Introduction

The recent International Dry Eye WorkShop (DEWS) report defined dry eye as “a multifactorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance, and tear film instability with potential damage to the ocular surface. It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface”.¹

A healthy tear film nourishes, lubricates and protects the ocular surface. Any dysfunction of the main or accessory lacrimal glands, the meibomian glands, eyelids, cornea, conjunctiva or the connecting neural reflex arcs (the components which together form the lacrimal functional unit) causes tear film instability, symptoms of grittiness and irritation, ocular surface inflammation and ultimately signs of ocular surface damage and visual impairment. (Figure 1)²

The prevalence of dry eye has been reported as 9% of patients over 40 years of age, increasing to 15% of those over 65.³,⁴ Given the trend towards an aging population, the impact of dry eye on clinical eye care services seems likely to increase in years to come. In optometric practice, dry eye remains the primary reason for reduced wearing times and for contact lens failure with studies reporting around 50% prevalence of self-reported dry eye in contact lens wearers compared with 20% in non-contact lens wearers.⁵

Tear film examination poses significant challenges to the clinician as the tear film, in its natural or basal state is transparent, colourless and around only 7µl in volume and 7µm in thickness. The structure is carefully ordered, with a thin superficial lipid layer, a thicker intermediate aqueous phase, and an underlying mucous layer adjacent to the glycocalyx which coats the hydrophobic corneal epithelium. Recent research has disputed the existence of boundaries between the layers, with the aqueous and mucin layer more likely comprising a single phase, increasing in mucin concentration towards the epithelium. (Figure 2)⁶ For the purposes of clinical tear film examination as described in the current article, however, the assumption of a trilaminar structure is sufficient.
Normal, basal (unstimulated) tear flow rate is little over 1µl per minute with a turnover rate of approximately 16%, but this can increase over 100-fold on stimulation of reflex tearing. Such reflex tears, induced by invasive examination, differ in composition from basal tears, and as a consequence, can adversely affect the value of test results.

**DRY EYE AETIOLOGY**

Whilst dry eye patients report similar symptoms of dryness, grittiness, irritation and burning, the causes can be diverse. Following on from the 1995 report of the National Eye Institute / Industry Workshop on clinical trials in dry eye, the 2007 DEWS report acknowledges dry eye to be a multifactorial disease that can be classified into two main aetiological groups; aqueous deficient and evaporative dry eye. Aqueous deficient dry eye encompasses both Sjögren’s Syndrome and non-Sjögren’s causes of lacrimal gland dysfunction. Evaporative dry eye is divided into intrinsic and extrinsic causes, where intrinsic factors include meibomian gland dysfunction (MGD) and lid abnormalities, and extrinsic factors include contact lens wear and ocular surface disease such as allergy. (Figure 3)

Aqueous deficient dry eye occurs when the main or accessory lacrimal glands are compromised. Evaporative dry eye, on the other hand, occurs with defective meibomian glands, ocular surface irregularities, anomalies of lid structure or by the wearing of contact lenses.

Contact lenses induce dry eye through lipid layer disruption, tear film thinning, corneal desiccation as a consequence of lens dehydration, loss of lid conformity and/or blink alteration. All contact lenses disrupt tear film structure to some extent. While patients with healthy ocular surfaces and tear film prior to lens fitting may be able to withstand this disruption, those with a fragile tear system, are more inclined to report dry eye symptoms with contact lens wear.
Aqueous deficient and evaporative dry eye may co-exist but it is important to establish the likeliest cause by thorough assessment, in order to manage the dry eye most effectively.

**SUBJECTIVE ASSESSMENT OF DRY EYE**

Dry eye signs and symptoms often do not correlate well, but both are considered important in the diagnosis and management of dry eye, with the patient’s symptoms and history playing a critical role.\(^\text{10}\)

‘Dry’, ‘gritty’, ‘burning’, ‘irritated’ eyes and ‘blurry’ vision are symptoms often volunteered by dry eye patients, irrespective of the cause of the dry eye. However it is important to elicit additional information during the patient evaluation to help identify the cause of dry eye. This might include a history of contact lens wear, previous treatment for dry eye, frequency of symptoms, sensitivity to provocative stimuli, use of systemic medications, and co-morbidity.

Borderline dry eye can become manifest in the presence of cigarette smoke, or in highly air-conditioned or centrally heated environments. Chlorine used to disinfect swimming pools is another known provocative stimulus, as is dehydration after alcohol consumption.

Validated questionnaires allow rapid assessment (possibly even in the waiting room before the consultation) and they ensure consistency in the collection of relevant information. This may be particularly useful in larger practices where more than one individual provides clinical care. The patient responses to the questions are assigned values, allowing the severity of the dry eye to be scored and the efficacy of treatments to be monitored.

Two validated questionnaires, popular in the area of dry eye assessment are the McMonnies Dry eye Questionnaire\(^{11,12}\) (Figure 4 – See Appendix 1) and the Ocular Surface Disease Index (OSDI) © Allergan Inc.\(^{13}\) (Figure 5 – See Appendix 2).

**PRACTICAL ASSESSMENT**

Objective assessment of the tear film and ocular surface can be subdivided into four main areas. It is important, in a comprehensive examination for dry eye, to evaluate each of the areas, by incorporating at least one test from each.
1. TEAR FILM QUALITY

In both aqueous deficient and evaporative dry eye, tear film stability is reduced and tear film osmolarity is increased. Both of these measurements give useful information about overall tear film quality. Non-invasive stability tests, conducted without touching either the tear film or ocular surface, are more valid than traditional tests, since fluorescein has the potential to destabilise the tear film and reduce the measured value. In a non-invasive test, mires are reflected from the tear film. The mires from a number of ophthalmic instruments can be used, as illustrated in Table 1 below. The time that elapses between a blink and the first sign of a distortion or disruption of the mires, while the patient refrains from blinking, is the tear thinning time.

<table>
<thead>
<tr>
<th>Mires for non-invasive tear film stability measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutcliffe-style one-position, variable-doubling keratometer (e.g. Bausch &amp; Lomb keratometer)</td>
</tr>
<tr>
<td><img src="image" alt="Figure 6a" /> <img src="image" alt="Figure 6b" /></td>
</tr>
<tr>
<td>Tearscope Plus™ (Keeler Ltd., Berkshire, UK) with grid insert</td>
</tr>
<tr>
<td><img src="image" alt="Figure 6c" /> <img src="image" alt="Figure 6d" /></td>
</tr>
<tr>
<td>Placido-based topography device (e.g. Orbscan topographer, Bausch &amp; Lomb)</td>
</tr>
<tr>
<td><img src="image" alt="Figure 7" /></td>
</tr>
</tbody>
</table>

Table 1: Examples of reflected mires for non-invasive tear film stability measurement

Tear film stability measurements are inherently variable therefore an average of at least three values should be recorded for each eye. In general non-invasive stability values are longer than those measured with fluorescein. The cut-off for a healthy vs. dry eye is usually considered to be >20 seconds with a non-invasive test, compared with >10 seconds with the traditional fluorescein break-up time test."
For practitioners reluctant or unable to measure stability non-invasively, valid results can be obtained using fluorescein to aid visualisation of the tear film break-up. However, the amount of fluorescein sodium instilled must be minimised, ideally to around 1µl (Figure 8(a)). Research at the University of Auckland has shown that instilled volumes of 1µl do not cause the same destabilisation of the tear film that occurs with larger volumes (Figure 8(b)). It should be noted that volumes of fluid instilled from minims are typically around 25 – 40µl. A Wratten (yellow) barrier filter used in addition to the cobalt blue filter greatly improves visualisation of the fluorescence.

Tear film osmolarity is a well-established laboratory test of dry eye and indeed, is considered the single best predictive test in dry eye diagnosis. Recently, 'lab-on-a-chip' technology has enabled osmolarity measurement to reach the clinical setting (TearLab, Ocusense (Figure 9)). The disposable probe, touched onto the lower tear meniscus at the lid margin, collects a nanolitre sample of tears, which is analysed within seconds to provide the clinician with an osmolarity reading. Normal values lie around 304mOsm/kg while values over 320mOsm/kg indicate dry eye.

2. TEAR QUANTITY

The Schirmer test, the traditional test of tear volume, is extremely invasive and induces significant amounts of reflex tearing. The use of topical anaesthesia prior to the test will improve patient comfort during the test but is not recommended, as there remains a reduced, but variable, contribution to the test result from reflex tearing. The Schirmer test is therefore of limited value, particularly in assessing the borderline dry eye patients seen most often in optometric practice. Its benefit is limited primarily to confirming any function of the lacrimal gland in the most severe of dry eyes. (Figure 10)
A similar objective, but significantly less invasive test is the Phenol Red Thread (PRT) test where a thin cotton thread, impregnated with phenol red dye is hooked over the lateral third of the lower eyelid, in a manner similar to a Schirmer strip.\textsuperscript{19} (Figure 11) Absorption of the slightly alkaline tear fluid (pH 7.4) induces a colour change in the thread from yellow to red. The wetted length is measured after a period of only 15 seconds and values less than 10mm are considered indicative of aqueous insufficiency. An advantage of this objective test is that most patients are barely aware of the thread in their eye during this test, however, there remains debate over the precise contributions of tear flow and resident tear volume to the test result, given the limited measurement time.\textsuperscript{20}

Dilution tests can be used to provide an indication of tear flow. Rose bengal and fluorescein are instilled simultaneously into the lower fornix and the degree of dilution is observed after 5 minutes. If the meniscus has become yellow in colour, this suggests that tear turnover is healthy, but if it remains red, this indicates poor turnover. Dilution standards can be prepared to enable comparison to the tear meniscus colour and afford more quantitative results.\textsuperscript{21}

The tear function index (TFI) is a measure which combines the assessment of both tear secretion and tear drainage. The TFI is the Schirmer test value (in mm) divided by the tear clearance rate (which is the dilution expressed as a fraction). Researchers have demonstrated that a TFI value of less than 96 is suggestive of dry eye.\textsuperscript{22}

A significant amount of information about tear quantity can be gained simply from observing the heights of the upper and lower tear menisci with the slit-lamp biomicroscope. Heights of less than 0.2mm (which can be estimated using the calibrated slit beam height adjuster on the slit lamp) indicate reduced tear fluid quantity. Observation of the meniscus profile is also extremely helpful. A regular tear meniscus is typically observed in a healthy eye while a meniscus with a scalloped edge is often associated with a dry eye. (Figure 12a and 12b)
3. ASSESSMENT OF THE LIDS, LASHES AND LIPID LAYER

Observation of blinking, and a thorough slit-lamp examination of the eyelids and lashes, may highlight abnormalities associated with an evaporative dry eye. The pattern of blinking should be regular, approximately one blink every 5 – 6 seconds (or 10 – 12 blinks per minute). Increased blink rates may be seen in dry eye, decreased rates in neurotrophic conditions, and incomplete blinks are often observed in contact lens wearers. Blinking quality should be noted, surreptitiously during history-taking, as drawing attention to the observation of blinking can dramatically affect the blink pattern.

Blepharitis may be seborrheic (Figure 13) (associated with oily skin and concomitant scalp dandruff), staphylococcal (bacterial over-colonisation, usually *S. aureus*), or a combination of both. Signs of blepharitis include oily secretions, ‘dandruff’ or collarettes around the eyelashes, and missing or misdirected lashes. Patients may complain of photophobia, tearing, pain, redness, blurred vision and/or discharge. Blepharitis is often associated with a poor quality tear film, as evidenced by reduced tear film stability.

Healthy meibomian glands produce a clear lipid secretion, which forms the superficial tear film layer. In meibomian gland dysfunction (MGD), the lid margins are often inflamed and the gland orifices may be obstructed or reduced in number. (Figure 14) Such gland inspissation and drop out can be observed most clearly by transillumination, ideally with an infra-red viewing system.

Digital expression of the glands may release a cloudy, opaque, semi-solid (toothpaste-like), or even waxy substance depending on MGD severity. This expression should be graded on at least a five-point scale (Table 2). Associated features, which should be observed and recorded, include foam or debris in the tear film, lid thickening or notching, and entropion.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description of expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Clear fluid expressed</td>
</tr>
<tr>
<td>1</td>
<td>Greasy, slightly turbid fluid expressed</td>
</tr>
<tr>
<td>2</td>
<td>Opaque thickened expression</td>
</tr>
<tr>
<td>3</td>
<td>Semi-solid substance expressed</td>
</tr>
<tr>
<td>4</td>
<td>Waxy substance expressed / entirely blocked</td>
</tr>
</tbody>
</table>

Table 2: Clinical grading of meibomian gland expression
Additional information about lipid quantity and quality can be obtained with the aid of a wide-angle lighting system with a cold-cathode light source. One such system, which allows interferometric observation of the lipid layer in the clinical setting, is the Tearscope Plus™ (Keeler Ltd., Berkshire, UK). This instrument, used in conjunction with a non-illuminated slit lamp biomicroscope, enables estimation of the lipid layer thickness and quality, based upon the visible lipid pattern. (Figure 6c) The patterns, described by Guillon and Guillon in 1994, are shown in Table 3. Soft contact lenses tend to reduce lipid thickness by around 2 grades on average, therefore it is helpful if a patient has at least a flow/wave pattern, or preferably an amorphous or normal coloured fringe pattern (Figure 15) prior to contact lens fitting, to reduce the risk of dry eye developing in association with contact lens wear. Abnormal coloured fringe patterns are often seen in dry eye, particularly when related to eyelid disease. It has been shown that in patients with a lipid layer that is continuous across the tear film surface, irrespective of the lipid layer thickness, tear film evaporation is inhibited. Where the lipid layer is abnormal or not visible, tear film evaporation rate increases 4-fold. Patients with thinner lipid layers are required to blink more frequently to ensure maintenance of an intact lipid layer and prevent rapid tear film drying.

<table>
<thead>
<tr>
<th>Lipid layer pattern</th>
<th>Appearance</th>
<th>Estimated thickness (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>No lipid layer visible</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Open meshwork marmoreal</td>
<td>Indistinct, grey, marble-like appearance, frequently visible only by the post-blink movement</td>
<td>10 – 20</td>
</tr>
<tr>
<td>Closed meshwork marmoreal</td>
<td>Well-defined, grey, marble-like pattern with a tight meshwork</td>
<td>20 – 40</td>
</tr>
<tr>
<td>Flow</td>
<td>Constantly changing wave-like pattern</td>
<td>30 – 90</td>
</tr>
<tr>
<td>Amorphous</td>
<td>Blue-whitish appearance with no discernable features</td>
<td>80 – 90</td>
</tr>
<tr>
<td>Normal coloured fringes</td>
<td>Appearance of coloured interference fringes. Colour changes are gradual</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Abnormal coloured fringes</td>
<td>Discrete areas of highly variable coloured fringes, changing rapidly in colour over a small area.</td>
<td>Variable</td>
</tr>
</tbody>
</table>

Table 3: Description of the appearance and approximate thickness of the lipid layer patterns observed by specular reflection.
4. OCULAR SURFACE

Bulbar and palpebral conjunctival hyperaemia should be observed and graded against a standardised grading scale. A number of clinically acceptable grading scales are available. However, it is important that the same scale be adopted within a practice to optimise inter- and intra-observer consistency as it has been shown that the various grading scales cannot be used interchangeably. 

Lid parallel conjunctival folds (LIPCOF), bordering the posterior lid margin in the primary direction of gaze, may be observed in dry eye. (Figure 16) An accepted LIPCOF grading scale is shown in Table 4, together with the associated risk of dry eye.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Number of folds</th>
<th>Increased risk of dry eye. relative to grade 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>no folds</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>single fold, less than tear prism height</td>
<td>15 x</td>
</tr>
<tr>
<td>2</td>
<td>multiple folds, up to the tear prism height</td>
<td>63 x</td>
</tr>
<tr>
<td>3</td>
<td>multiple folds, higher than tear prism height</td>
<td>190 x</td>
</tr>
</tbody>
</table>

Table 4: Grading of lid parallel conjunctival folds (LIPCOF). 

Only after all non-invasive and minimally invasive examination of the ocular surface has been completed, should staining agents be utilised to facilitate visualisation of corneal and conjunctival cellular damage. Fluorescein, viewed optimally with a barrier filter, will highlight epithelial cell loss, while either rose Bengal or Lissamine green will highlight epithelial surfaces that have been deprived of mucin protein protection or which have exposed epithelial cell membranes. (Figure 17a and 17b) In dry eye, the inferior, interpalpebral areas of the cornea and conjunctiva most commonly show staining, varying in intensity from scattered spots to larger confluent areas. In the same eye, rose Bengal and Lissamine green will show a similar staining pattern, but Lissamine green causes significantly less irritation on instillation, even in a patient with dry eye.
If rose Bengal is used, every effort should be made to limit the volume instilled, in order to minimise discomfort for the patient. However, for equivalent ease of staining visualisation, it may be necessary to instil a larger volume of Lissamine green (> 10µl), and wait a little longer before viewing (optimally between 1 and 4 minutes post-instillation). The severity of staining should be scored, once again, against a grading scale, such as the CCLRU grading scale or Oxford grading scale. (Figure 18)  

Lid wiper epitheliopathy may be observed in symptomatic patients in the absence of routine clinical findings. The lid wiper is the portion of the marginal conjunctiva of the upper eyelid that wipes the ocular surface during blinking. Inadequate lubrication of the apposing epithelial surfaces, leading to increased friction, is believed to play a pivotal role in the development of this epitheliopathy. On everting the upper eyelid, the lid wiper zone is best viewed with a combination of rose Bengal and sequential fluorescein staining.

CONCLUSION

The preocular tear film is a remarkably complex structure and all aspects of its physiology are interdependent. Numerous methods for assessing the structure and properties of this highly dynamic film exist, many of which are appropriate for use in the clinical setting. In some cases, however, the testing procedure can influence the parameter under investigation by inducing reflex tearing. The aim in recent years has been to develop and promote the use of less invasive or ideally, non-invasive, methods for investigating the tear film. In this way, the condition of the film can be evaluated in as close to its ‘physiological’ state as possible. The clinician can reduce the contaminating effect of reflex tears by performing the tests in the same order each time, from the least invasive to the most invasive.

It is important to note that, due to the inter-related nature of the tear film components, no single clinical test is sufficiently sensitive or specific to diagnose dry eye and predict the most accurate management strategy. It is recommended that a combination of tests, with at least one from each of the sections 1 – 4 above be performed for each case of dry eye to best determine the aetiology, and thereby aid the practitioner in selecting the most appropriate management strategy. (Figure 19 – See Appendix 3)
Figure 1: The functional unit. (adapted from Stern ME et al, 1998)
Figure 2: Tear film structure. (adapted from Dilly, 1994)
Figure 3: Major aetiological classes of dry eye following the International Dry Eye WorkShop in 2007. (adapted from Ocul Surf 2007;5(2):75-92.)
Figure 4: McMonnies Dry Eye Questionnaire, adapted from McMonnies and Ho, 1986. Scores for each response are shown in superscript.
Figure 5: OSDI (Ocular Surface Disease Index) (© Allergan, Inc., Irvine CA, USA) with scoring instructions.
Figure 6: Keratometer mires (a) or Tearscope Plus™ (c), reflected from the tear film (b) and (d), respectively, facilitate measurement of tear thinning time.
Figure 7: Placido rings from Orbscan topographer provide suitable mires for reflection from the tear film and measurement of non-invasive tear film stability
Figure 8: Fluorescein used to aid visualisation of tear break up time, should be instilled sparingly (a) and not liberally (b) to prevent tear destabilisation and to obtain the most valid results.
Figure 9: The recently developed TearLab (Ocusense) for the clinical evaluation of tear film osmolarity. (courtesy of Birmingham Optical Group)
Figure 10: Schirmer test: a filter paper strip is hooked over the lateral 1/3 of the (unanaesthetised) lower eyelid, and the wetted length after 5 minutes recorded. Values of less than 5mm in this time indicate aqueous insufficiency.
Figure 11: Phenol Red Thread test: the cotton thread is hooked over the lateral 1/3 of the lower eyelid. A wetted length of less than 10mm in 15 seconds is suggestive of aqueous deficiency
Figure 12: Tear meniscus height: the meniscus should be regular and at least 0.2mm in height (a). An irregular meniscus with a scalloped edge is suggestive of dry eye (b).
Figure 13: Dry flakes (“dandruff”) around the eyelash bases in sebhorreic blepharitis (courtesy of Brian Tompkins)
Figure 14: Grade 3 meibomian gland dysfunction with associated thickened lid margins with surface telangiectasia. Expression has a semi-solid (toothpaste-like) consistency. (courtesy of Brian Tompkins)
Figure 15: Normal coloured fringe pattern observed with the Tearscope Plus™.
Figure 16: Lid parallel conjunctival folds (LIPCOF) in a patient with severe dry eye. (courtesy of Brian Tompkins)
Figure 17: Rose Bengal (a) and Lissamine green (b) ocular surface staining in two different dry eye patients, both viewed with white light. (Figure 15(b) courtesy of Brian Tompkins)
Figure 18: Grading of corneal and conjunctival staining; Oxford Scheme. This scale has been published with the recommendation that it be scanned and reproduced for clinical use. (From Bron et al; Cornea 2003; 22(7): 640 –50.)
Figure 19: Flowchart for the clinical assessment of the dry eye patient. At least one test should be performed from each group (1 to 4) to enable differentiation of the dry eye into aqueous deficient or evaporative dry eye and facilitate appropriate management of the patient.
References

Appendix 1 – Figure 4

McMonnies Dry Eye Questionnaire

Please answer the following by underlining the responses most appropriate to you:

Female / Male.
Age: less than 25 years\(^0\) / 25 - 45 years\(^{M1/F3}\) / more than 45 years\(^{M2/F6}\).
Currently wearing: no contact lenses / hard contact lenses / soft contact lenses.

1. Have you ever had drops prescribed or other treatment for dry eyes? Yes\(^6\) / No\(^0\) / Uncertain\(^0\)
3. How often do your eyes have these symptoms? (underline) Never\(^0\) / Sometimes\(^1\) / Often\(^4\) / Constantly\(^8\)
4. Are your eyes unusually sensitive to cigarette smoke, smog, air conditioning, or central heating? Yes\(^4\) / No\(^0\) / Sometimes\(^2\)
5. Do your eyes become very red and irritated when swimming? Not applicable\(^0\) / Yes\(^2\) / No\(^0\) / Sometimes\(^1\)
6. Are your eyes dry and irritated the day after drinking alcohol? Not applicable\(^0\) / Yes\(^4\) / No\(^0\) / Sometimes\(^2\)
7. Do you take (please underline) antihistamine tablets\(^2\) or use antihistamine eye drops\(^2\), diuretics\(^5\) (fluid tablets), sleeping tablets\(^1\), tranquillisers\(^1\), oral contraceptives\(^1\), medication for duodenal ulcer\(^1\), digestive problems\(^1\), high blood pressure\(^1\), antidepressants\(^1\) or ...? (Write in any medication you are taking that is not listed.)
8. Do you suffer from arthritis? Yes\(^2\) / No\(^0\) / Uncertain\(^0\)
9. Do you experience dryness of the nose, mouth, throat, chest or vagina? Never\(^0\) / Sometimes\(^1\) / Often\(^2\) / Constantly\(^4\)
10. Do you suffer from thyroid abnormality? Yes\(^2\) / No\(^0\) / Uncertain\(^0\)
11. Are you known to sleep with your eyes partly open? Yes\(^2\) / No\(^0\) / Sometimes\(^1\)
12. Do you have eye irritation as you wake from sleep? Yes\(^2\) / No\(^0\) / Sometimes\(^1\)

**Scores:** Normal (< 10) Marginal dry eye (10 - 20) Pathological dry eye (>20)
Appendix 2 – Figure 5

OCULAR SURFACE DISEASE INDEX©

Please answer the following questions by checking the box that best represents your answer.

Have you experienced any of the following during the last week:

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Half of the time</th>
<th>Some of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Eyes that are sensitive to light?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Eyes that feel gritty?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Painful or sore eyes?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Blurred vision?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Poor vision?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Have problems with your eyes limited you in performing any of the following during the last week:

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Half of the time</th>
<th>Some of the time</th>
<th>None of the time</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>Reading?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Driving at night?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Working with a computer or bank machine (ATM)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Watching TV?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Have your eyes felt uncomfortable in any of the following situations during the last week:

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Half of the time</th>
<th>Some of the time</th>
<th>None of the time</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>Windy conditions?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Places or areas with low humidity (very dry)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Areas that are air conditioned?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
OCULAR SURFACE DISEASE INDEX®

Scoring Instructions

**Item Scoring**
The total OSDI score is calculated based on the following formula:

\[
\text{OSDI} = \frac{\text{sum of severity for all questions answered} \times 100}{\text{total # of questions answered} \times 4}
\]

where the severity was graded on a scale of
- 0 = none of the time,
- 1 = some of the time,
- 2 = half of the time,
- 3 = most of the time,
- 4 = all of the time.

**Interpretation**
A score of 100 corresponds to complete disability (a response of “all of the time” to all questions answered), while a score of 0 corresponds to no disability (a response of “none of the time” to all questions answered). Therefore, change from baseline of –12.5 corresponds to an improvement by at least one category in half of the questions answered.

**Subscale Scoring**
Subscales scores are computed similarly with only the questions from each subscale used to generate its own score. Therefore, any subscales analyzed separately would also have a maximum possible score of 100.

The three subscales (vision-related function, ocular symptoms, and environmental triggers) are broken out as follows:

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision-Related Function</td>
<td>4, 5, 6, 7, 8, 9</td>
</tr>
<tr>
<td>Ocular Symptoms</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Environmental Triggers</td>
<td>10, 11, 12</td>
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