Supplement to
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Special issue NUTRITION

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DECEMBER 2011

- Age-related macular degeration
- Omega-3 and glaucoma
- Vitamin D
- Retinal health
- Zeaxanthin and lutein
- Dietary supplements

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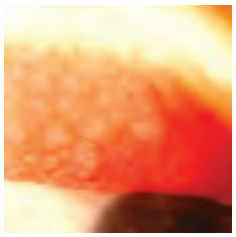

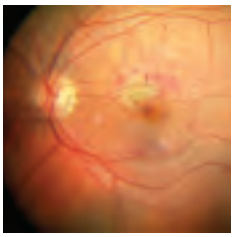

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COVER
Advanced AMD
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Retinal health through nutrition

'Research on nutrients found in the eye and its important structures, including the retina, is increasingly indicating eye health benefits from greater intake of these compounds.'

Dr Jeffrey Anshel
OD FAAO
President, Ocular Nutrition Society, USA

As eye-care practitioners, we tend to concentrate on eye health independent of other physical factors in our patients. Eyesight problems—refractive errors, binocular vision issues, dry eyes and so on—are often considered as just 'eyeball' problems and rarely considered in conjunction with the eye-body connection. The eyes are not only the window to the soul but are also a mirror of the body. We need to realise that nutritional aspects of health affect the eyes in numerous ways and most critically, the retina.

High-resolution central vision is achieved by the macula, the yellow-pigmented area near the centre of the retina. Its yellow colour comes from its content of the xanthophyll carotenoids lutein and zeaxanthin, and is responsible for the macula's ability to filter blue and ultraviolet (UV) light.

Lutein and zeaxanthin are derived from the diet. They are found in abundance in dark, leafy greens such as spinach, kale and collards, and moderately plentiful in vegetables such as capsicum, corn and broccoli. There is mounting evidence that increased consumption of lutein and zeaxanthin improves the macular pigment optical density (MPOD), indicating an important role in preserving vision and supporting retinal function.[1] Researchers from DSM Nutritional Products found the xanthophylls increased MPOD in different areas of the macula; lutein appears to be predominant in the fovea, while zeaxanthin covers a wider retinal area.[2]

Zeaxanthin has been shown to improve human colour vision, visual acuity and vision in low-light conditions in healthy adults.[3] Subjects took regular supplements of zeaxanthin, lutein, a combination of the two or placebo. Those who took lutein and zeaxanthin showed significant improvements in visual acuity and colour vision. These yellow carotenoids take a multifaceted approach to eye health, absorbing potentially harmful bands of spectral light, protecting against oxidative stress and damage, and helping to stymie inflammation.

These xanthophylls are the best filters of scattered light in the retina and help the eye recover fast from photostress, in addition to increasing tolerance for photostress or glare. A 2007 report supported the theory that higher MPOD correlated to shortened recovery time from photostress and improved resistance to glare.[4] A 2008 report followed, detailing how four to six months of supplementation with 12 mg/d of lutein and zeaxanthin for six months significantly increased MPOD and improved visual performance in glare for most subjects in the trial.[5] The researchers measured MPOD, glare disability and photostress recovery at baseline and then one, two, four and six months after starting supplementation.

MPOD increased in most subjects after one month of supplementation, with an average increase of 12 per cent at two months, 24 per cent at four months and 39 per cent at six months, relative to baseline values. The increases were seen across the board, regardless of MPOD at the start of the trial. A significant increase in veiling glare tolerance starting at the four-month mark, as well as a significant improvement in photostress recovery times (a decrease of five seconds after six months of supplementation) were noted.

The Blue Mountain Eye Study conducted in Australia and published in 2002 featured 3,654 adults 49 years and older examined initially, and 2,335 re-examined five years later for nutrient intakes and eye issues.[6] In 2008, using lens photographs taken during these examinations, the research team conducted a specific investigation of cataract incidence and intakes of vitamin, mineral and carotenoid antioxidants.[7] Higher antioxidant intakes had long-term protective associations against development of nuclear cataract, but not incident cortical or posterior subcapsular cataract.

Researchers from Scheie Eye Institute at the University of Pennsylvania, Philadelphia, investigated serum carotenoids, visual acuity, foveal sensitivity and retinal thickness in patients with either of these diseases as well as foveal fixation.[8] They found this group of patients has reduced foveal MPOD and significantly lower than normal serum concentration of lutein and zeaxanthin. However, oral lutein supplementation for six months significantly increased serum lutein in 91 per cent of patients and significantly augmented MPOD in 63 per cent of patients. Despite these improvements, there was no improvement to central vision in these patients after six months of lutein supplementation; longer-term studies were recommended.

The other good news is supplementation with lutein and zeaxanthin can provide some benefit to AMD patients. The Lutein Antioxidant Supplementation Trial (LAST), undertaken by the Department of Veterans'

Omega-3 fatty acids, anthocyanins, and the carotenoids lutein and zeaxanthin have secured their place in the eye-body relationship.

Affairs, Chicago, looked at 90 patients with atrophic AMD who received 10 mg of purified lutein, purified lutein plus a broad spectrum antioxidant, or placebo for 12 months.[9] Subjects in the lutein (10 mg) and lutein combination groups experienced improvements in visual parameters such as MPOD, visual acuity and contrast sensitivity, suggesting a potential role for lutein in treating AMD.

Follow-up research showed lutein supplementation increased MPOD, which declined in those not taking supplements.[10] AMD patients who did respond to lutein supplementation (either 10 mg lutein alone or 10 mg lutein combined with vitamins, minerals and antioxidants) had continuing increases in MPOD, even at 12 months of supplementation. The researchers concluded such an intervention could effectively re-establish the beneficial macular barrier.

Optometrists at Singapore University compared macular response to lutein supplementation in both AMD and non-AMD subjects, finding the disease is not linked to intestinal mal-absorption of the relevant macular carotenoids, and a diseased macula can accumulate and stabilise lutein and zeaxanthin.[11] Both AMD and non-AMD subjects took 20 mg/d lutein ester (supplying the equivalent of 10 mg/day free lutein) for 18 to 20 weeks; MPOD and plasma lutein were measured. The results showed similarly significant plasma lutein and MPOD increases in both groups.

While the original AREDS and Blue Mountain Eye Study both failed to find associations between antioxidants and AMD, the National Eye Institute (NEI) decided to add other nutrients, such as lutein and zeaxanthin, to the original AREDS formula for use in the AREDS 2 trial, which is still underway. They recruited 4,000 AMD patients who will receive for five years one of four treatments—10 mg/d of lutein plus 2 mg/d of zeaxanthin; 1 g/d of omega-3 fatty acids; a combination of lutein, zeaxanthin and omega-3s; or a placebo.

Omega-3s are included in AMD interventions due to a multi-mechanism benefit to eye health similar to lutein/zeaxanthin. In 2005, NEI researchers detailed the various roles played by docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) in the eye: protecting against light- and oxygen-induced oxidative damage; bolstering the health of retinal photoreceptor cell membranes; fighting inflammation and endothelial cell dysfunction; and down-regulating genes associated with vascular instability.[12]

Tufts University, Boston, researchers examining the formula and patients from AREDS found combining a low-glycemic index (GI) diet with the AREDS nutrients (including both DHA and EPA) had the greatest reduction in risk for prevalent drusen and advanced AMD.[13] Another analysis by the same team revealed a DHA-rich diet was associated with lower progression of early AMD, while combining a lower GI diet with increased DHA and EPA intake correlated with reduced progression of advanced AMD.[14]

Antioxidant and anti-inflammatory mechanisms appear effective in various areas of eye health and are the mechanisms behind the use of various flavonoid-rich herbal products in protecting the eye and visual abilities, as well as improving eye function.

Anthocyanins have been specifically studied in eye health botanicals. A review from The Horticulture and Food Research Institute of New Zealand Ltd, Auckland, highlighted the antioxidant and anti-inflammatory benefits of anthocyanins in detailing their ability to preserve capillary integrity and improve vision.[15]

Containing more than 15 different antioxidant anthocyanins, black currant (Ribis nigrum) has demonstrated some potential benefits to the eyes. Researchers at Meiji Seika Kaisha Ltd, Saitama, Japan, investigated the ocular distribution of black currant anthocyanins in animals after oral, intravenous and intraperitoneal administration.[16] They discovered intact forms of the anthocyanins could pass through the blood-aqueous barrier and blood-retinal barrier, and found these anthocyanins in the vitreous, lens and ocular tissues.[17] *In vitro* research conducted by this team further demonstrated the ability of black currant anthocyanins to regenerate rhodopsin, a purple pigment in the retina that is responsible for the formation of photoreceptors.[18]

In clinical research on healthy adults, black currant anthocyanins administered at three dose levels (12.5 mg, 20 mg and 50 mg) significantly improved eye adaptation to darkness and subjective symptoms of visual fatigue in a dose-dependent manner.[19] These flavanoids were also beneficial in the phototransduction transformation of rhodopsin in the eye on and after light absorption in another clinical trial.[20]

More definitive benefits were generated in research on bilberry and protecting the retina from oxidation. Columbia University, New York, *in vitro* research revealed bilberry anthocyanins could protect retinal epithelial cells against photo-oxidation and membrane permeability.[21] Additionally, bilberry anthocyanoside and its constituents (cyanidin, delphinidin and malvidin) were found to protect retinal ganglion cells from damage via antioxidant mechanisms, according to Japanese researchers.[22] Oral administration of bilberry extract showed a dose-dependent decrease in oxidative stress and ocular inflammation in a Chinese animal study of endotoxin-induced uveitis.[23]

Research on nutrients found in the eye and its important structures, including the retina, is increasingly indicating eye health benefits from greater intake of these compounds. The mechanisms appear to be antioxidative, anti-inflammatory and absorptive, offering protection from damage, stress and degeneration. Various eye diseases appear to improve with supplementation of such nutrients, and constituents of various botanicals can offer additional antioxidant and protective benefits to eye health. ■

References are available from j.megahan@optometrists.asn.au, subject: Anshel nutrition 2011

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Dietary supplements

the relationship with vision and eye health

Ocular side-effect	Associated herb or supplement
Accommodation, impaired	Henbane (*Hyoscyamus niger*)
	Kava kava (*Piper methysticum*)
	Scopolia (*Scopolia carniolica*)
Colour perception, disturbed	Lily-of-the-valley (*Convallaria majalis*)
	Strophanthus (*Strophanthus Kombé*)
Conjunctivitis	Chamomile (*Matricaria chamomilla*)
	Cypress spurge (*Euphorbia cyparissias*)
	Goa powder (*Andira araroba*)
	Propolis
	Psyllium (*Plantago ovata*)
	Psyllium seed (*Plantago afra*)
Conjunctivitis, allergic	German chamomile (*Matricaria chamomilla*)
Corneal defects	Cypress spurge (*Euphorbia cyparissias*)
Crystalline retinopathy	Canthaxanthine
Cystoid macular oedema	Niacin
Diplopia	Yellow jassamine (*Gelsemium sempervirens*)
Dry eyes	Niacin
Eyes, burning of	Dimethyl sulfoxide (DMSO)
Eye movements, abnormal	Yellow jassamine (*Gelsemium sempervirens*)
Eyelid swelling	Cypress spurge (*Euphorbia cyparissias*)
Eyelids, heavy	Yellow jassamine (*Gelsemium sempervirens*)
Eyes, irritation of	Black mustard (*Brassica nigra*)
Hyphaema	Ginkgo (*Ginkgo biloba*)
Intracranial hypertension	Vitamin A
Keratitis	Pyrethrum (*Chrysanthemum cinerarifolium*)
	Not Nice to Lice Shampoo

Ocular side-effect	Associated herb or supplement
Miosis	Herb Paris (*Paris quadrifolia*)
Mydriasis	5-Hydroxytryptophan
	Henbane (*Hyoscyamus niger*)
	Mandrake (*Mandragora officinarum*)
	Valerian (*Valeriana officinalis*)
	Datura (*Datura Wrightii*)
Photosensitivity	Chlorella
	Parsnip (*Pastinaca sativa*)
	Pimpinella (*Pimpinella major*)
	Rue (*Ruta graveolens*)
	St John's wort (*Hypericum perforatum*)
Phototoxicity	Bishop's weed (*Ammi visnaga*)
	Bitter orange (*Citrus aurantium*)
	Burning bush (*Dictamnus albus*)
	Celery (*Apium graveolens*)
	Contrayerva (*Dorstenia contrayerva*)
	Haronga (*Haronga madagascariensis*)
	Hogweed (*Heracleum sphondylium*)
	Lovage (*Levisticum officinale*)
	Masterwort (*Peucedanum ostruthium*)
	Parsnip (*Pastinaca sativa*)
	Tolu balsam (*Myroxylon balsamum*)
	Wafer ash (*Ptelea trifoliate*)
Retinal haemorrhage	Ginkgo (*Ginkgo biloba*)
Retrobulbar haemorrhage	Ginkgo (*Ginkgo biloba*)
Vision blurred	5-Hydroxytryptophan
	Huperzine A
	Niacin
Vision, temporary loss of	Mountain laurel (*Kalmia latifolia*)
Visual disturbances	Chaulmoogra (*Hydnocarpus species*)
	Horse chestnut (*Aesculus hippocastanum*)
	Wormseed (*Artemisia cina*)
	Licorice (*Glycyrrhiza glabra*)

Ocular side-effects associated with dietary supplements*

* Tables reprinted with permission: *Clinical Ocular Toxicology Drugs, Chemicals and Herbs*. Fraunfelder FW. Herbal medicines and dietary supplements: an overview. Philadelphia USA: Elsevier, 2008; pp 41-42.

Condition	Herb or supplement used
Conjunctivitis, unspecified	California peppertree (*Schinus molle*)
	Catechu (*Acacia catechu*)
	Cornflower (*Centaurea cyanus*)
	Eyebright (*Euphrasia officinalis*)
	Hibiscus (*Hibiscus sabdariffa*)
	Holly (*Ilex aquifolium*)
	Jequirity (*Abrus precatorius*)
	Lily-of-the-valley (*Convallaria majalis*)
	Marigold (*Calendula officinalis*)
	Turmeric (*Curcuma domestica*)
Eyes, infections of	Vinpocetine
Eye, inflammation of	Jack-in-the-pulpit (*Arisaema atrorubens*)
Night blindness	Guar gum (*Cyamopsis tetragonoloba*)
	Vitamin A
Night vision enhancer	Bilberry (*Vaccinium myrtillus*)
Nystagmus	Fish berry (*Anamirta cocculus*)
Ophthalmia	Asarum (*Asarum europaeum*)
	California peppertree (*Schinus molle*)
	Cape aloe (*Aloe ferox*)
	Chickweed (*Stellaria media*)
	Corydalis (*Corydalis cava*)
	Cornflower (*Centaurea cyanus*)
	Eyebright (*Euphrasia officinalis*)
	Jimson weed (*Datura stramonium*)
	Poison ivy (*Rhus toxicodendron*)

Condition	Herb or supplement used
Ophthalmic disorders	Black catnip (*Phyllanthus amarus*)
	Black nightshade (*Solanum nigrum*)
	Chinese motherwort (*Leonurus japonicus*)
	Clove (*Syzygium aromaticum*)
	Dusty miller (*Senecio bicolor*)
	Horseradish (*Armoracia rusticana*)
	Licorice (*Glycyrrhiza glabra*)
	Male fern (*Dryopteris filix-mas*)
	Northern prickly ash (*Zanthoxylum americanum*)
	Oleander (*Nerium oleander*)
	Pasque flower (*Pulsatilla pratensis*)
	Red sandalwood (*Pterocarpus santalinus*)
	Scurvy grass (*Cochlearia officinalis*)
	Stavesacre (*Delphinium staphisagria*)
Retinopathy, diabetic	Bilberry (*Vaccinium myrtillus*)
Styles	Eyebright (*Euphrasia officinalis*)
Uveitis, chronic anterior	Curcuminoids
Visual disturbances	Nutmeg (*Myristica fragrans*)

Dietary supplements used to treat eye disease* ■

Diet and dry eye

Researchers have offered further confirmation that polyunsaturated fatty acids found in the diet may be linked to dry eye symptoms.

Their study in France evaluated whether polyunsaturated fatty acids affect the lipid composition of conjunctival epithelium and whether these changes affect prostaglandin production after inflammatory stimulation.

Human cells were treated with a combination of two polyunsaturated fatty acids: GLA and EPA. The levels of anti-inflammatory and inflammatory prostaglandins were measured after the treated cells were stimulated with interferon-gamma for 48 hours.

Two types of prostaglandins were assessed: PGE1 and PGE2; PGE1 has anti-inflammatory properties, while PGE2 is a key mediator of inflammation.

The results showed that the combination of GLA and EPA did not change the production of PGE1 but decreased the production of PGE2. This suggests that modulation of fatty acid composition and prostaglandin production by polyunsaturated fatty acids is possible in the conjunctival epithelium, which is an important site of inflammation in dry eye syndrome

Graefe Arch Clin Exp Ophthalmol. Published online 6 September 2011.

Urine test for AMD

Researchers at the Centre for Eye Research Australia have discovered urine could be a potential source of biomarkers for age-related macular degeneration (AMD).

After researchers began to view AMD as a chronic low-grade inflammatory disease and started looking at the blood and urine for potential biomarkers, two urinary proteins were found to be associated with AMD.

Patients with early AMD were found to have significantly increased levels of the transforming growth factor-beta protein, while patients with both the early and late stages of AMD were found to have significantly increased levels of the protein macrophage chemo-attractant protein-1.

The discovery of these biomarkers could lead to the development of a simple urine test for the early detection of AMD.

Nutritional supplements for AMD

'Strong evidence for a beneficial effect of nutritional supplements in AMD has come from the Age-Related Eye Disease Study.'

Dr Simon Chen
MBBS BSc FRCOphth
FRANZCO
Retinal specialist
Vision Eye Institute, Sydney

Age-related macular degeneration (AMD) is the leading cause of blindness in elderly persons in Australia and is set to become a major public health problem as the aged population grows. New therapies such as anti-vascular endothelial growth factor agents offer the prospect of restoring vision in many patients with the exudative (wet) form of AMD. However, these treatments are ineffective against the non-exudative (dry) form of AMD that represents 90 per cent of all cases of AMD.

The pathogenesis of AMD is incompletely understood but there is increasing evidence that oxidative stress plays an important role. Numerous antioxidant supplements are touted to have beneficial effects on the development or progression of AMD based on the results of observational epidemiologic studies. Practitioners should remember that such studies are often prone to multiple confounding factors and that only large, controlled, randomised trials can account for unknown confounders.

Age-Related Eye Disease Study

Strong evidence for a beneficial effect of nutritional supplements in AMD has come from the Age-Related Eye Disease Study (AREDS).[1] This was a multicentre, randomised, placebo-controlled trial involving 3,640 participants. It evaluated the role of nutritional supplements in preventing the progression of AMD.

AREDS demonstrated that in persons with intermediate AMD, a daily combination of zinc (80 mg), copper (2 mg), and the antioxidants vitamin C (500 mg), vitamin E (400 IU) and beta-carotene (2500 IU) reduced the relative risk of progression to advanced AMD by 25 per cent at five years and reduced the risk of visual loss. The absolute risk reduction in progression to advanced AMD was only eight per cent, from 28 per cent in the placebo group compared to 20 per cent in the group taking the AREDS formula.

Nutritional supplements and AMD

Carotenoids

These are pigments including beta carotene, lutein and zeaxanthin that occur in plants. Beta-carotene is converted by the body into vitamin A and has antioxidative actions. Lutein and zeaxanthin are components of the yellow pigment found in the macula where they absorb ultraviolet radiation and are thought to prevent oxidative stress. Epidemiologic data suggests that increased dietary intake of these nutrients is associated with a decreased risk of AMD.[2]

Zinc

An early randomised, placebo-controlled, clinical trial demonstrated that daily zinc supplementation at a dose of 80 mg reduced the risk of vision loss in patients with AMD.[3] This finding was subsequently supported by the AREDS. The mechanism of the beneficial effect of zinc is unknown. Because high dose zinc can cause copper deficient-anaemia, copper was included in the AREDS formulation to prevent this.

Vitamins C and E

These vitamins are known to have antioxidative effects. A meta-analysis of vitamin E concluded that doses of 400 IU or higher were associated with an increased risk of death. However, criticisms have been raised about the analysis and other studies have suggested that the dose of vitamin E used in the AREDS formulation is safe.[4]

Omega-3 polyunsaturated fatty acids

High levels of the omega-3 fatty acids such as docosahexaenoic acid are present in retinal photoreceptors and are important in retinal functioning due to their biophysical effects on cell membranes. Epidemiologic data suggests that they are associated with a decreased risk of AMD. They are found in foods such as fish, shellfish, some nuts and various plant oils.

Risks of high-dose nutritional supplements

The AREDS formulation includes doses of nutrients up to 15 times the normal recommended daily intake. Although the AREDS supplements are generally safe, the risks include:

- Increased risk of lung cancer in patients who smoke, associated with the use of beta-carotene. The reason for this is unknown. Lutein and zeaxanthin are recommended as alternative carotenoids suitable for use in smokers.
- Yellow skin due to beta-carotene use.
- Genitourinary problems. Zinc has been associated with genitourinary problems, most commonly enlargement of the prostate. Vitamin C has been linked to kidney stone formation.
- Copper deficient anaemia can occur with zinc use. This can be prevented by copper supplementation.
- Decrease in HDL cholesterol or an increase in LDL cholesterol associated with zinc

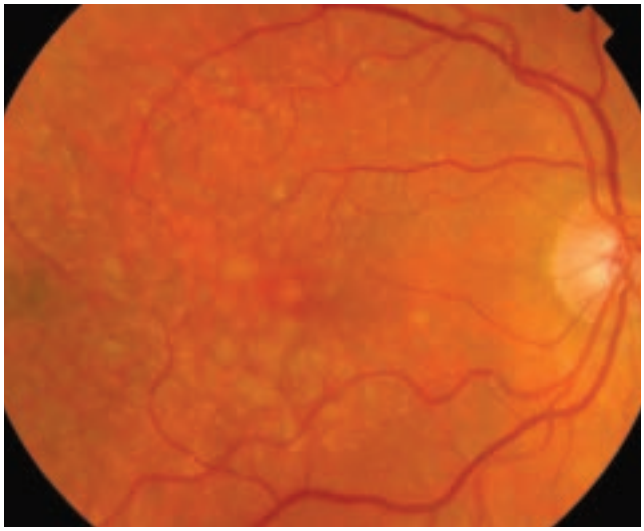

Figure 1. Intermediate AMD: extensive intermediate and large-sized drusen. This patient would be advised to take the AREDS formulation of high dose antioxidants and zinc to reduce the risk of vision loss.

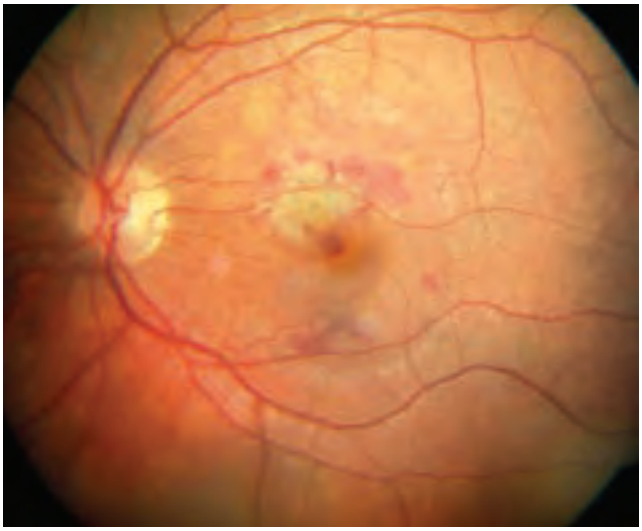

Figure 2. Advanced AMD: macular haemorrhages and macular oedema

- A relationship between zinc and Alzheimer's disease has been reported, although no decrease in cognitive functioning was found in the AREDS participants taking zinc. Nutritional experts continue to raise concerns about the use of zinc in such high doses.
- Vitamin E and omega-3 fatty acids can interact with warfarin, leading to an increase in the blood clotting time. Patients on anticoagulants should seek advice from their medical practitioner before starting AREDS or omega-3 fatty acid supplements.

Who should take nutritional supplements for AMD?

People who do not have AMD and even those with only early AMD have a low risk of developing advanced AMD (less than two per cent over five years). As AREDS supplements have not been shown to prevent the progression of early AMD, there is no evidence to recommend them for individuals with no AMD or only early AMD. Similarly, there is no evidence that patients without AMD but with a family history of the condition, will benefit from taking the supplements.

Appropriate measures to reduce the risk of developing AMD are to eat a diet rich in oily fish, fruits and vegetables (especially dark green leafy ones such as spinach), exercise regularly and avoid smoking. Regular eye examinations are important for early detection of AMD as symptoms are not always present in the initial stages of the disease. An individual's risk of developing AMD can be determined by the presence of ophthalmoscopic features including certain subtypes of drusen and retinal changes in the macula.

For persons with an intermediate or high risk of developing advanced AMD, AREDS supplements are recommended to reduce the risk of visual loss. The high levels of vitamins and minerals found in the AREDS formulation are difficult to achieve from diet alone and are not found in typical multivitamin preparations.

Bausch and Lomb holds the worldwide patent for the AREDS formulation, which is available commercially in the preparation Ocuvite Preservision. There are numerous other nutritional supplements marketed for people with AMD (for example, Macuvision) and recommended by eye-care practitioners but none of these formulations exactly matches the AREDS formula and so the positive results of the AREDS trial cannot necessarily be extrapolated and applied to these other supplements. Many of the newer formulations use lutein or zeaxanthin as a substitute for beta carotene due to concerns regarding the risk of lung cancer in smokers.

The AREDS 2 is a randomised trial in progress and designed to assess the effects on AMD progression of lutein, zeaxanthin and omega-3 fatty acids. It will also evaluate whether the AREDS formula is effective without beta carotene and whether the dose of zinc can be reduced without reducing its efficacy. The results will be available in 2013.

Conclusion

With the discovery that a specific combination of high-dose antioxidants including vitamins C and E, beta-carotene, zinc and copper can reduce the relative risk of developing advanced AMD by 25 per cent, patients with AMD can take a proactive approach to preserving their vision. Other nutrients such as omega-3 fatty acids, zeaxanthin and lutein may also be protective against AMD. Many of these nutrients are used in higher doses than those found in ordinary multivitamin supplements and are not suitable for everyone because of the potential side-effects. The risks and benefits of using high dose antioxidants should be carefully considered. Any person with AMD should discuss these issues with their eye-care practitioner.

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Omega-3 and glaucoma

'Currently, the only method available for glaucoma treatment is IOP lowering via pharmacological or surgical means. Our recent studies indicate that diet may also be a modifiable risk factor for glaucoma.'

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Dr Bang V Bui
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Why omega-3?

Omega-3 is the new buzz phrase in nutritional supplements and has inundated our television advertising and supermarket shelves. You can find it in tablets for heart disease, for children with ADHD, incorporated into your milk and even in your pet food. How much of this is media hyperbole and how much is based on fact?

Several large-scale clinical studies have shown beneficial effects of omega-3 consumption for heart disease[1-3] and infant development.[4,5] Given this evidence, organisations such as the National Heart Foundation and the Early Nutrition Academy recommend omega-3 consumption for these conditions. In other areas such as dementia and ADHD, the evidence is not as clear-cut and awaits further study. In terms of the eye, early research indicates that omega-3 could play some role in the treatment of dry eye, AMD and diabetic retinopathy, although more studies need to be conducted to confirm these findings (see SanGiovanni and colleagues[6] for a comprehensive review).

Why has there been sudden interest in omega-3? Part of the answer lies in the recognition that our dietary habits have changed dramatically over the past 100 years.[7] The modern Western diet is low in omega-3 for two reasons. The first is the decreased intake in foods rich in omega-3 fats such as oily fish, green leafy vegetables and certain nuts. The second is a recent over-consumption of omega-6 fats that are competitive against omega-3 fats as they share the same desaturase and elongase

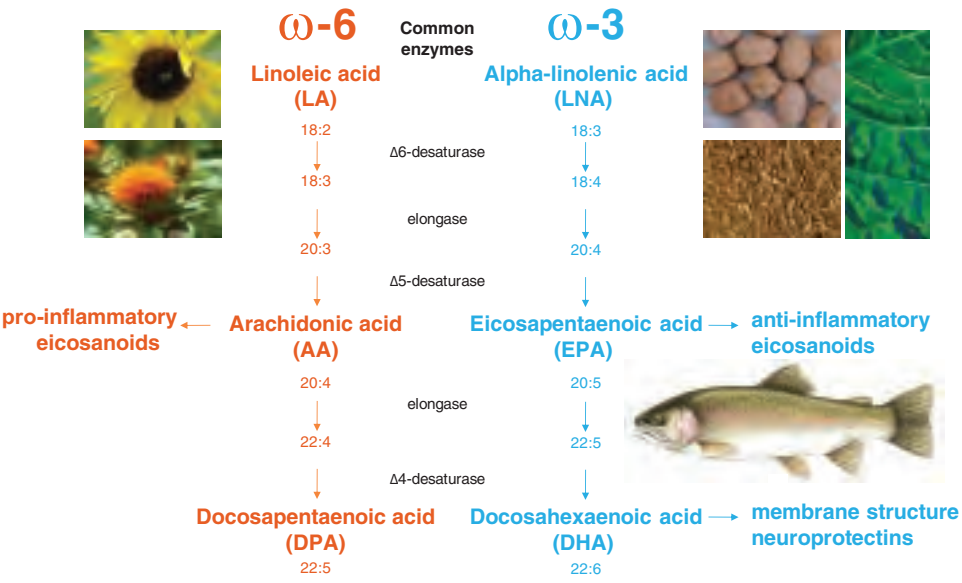

Figure 1. Types of omega-3 and omega-6 fatty acids
These essential fatty acids compete for common enzymes; therefore, the balance in dietary intake of the two determines the amount of omega-3 available in the body. Foods rich in omega-6 are sunflower and safflower seeds and oils. Foods high in omega-3 are certain nuts, linseed, green leafy vegetables and fish that are particularly high in the long chain omega-3s such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

enzymes (Figure 1). Over-consumption of omega-6 in the modern Western diet results from increased consumption of foods such as deep-fried fast foods that are cooked in omega-6 oils and from livestock that have been fed omega-6 grains (that is, sunflower and safflower oils). Although both omega-6 and omega-3 are important for health, the modern diet has tipped the scales away from omega-3.

Types of omegas

There are many different types of omega-3 and omega-6 (Figure 1). These play different roles in the body and vary biochemically in their double bond characteristics and number of carbon atoms.

In general, the omega-3 fats (eicosapentaenoic acid, EPA) give rise to anti-inflammatory metabolites, whereas the omega-6 fats (arachidonic acid, AA) tend to produce pro-inflammatory metabolites. Docosahexaenoic acid or DHA is the most 'famous' omega-3 fatty acid and extensive research has been conducted on it.

One of the mechanisms through which DHA works involves its incorporation into the phospholipid bilayer, which surrounds all living cells. Here it makes this cellular envelope more 'fluid', allowing the proteins embedded within it to move more easily and improve their functional capabilities.[6] In addition, docoshexaenoic acid is a precursor of the docosanoids, which are a group of substances that can modulate cell death, thereby having neuroprotective properties.[8]

Omega-3 and glaucoma: the evidence

Given the omega-3 deficiency in modern Western diets and their proven beneficial effects in other diseases, could omega-3 be beneficial for glaucoma, the leading cause of irreversible blindness?[9] Recent rodent studies from our laboratory indicate that omega-3 could modify glaucoma risk in two ways. Rodents fed with diets sufficient in omega-3 had intraocular pressures (IOP) 23 per cent lower than did rodents on diets deficient in omega-3[10] (Figure 2A).

The magnitude of this IOP drop is similar to that found with commonly-used glaucoma medications. This finding is in agreement with epidemiological studies that show divergent IOPs in Western populations (omega-3 deficient and high IOP) versus Japanese populations (omega-3 sufficient and low IOP).[11]

The IOP reduction found in our omega-3 sufficient animals occurs via an improvement in aqueous outflow facility (Figure 2B), which is likely to be driven by eicosanoids (oxygenated metabolites of omega-3 and omega-6 fatty acids).[10] Omega-3 sufficient rats show greater capacity to buffer IOP following challenge with small volumes of fluid, indicating that they would be less prone to damaging IOP spikes (Figure 2C).[10] In addition to IOP lowering, our studies show that omega-3 optimises ganglion cell function. This provides a greater functional reserve to protect ganglion cells against intraocular pressure challenges[12] (Figure 3).

In summary, omega-3s have beneficial effects on two of the most important aspects of glaucoma. First, it reduces IOP, the most well-documented risk factor for glaucoma and second, it reduces ganglion cell loss, the hallmark of glaucoma. This two-pronged benefit of omega-3 has advantages over currently-used medications that target only IOP. Further human trials are needed to clarify the impact of this important discovery made in rats but the implications are very exciting.

Omega-3 and glaucoma: a possible intervention

The benefits of omega-3 for the eye open up the possibility that we could use alternative methods to treat or protect against glaucoma. Currently, the only method available for glaucoma treatment is IOP lowering via pharmacological or surgical means. Our recent studies indicate that diet may also be a modifiable risk factor for glaucoma. The concept of using diet as a modifiable risk factor for disease is not new; this is the first

Continued page 10

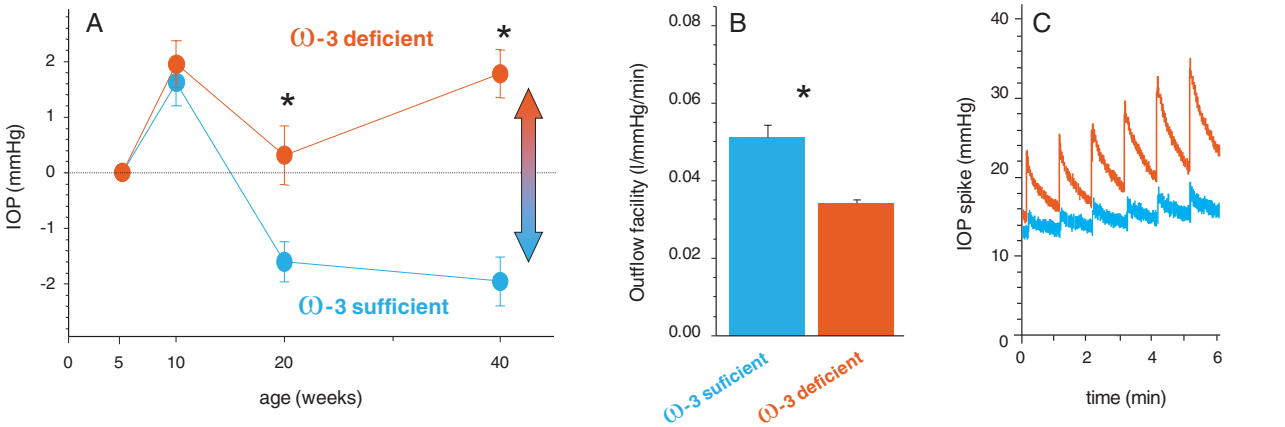

Figure 2. Omega-3 decreases intraocular pressure in a rodent model

A. Animals fed omega-3 sufficient diets experienced decreasing IOP with age in contrast to those fed omega-3 deficient diets, which showed increasing IOP. This resulted in a 23 per cent reduction in IOP at 40 weeks of age, that is, a 'middle-aged' rat

B. This reduction in IOP was associated with an improvement in aqueous outflow facility

C. Infusion of 1µl boluses of fluid into the eye every minute results in an IOP spike with subsequent drop in IOP; this method illustrates that the omega-3 sufficient group (blue) shows greater capacity than the omega-3 deficient group (orange) to buffer IOP spikes

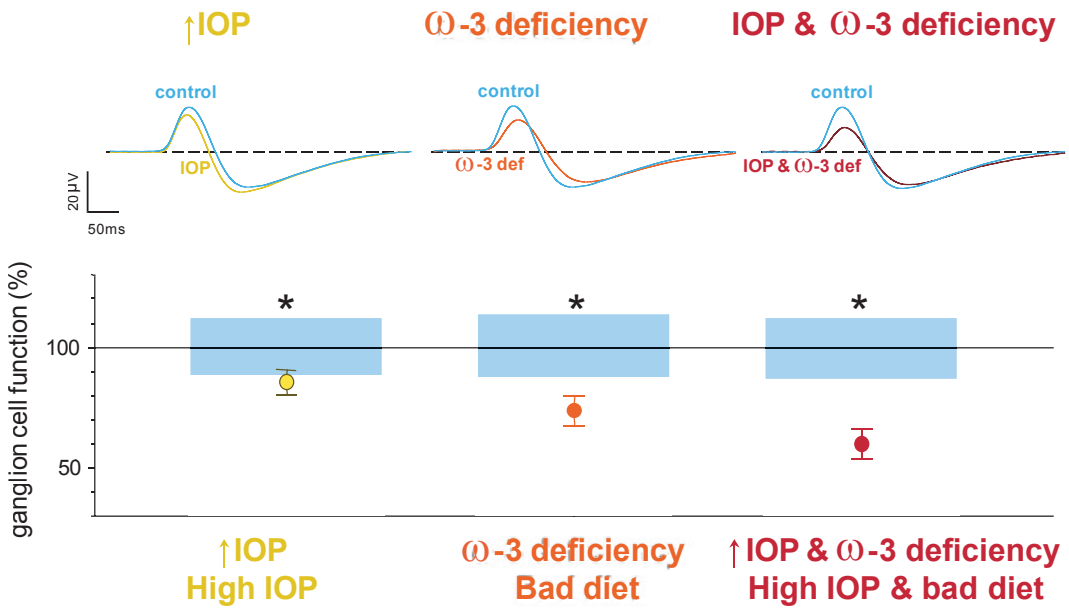

Figure 3. Omega-3 deficiency and elevated IOP are cumulative risk factors
Ganglion cell function drops in the presence of IOP challenge and in rats eating omega-3 deficient diets. The greatest loss is seen in groups fed the bad (omega-3 deficient) diet when under IOP stress. Omega-3 improves ganglion cell function, thus providing a greater functional reserve against intraocular pressure challenges.

Omega-3 and glaucoma

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line of treatment in many systemic diseases, including those at risk of heart disease and in diabetes.

As more studies need to evaluate the beneficial effects of omega-3 on human glaucoma, it cannot be relied on as a stand-alone therapy at this stage. Nevertheless, as omega-3 has many other health benefits (especially in cardiovascular function) and minimal side-effects, we have the opportunity to be proactive and employ these new findings with our glaucoma patients. In particular, omega-3 supplements may be useful as a preventative therapy for patients at risk of getting this disease, such as those with a positive family history, ocular hypertension or thin corneas. Furthermore, omega-3 could be used as an adjunctive therapy for those currently on conventional glaucoma treatment.

Benefits of Omega-3 on glaucoma

Reduces intraocular pressure by improving aqueous outflow and thus reduces pressure spiking tendency	Improves ganglion cell function increasing functional reserve against intraocular pressure insult

Who to advise

Preventative therapy for at risk patients, i.e. positive family ocular history, ocular hypertension	Adjunct therapy to conventional glaucoma treatment

How much to advise

	Maintenance for normal health	Therapeutic e.g. cardiovascular disease
Omega-3 dose	500 mg long chain omega-3 (i.e. EPA and DHA)/day	1000 mg long chain omega-3 (i.e. EPA and DHA)/day
Dietary recommendation	1-2 oily fish meals/week	2-3 oily fish meals/week
Supplement recommendation	2 fish oil capsules (2000 mg)/day ± 1 flax oil capsule (1000 mg)/day	4 fish oil capsules/day

Note • sufficient antioxidants (vitamin E) should be taken in conjunction
• it takes time for dietary effects to become apparent (6-24 weeks)

Table 1. Summary of advice for omega-3 and glaucoma

Omega-3: how much and from where?

How much omega-3 should our patients take and where can they get it? For maintenance doses it is recommended that we consume 500 mg of long-chain omega-3 (EPA and DHA) in our diets each day. This equates to one or two oily fish meals (salmon, sardines, herring) per week or two fish oil capsules (2000 mg) and about one flax oil capsule (1000 mg) per day (Table 1).

More studies are required to determine the exact dose that will help glaucoma suspects and patients but therapeutic doses of omega-3 for other diseases are higher. For example, 1000 mg of EPA/DHA per day is recommended for those with heart disease,[13] which is equivalent to four fish oil capsules a day.

Health organisations including the CSIRO advise that it is preferential to consume omega-3 from natural food sources, such as oily fish. Some caution should be exercised against consuming large quantities of predatory fish (shark, swordfish)[14] particularly for pregnant or nursing women, due to excess mercury levels. Nevertheless, after extensive review, researchers from Harvard's School of Public Health in the *Journal of the American Medical Association*[15] reported that the benefits of fish intake generally far outweigh the potential risks of heavy metal intoxication. Fish oil supplements undergo processing that eliminates these toxins, making them a relatively safe source of omega-3 substrates. Note that when consuming omega-3, sufficient antioxidants (vitamin E) should also be consumed in conjunction. Also keep in mind that the beneficial effects of omega-3 take a while to become apparent, about six to 24 weeks, so encourage your patients to persevere and remind them that it takes time to reverse a life-long deficiency.

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Doubt cast over vitamin D and AMD link

Doubts have been raised over the association between reduced vitamin D levels and the prevalence of age-related macular degeneration (AMD).

A cross-sectional study surveyed the patient records of 9,169 members of one of the largest Israeli health maintenance organisations. All patients were aged 60 years or older; 1,045 were diagnosed as having AMD, while 8,124 did not have AMD. The patients' vitamin D levels were monitored as part of routine examinations between 2000 and 2008.

The research revealed a mean ± SD level of 25-OH vitamin D of 24.1 ± 9.41 ng/ml for AMD patients and 24.13 ± 9.50 ng/ml for non-AMD patients. Vitamin D levels were less than 16 ng/ml in 33.6 per cent of AMD patients and 32.86 per cent of the controls, and the proportions of examinations in which the vitamin D level was greater than 74 ng/ml were 0.19 and 0.14 per cent, respectively.

No association was detected between vitamin D levels and AMD in the study, leading researchers to reconsider the connection between reduced levels of vitamin D and AMD.

Eye 2011; 25: 9: 1122–1129

Energy drinks reduce IOP

Energy drinks such as Red Bull significantly reduce intraocular pressure but have no effect on blood pressure, it was reported in *Clinical Optometry*.

Researchers at the Department of Optometry, University of Cape Coast, Ghana, conducted the study of 30 randomly selected university students aged from 18 to 30 years. All participants had best corrected visual acuity of 6/9 in both eyes and no ocular pathology.

Participants were divided into two groups. Members of the control group, who abstained from caffeine for 48 hours prior to the study, were asked to drink 250 ml of water. Members of the experimental group consumed 250 ml of an energy drink. Measurements for both groups were repeated at 30, 60 and 90 minutes.

When compared to the baseline, a decrease in mean IOP ($p < 0.05$) at 60 and 90 minutes was observed in the experimental group, with no corresponding change in systolic or diastolic blood pressure. An IOP increase of less than or equal to 2 mmHg was observed in two subjects; 11 subjects had a decrease in IOP of more than or equal to 2 mmHg. Four subjects experienced no change at all in IOP.

Researchers suggest that the decrease in IOP may be the result of the combination of the two main ingredients in energy drinks, caffeine and taurine, or may be the result of the known hypotensive effect of taurine.

Clinical Optometry 2011;3:1: 5-12

Supplementation and surgery

Can optometry play a role?

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Herbal supplementation continues to be a contentious issue in the health-care professions. The medical community's hesitancy to prescribe supplementation is understandable. The claims that support alternative approaches are many yet the trial studies of these claims are comparatively few. This leaves the ophthalmic practitioner caught between a patient eager to heal and an unregulated therapeutics market eager to sell products. While many patients consume these alternatives without complication, there are occasions when use becomes problematic, such as when surgery is required.

Overview

It has been reported that of the patients who complete pre-operative surveys, 22 per cent will admit to taking herbal medications.[1] Similarly compiled statistics of ambulatory surgery patients showed a 32 per cent usage of alternative medicine.[2] It was also found that of those who disclose their herbal consumption, 20 per cent were unaware of the type of medication they were using.[3] More striking is the fact that 70 per cent of patients do not divulge information about their supplementation to their medical doctors.[2] While it can be conceded that a portion of this statistic is a result of improper patient education, there are greater concerns for their reticence to discuss the topic with their doctor. A study has shown that

Therapeutic	Indication	Evidential support	Perioperative concern
Gingko biloba	A. Memory[7] B. Alzheimer's[8]	A. No improvement with use[7] B. Small but significant effect in improving cognitive function over six months with 120-240 mg/day consumption[8]	Inhibition of platelet activating factor, leading to potential increased bleed times[9]
Ginseng	Depression, diabetes and weight loss[10]	200-mg dose of ginseng elevated mood, improved psychophysical performance and reduced fasting blood glucose and body weight	Lowering of blood glucose and inhibition of platelet aggregation leading to hypoglycaemia and increased bleeding[9]
Altium sativium (garlic)	A. Hypertension[11] B. Hyperlipidaemia[12]	A. Showed a decrease of 4.6 ± 2.8 mmHg for systolic blood pressure compared to the placebo. B. Lowers LDL 15 mg/dl with one clove per day[12]	Inhibition of platelet aggregation and increased fibrinolysis leading to increased bleeding[9]
Glucosamine	Osteoarthritis[13,14]	Some studies show no benefit to using glucosamine with respect to placebo;[12] other studies showed that glucosamine prevented joint space narrowing over a three-year period[14]	Theoretical haemostatic effect shown in rabbits through platelet adding effect;[15] similar, topical effect noted in humans, which may lead to increased clotting[16]
St John's wort	A. Depression[17]	Meta analysis showed that St John's wort was statistically more effective than placebo and similar to prescription anti-depressants[17,18]	Inhibition of neurotransmitter reuptake affecting metabolism of multiple drugs metabolised by P450 enzymes[9]
Echinacea	Upper respiratory infection (URI)[19]	Analysis shows statistically significant treatment effect during URI but no ability to prevent as compared to placebo[19]	Activation of cell mediated immunity causing allergic reaction, decreased immunosuppression and potential for long-term immunosuppression[9]

Table 1. Overview of most commonly used supplements

'A study has shown that nearly half of all Americans polled believed that doctors are either prejudiced against or ignorant about supplementation.'

nearly half of all Americans polled believed that doctors are either prejudiced against or ignorant about supplementation.[4]

Optometric involvement

While optometry is not a surgically-intensive field, there is an indirect, albeit significant role that the profession can play in the framing of a patient's perceptions. There are about 4,400 optometrists practising in Australia.[5] Given the primary care nature of the profession, this amounts to significant interaction time with patients. Paramount to this situation is the need to address the distrust the patient may harbour about their health-care practitioner's attitude toward herbal supplementation.[3] This could be as simple as a quick question concerning consumption of alternative medications while taking a case history. A demonstration of basic knowledge in any part of the assessment could yield benefits for both the optometrist and other medical professionals, notably surgeons, who would examine the patient subsequently.

Basic supplementation

According to a survey conducted by Kaufman and colleagues, the six most common herbal supplements consumed are ginseng, gingko biloba, altium sativium (extract of garlic), glucosamine, St John's wort and echinacea.[6] Table 1 lists the indication, evidential support and perioperative concern for each supplement.

Conclusion

Given optometry's role as a provider of primary care, it is important for optometrists to be familiar with patients' use of supplements. Basic knowledge and education are the key to earning a patient's trust—for the profession of optometry and for the whole health-care community.

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D is the new C

'High serum vitamin D levels may be protective against AMD in women younger than 75 years.'

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Linus Pauling was largely responsible for promoting the beneficial anti-oxidant properties of vitamin C. The Oregon State University continues his legacy with an eponymous institute covering micronutrients (lpi.oregonstate.edu). The section on vitamin C contains more than 120 references, the majority of which are from the 21st Century. Just as in the world of fashion, where colours come into and go out of vogue, so it is too with vitamins and supplements.

In recent years the significance of vitamin D supplementation has emerged; specifically, vitamin D3 (cholecalciferol), which is often described as a hormone. It is synthesised in the skin by exposure to ultraviolet-B (UVB) radiation from sunlight. Alternatively, dietary sources include cold-water fish such as salmon, mackerel and sardines; fortified milk, orange juice, cereal and egg yolk.

Vitamin D availability is limited to relatively few foods, which makes supplementation a preferred means to maintain healthy levels. Deficiency of vitamin D has been linked to diverse disorders such as rickets, osteomalacia, osteoporosis; colorectal, breast and prostate cancer; several autoimmune diseases including diabetes mellitus, multiple sclerosis and rheumatoid arthritis; systemic hypertension, muscle weakness and pain. Rickets and its successful treatment through sunlight exposure led to the fortification of milk with vitamin D.

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D is the new C

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Vitamin D deficiency can be assessed through laboratory tests measuring 25(OH)D level. While most of us will not be ordering or interpreting such test results, it is worth noting that most experts agree that a 25(OH)D level >30 µg/mL is considered to represent sufficient vitamin D, while levels between 21 and 29 µg/mL are insufficient. There is some variability according to age and sex, and the interested reader can access these.[1]

An outbreak of hypercalcaemia linked to vitamin D in the 1950s in England resulted in regulations forbidding the fortification of dairy products with vitamin D throughout Europe.[1] Another disadvantage was that the natural synthesis of vitamin D by sun exposure was reduced by the campaign against skin cancer from excessive sunlight exposure and the use of sunscreens—a fact that is familiar to all Australians.

Recently, the pendulum began swinging back to limited sun exposure for vitamin D deficiencies. This has spurred research into vitamin D's role in a variety of diseases. A study on the role of vitamins A, D and E among Sjögren patients reported that only the levels of the antioxidant vitamins (A and E) were reduced in the Sjögren patients compared to the control group.[2]

More pertinent to the eye is the potential positive effect of vitamin D at adequate levels in the reduction of risk for macular degeneration. The CAREDS Group (Carotenoids in Age-Related Eye Disease Study) showed that serum vitamin D (25-hydroxyvitamin D) (25[OH]D) concentrations (nmol/L) levels were associated with a decreased risk of AMD. These positive associations were reported among women under the age of 75 years. The study methods found the correlations of serum vitamin D levels and dietary and supplement intake but not for reported sunlight exposure. The authors conclude that high serum vitamin D levels may be protective against AMD in women younger than 75 years.[3]

Finally, there may be a role for vitamin D supplementation in patients suffering from multiple sclerosis. While this is likely to be beyond the scope of optometry, it is worthwhile knowledge for anyone encountering an MS patient. One small trial looked at 25 patients who received escalating doses of vitamin D over one year compared with 24 controls.

Age	Male	Female	Pregnancy	Lactation
0–12 months*	400 IU (10 µg)	400 IU (10 µg)		
1–13 years	600 IU (15 µg)	600 IU (15 µg)		
14–18 years	600 IU (15 µg)	600 IU (15 µg)	600 IU (15 µg)	600 IU (15 µg)
19–50 years	600 IU (15 µg)	600 IU (15 µg)	600 IU (15 µg)	600 IU (15 µg)
51–70 years	600 IU (15 µg)	600 IU (15 µg)		
W > 70 years	800 IU (20 µg)	800 IU (20 µg)		

* Adequate intake (AI)

Table 1. Recommended daily allowances in the USA

Those in the intervention group experienced less relapse activity of MS and improved Expanded Disability Status Scale scores.[4]

Dosing in vitamin D deficiencies and for general consumption vary widely. Vitamin D dosing is measured in international units of IU. This is a departure from most supplements, which are dosed in milligrams (mg). The conversion is: 100 IU = 2.5 µg (micrograms).

Supplementation of vitamin D may be obtained from multivitamin supplements, typically 400 IU (10 µg) daily. Single ingredient vitamin D supplements may provide 400 to 2,000 IU of vitamin D, but 400 IU is the most commonly available dose. Vitamin D is lost at the rate of about 200 IU per day and would need to be replaced at this rate to maintain equilibrium for bone synthesis, for example.[5] Toxicity is associated only with excessive supplemental intake (usually well above 20,000 IU/day).[6] Loading doses may be recommended, based on laboratory tests with careful monitoring. These may be as high as 100,000 IU dosed monthly. A number of calcium supplements may also provide vitamin D. Although adverse events are unlikely, serum vitamin D levels should be monitored when administering supplements.

Recommended daily allowances in the USA are shown in Table 1.[7]

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Vitamin C vital for retina

New research suggests that proper retinal cell function can be prolonged with regular vitamin C intake.

Researchers at the Vollum Institute at Oregon Health and Science University, Portland, USA used goldfish eyes to discover that both ascorbic acid and gamma-aminobutyric (GABA) receptors in the retinal cells do not function properly when vitamin C is removed.

Without vitamin C inside and outside of the cells in the retina, the cells and receptors started to break down. Because retinal cells are a form of brain cells, researchers proposed that GABA receptors in the brain also required vitamin C to function properly.

The discovery could have implications for diseases such as glaucoma and epilepsy, which are caused by nerve cell dysfunction in the retina and brain due to improper GABA receptor function.

Calero CI, Vickers E, Moraga Cid G et al. *Journal of Neuroscience* 2011; 31: 26: 9672-9682.

White fruits protect from stroke

Increasing your intake of white flesh fruits and vegetables such as apples and pears may protect you against stroke.

Dutch researchers classified fruits and vegetables into four colour groups based on their flesh rather than skin: orange and yellow, green, red and purple, and white.

In the study, 20,000 adults with an average age of 41 years were asked questions about what they ate over the previous year; all were free of cardiovascular diseases at the start of the study.

After 10 years, 233 participants suffered strokes. It was found that those with a high intake of white fruits and vegetables had a 52 per cent lower risk of stroke than those who ate few foods in that colour group.

The colour of the edible portion of fruits and vegetables reflects the levels of plant compounds such as carotenoids and flavonoids, which can influence the risk of stroke. White fruits and vegetables contain an antioxidant flavonoid called quercetin as well as high doses of dietary fibre that may lower stroke risk.

Other colour groups did not affect the participants' risk of stroke but they should not be dismissed as they may protect against other chronic diseases. The researchers advise that the study findings should be interpreted with caution because food frequency questionnaires are subject to errors.

Stroke: Journal of the American Heart Foundation 2011; 42: 3190-3195.

Cardiovascular disease and xanthelasmata

A heart study conducted by Danish researchers has found that the presence of xanthelasmata on the eyelids is an independent predictor of cardiovascular disease.

The lipid-containing yellow plaques known as xanthelasmata raise the risk of ischaemic vascular disease and death by 12 per cent, according to the researchers.

The Copenhagen City Heart Study surveyed 12,745 individuals between the ages of 20 and 93 years who were all free of heart disease when the survey commenced in 1976.

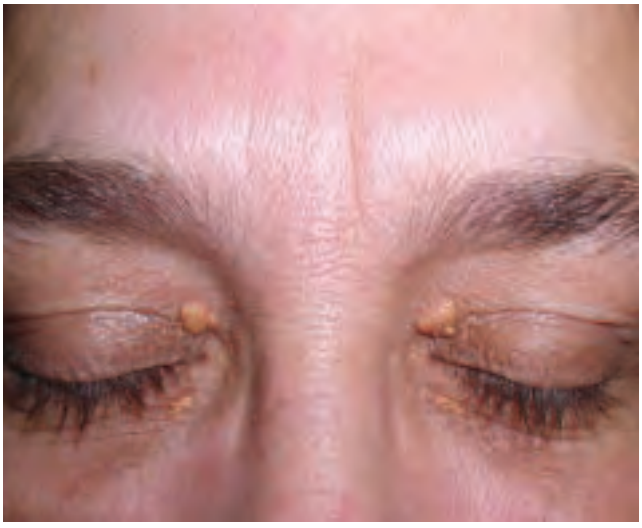
At the start of the study, 4.4 per cent of participants had xanthelasmata; during the follow-up 1,872 participants had a heart attack, 3,699 developed heart disease, 1,498 had a stroke, 1,815 developed cerebrovascular disease and 8,507 had died. There was a 100 per cent complete follow-up, which continued until 2009.

Men aged between 70 and 79 years were the highest risk group and those with xanthelasmata had a 53 per cent increased risk compared to a 41 per cent risk for men without the condition.

The increased risk for women was eight per cent. There was also a 69 per cent increased risk of atherosclerosis in patients with xanthelasmata compared to those without.

Researcher Professor Anne Tybjærg-Hansen suggests that an increased propensity of those with xanthelasmata to deposit cholesterol in connective tissues may be an explanation for the correlation with cardiovascular disease.

British Medical Journal 2011; 343: d5497.



Xanthelasmata correlates with an increased risk of atherosclerosis

Zeaxanthin an essential of

'Zeaxanthin is a versatile compound and should be considered as a generalised promoter of optimal macular health, in addition to preventing degenerative disease processes, like AMD.'

Dr Sherrol A Reynolds
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Dr Diana L Shechtman
OD FAAO

Associate professors at Nova Southeastern University College of Optometry, Fort Lauderdale, FL USA

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OD FAAO

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Zeaxanthin is a xanthophyll pigment that is not synthesised by the human body and is entirely derived from dietary intake. Like lutein, zeaxanthin is often found in various colourful fruits and vegetables but lutein is far more abundant than zeaxanthin in the Western diet. Sources of zeaxanthin may include melons, oranges, goji berries, yellow peppers and dark leafy green vegetables such as spinach and kale. Other sources include corn and egg yolks. Dietary consumption of carotenoids is far below levels needed to truly promote beneficial effects.[1]

Zeaxanthin along with lutein and meso-zeaxanthin are the major carotenoids found in the macula, comprising the macular pigment. The concentration of these carotenoids in the macula is 10,000 times higher than the concentration in the blood.[2] In the macula, carotenoids like zeaxanthin play a major protective role. Zeaxanthin acts like a strong antioxidant in addition to absorbing excess high-energy blue light, thereby protecting the underlying photoreceptors.[3] Concentrations of zeaxanthin are also found in the crystalline lens and are believed to play an antioxidant protective role.[4,5] Thus, there is a growing body of evidence that identifies zeaxanthin as a potent antioxidant, benefitting various degenerative ocular conditions, including cataract formation and age-related macular degeneration (AMD). Further benefits include the impact on visual function.

Protective role in the eye

Augmentation of macular pigment is directly associated with increased consumption of dietary or nutritional supplementations of carotenoids. The concentration of zeaxanthin, meso-zeaxanthin and lutein differs in the macular area. Zeaxanthin has been found to preferentially accumulate in the central foveal region, outweighing the amount of lutein in the region by two to one.[6] Due to its spatial concentration within the foveal region, it has been postulated to play a significant protective role.[7] As mentioned previously, zeaxanthin is a strong antioxidant that quenches free radicals in addition to filtering blue light.

Low dietary carotenoids as well as low macular pigment have been implicated as risk factors in the development of AMD. Supportive epidemiological studies show an inverse correlation between AMD and macular pigment.

The Eye Disease Case Control Study found a significantly lower risk for developing AMD in people whose diet included a high consumption of both lutein and zeaxanthin.[8] Diets high in carotenoids, along with other vitamins and minerals, independently reduced the risk of progression of AMD.[8] Seddon and associates found that consuming 6 mg per day of lutein and zeaxanthin was associated with a reduced risk of developing AMD.[9] Further studies confirmed the high concentrations of serum zeaxanthin were associated with a dramatic risk of AMD.[10]

Another benefit of zeaxanthin includes the plausible capability to protect against the development of cataract formation. Oxidative insult has long been implicated as the major contributor to the formation of cataracts. Studies have established a positive relationship between zeaxanthin and cataract formation. Increased levels of zeaxanthin have been shown to have a significant correlation with a decreased risk of cataract formation.[4] The Beaver Dam Eye Study showed that people whose diet was rich in lutein and zeaxanthin had a lower risk of developing cataracts compared to those individuals who had lower consumptions in their diet.[5]

Affects on visual function

Zeaxanthin, by acting as an accessory to macular pigment, has been linked to visual performance enhancement in various studies.[11-14] Improvement in various aspects of visual function includes contrast sensitivity, photophobia, colour vision and glare.[15-16] The anatomical position of zeaxanthin within the fovea may be likely to be associated with cone-enhancing characteristics.[17] Richer and associates concluded that dietary supplementation of zeaxanthin was more likely to be associated with improvement of shape discrimination, scotoma resolution and high contrast acuity, than dietary supplementation of lutein.[12]

Decreased contrast sensitivity, photophobia and increased glare are often linked to early functional changes noted among our AMD patients. In addition, many of our adult patients complain of eye discomfort, which is often associated with glare, particularly while driving. Thus, improvements in visual function may enhance the quality of vision for many of our patients.

component macular pigment

Recommendations

Because most Americans do not meet the recommended levels of zeaxanthin through dietary intake, nutritional supplementation may be necessary. Although increased dietary and nutritional supplementation of zeaxanthin is associated with increased macular pigment, individual responses vary drastically.[18] Gender, mal-absorption, medications, body fat, smoking and even genetics can all contribute to bioavailability.[18]

Currently, there are no absolute guidelines on the amount of supplements to be taken but recommended levels range between 2 mg and 10 mg. Adverse effects associated with zeaxanthin supplementation have not been reported. Zeaxanthin is considered relatively safe and has been the subject of a Food and Drug Administration petition as part of the 'no adverse effect level' (NOAEL) guidelines.[1]

Recommendation of zeaxanthin supplements should be considered for patients who are at risk of developing macular degeneration, those showing early signs of macular degeneration or patients with symptoms attributed to decreased macular function–photophobia, decreased contrast sensitivity and glare. The benefits of zeaxanthin may be observed even at a late stage of the disease. Zeaxanthin has been shown to normalise vascular endothelial growth factor (VEGF).[19]

Reduction of such retinal oxidative biomarker may contribute to the protective benefits against the late stage of the disease. A recent poster had reported that 20 mg of Zeaxanthin given orally before and during 'triple therapy' (laser, steroid and anti-VEGF injection) to patients with wet AMD may decrease the need to retreat over the course of the year. Additional benefits may include a decreased risk of progression for the fellow eye.[20]

Conclusion

Numerous studies have confirmed that zeaxanthin is an essential component of the macular pigment.[21] AREDS2 will further evaluate the potential benefit of 2 mg of zeaxanthin (along with lutein, omega-3 and other antioxidants) on the progression of AMD for subjects who already show moderate to advanced-stage dry AMD. Additionally, benefits on cataract formation as well as visual function will also be assessed.[22]

There is abundant evidence on the ramifications associated with zeaxanthin. Structural preventive protective properties and visual functional benefits have been documented in the literature. If higher macular pigment is related to both structural and functional benefits, particularly enhancing visual performance, then optimising macular concentrations of carotenoids like zeaxanthin is crucial in the management of many of our patients. Zeaxanthin is a versatile compound and should be considered as a generalised promoter of optimal macular health, in addition to preventing degenerative disease processes, like AMD. Although absolute guidelines regarding zeaxanthin recommendation have not been established, it is clear that the research suggests the need to supplement in many individual cases.

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Abstracts

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Vegetarianism lowers risk of cataract

Vegetarians have been found to have a significantly lower risk of age-related cataract than omnivores. The European Prospective Investigation in Cancer and Nutrition (EPIC-Oxford) study derived data from 27,670 self-reported non-diabetic patients, aged over 40 years at recruitment. Cox proportional hazards regression analysis was used to assess cataract risk in relation to baseline dietary and lifestyle characteristics. A strong relationship was identified between cataract risk and dietary group, with a progressive decrease in risk of cataract from high meat eaters (≥ 100 g meat/day) to low meat eaters (< 50 g meat/day), fish eaters (participants who ate fish but not meat), vegetarians and vegans.

Am J Clin Nutr 2011; 93: 5: 1128-1135.

Lifestyle influences the risk of age-related macular degeneration

A healthy lifestyle has been shown to decrease the risk of subsequently developing age-related macular degeneration (AMD). A population of 1,313 female participants (aged 55-74 years) completed a food frequency questionnaire and were questioned with regard to their level of physical activity and lifetime smoking history. Scores on a modified 2005 Healthy Eating Index (HEI) were assigned from the questionnaire responses. On average, six years later, stereoscopic fundus photographs were used to assess the presence and severity of AMD. Multivariate analysis indicated that women whose diets scored in the highest quintile compared with the lowest quintile on the HEI had 46 per cent lower odds for early AMD. A combination of three healthy behaviours (healthy diet, physical activity and not smoking) was associated with a 71 per cent lower odds for AMD compared with having high-risk scores. The authors concluded that modifying lifestyle may reduce the risk for early AMD as much as three-fold.

Arch Ophthalmol 2011; 129: 4: 470-480.

Topical caffeine inhibits the formation of cataract

The administration of micromolar amounts of topical caffeine has been demonstrated to be effective in inhibiting the formation of galactose cataract in an experimental model of cataract. Cataract was induced by feeding young rats a diet containing 24 per cent galactose for a period of 25 days. An experimental group received treatment with a topical preparation of caffeine (concentration: 72 mM); controls received a placebo eye-drop (hydroxy propyl cellulose wetting agent). Administration of caffeine eye-drops significantly inhibited the onset and progress of cataract formation. The effects were attributed to the prevention oxidative stress and maintenance of tissue metabolic and transport functions. The authors proposed a potential benefit for topical caffeine in the treatment of diabetic cataracts.

Mol Vis 2010; 8: 16: 2626-2633.

Vitamin D reduces risk of early age-related macular degeneration

Data from the Carotenoids in Age-Related Eye Disease Study indicates that high serum 25-hydroxyvitamin D (25[OH]D) concentrations (nmol/L) may protect against early AMD in women younger than 75 years. Stereoscopic fundus photographs, taken from 2001-2004, assessed AMD status. Baseline (1994-1998) serum samples for 25(OH)D were available from 1,313 women. Odds ratios (ORs) and 95% confidence intervals (CIs) for early AMD (n = 241) were estimated with logistic regression and adjusted for age, smoking, iris pigmentation, family history of AMD, cardiovascular disease, diabetes and hormone therapy usage. Higher serum 25(OH)D was associated with decreased odds of early AMD in women younger than 75 years (n = 968; OR = 0.52, CI: 0.29-0.91; p = 0.02); a similar protective effect was not observed in women aged older than 75 years.

Arch Ophthalmol 2011; 129: 4: 481-489.

Polyunsaturated fatty acids modify prostaglandin production in the conjunctival epithelium

Dietary supplementation with polyunsaturated fatty acids (PUFAs) has been found to alter the lipid composition of the conjunctival epithelium and alter prostaglandin production after inflammatory stimulation. Cultured human conjunctival cells were treated with the PUFAs γ-linolenic acid (GLA) and eicosapentaenoic acid (EPA) for 72 hours and then treated with interferon-gamma (IFN-γ) for 48 hours. Changes in the composition of neutral lipids, phospholipids and prostaglandins were measured. PUFA supplementation induced incorporation of these fatty acids and their metabolites in neutral lipids and phospholipids of the conjunctival cells. Combined supplementation of GLA and EPA reduced the production of prostaglandin-E2. The authors proposed that modulation of fatty acid composition and PG production by PUFA supplementation may be of benefit in reducing conjunctival inflammation in dry eye syndrome.

Graefes Arch Clin Exp Ophthalmol 2011; 6. (Epub ahead of print).

Trehalose an intriguing disaccharide

Trehalose, a disaccharide comprising two molecules of glucose, can protect cellular membranes and labile proteins against damage and denaturation as a result of oxidative stress. At this stage the mechanism underlying this effect is not fully known. The disaccharide is widespread in many species of plant and animals, where its function is understood to protect cells against desiccation, but is not found naturally in mammals. Trehalose is under investigation for a number of medical applications, including the treatment of Huntington's chorea and Alzheimer's disease. Recent studies have also shown that trehalose may be a useful component of treatments for dry eye syndrome, as it can prevent damage to mammalian eyes caused by oxidative insult and desiccation. Further work is required to fully understand the unique properties of this disaccharide and its full potential for use in the management of ophthalmic conditions and other disease states.

Clin Ophthalmol 2011; 5: 577-578.

Folate insufficiency

A cross-sectional study conducted as part of the Elderly Nutrition and Health Survey in Taiwan (1999-2000), has demonstrated that Taiwanese men aged ≥ 75 years who were either deficient in folate or treated with anti-hypertensive medications were at a higher risk of age-related cataract than age-matched control patients. The study population consisted of 661 males and 645 females (age: ≥ 65 years). Potential risk factors for cataract were determined by multiple logistic regression analysis of data obtained from a health examination, blood biochemistry and interviewer-administered questionnaires. In older men, cataracts were associated with age, diabetes, anti-hypertensive medication and folate insufficiency; age and anti-hypertensive medication were factors for women. The authors indicate that the maintenance of good folate status should be emphasised to reduce the risk of cataract in the Taiwanese elderly.

J Nutr Health Aging 2011; 15: 4: 304-310.

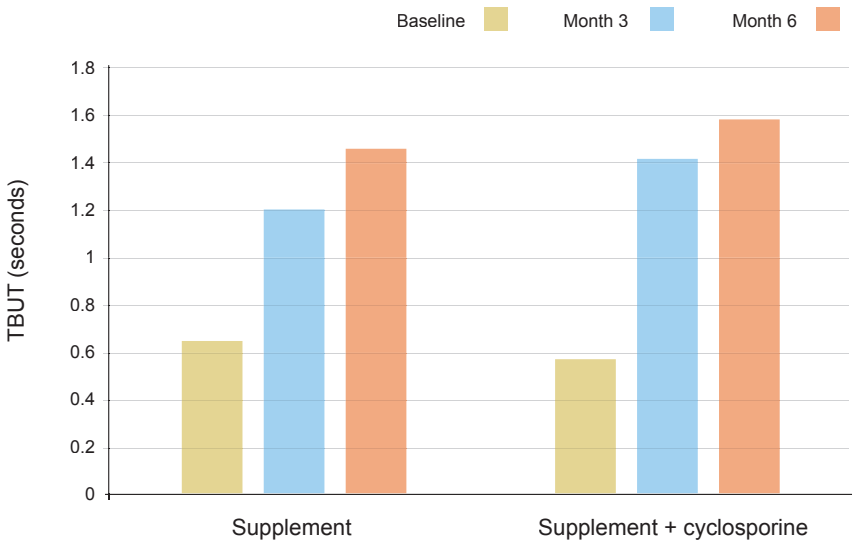
Wolfberry protects retina

Dietary intake of wolfberry, a traditional Asian fruit that contains high levels of the pigments zeaxanthin and lutein, has been shown to impart retinal protection in a mouse model of diabetic retinopathy. Hyperglycaemia-linked oxidative stress and/or consequent endoplasmic reticulum (ER) stress are recognised as causative factors in the pathogenesis of diabetic retinopathy. It has been proposed that dietary bioactive components that mitigate oxidative stress may slow disease progression. Male db/db mice (age: six weeks), a recognised model of type 2 diabetes, were fed a control diet with, or without one per cent (kcal) wolfberry, for eight weeks. Dietary wolfberry was found to restore the thickness of the entire retina, in particular the inner nuclear and photoreceptor layers; ganglion cell numbers were also increased. This protective effect was linked to lowered expression of ER stress biomarkers.

Exp Biol Med (Maywood) 2011; 236: 9: 1051-1063. ■

Dry eye and supplements

'The addition of topical cyclosporine did not improve tear break-up time in a statistically significant way ...'



Symptoms improved in both groups, leading researchers to conclude that the medical food supplement improved tear break-up time

Proper balance of omega-3 and omega-6 essential fatty acids plays a significant role in the treatment of dry eye, according to a study published in *Clinical Ophthalmology*

Researchers followed 43 subjects in two groups for six months. To participate in the study, subjects had to have a minimum diagnosis of level 1 dry eye, in accordance with the guidelines established by the international task force of dry eye experts.

Participants in group 1 took two soft geltabs of a new, prescription-only medical food supplement twice daily for six months. Those in group 2 took the supplement in the same manner, along with the topical cyclosporine, which was instilled twice daily during the last three months of the study.

Subjects were evaluated for conjunctival staining, corneal staining and change in subjective symptoms at baseline, month one, month three and month six.

Both groups had similar, statistically significant improvement in tear break-up time; there were no significant differences in corneal or conjunctival staining between the groups. Subjective symptoms improved in both groups.

The addition of topical cyclosporine did not improve tear break-up time in a statistically significant way, leading researchers to conclude that the medical food supplement alone improved tear break-up time and relieved patient symptoms.

Clin Ophthalmol 2011: 5: 1201 – 1206 ■

Fatty acids and the

'The evidence for some improvement in outcomes of ocular dryness with omega-based dietary supplementation can be considered moderate.'

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The concept of dry eye has moved from focusing on the tear film to looking at the ocular surface as a system comprising multiple structures—the cornea, conjunctiva, eyelid, and lacrimal and meibomian glands linked to one another via neural, hormonal and chemical feedback mechanisms.[1] Estimates of the prevalence of dry eye from large epidemiological studies conducted worldwide range from around five per cent to as high as 35 per cent.[1]

The impact of dryness symptoms is often downplayed, yet quality of life studies have shown that patients with ocular surface dryness were about three times more likely to report problems with reading, carrying out professional work, using a computer, watching television, driving during the day and driving at night than those without dryness.[2]

The interest in fatty acids from the field of ocular surface disease arose out of research published in 2005.[3] More than 30,000 American women aged from 45 to 85 years participated in the study, which aimed to determine the association between dietary intake and ratio of omega-3 and omega-6 fatty acids and dry eye syndrome. The study found that the odds of self-reporting dry eye disease increased 2.5 times in women with an omega-6 to omega-3 ratio of more than 15 to 1 compared to participants with a ratio of less than 4 to 1.[3] In addition, the odds of self-reporting dry eye disease were significantly lower in women consuming more than five servings of tuna per week when compared with those consuming less than one serving of tuna per week.[3] This research presented clinicians with a compelling reason to consider both dietary intervention and/or dietary supplementation with omega-based foods as a possible treatment for ocular dryness.

How exactly do omega-rich foods and oily fish benefit the ocular surface? Polyunsaturated fatty acids (PUFAs) are often called 'essential' fatty acids as they are required for survival and humans must obtain them from their diet. They are broadly categorised into omega-3 and omega-6 fatty acids depending on their chemical structure and are found in a wide range of foods (Table 1).

Omega-3 fatty acids include alpha-linolenic acid (ALA), eicosapentaneoic acid (EPA) and docosahexaenoic acid (DHA). Omega-6 fatty acids include linoleic acid (LA), gamma-linolenic acid (GLA), dihomo-gamma-linolenic acid (DGLA) and arachidonic acid (AA). By-products of omega-3 metabolism includes the anti-inflammatory prostaglandin 3 while omega-6 fatty acids convert into both pro- (prostaglandin 2 derived from arachidonic acid) and anti-inflammatory (prostaglandin 1) mediators. Prostaglandin 1 is able to stimulate lacrimal gland tear secretion.[4] The modulation of inflammatory activity in the body is thought to be based on the balance of EPA/DGLA/AA in the body.

The ratio of omega-6 to omega-3 is commonly used as an index of dietary intake of fatty acids. From an evolutionary perspective, this ratio has been dramatically rising in line with the industrial revolution from a ratio of 1:1 in the diet of prehistoric men to one ranging from 15:1 to 20:1 in today's 'Western' diets.[5] A ratio of 4:1 is considered more adequate and apt to minimise inflammatory stimuli.[5] A high omega-6 to omega-3 ratio is thought to promote pathogenesis of several diseases including inflammatory and autoimmune diseases such as asthma and rheumatoid arthritis.[5] The current definition of dry eye states that 'it is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface'.[1] This inflammatory component to the disease is consistent with the findings of lower prevalence dryness in women ingesting larger amounts of omega-3 containing foods.[3]

Although the published findings mentioned above demonstrate an association between dietary fatty acid intake and dry eye disease, several questions remain unanswered. For example, is this relationship also present in men? Does the benefit arise out of lifelong (40 years +) eating habits or can it be replicated in the shorter term (weeks or months) by intervening in people's dietary habits? Have these results been confounded by the likelihood of women with more 'healthy' dietary habits also being more

Fatty acid	Chemical formula	SC/LC	Example food source
Omega-3 fatty acids			
Alpha-linolenic acid (ALA)	18:3 ω-3	SC	Fish, seafood, seeds (flaxseed,
Eicosapentaneoic acid (EPA)	20:4 ω-3	LC	walnuts, pecans, hazelnuts),
Docosahexaenoic acid (DHA)	22:6 ω-3	LC	green leafy vegetables
Omega-6 fatty acids			
Linoleic acid (LA)	18:2 ω-6	SC	Corn, peanut, safflower, rapeseed,
Gamma-linolenic acid (GLA)	18:3 ω-6	LC	sunflower, poultry, eggs, cereals,
Dihomo-gamma-linolenic acid (DGLA)	20:3 ω-6	LC	whole-grain breads
Arachidonic acid (AA)	20:4 ω-6	LC	

SC = short chain – must be obtained from diet
LC = long chain – can be obtained from diet or from SC-PUFA

Table 1. Characteristics of polyunsaturated fatty acids (PUFAs)

ocular surface

Findings	Limitations
Increased tear prostaglandin-1, reduced symptoms and corneal staining[6]	Very small sample sizes used (less than 100) limited power to demonstrate effectiveness.
Increased comfort and tear meniscus height[7]	May not be generalisable to all types of ocular dryness (for example, MGD, CL wearers).
Reduced symptoms and lissamine green staining[8]	Concentration of LA, GLA, EPA or DHA in capsules generally low (less than 1,000mg per day).
Reduced turbidity and MG obstruction[9]	Short exposure time (one month to six months) and retention and/or reversibility of effect not assessed.
Improved OSDI score, TBUT, meibum score[10]	
Improved overall symptoms score, increased tear clearance and production[11]	
Less increase in tear osmolarity, less redness and burning in test group[12]	
Improved TBUT and ocular fatigue symptoms[13]	
Reduced HLA-DR expression in conjunctival epithelium[14]	

Table 2. Overall summary of results from published trials on the effectiveness of various Omega-based dietary supplements

likely to adopt healthier lifestyles overall, for example, more likely to exercise and eat foods containing other beneficial ingredients such as antioxidants? Are these findings generalisable to other causes of ocular dryness such as sufferers of meibomian gland disease or contact lens wearers? Would an intervention or treatment with omega-based dietary supplements be equivalent to diet changes? If so, how much PUFAs, which fatty acid and how long treatment should be need to be determined. To attempt to answer these questions, a literature review of studies in this area was performed. Key results are briefly summarised in Table 2.

Table 2 appears to demonstrate that every study published in this area showed at least some small benefit of omega-based dietary supplementation. Strikingly, the majority of published trials tested the effect of supplementing with omega-6 supplements such as evening primrose oil or flaxseed oil.[6-11] More recent trials[12-14] have looked at combinations of supplements bringing together the potential benefits of both omega-3 and omega-6 based supplements. Limitations of published trials are also highlighted in Table 2.

This review did not assess unpublished registered clinical trials where negative results may not have been published and as such, may be tainted by publication bias. Additionally, no currently published trial in this area included measurement of the bioavailability of the fatty acid supplements in the blood and/or at the ocular surface. Therefore, factors such as capsule formulation and patient compliance may have significantly impacted some of these results.

Based on this, what do I tell my patients?

I can confidently state that there is good evidence for consumption of omega-3 rich foods, that is, oily fish and green leafy vegetables, having a protective effect against dry eye. I can also indicate that although there is good evidence for oral supplementation such as fish oil or evening primrose oil having some benefits in treating ocular dryness symptoms, this is still to be fully proven. I always remember that omega supplementation may be contraindicated in some patients such as those on blood-thinning therapy, for example, warfarin, and warn all my patients of the potential risks for undesirable side-effects such as increased bleeding and gastric upset. It is always good practice to communicate the details of your recommendations to the patient's general practitioner.

Mercury poisoning and toxicity from rancid oil are other potential issues, making it important to explain to patients the importance of choosing reputable sources of dietary supplements with proven manufacturing quality control processes in place. I always warn my patients against internet shopping for cheaper manufacturers and inform them that not all formulations may be equally effective due to small differences in concentration and formulation.

In summary, the evidence for some improvement in outcomes of ocular dryness with omega-based dietary supplementation can be considered moderate. There remains a need for more properly constructed unbiased studies looking at larger populations and measuring the bioavailability of these components in the blood and/or on the eye. As a clinician, I use both diet modification and dietary supplementation as two of many tools available to manage and treat the challenging spectrum of conditions associated with ocular surface disease and dry eye.

Disclosure
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Tear film stability affected by time of day

Tear film stability is significantly reduced at the end of the day.

Morning and afternoon clinical parameters of tear film for 51 participating subjects were assessed in a study. Schirmer test, tear meniscus height, break-up time and non-invasive break-up time were measured on the same day for each individual.

While no significant changes in tear volume during the day were observed, tear film stability was significantly reduced by the end of the day. The study suggests that end-of-day ocular discomfort from contact lens wear might be a consequence of alterations in tear film. Contact lens intolerance might be caused by the daily physiological changes in tear film stability.

The authors of the study caution researchers and clinicians to consider the diurnal differences of tear film when a patient is observed at different times of the day or when comparisons are made between studies of populations. If a patient complains of dry eye at the end of the day, the authors of the study suggest that special attention should be given to the time of the day tear film is assessed.

Clin Exp Optom 2011; 94: 6: 557–562

Labels impact quality and safety of medicine

Lack of clear and easily identifiable information can lead to confusion and significant risks to patient safety in hospitals and in the community. Health professionals, regulators, researchers and the pharmaceutical industry have been called on to work together to improve the effectiveness of medicine labels.

The project manager of Medication Safety, Clinical Excellence Commission, Daniel Lalor, says in an article in *Australian Prescriber* that the limited labelling standards dictated by the Therapeutic Goods Administration have a considerable impact on the utility of medicine labels.

Lalor recommends that knowledge from the fields of graphic design and ergonomics should be used to assist in developing labels and packaging that are distinct and easily identifiable.

His proposals include increasing the prominence of the generic name and standardising its position on the label.

He recommends the use of a typographic technique known as 'tall man lettering' to highlight the differences in similar names, for example, fluOXETine and fluVOXAMine, and applying the outcomes-based standards for labelling non-prescription medicines in Australia to labels produced by health-care professionals.

Australian Prescriber 2011; 34: 5: 138

Multifocal toric intraocular lens improves vision

Distance and near visual function in eyes with cataract and high corneal astigmatism can be restored using a toric intraocular lens, according to a study published in the *Journal of Cataract & Refractive Surgery*.

The study, based on 23 eyes of 12 patients with a mean age of 50.08 years, found that the AT Lisa 909M toric multifocal IOL by Carl Zeiss Meditec showed high predictability in improving visual acuity while correcting corneal toricity.

The visual, refractive, corneal topographic, internal astigmatism, defocus curves and contrast sensitivity outcomes were evaluated at day one, and one, three and six months following the cataract surgery and implantation of the IOL.

Evaluation was based on Snellen uncorrected and corrected visual acuity at distance and near, manifest refraction, IOP, corneal topography, aberrations, biometry and endothelial cell counts.

The study results revealed statistically significant improvements in uncorrected distance visual acuity, uncorrected near visual acuity and refractive cylinder at one month postoperatively (all $P < 0.01$). Corrected distance visual acuity improved significantly from the time prior to surgery to six months ($P = 0.06$).

No serious adverse events occurred during the study; however, the authors reported two cases of posterior capsule opacification, which were resolved with Nd:YAG laser capsulotomy.

Journal of Cataract and Refractive Surgery 2011; 37: 7: 1217-1229.

Myopia gene found

A gene that causes myopia has been identified by researchers at the Ben-Gurion University of the Negev in Israel.

The research, published online in the American Journal of Human Genetics, discovered that a mutation in the LEPREL1 gene is linked to myopia.

It was found that the gene encodes an enzyme that is essential for the final modification of collagen in the eye; without the active form of this enzyme, aberrant collagen is formed, causing the eye to be longer than normal.

The research was conducted on members of a specific Bedouin tribe in whom myopia is common but future studies will be conducted to determine if the gene plays a role in the disorder in the general population.

Myopia is the most common human eye disorder and is mostly a hereditary trait, yet scientists have previously not known much about the genes that cause it.

American Journal of Human Genetics 2011; 89: 3: 438–445.

Clinical perspective of ocular allergy

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Recent developments in the area of management of ocular allergy include the use of new topical medications such as cyclosporine and synthetic peptides.

Ocular allergy is one of the most frequent clinical problems encountered by the allergist and ophthalmologist alike. The importance of ocular allergy is due more to its frequency than to its severity. The vast majority of ocular allergy affects the conjunctiva, so we usually speak of ocular allergy and allergic conjunctivitis synonymously. The largest group of allergic conjunctivitis presents as the ocular component of allergic rhinoconjunctivitis.

Ocular allergy may be classified broadly into five categories: seasonal allergic conjunctivitis or 'hay fever' (SAC), perennial allergic conjunctivitis, vernal keratoconjunctivitis (VKC), atopic conjunctivitis (AKC), and giant papillary conjunctivitis (GPC).[1,2] The immunopathophysiological mechanism of acute ocular allergy involves an acute IgE-mediated mast cell degranulation, whereas chronic ocular allergy such as VKC and AKC involves persistent activation of mast cells and delayed-type hypersensitivity response.[3]

Seasonal allergic conjunctivitis

The most common form of ocular allergy is SAC, which is associated with seasonal rhinitis (hay fever) and sensitisation or exposure to airborne allergens such as ragweed and pollen. The incidence of SAC is higher during spring and autumn.[4] Symptoms usually consist of low-grade ocular itching, tearing, stinging, redness and watery discharge. These ocular symptoms are typically worse when the weather is warm and dry. The conjunctiva usually demonstrates mild or moderate oedema and injection. There can be associated periorbital oedema that is more prominent around the lower eyelid.[4,5]

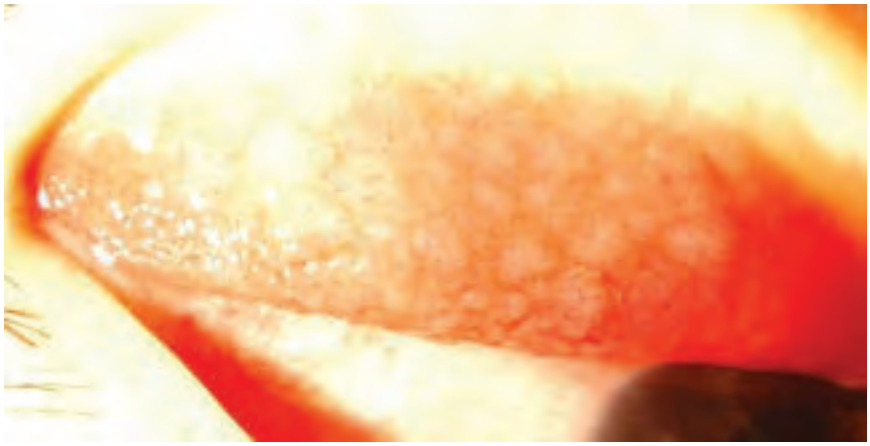
Vernal keratoconjunctivitis

VKC is a bilateral ocular allergic disease that predominantly affects children living in temperate zones.[6] VKC often but not always resolves on entrance into puberty. Patients with VKC frequently have a history of atopic disease such as atopic eczema, or asthma.[7] In its typical form, VKC presents with pruritus, hyperaemia, photophobia and watering. Pruritus may be exacerbated by exposure to hot weather or physical exertion associated with sweating.[6,7]

Continued page 24

Category	Medication	Action	Brand name
Antihistamines	Naphazoline	H1 receptor antagonist + alpha adrenergic agonist	Privine (Novartis)
	Levocabastine hydrochloride 0.05%	H1 receptor antagonist	Livostin (Novartis)
Mast cell inhibitors	Cromolyn sodium	Decrease calcium uptake blocking mast cell degranulation	Opticrom (Sanofi-Aventis)
	Nedocromil sodium 2% Lodoxamide tromethamine 0.1%		Alocril (Allergan) Lomide (Alcon)
Antihistamines/ mast cell inhibitors	Olopatadine HCL 0.1%	Decrease calcium uptake blocking mast cell degranulation + H1 receptor antagonist	Patanol (Alcon)
	Ketotifen fumarate 0.025% Epinastine hydrochloride 0.05%		Zaditen (Novartis) Elestat (Allergan)
NSAIDs	Ketorolac 0.5%	Inhibition of cyclo-oxygenase, blocks prostaglandins	Acular (Allergan)
Corticosteroids	Loteprednol 0.2%	Inhibits phospholipase A, blocks prostaglandins and leukotrienes	Lotemax (Bausch + Lomb)

Table 1. Overview of pharmacological treatments for ocular allergy



Papillae on the palpebral conjunctiva in vernal keratoconjunctivitis

Ocular allergy

From page 23

The hallmark of vernal keratoconjunctivitis is the presence of giant papillae on the palpebral conjunctiva and a sticky 'ropy' discharge (Figure 1). A pseudomembrane may be present in severe cases (Maxwell-Lyon sign). Corneal findings include superficial corneal ulcers and plaque-like deposits in the anterior cornea and Trantas' dots at the limbus.

Atopic keratoconjunctivitis

AKC is a bilateral allergic inflammation affecting individuals with a history of atopic dermatitis. This condition is usually chronic, has no geographical prevalence and predominantly affects adults between 20 and 50 years old.[8-10] Unlike VKC, the symptoms of AKC become more severe in winter. Patients present with mucoid discharge, chemosis, tearing, and intense bilateral pruritus of the eyelids and periorbital area. Complications of AKC include corneal infections and secondary *Staphylococcus aureus* eyelid infections. In long-standing cases, keratoconus and atopic cataracts have been described as a complication of atopic dermatitis.[10,11]

Giant papillary conjunctivitis

GPC is a chronic ocular inflammatory condition resulting from constant mechanical irritation of ocular surfaces by contact lenses or ocular prostheses.[12] It is more common in individuals using soft contact lenses. Frequent use of contact lenses facilitates repetitive physical trauma to the upper tarsal conjunctiva, resulting in papillary hypertrophy.[13] Common symptoms of GPC include intense itching, conjunctival injection, tearing, mucous discharge, foreign body sensation and contact lens intolerance.[14]

Drug-induced or contact allergy

Drug-induced allergic conjunctivitis is often caused by an adverse reaction to chemical preservatives in the ophthalmic solution. Ocular preparations containing neomycin sulfate, atropine and thimerosal are the most commonly implicated sensitisers.[1,15]

Some long-standing cases have also occurred with glaucoma medications. These reactions often occur in the lower eyelid and inferior conjunctiva. The skin of the eyelids may be red and oedematous. Conjunctival involvement is characterised by pronounced vasodilatation, papillary response, chemosis and watery discharge. Corneal involvement may occur in severe cases causing epithelial defects.[1]

Diagnosis

A strong clinical suspicion with a supporting history from the patient is the most important diagnostic tool for ocular allergy. The associated clinical findings include puffy eyelids, redness, chemosis and watering. Antigen skin testing can be very helpful to identify specific allergens using low dose environmental allergen or the offending drug.

Management options

The number of visits to the ophthalmic office triggered by ocular allergy as well as the strategies for the management of ocular allergy are growing in parallel. There is a need to prevent the occurrence of these allergic attacks but there is also an imperative concern to decrease health-care burden.[1,16-18]

After exposure to the allergens occurs, simple measures like cold compresses and frequent irrigation of the eyes are helpful in alleviating the symptoms. In addition, several pharmacological treatment options are available for the management of ocular allergy (Table 1). They can be broadly classified into:

- antihistamines
- topical mast cell stabilisers
- combination of topical antihistamines and mast cell stabilisers
- non-steroidal anti-inflammatory drugs
- corticosteroids.

Although corticosteroids may be extremely effective in relieving symptoms of allergy, they should be used judiciously only in extreme situations. Recent developments in the area of management of ocular allergy include the use of new topical medications such as cyclosporine and synthetic peptides. These new drugs are specifically aimed to act at the receptor levels to prevent future recurrences of ocular allergy.[18]

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PBS list of medicines for optometrists

1 December 2011

Six more ophthalmic drugs were listed for prescription by optometrists through the Pharmaceutical Benefits Scheme (PBS) on 1 September 2011.

	Product	Restriction	Max qty	Repeats
Antibiotics				
Ciprofloxacin eye-drops 3 mg per mL (0.3%), 5 mL	CiloQuin, Ciloxan	Authority required bacterial keratitis*	2	0
Gentamicin sulfate eye-drops 3 mg (base) per mL (0.3%), 5 mL	Genoptic	Restricted	1	2
Ofloxacin eye-drops 3 mg per mL (0.3%), 5 mL	Ocuflox	Authority required bacterial keratitis*	2	0
Tobramycin eye-drops 3 mg per mL (0.3%), 5 mL	Tobrex	Restricted	1	2
Tobramycin eye ointment 3 mg per g (0.3%), 3.5 g	Tobrex	Restricted	1	0
Anti-inflammatory agents				
Dexamethasone eye-drops 1 mg per mL (0.1%), 5 mL	Maxidex	Unrestricted	1	0
Prednisolone acetate with phenylephrine hydrochloride eye-drops 10 mg -1.2 mg per mL (1% - 0.12%), 10 mL	Prednefrin Forte	Restricted	1	0

*Optometrists can continue to prescribe these agents in any appropriate clinical situations as NON-PBS prescriptions. For the patient to receive a PBS benefit, the prescription can be written as a PBS prescription if the patient is under the supervision and direction of an ophthalmologist.

The September issue of *Pharma* included a list of Schedule 4 medicines that can be prescribed by optometrists with a scheduled medicines endorsement. In the published list, Lignocaine and Pilocarpine are marked as 'not available in the ACT'.

Although Lignocaine is not on the list of medicines that endorsed optometrists can prescribe, non-endorsed optometrists can use Lignocaine for tonometry and for fitting contact lenses. For those purposes, Lingocaine is available in the ACT.

Pilocarpine is also listed as one of the medicines that endorsed optometrists in the ACT cannot prescribe; however, Pilocarpine can be used by non-endorsed optometrists in the ACT 'after instillation of mydriatic substance'. Therefore, Pilocarpine is available in the ACT as a miotic.

Pilocarpine was correctly listed as available in the ACT as an anti-glaucoma agent.

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