear prism 0.2mm</p> 	
KEY FACTORS			
<ul style="list-style-type: none"> <li>• MGD G2</li> <li>• Streaky tear film with NaFl</li> </ul>			
CONSIDER			
<ul style="list-style-type: none"> <li>• Fitting a hydrogel lens due to MGD and higher risk of deposition on a SiHy material</li> <li>• Treating MGD alongside contact lens fitting for efficiency and convenience for patient</li> <li>• Daily replacement modality to meet the need for occasional wear</li> <li>• Monocular astigmatism, therefore consider fitting with prism free optics</li> </ul>			

CONTACT LENS RECORD			
Name	Claire Wolds	Date	
Age	36	Last E/E date	
Occupation	Marketing Manager	Rx	R -9.50/-1.75 x 180
Current Lenses	Never worn		L -9.00/-1.50 x 5
		Keratometry	R 7.75@180, 7.40@90
			L 7.75@180, 7.45@90
Reason for Visit			
Wants CLs for full time wear, often at the office until 10pm. Air-conditioned environment using laptop/ipad 8+hours/day GH – Good, no meds or allergies OH - None Hobbies - Running			
Ocular Examination			
<div>Right</div> <div></div> <div>Clean / clear</div> <div>Clear</div> <div>No stain with Nafl</div> <div>TBUT 7secs</div> <div>Tear prism 0.2mm</div>	<div>Lids / Lashes</div> <div>Conjunctiva</div> <div>Cornea Staining</div> <div>Tears</div>	<div>Left</div> <div>Clean / clear</div> <div>Clear</div> <div>No stain with Nafl</div> <div>TBUT 8secs</div> <div>Tear prism 0.2mm</div> <div></div>	

KEY FACTORS
<ul style="list-style-type: none"><li>• High Rx</li><li>• Long wear time</li><li>• Potentially dry environment</li></ul>
CONSIDER
<ul style="list-style-type: none"><li>• Availability of Rx - re-usable soft/RGP ranges may accommodate more easily</li><li>• Spherical RGP as this may provide better vision whilst correcting astigmatism</li><li>• Fitting a SiHy lens due to the high Rx, and therefore lower Dk/t</li><li>• Material properties which will maintain wettability over the day in a dry environment</li></ul>

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