SPECIAL ARTICLE

TFOS: Unique challenges and unmet needs for the management of ocular surface diseases throughout the world

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Abstract

The mission of the Tear Film & Ocular Surface Society (TFOS) is to advance the research, literacy, and educational aspects of the scientific field of the tear film and ocular surface. Imagination and innovation are central to the TFOS vision. TFOS is about making things happen. One such recent happening was the TFOS organization of a special live/virtual meeting in Rome, Italy (September 9, 2020). Invited experts from Africa, Asia, Oceania, Europe, and the Americas were asked to address from their perspective the unique challenges and unmet needs for the management (e.g., diagnosis and treatment) of ocular surface diseases in

their regions, as well as what they perceived as short and long term scientific and clinical solutions. These medical needs and proposed solutions are the subject of this TFOS Special Meeting report.

Abbreviations

DALK	Deep anterior lamellar keratoplasty
DED	Dry eye disease
DMEK	Descemet membrane endothelial keratoplasty
DSAEK	Descemet stripping automated endothelial keratoplasty
MGD	Meibomian gland dysfunction
MMP	Mucous membrane pemphigoid
OSD	Ocular surface disease
SJS	Stevens-Johnson syndrome
TBUT	Tear film break-up time
VKC	Vernal keratoconjunctivitis

Introduction

TFOS Global Mission. *Amy Gallant Sullivan and David A. Sullivan, TFOS, Boston, MA, USA, and Piera Versura, Department of Specialized, Experimental, and Diagnostic Medicine, University of Bologna, Bologna, Italy*

The Tear Film & Ocular Surface Society (TFOS; www.tearfilm.org), a non-profit organization, was created to advance the research, literacy, and educational aspects of the scientific field of the tear film and ocular surface. TFOS has launched numerous initiatives, including the organization of a Special Meeting in Rome, Italy (September 9, 2020). Invited experts were asked to address from their perspective the unique challenges and unmet needs for the diagnosis and treatment of OSDs in their regions of the world, as well as what they perceived as short and long term scientific and clinical solutions. This meeting was scheduled to

be held in Cernobbio, Italy, at the beginning of the 9th International Conference on the Tear Film & Ocular Surface: Basic Science and Clinical Relevance. However, because of COVID-19 restrictions, the Conference was cancelled and replaced by a hybrid live and virtual meeting, with the "live" sessions occurring in the Museo dell'Ara Pacis, Rome, Italy. Participants were OSD experts from Africa, Asia, Oceania, and the Americas, and the number of online registrants exceeded 1650. The report of this TFOS Special Meeting appears below. The views expressed within this meeting summary are those of the individual presenters and do not necessarily represent the views of TFOS. An abbreviated version of this TFOS report was published in The Ocular Surface (Ocul Surf. 2021 Sep 10:S1542-0124(21)00096-3. doi: 10.1016/j.jtos.2021.08.014. Epub ahead of print. PMID: 34517137).

The Importance of Understanding the Unmet Needs for the Management of Ocular Surface Disease Throughout the World. *Monica Alves. Department of Ophthalmology and Otorhinolaryngology, Faculty of Medical Sciences, University of Campinas – UNICAMP, São Paulo, Brazil. https://orcid.org/0000-0001-7940-0194*

OSD is the disease for which patients most frequently seek help from eyecare professionals, and it is the fourth most common cause of blindness worldwide. OSD encompasses a plethora of eye diseases, including DED, MGD and many forms of keratitis and keratoconjunctivitis. It can be caused by various mechanisms, such as the aging process, hormone dysfunction, environmental exposure, infection, and inflammation. It can involve multiple interconnections and pathways that interfere with ocular surface homoeostasis. Because of the multifaceted nature of OSD, it is challenging to identify and describe the unmet needs in its diagnosis and treatment. Moreover, the challenges vary in different regions of the world, with regard not only to etiology and manifestations of disease, but also to factors such as the populations affected, socioeconomic and environmental conditions, and access to eyecare. For each region, we need to ask certain questions. What are the most prevalent OSDs? How variable are the clinical presentations and risk factors? Which diagnostic test or set of tests will be most beneficial? How can proper treatment be provided?

When I first participated in the TFOS DEWS II Epidemiology subcommittee,[1] I was surprised that there were no data about DED in my country, Brazil, and almost no information on countries below the equator. I began to develop the first DED epidemiological study in Brazil, which required surveying very distinct and widely spread areas of a huge country.[2] Our study team enrolled more than 3,000 participants. Using the Women's Health Study questionnaire, we found the overall prevalence of DED in Brazil to be 12.8%., representing more than 25 million people in a population of 212 million.

Our study was conducted in the five main geopolitical regions of the country. The regions differed in climate and socioeconomic conditions, and, accordingly, in DED rates. At that time, I also joined the voluntary working group that delivers eyecare assistance to central Brazil. This is the Xingu indigenous national reserve, an untouched area of forest, where indigenous people can live isolated and protected in nature. With our survey questions in mind, I asked everyone I met about DED symptoms, e.g., dryness sensation and eye irritation, and I consistently received negative answers. Interesting! Inside that wonderful reserve, there is no DED. Also, there are no electronics, no pollution, no stress. People live and eat in a healthy way. They exercise all day, and they breathe pure air. Because Xingu inhabitants have high sun exposure, pterygium is a common OSD. Infections such as trachoma, in some areas in the north, and river blindness, are also frequently seen.

In my career, I have witnessed the enormous regional differences in prevalence and types of eye disease and availability of eyecare. I live in the most developed area of Brazil, the state of São Paulo, where the most modern medical facilities, techniques, devices, and novel treatment options are available. In Xingu, a remote area of the same country, the situation is completely different. Such contrasts are present worldwide. The main differences in OSD fall within three main categories: 1) risk factors and prevalence, 2) manifestations, and 3) management. Approaches to addressing unmet needs in OSD should focus on understanding these differences, obtaining better epidemiological data, identifying risk factors, and providing more precise diagnostic tools and more effective treatments. Access to advances in all areas, including diagnosis and treatment of OSD and education, must be widely available.

Corneal disease represents the broadest group of OSDs, including dystrophies, which need improved surgical techniques; trauma, which affects mostly children and young people; infections, and some neglected diseases, such as trachoma and vitamin A deficiency. Corneal diseases can result in opacities, visual impairment, and blindness. Fortunately, many are preventable and treatable.

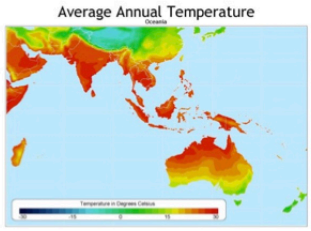
Unmet needs vary according to the type of OSD. Pterygium, which is related to UV exposure, is more severe and has greater impact on vision in tropical areas, frequently requiring surgery. MGD and DED are common causes of OSD worldwide, but actual prevalence rates, according to geographical area, need to be more precisely documented. Diagnostic and treatment strategies must be improved, and better education must be provided for both eyecare professionals and patients.

In summary, there remain many unmet needs in understanding and managing OSD, and these vary according to region, country, and environmental and socioeconomic conditions. At this meeting, TFOS ambassadors and colleagues from the Americas, Asia, Africa, Europe, and Oceania share their observations and insights with the goal of elucidating the global challenges presented by OSD.

Oceania

Fiona Stapleton, School of Optometry and Vision Science, UNSW Sydney, Sydney, Australia, and Jennifer P. Craig, Department of Ophthalmology, New Zealand National Eye Centre, The University of Auckland, Auckland, New Zealand.

Oceania is a large region in the southern hemisphere between Asia and the Americas. It has about 42 million inhabitants, distributed among 30,000 islands, which are grouped into four main regions: Australasia (which includes Australia and New Zealand), Melanesia, Micronesia, and Polynesia. Oceania comprises 14 sovereign countries, with Australia having the largest population. Among the regions, 29 languages are spoken. Challenges related to healthcare in general, and eyecare in particular, are associated with climate, geographical isolation, poverty, and culture (Figure 1).[3]



Country	HDI	Development level
Australia	0.935	Very high
New Zealand	0.913	Very high
New Caledonia	0.852	Very high
French Polynesia	0.791	High
Palau	0.780	High
Cook Islands	0.728	High
Fiji	0.727	High
Niue	0.659	Medium
Micronesia	0.640	Medium
Vanuatu	0.594	Medium
Tuvalu	0.590	Medium
Kiribati	0.590	Medium
Tokelau	0.539	Low
Solomon Islands	0.506	Low
Papua New Guinea	0.505	Low

Climate

- 7 climate zones represented
- High peak UV intensities
- Profile of eye disease

Geographical isolation

- Islands up to 5000Km away from major population centres
- COVID impacts – 10 sovereign states reported no cases
  - Limited already irregular visits from health care professionals

Poverty

- Health care systems suboptimal

Cultural health beliefs

- Māori philosophy of health and wellbeing
- Aboriginal and Torres Strait Islander – importance of social and spiritual dysfunction

Figure 1. Oceania - Challenges to healthcare and eyecare delivery. Please refer to Maher P: *Aust J Rural Health* 1999[3] for more information about aboriginal traditional health beliefs.

Oceania has seven climate zones, some with peak UV intensities considerably higher than those found at similar latitudes in the northern hemisphere. Therefore, eye diseases related to UV exposure (pterygium, cancers, early onset of cataract, and age-related macular degeneration) have high prevalence.

The huge expanse of Oceania results in geographical isolation for many people. Some islands are up to 5,000 miles from major population centers. COVID has worsened the impact of isolation with the closure of borders, which has further limited already irregular visits from healthcare professionals. In countries that have training programs for eyecare professionals, it has been possible to maintain patient care, despite the pandemic.

Levels of poverty vary greatly across Oceania. Countries with high levels of poverty (such as Papua New Guinea, Solomon Islands, Tokelau) have low health development index scores compared with countries like Australia, New Zealand, and New Caledonia.

Healthcare challenges also stem from cultural beliefs about health, especially among the "First Nations" populations. Māori comprise about 16% of the New Zealand population, and aboriginal and Torres Strait islanders comprise about 3% of the population in Australia. Both access to and utilization of healthcare and eyecare services among those groups are limited and are not representative of healthcare delivery in other regions.

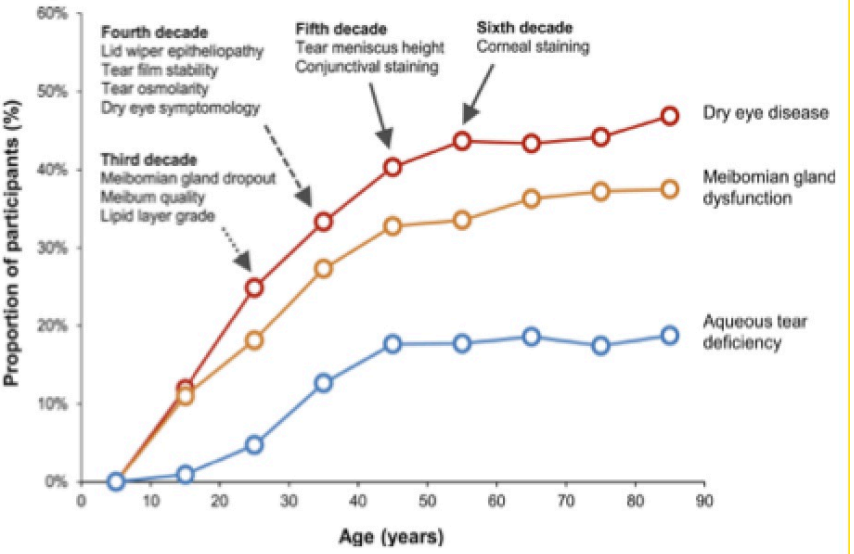
In considering unmet needs for providing eyecare in Australia and New Zealand, this presentation will focus on answering three questions. Does the population have adequate access to care? Is the care appropriate? Is the care affordable?

Australia has a population of just over 25 million people, 46% of whom are above the age of 40.[4] New Zealand's population is about 20% that of Australia, with a similar proportion aged over 40 years.[5] Optometrists are the primary eyecare providers in both countries and are responsible for more than 90% of initial consults. Australia has about 6,500 eyecare practitioners (including 738 ophthalmologists),[5-7] representing a reasonably good ratio to the total population (1:3850). However, the distribution of ophthalmologists across Australia is uneven, with a concentration on the eastern seaboard and the major cities and very few in the rural and regional areas. This uneven distribution is similar in New Zealand, particularly in the South Island.[7] First people are disproportionately affected in lack of access to eyecare.

The cost of primary eyecare in Australia is covered fully or in part by Medicare, the public system, but private healthcare may cover the cost of corrective eyewear. In Australia, based on the number of hours that ophthalmologists work in private and public facilities, 84% of full-time equivalents in ophthalmology work in the private sector, and 30% of all cataract surgery is delivered in the public system.[7]

In New Zealand, there are about 850 eyecare practitioners (including 157 ophthalmologists), about 1 per 7,000 of population.[8] In New Zealand, 30% of the full-time equivalents in ophthalmology work in the private sector, and this may reflect that 30% of the populace has health insurance. About 50% of cataract surgery is delivered in the public system.

With regard to DED in Oceania, current population-based prevalence data are limited. There have been some recent studies from New Zealand. The first of these presented a prevalence estimate in a 45-year-old cohort, estimating about a 9% prevalence, with the rate of MGD about three times that of aqueous deficient DED.[9] In a New Zealand registry of 1300 subjects, the effect of age on clinical indicators of DED was nicely demonstrated. Figure 2 depicts the proportion of participants affected by age group (upper graph).[10] The indicators show when these signs start to become prevalent in the population.



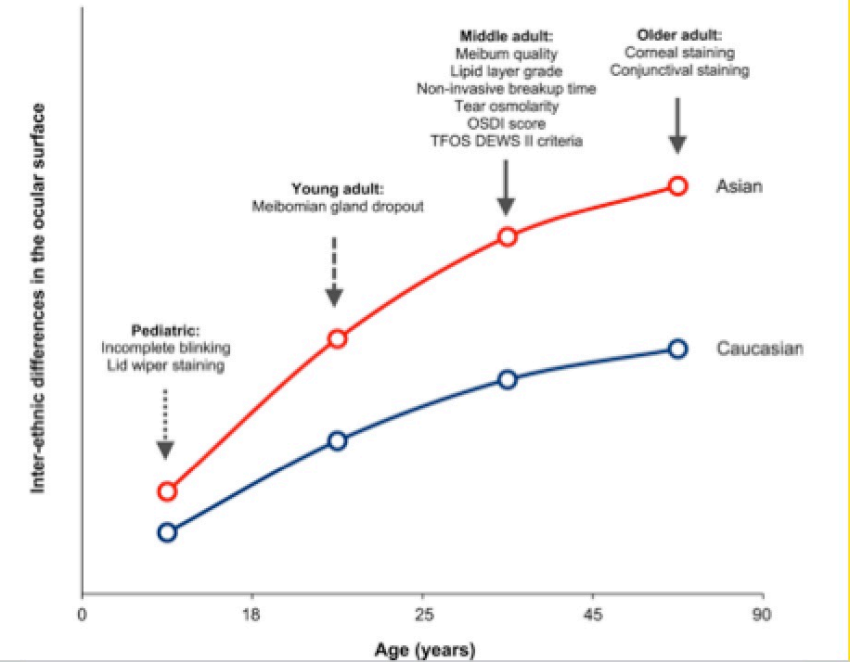


Figure 2. Oceania - Unmet needs in DED. The upper and lower graphs originate from Wang MTM, et al: *Ocul Surf.* 2020,[11] and Wang MTM, Craig JP: *Ocul Surf.* 2019,[12] respectively.

Meibomian gland changes are noted by the third decade, and signs like corneal staining appear by the sixth decade. There have been some recent cross-sectional studies to establish risk factors for DED in the New Zealand population, addressing ethnicity (Asian versus Caucasian), as well as age and some other risk factors that have been previously identified.[11]A further study pooled analysis from different studies to explore the effect of age on those ethnicity differences in the signs and symptoms of DED.[12] The lower graph shows the interethnic differences in the signs of OSD or DED by age. Even in the pediatric age group, the Asian eye has a higher rate of ocular surface changes than the Caucasian eye, and by young adulthood, when meibomian gland changes appear, the difference between the ethnic groups starts to increase. At age 60 and above, there is a very wide difference between Asian and Caucasian eyes in the rates of ocular surface signs.

Appropriateness of eyecare should be considered relative to "best practice" standards. In Australia, eyecare is delivered in accordance with accepted guidelines in just over 70% of cases.[13] For DED, the rate is a little lower in terms of factors like underdiagnosis and underestimation of severity and impact of the disease, delayed diagnosis or misdiagnosis, and patient frustration with the healthcare systems.[14-16] Our evidence for the quality of DED management by practitioners was derived from surveys, and the findings suggest that symptoms of DED are frequently discussed in practice but that use of questionnaires for either diagnosis or monitoring of disease is limited. Grading scales and questionnaires are not widely adopted in New Zealand by either optometrists or ophthalmologists; however, both practitioner groups recognize the importance of continuing education[17] and raising awareness. In both countries, there is reasonable awareness and adoption of the TFOS diagnosis and management guidelines. Available treatments for DED can be grouped as treatments for aqueous deficiency; treatments for MGD and lid abnormalities; and anti-inflammatory therapies.

There is some evidence that the risk factors for OSD are different in First Nations people. More must be learned about cultural impacts on eye disease and workforce capacity building in First Nations people, given the cultural differences in the approach to healthcare. Data on the prevalence of DED from large-scale population-based studies are still lacking. There are some large cohorts with ongoing measurement of DED prevalence and risk factors in New Zealand, and, for the first time in Australia, the National Eye Health Survey will include DED. Youth appears, at least in Asia, to be associated with high prevalence of DED, perhaps higher than expected. Other risk factors are specific to the population, including climate and, probably, indigenous health.

It appears that MGD signs predict worsening of symptoms, but there is limited evidence for the effects of intervention. A DED registry soon to be launched in Australia should contribute helpful information on this subject.

Medical devices or procedures for the treatment of DED are not subsidized in Australia or New Zealand, and many later-generation artificial tears, such as those that contain lipid, are only available privately. Reimbursement mainly covers historical artificial tears, topical corticosteroids, and topical antibiotics. It does not cover diagnostic technologies like osmolarity or MMP-9 testing. There are no agents available for the management of ocular neuropathic pain beyond autologous serum, which currently cannot be prescribed by optometrists. Certain DED treatments available in other countries are unavailable in Australia and New Zealand.

In the future, a focus on preventative care, personalized care, and health delivery using new technologies may present new opportunities. The use of evidence generated during routine practice and collaboration between agencies may help to bring other treatments to this region. To accomplish major improvement in eyecare delivery, reimbursement policies must extend to more procedures and medications.

Asia

Eastern Asia. *Shigeru Kinoshita, M.D., Ph.D., Department of Frontier Medical Science and Technology for Ophthalmology, and Chie Sotozono, M.D., Ph.D., Department of Ophthalmology, Kyoto Prefectural University of Medicine, Kyoto, Japan*

Eastern Asia is generally considered to include Japan, South Korea, North Korea, Taiwan, and China. Because specific information on ophthalmology in North Korea is scarce, this discussion focuses on unmet needs and future directions in the management of OSDs in the other four countries.

The climate in Japan is similar to that in the other Eastern Asian countries; i.e., a monsoon climate comprised of a rainy season with high relative humidity and relatively mild temperatures, yet four distinct seasons. However, in China, the climate and geologic environment differ significantly between the coastal and inland regions, as well as between the northern, central, and southern regions.

The populations of Japan, South Korea, Taiwan, and China are approximately 120 million, 50 million, 24 million, and 1.4 billion, respectively. Of note, Japan has the highest ratio of elderly people in the world. Moreover, China and South Asia in general have high levels of air pollution. These factors impact the prevalence of OSDs..In this presentation, we discuss some challenges and unmet needs in the diagnosis and treatment of OSD in Eastern Asia and summarize short-term and long-term scientific and medical solutions.

OSDs can be divided into two major categories: 1) diseases that are commonly encountered and generally treated conservatively, such as DED, MGD, ocular allergies (including atopic keratoconjunctivitis [AKC] and vernal keratoconjunctivitis [VKC]), and ocular surface infections, and 2) diseases such as pterygium, recurrent pterygium, and devastating OSDs (e.g., thermal/chemical injury, mucous membrane pemphigoid (MMP), and Stevens-Johnson syndrome (SJS), which generally require surgical treatment. Another group includes corneal dystrophies, especially granular corneal dystrophy type II and gelatinous drop-like corneal dystrophy (GDLD).

Government-approved eye drops for the treatment of DED differ substantially between countries. In Japan, the main topical treatments are diquafosol sodium, rebamipide, and hyaluronic acid eye drops, while cyclosporine and lifitegrast eye drops, which are currently available in the United States, have not been approved. Cyclosporine eye drops are available in South Korea, but not in Taiwan or China.[18] In Japan, MGD and meibomitis, which is considered posterior blepharitis, are viewed as overlapping yet slightly different entities. Since meibomitis is also closely related to rosacea, antimicrobial therapy might serve as a meibomitis treatment.[19]

The treatment of allergic diseases, such as AKC and VKC, is complicated. It is reasonable to assume that the ocular surface epithelial barrier function is clinically or subclinically impaired, which allows various antigens to enter the cornea and conjunctiva. This activates the innate immune system, the acquired immune system, and the mucosal immune system, such as conjunctiva-associated lymphoid tissue. Yet, in clinical practice, the daily administration of a single-dose unit of either cyclosporine or tacrolimus eye drops is accepted as a suitable treatment.

Corneal infections are a significant problem in all Asian countries. The Asia Cornea Society conducted a survey of corneal infections in 13 major ophthalmologic institutions in 8 Asian countries.[20] That study showed that the causes of infections in Japan and South Korea are similar, but that fungal infections are a significant problem in China (Table 1). In Japan and South Korea, changes in the commensal bacterial flora, especially MRSA infections, are opportunistic infections in the elderly population. Thus, we must seriously consider what to do next if drugs such as vancomycin ointment become ineffective for MRSA. In addition, quinolone-resistant *Corynebacterium sp*. is increasing, and there are now an alarming number of reports of such corneal infections. In Eastern Asia, severe corneal infections caused by *Pseudomonas aeruginosa* and *Acanthamoeba* due to continuously worn soft CLs and colored CLs are an increasing problem, and strong warnings are being sent to young CL users.

Table 1. Causes of infectious keratitis in subject eyes, by country.

Final Diagnosis	Total Number of Eyes (%)	Country							
		IN	CH	SG	PH	JP	TH	KR	TW
Bacterial	2521	1423	144	224	185	144	150	107	144
	(38.0%)	(38.3%)	(15.3%)	(41.3%)	(53.2%)	(47.8%)	(50.5%)	(42.8%)	(61.8%)
Fungal	2166	1694	284	4	94	19	27	25	19
	(32.7%)	(45.6%)	(30.2%)	(0.7%)	(27.0%)	(6.3 %)	(9.1%)	(10.0%)	(8.2%)
Parasitic	159	78	8	7	20	15	12	3	16
	(2.4%)	(2.1%)	(0.9%)	(1.3%)	(5.7%)	(5.0%)	(4.0%)	(1.2%)	(6.9%)
Viral	836	255	434	38	7	50	18	15	19
	(12.6%)	(6.9%)	(46.2%)	(7.0%)	(2.0%)	(16.6%)	(6.1%)	(6.0%)	(8.2%)
Infectious keratitis	944	264	70	270	42	73	90	100	35
(not specified)	(14.2%)	(7.1%)	(4.4%)	(49.7%)	(12.1%)	(24.3%)	(30.3%)	(40.0%)	(15.0%)
Total	6626	3714	940	543	348	301	297	250	233

CH = China; IN = India; JP = Japan; KR = South Korea; PH = Philippines; SG = Singapore; TH = Thailand; TW = Taiwan.

Reprinted with permission from Khor WB, et al: *Am J Ophthalmol* 2018.[20]

Simple limbal epithelial transplantation and limbal transplantation can both be used to treat corneal epithelial stem cell deficiency, especially unilateral chemical injury. For bilateral chemical injury, autologous cultivated oral mucosal epithelial transplantation (COMET)[21,22] and allogeneic corneal epithelial transplantation are occasionally being used, with varied clinical outcomes. Clinical research on cultured corneal epithelial sheets made from iPS cells has begun, and break-throughs are anticipated.[23] MMP is probably the disease presenting the greatest research challenges with regard to its pathogenesis and treatment. At present, immunosuppressive treatment and ocular surface reconstruction are being performed for MMP, although there is no established concept on how to deal with major MMP target autoantigens, such as integrin β 4.

It is now known that in SJS with severe ocular complications (SOCs), the predictive factors are the use of non-steroidal anti-inflammatory drugs (NSAIDs) or cold remedies, rather than allopurinol, and patient age, etc.[24,25] Furthermore, SJS patients with SOCs in the chronic phase usually had severe damage to the ocular surface in the acute phase. Our recently developed tear-exchangeable limbal-rigid CL (CL)[26] is approved for use in Japan for the treatment of SJS with SOCs. Moreover, clinical trials of COMET have now been completed in Japan, and the treatment is awaiting official government approval. While a keratoprosthesis may be the treatment of choice for severe SJS in the chronic phase, COMET combined with the use of the limbal-rigid CL provides much improved vision. In addition, steroid pulse therapy[27] and amniotic membrane transplantation are now being used to treat the acute phase of the disease.

Granular corneal dystrophy type II and GDLD are serious problems in South Korea. Laser-assisted in situ keratomileusis (LASIK) is performed on very early-stage patients, and this is followed by recurrence of corneal opacity in the corneal stroma interface, resulting in severe visual impairment. GDLD is a severe disease with autosomal recessive inheritance, which occurs mainly in the Japanese population. An abnormality in the TACSTD2 gene disrupts the corneal epithelial barrier and causes lactoferrin and other

substances in tear fluid to be deposited in the corneal stroma, resulting in amyloid formation. Therefore, understanding of GDLD is relevant for the elucidation of the pathogenesis of the other diseases, such as secondary corneal amyloid deposition related to eyelashes, etc.,[28] corneal impairment caused by eye drop preservatives, eye-drop-related self-injury, and even climatic droplet keratopathy (spheroidal degeneration).

Southern Asia. *Geetha Iyer, Sankara Nethralya, Chennai, Tamil Nadu, India*

Unmet needs for management of OSD in Southern Asia can be considered in two categories. One is based on unexpressed demand, whereby, for some reason, affected individuals do not seek healthcare or are not aware of the need to seek healthcare. The other involves an unmet supply, whereby an expressed demand for diagnosis, monitoring, and therapy is not adequately met. In the latter category, research, both translational basic science and clinical advances, is needed to improve the ability of the medical community to fulfill unmet needs. Moreover, accessibility to eyecare needs to be improved. Although India has a universal health care system, vast differences in quality and accessibility of care exist between rural and urban areas. Specialized training in diagnosis and management of OSD is another need. A holistic Ocular Surface Fellowship, like the one offered by our tertiary eyecare center, facilitates super-specialization and training in the field.

Our clinic has a dedicated ocular surface service as a sub-speciality of the cornea unit. My perspective in identifying problems and unmet needs in eyecare is based on patients residing in India and patients from other Southern Asian countries who are referred to our tertiary referral eyecare center. Non-cicatricial DED, chemical injuries, and SJS comprise a large number of OSDs, and because of the tropical climate, allergic conjunctivitis, especially the refractory type, is also highly prevalent. Recent advances in understanding and management of these conditions have been significant, with a specific emphasis on new or investigative modalities and newer molecules, as well as equipment for therapy.

Unfortunately, we do not have accurate data to assess the extent of the problem of OSD, because we do not have systematic reporting registries. However, we do have a significant amount of data, especially retrospective data from tertiary referral eyecare centers, with respect to each of the conditions mentioned above, and these data highlight the existential nature of various conditions. The incidence of vitriolage (i.e., acid attack) in India and its neighboring countries is significant, with almost 500 cases reported annually. An OSD that is unique to our country is chemical injury caused by lime or *chuna* (calcium hydroxide), which is commonly ingested by elders with betel leaves. Often, children are sent to buy the chuna, which is sold in plastic packets, enticing the children to play with it. This causes the plastic to rupture, and the packed chuna explodes into the face of the child.

Considering the physical, psychological, social, and economic effects of the OSDs noted above, their impact is substantial, taking a huge toll on patients and on the medical community. Therefore, the lack of educational measures to increase awareness of preventable disorders represents an important unmet need. There is a particular need for mass outreach campaigns to educate the public with respect to the prevention of accidental domestic and industrial chemical injuries. It is equally important to sensitize the public, as well as ophthalmologists and other physicians, to the need for systemic investigations in patients with persistent non-cicatricial aqueous tear deficiency with no identifiable cause. We launched a national campaign for the prevention of corneal blindness due to chemical injuries, which was spearheaded by our institute, along with the leading ophthalmic national eye institutes, societies, and non-governmental organizations. We presented an appeal for a nationwide ban on the sale of acid and *chuna*, and placed advertisements in newspapers and other media to highlight the danger of *chuna*. Our campaign included a plan for a holistic cure and rehabilitative measures for patients with chemical injuries. We also undertook clinical research on the pathophysiology of chemical injuries.

Multiple new molecules have emerged for the management of VKC, and there is a significant shift toward immunotherapy as a major treatment modality for this disease. Our own recent work has described advances in the management of acute ocular chemical injuries.[29,30]

SJS is another important OSD in Southern Asia. Timely management of SJS can prevent chronic sequelae that may necessitate a keratoprosthesis. Current research into retinoid metabolism, as shown by cytokine analysis, and genetic markers may lead to earlier and more targeted therapy for SJS. The keratoprosthesis used for end-stage SJS is usually a type 2, primarily the osteo-odonto-keratoprosthesis and the Boston type 2 keratoprosthesis. These may not be entirely successful,[31] and modified designs have been developed, such as the Lux Keratoprosthesis, which was designed by the Boston KPro Foundation.[32] We have used the Lux Keratoprosthesis in patients for whom the earlier KPro was not appropriate, and results after two years of follow-up are encouraging.

Efforts to meet needs for managing OSDs worldwide must focus on research that is specifically directed to elucidating pathophysiology and developing targeted therapies. Chemical injuries require more awareness campaigns. For VKC, we need more studies to understand the refractory nature of the disease. For SJS, we need to be able to identify individuals at high risk by genetic or HLA diagnostic means. To improve management of DED, eyecare providers must collaborate with dermatologists and rheumatologists at the national level to establish diagnostic and monitoring criteria. A follow-up platform in addition to the algorithmic approach provided by the TFOS DEWS II Diagnostic Methodology Subcommittee report for assessing patients with a preliminary diagnosis of DED should be used at multiple eyecare centers, providing a consistent and ongoing database.[33]

Significant effort and funding from government and private agencies are required to provide an appropriate standard of care for all socioeconomic groups in all geographic areas.

Middle East. *Elias F. Jarade, Cornea and Refractive Surgery, Beirut Eye and ENT Specialist Hospital, Ophthalmology Department, Lebanese University, Beirut, Lebanon, and Mediclinic Dubai Mall, Dubai, United Arab Emirates, Maroun Eid and Reeda Bou Said, Ophthalmology Department, Lebanese University, Beirut, Lebanon, and Nicole Mechleb, Ophthalmology Department, Saint Joseph University, Beirut, Lebanon*

I, Dr. Jarade, practice mainly in Lebanon, Dubai, and Kingdom of Saudi Arabia, and I am also a visiting doctor in Bahrain, Kuwait, Iraq, Syria, Egypt and Jordan. Thus, my practice covers most of the Middle East and Arabic countries in this area. I am writing this report on unmet needs for OSD in the Middle East in collaboration with my colleagues, Drs. Eid, Said, and Mechleb.

Conditions that present particular challenges include trachoma, keratoconus (with pediatric keratoconus being especially problematic), and traumatic limbal stem cell deficiency due to the continual armed conflict in many areas. DED is also common. Management of eye disease is limited by inadequate eye banking facilities, patients' medical attitudes (e.g., poor compliance; non-medical advice), social medical behavior (beliefs based on non-evidence-based medicine or myth-based medical advice)**,** and the lack of awareness of eye disease among medical practitioners.

Trachoma is a leading cause of preventable blindness. It starts in early childhood with infection by *Chlamydia trachomatis,* which recurs repeatedly, leading to destruction of the conjunctiva, the bulbar conjunctiva, and tarsal conjunctiva, which, in turn, leads to cicatrization of the tear-producing glands and cells, and entropion. Continuous friction and rubbing over the cornea causes corneal opacity and DED. A 2001 survey showed that trachoma played a major role in blindness in the Middle East, with prevalence of around 25%.[34] Trachoma has been endemic in Saudi Arabia, Iraq, Qatar, Bahrain, and the United Arab Emirates -- mainly in the Gulf area, much less in Lebanon, Syria, and Jordan. A 1984 survey found that about 22% of the Saudi population had ongoing active trachoma. In 1994, the number had dropped to 10-11%, due to improvement in socioeconomic status and in the healthcare system, as well to increased public awareness of the disease.[35] Despite the decrease in active disease, the cycle of the disease persists at a high rate, because most of the older patients, who contracted the disease in childhood, continue to suffer its effects. Therefore, physicians should be familiar with the disease and its management; this is often not the case with visiting doctors from countries with low prevalence of trachoma.

Keratoconus and predominantly pediatric keratoconus affect young patients and have great socioeconomic impact. Keratoconus is highly prevalent in the Middle East, and its visual rehabilitation poses major challenges, as described below.

We conducted a study of about 16,800 patients at various eye specialist hospitals over five years and found overall prevalence of keratoconus to be more than 3.7% and the prevalence of pediatric keratoconus to be 0.53% -- much higher than the 1/2000 global prevalence.[36] Given that our patients were at tertiary referral centers, our high numbers would be expected, but even so, our percentages were very high compared to those in other parts of the world. Of 16 patients with pediatric keratoconus, 30% had stage 4 disease, with two having hydrops at first presentation. That indicates that the keratoconus in our area starts early in life and follows a progressive course, leading to visual impairment at an early age. Saudi Arabia reported an even higher prevalence of pediatric keratoconus, about 4.8%, but that study included patients aged 6 to 21 years,[37] whereas our patients were less than 14 years of age.

We are studying the characteristics of our population with keratoconus. Consanguinity plays a major role, with 28% of patients having parents who are related by blood. Almost 60% of keratoconus patients rubbed their eyes, a common practice of patients with ocular allergy. We concluded that every child with ocular allergy/eye-rubbing should receive yearly examinations with topography as soon as they are old enough to rest their chin in the topographer. Any child with a family history of keratoconus, unexplained loss of vision, or astigmatism should also be examined with corneal topography at an early age.

Figure 3 shows an algorithm for treatment of adult keratoconus with some modifications for pediatric keratoconus (Dr. Jarade's nomogram for the treatment and visual rehabilitation of pediatric keratoconus[36]). Correcting refractive errors in pediatric keratoconus is important, as significant anisometropia can hinder binocular visual function and lead to amblyopia. Hence, use of intracorneal ring segments and/or intraocular phakic lenses to address anisometropia and reduce refractive errors is still indicated. When corneal transplant is indicated, a partial transplant, like a deep anterior lamellar keratoplasty (DALK) procedure, is recommended. However, patients usually present at an advanced stage of disease, making DALK challenging. Penetrating keratoplasty may be the only option, with a risk of failure and/or rejection. Phakic implantable collamer lens implantation is also recommended to address refractive errors, in case relatively good corrected distance visual acuity may also be required in the keratoconus patient.

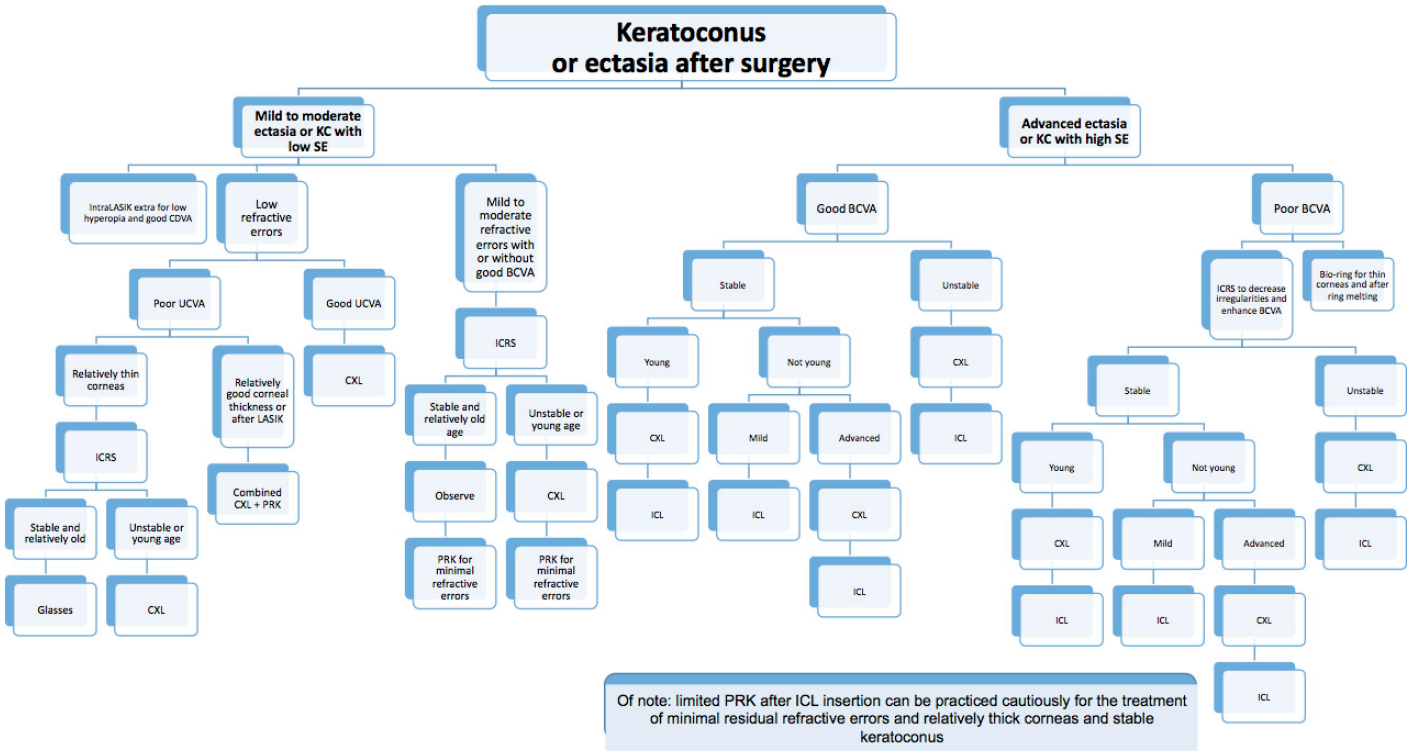


Figure 3. Dr. Jarade's algorithm for the management of keratoconus or ectasia after corneal refractive surgery. Decisions are made according to the staging of keratoconus and amount of spherical equivalent of associated refractive error. BCVA = best-corrected visual acuity; CDVA = corrected distance visual acuity; CXL = corneal collagen cross-linking; ICL = implantable collamer lens; ICRS = intracorneal ring segment (ICRS); KC = keratoconus; PRK = photorefractive keratectomy; SE = spherical equivalent; UCVA = uncorrected visual acuity; IntraLASIK extra= femto-LASIK with under-the-flap corneal crosslinking[38]; Bio-ring= biological stromal ring. [39]

The visual rehabilitation of keratoconus in the Middle East presents particular challenges. It is difficult to use hard contact lenses because of the sand and allergens in the air and the resultant dryness of the eyes. There are no eye banks in the Middle East, so it is difficult to obtain tissue for corneal transplant or partial transplant, like the DALK procedure. Visual rehabilitation is expensive and usually not covered by a third party in this area of the Arabic world. This is true even for pediatric keratoconus.

Blast injury, penetrating eye injury, and thermal and chemical burns incurred during armed conflict may require repeated surgery, leading to limbal stem cell deficiency. Modern methods of rehabilitating the ocular surface using transplantation of stem cells and ex vivo cultivated limbal stem cells are practically non-existent in the Middle East.

A recent article in the *Gulf News* stated that DED is the major eye problem in the Middle East and Northern Africa. Its high prevalence was attributed largely to the arid climate, the use of air conditioners,

and the widespread use of electronic devices. High prevalence of DED has been demonstrated in other studies in Saudi Arabia. [40,41]

Eye banking is absent in most of the Arabic world. I am aware of only one eye bank, which is in Lebanon, but it functions at very low capacity. The number of corneas needed markedly exceeds the number available. Most corneal tissue used in Lebanon is imported. The educational level and the moral concepts of the Arabic world population discourage the donation of corneas or other organs. The cost of imported corneal tissues (US$2,500 to US$3,000) is very high relative to the income in most of the Arabic world. Moreover, the quality of imported tissues is not optimal, because delivery takes several days and the tissues that are exported are often not as good as those retained for use in the exporting country. Before we can establish eye banking in the Middle East, we need to educate the population about the need to donate corneas and other organs, and create a new codified strategy to optimize the capabilities of our eye and organ banking system.

A significant unmet need for eyecare in the Middle East relates to the limited access to eyecare specialists. Lebanon has more than 500 ophthalmologists, but only about 35 of them have fellowship training in cornea and OSD. They are concentrated in the university-based hospital in Lebanon's capital, Beirut. Corneal subspecialists are absent in the rural and suburban areas of Lebanon. Doctors may be reluctant to refer to subspecialists because they prefer to keep the patients in their private practices. Patients may not request a referral, because they are not aware that subspecialists exist, or they may not be aware that their problem could be better managed by a cornea or ocular surface specialist. Regular eye examinations are non-existent in most of the Middle Eastern population. Patients, especially the elderly, tolerate sub-optimal vision. They do not realize the magnitude of their eye problems and do not seek specialized care. In the absence of a trusting relationship with a doctor, the patient may suspect a financial motive when a doctor recommends treatment, especially if it is a preventive treatment for a condition that is not yet debilitating.

We need to develop campaigns to increase patient awareness of the existence and progression of ocular diseases in order to reduce the risks of blinding visual complications. Patients need to appreciate the importance of regular eye examinations, and these must be included as part of the healthcare system. Regular follow-up must be provided for patients with ocular disease, and patients must comply with the follow-up regimen. All of this requires a healthcare system that can provide education, accessible medical facilities with specialized personnel, and comprehensive services for preventing and managing disease.

Africa

Northern Africa. *Sihem Lazreg, Cabinet Ophthalmologie, Alger Centre, Algiers, Algeria, and Mohamed Shafik Shaheen, University of Alexandria, Alexandria, Egypt*

The growing sub-specialty of OSD includes not only DED, but a multitude of pathologies involving the ocular surface, such as immunological disease, inflammatory traumatic disease, and infectious and allergic disease. Among these, certain pathologies have particularly high prevalence in Northern Africa.

Although new cases of trachoma are not common today, except in underserved and poor areas, older people who were infected in childhood suffer late sequelae, such as DED and stem cell deficiency. Ocular allergy is very aggressive in our area due to climatic conditions. Severe VKC with corneal involvement is one cause of blindness in the pediatric population. Keratoconus has high prevalence among young people in the Mediterranean area, not only Northern Africa. It can be secondary to allergic disease, or it can be genetic. We recommend regular topographic examination for all patients with ocular allergy. Infections characteristic of tropical zones, such as acanthamoeba and fungal keratitis, are common in our area, as are immune-related disorders that present with aggressive secondary DED in addition to other ocular surface manifestations.

A major hinderance to understanding ocular disease in our area has been the lack of good epidemiologic studies. Fortunately, current studies are yielding useful information.

Inadequacy of ophthalmology education and training programs contributes to the unmet needs in management of OSD. OSD is not included in the ophthalmology training curriculum in most Northern African universities. This year, my colleague Professor Mohammed Belmekki and I introduced at Rabat University of Morocco a diploma in ocular surface, and next year we hope to introduce it as a credit-hour subject in the Master of Ophthalmology degree program in Alexandria, Egypt University. Some regional ophthalmology societies with the help of ophthalmic industries present educational sessions on the ocular surface. The universities must create credit-hour courses for postgraduate studies. Continuing Medical Education programs should include courses on the ocular surface. The TFOS Ambassadors Program is of great help in expanding education in this area.

To meet the needs for eyecare in everyday practice in Northern Africa, eyecare providers must be well-trained in both traditional and innovative diagnostic and therapeutic technology. They must standardize diagnosis parameters and treatment guidelines, using standardized terminology. The cost of the newest treatments and technologies are often prohibitive, and we would welcome the support of industry in facilitating access to better diagnostic and management options. We need to create well-equipped specialized ocular surface clinics in both private and governmental sectors. Over the past few years, I have established a speciality practice in my country and a second one in Alexandria, Egypt, and and it is hoped that such practices will be increased in our area. One of the most important challenges is to increase public

education and demand for OSD services. This will entail using social media, television, clinics, and brochures to overcome ignorance and false beliefs.

Western Africa. *Emmanuel Kobia-Acquah. Department of Optometry and Visual Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana*

Western Africa is made up of 16 countries with a combined population of about 381 million people. Despite the recent economic development in some countries, the region is still considered to be one of the poorest in the world.

Most hospitals, clinics, and pharmacies in Ghana are located in urban centers. Rural areas often have no modern healthcare, and patients in these areas either rely on traditional medicine or travel great distances for care. In 2017, there were 941 eyecare professionals (370 registered optometrists, 91 ophthalmologists, and 500 ophthalmic nurses) to meet the eyecare needs of over 28 million Ghanaians. The hospitals and health facilities of the Ghana Health Service are the main providers of eyecare services, with support from the Christian Health Association of Ghana (CHAG) health institutions. Initiatives to train more eyecare professionals have been implemented through teaching hospitals and nursing schools. A major advance has been the introduction of optometry education programs and subsequent training of optometrists in two public universities in the country. The goal of the Ghana Health Service is to have at least one functioning eye unit in every district of the country. Much work is still needed to improve access to eyecare in Ghana because of the limited infrastructure and low number of eyecare professionals.

A number of OSDs are prevalent in Western Africa. Based on my personal experience and available data, I will focus on keratoconus and DED, using data from Ghana as proxy for Western Africa. I have identified keratoconus and DED as conditions with unmet needs, because, over the years, I have been unable to provide adequate treatment to several keratoconus patients, and for management of DED, optometrists and other eyecare practitioners in Ghana rely largely on artificial tears.

In early 2020, we found the overall occurrence rate of keratoconus in Ghana to be 0.04%,[42] a rate comparable to that in the US (0.05%). Two-thirds of the patients in Ghana with keratoconus had moderate-to-severe disease. The majority (61.4%) of patients received corneal transplants, and only 2.9% were fitted with rigid gas permeable (GP) contact lenses. The use of GP lenses is very limited in Ghana; only one of the tertiary care facilities included in our study provides GP lens services. This is a private facility, and most of the patients who are referred there cannot afford the high costs of the GP lens services. GP lenses have known efficacy in improving the vision of keratoconus patients, and their limited availability represents a serious unmet need.

There is no contact lens manufacturing facility in Ghana or anywhere in Western Africa. There is no easy way to import GP lenses and lens cleaning and disinfection solutions. Therefore, the cost of contact lenses is prohibitive for most patients. Without lenses available, practitioners do not obtain fitting skills in optometry training institutions or in clinical practice. To address this problem in the short-term, I propose that manufacturers of GP lenses worldwide provide an affordable source of GP lenses, along with cleaning and disinfection solutions. Then, workshops and Continuous Professional Development programs should be provided to train optometrists to fit the lenses. In the long term, funding and support should be provided to establish a GP lens manufacturing laboratory in Ghana. The faculty of optometry training institutions should be trained to teach GP contact lens fitting.

Management of DED represents a second unmet need in Western Africa. Interest in DED has historically been focused on Western and Asian countries, perhaps because of the lack of population data in Africa. For instance, the 2017 TFOS meta-analysis included no data to estimate the prevalence of DED in Africa.[1] We therefore performed a meta-analysis based on 15 studies that met our inclusion criteria.[43] These studies were predominantly from Ghana, Nigeria, Egypt, and Southern Africa. Overall, we estimated the prevalence of DED in Africa to be 42%. The prevalence of DED based on symptoms only was estimated to be 36.2%. The prevalence of DED was 38.3% in Ghana and 41.4% in Nigeria.

In 2019, our research discovered that the overall prevalence of symptomatic DED in Ghana was 69.3%, and the associated factors were age, sex, arthritis, and ocular allergy.[44] This prevalence seems very high, perhaps because we surveyed the participants from November to February, which is the dry and windy season of Ghana. Most of the participants who reported DED symptoms had severe symptoms. The high prevalence and severity of symptomatic DED represents a significant burden in Ghana.

Osei et al. (2020), in a study to profile the clinical practice patterns of practitioners in Ghana, surveyed 113 practitioners and found that 34% of them performed up to 20 DED assessments per month.[45] Of those practitioners, 57% diagnosed up to 20 cases of DED monthly. The procedures used most commonly to diagnose DED were case history, fluorescein tear break-up time (TBUT), and corneal fluorescein staining. None of the practitioners mentioned the use of DED symptoms questionnaires, whereas in the UK, 31% of practitioners reported using standardized questionnaires to assess DED symptoms.[15] None of the respondents had access to rose bengal, phenol red thread, lissamine green dye, osmolarity technology, or meibography equipment. Specific types of DED were not identified.

When asked how they graded the severity of DED, nearly 70% of the surveyed practitioners indicated that their decisions were based on the patients' reported symptoms and between 1 and 3 clinical tests; 22% of the practitioners mentioned using their intuition. Across all disease severities, preserved lubricants were

the most prescribed eye drops, similar to that reported in the US.[46] The second most prescribed medications for the treatment of severe DED were omega-3 supplements and topical steroids.[5] Topical cyclosporine or punctal plugs were used rarely, and autologous serum tears, thermal pulsation, and scleral lenses were not mentioned. The treatment patterns observed in this study were severely limited by the unavailability of state-of-the-art treatment options. The extensive options for eye medications to treat DED are largely unknown in Ghana. The common ones contain preservatives, which can be harmful to the ocular surface.

The absence of diagnostic tools and effective DED treatments comprises a major challenge for DED practice in Ghana. Patients' inability to afford DED treatments also poses a significant challenge, with 21.4% of Ghanaians living below the poverty line.

Over the long term, training institutions must have the resources to provide optometry students with high-level training in DED diagnosis and management, covering all the modern techniques and strategies. With improved training in modern methodology for managing DED, Western Africa will become an emerging market for DED-related products. Industries, including pharmaceutical companies, should explore opportunities to become involved in training efforts and in better meeting patients' needs.

Eastern Africa. *Naomi Nsubuga, Department of Optometry, School of Health Sciences at the College of Health Sciences, Makerere University, Kampala, Uganda.*

Eastern Africa traditionally refers to the area now comprising the three countries of Uganda, Kenya, and Tanzania, known as the East African Community. The East African Community has now added three more countries, Rwanda, Burundi, and South Sudan. The whole of Eastern Africa sometimes includes Eritrea, Djibouti, Ethiopia, and Somalia as well, but those are best known as the Horn of Africa. This presentation focuses primarily on the Eastern African countries, although the Horn of Africa (Ethiopia) is mentioned.

There is limited literature about OSDs in Eastern Africa, and in my research, I have noted that the majority of ocular surface studies focus on allergic conjunctivitis rather than on DED and other OSDs. When we implemented the East Africa Child Eye Health project between 2013 and 2016 in Kenya, Tanzania, and Uganda, the most common problem among children, especially school-going children, was allergic conjunctivitis. The prevalence of DED in African communities is poorly documented. This was noted by Matsumoto in a study undertaken in Uganda.[47] Of the few studies published, most were conducted in Kenya, with one or two in Uganda and Ethiopia. Little information is available on Tanzania, Eritrea, or South Sudan, which have similar environments.

Diagnosis of allergic conjunctivitis is based mainly on patient history and signs and symptoms, such as itching, foreign body sensation, photophobia, ocular swelling and redness, and mucoid discharge, as well as the presence of papillae and hyperpigmented conjunctivae and lids. The condition is often classified according to severity, i.e., mild, moderate, or severe. It can also be classified according to form: seasonal, perennial, allergic conjunctivitis, atopic keratoconjunctivitis, or VKC.

Many studies have focused on VKC, as this form of OSD has the greatest impact on the community, even though general seasonal perennial allergic conjunctivitis is more common. In Ethiopia, a study conducted among primary schools in Butajiira found the prevalence of VKC to be 5.2%, indicating, as the Ugandan study did, that it was not rare among young people.[48] The prevalence of VKC among children in Gambella, Ethiopia was around 11.1%, a level of public health significance because of the effect it has on the children. In Gondar, Northwest Ethiopia, the prevalence was 5.8%.[49]

Several studies conducted in Kenya found that diseases of the conjunctiva, allergic conjunctivitis specifically and VKC, are the most common problems. Rono et al. analyzed eyecare service delivery in secondary units in northwestern Kenya and found allergic or other conjunctivitis in 61% of patients seen in the eye unit.[50] They concluded that specialist eyecare services were heavily utilized by people whose conditions could be managed at the primary healthcare level.

Among 4200 inhabitants of Kibera and Dagoretti (divisions of Nairobi) 7.6% had allergic conjunctivitis and conjunctival growths, conditions identified as major problems in both rural and urban areas.[51] In our Child Eye Health Project, allergic conjunctivitis was present in most of the patients attending eye clinics, and it was the second largest non-vision-impairing condition seenin a southwestern Uganda study.[52] In Kampala, a study found a 32% prevalence of allergic conjunctivitis, often accompanied by pinguecula, pterygium, and papillae.[53] In a Ugandan study, VKC was prevalent among males, with complications including superficial punctate keratopathy and epithelial disturbances. It was common in children of both sexes.[54] VKC was also prevalent in a Rwandan study of children.[55] The environment in many areas of East Africa is dry and dusty, contributing to the high prevalence of these OSDs.

Challenges in the management of OSDs in East Africa include the lack of standardized guidelines, the high cost of medications, and limitations of treatment options. Some standard clinical guidelines have been developed in Uganda and Kenya for management of VKC and allergic conjunctivitis at various levels of severity. These could form the basis for national guidelines, but their widespread implementation will require education and creation of awareness among eyecare providers at all levels.

The high cost of drugs in the Eastern African countries greatly limits treatment options for OSDs. Some countries have access to generic versions of drugs, some of them produced locally and some imported from mid- and low-income countries. Brand-name drugs are available, but they are prohibitively expensive for

most people. In our Child Eye Health Project, it was difficult to get generic sodium cromoglycates, and children, even those with mild-to-moderate disease, were often given steroids instead, placing them at risk of developing glaucoma and cataracts. According to the Kenyan guidelines, topical mast cell stabilizers and antihistamines are the first line of treatment, and mild topical steroids are used for moderate disease. Severe disease is treated with a pulsed topical steroid regimen. In Uganda, the guidelines for eyecare developed by the Ministry of Health recommends non-steroidal anti-inflammatory drugs where available and affordable. Unfortunately, at the lower-level health facilities, non-steroidals and mast cell stabilizers are not readily available or affordable. We are trying to educate mid-level eyecare workers about limiting steroid use.

Some non-governmental organizations (NGO's) have established drug production units in medical facilities. Their drugs are relatively affordable, but production is sometimes suspended. For projects supported by NGOs, drugs may be distributed at no cost, but when the project ends, patients cannot afford to purchase even the generic drugs. These drugs should be included on the Ministry of Health's drug formulary, so they can be imported at a reasonable cost, allowing hospital pharmacies to provide them free or at a subsidized cost. Some antibiotics and other drugs are available in this way, but mast cell stabilizers are not.

Although DED is relatively undocumented in Eastern Africa, patients do present to clinics in Uganda with DED symptoms. They usually are treated based on symptoms, but proper clinical testing is unavailable or inadequate. Testing for MGD, TBUT measurement, and staining with fluorescein and lissamine green are not available at most of our hospitals.

Artificial tears can be purchased from private pharmacies in urban areas, but they are not available in the public health sector, government hospitals, etc. Poorer people who are outside farming, living in dusty areas, and using charcoal firewood are particularly likely to have DED symptoms, but are unlikely to have access to proper management. An important goal should be to make services and treatment available to people with poor access to resources.

Although few studies on OSD have been conducted in Eastern Africa and the Horn of Africa, we know that allergic conjunctivitis and VKC are significant public health problems. To address these problems, we need to obtain more epidemiological data, set guidelines for diagnosis and treatment, and better educate clinicians and mid-level eyecare workers, so they can provide quality care as well as education for their patients. Eyecare workers must recognize the various levels of severity of eye disease, know the appropriate treatment for each level, and have access to the appropriate drugs. The available drugs must comprise an efficacious alternative to steroids. Because many patients will require a long duration of treatment, we must increase the availability and affordability of drugs.

Southern Africa. *Leonard Heydenrych, University of Cape Town, Cape Town, South Africa*

Southern Africa has both private and public healthcare systems. The public system serves the majority of the population.

At the walk-in triage at Groote Schuur Hospital in Cape Town, we see keratoconus in 5.15% of patients, keratitis in 3.85%, and dystrophies (mainly Fuchs') in 2.5%. At Red Cross Children's Hospital in Cape Town, there was a marked male predominance in VKC patients, and limbal disease was frequently seen.[56]The main complication of VKC is fibrosis, followed by erosions of the cornea, plaques, ulcers, and keratoconus. Patients with keratoconus present with very dry eyes and allergic eye disease. Scleral lenses are generally not available in the state sector, but the Slick Restaurant Group (of Cape Town) in conjunction with Tygerberg Hospital now sponsors scleral lenses for these patients. We perform penetrating keratoplasty and DALK surgery when indicated.

Trauma is an important cause of OSD in Southern Africa, with one prospective study reporting 249 open globe injuries, mostly in males, over a two-year period.[57] These injuries led to significant OSD due to corneal lacerations, globe lacerations, and severe eyelid deformities. DED is associated with HIV, and since there are 7.7 million people (20.4% of adults between 15 and 49 years of age) in Southern Africa living with HIV, DED is very prevalent. These patients can develop MGD and mucin/lipid deficiency, but early HIV diagnosis and prompt initiation of antiretroviral therapy may preserve meibomian gland integrity. The limbal stem cell failure that we see is mostly due to SJS in patients who are on antiretrovirals. We also see limbal stem cell failure due to severe allergic eye disease and chemical and thermal injuries. Ex vivo cultured stem cell transplantation is not possible in our country due to a lack of resources. Ex vivo epithelium has successfully been cultured from eviscerated corneas.[58] Corneal ulceration is also prevalent in Southern Africa. It mostly affects males and involves common organisms, such as pseudomonas, staphylococcus, and fungi. Putter and Smit showed that in 29.2% of cases, there was herpes simplex virus co-infection.[59]Acanthamoeba keratitis is not seen frequently. Topical trifluridine is unavailable for treatment in Southern Africa, and topical acyclovir can be prepared only in compounding pharmacies. There is no confocal microscope available in the Western Cape to monitor acanthamoeba keratitis. Herpes virus infection most often involves herpes simplex virus 1 and Epstein-Barr virus.

We frequently see toxic epitheliopathy due to preservatives. The only preservative-free anti-glaucoma medication available in this country is tafluprost. The only other option is to place patients who are intolerant to anti-glaucoma drops on acetazolamide orally. We currently do not have Azyter or Ikervis on our shelves, but I but they can be mixed in compounding pharmacies.

Endothelial disease is very prevalent in Southern Africa, where Fuchs' corneal endothelial dystrophy is seen mainly in mixed race people and white people. Pseudophakic endothelial decompensation is seen frequently and requires Descemet membrane endothelial keratoplasty (DMEK) surgery because of bullous keratopathy. Endothelial surgery in my setting has several challenges. First, Descemet stripping automated endothelial keratoplasty (DSAEK) is not available in the state sector due to cost and a lack of resources. DMEK is the only option available if the surgeon can prepare his or her own tissue. We currently have one fellowship-trained lamellar corneal surgeon with a full-time appointment in the state sector in Southern Africa. Groote Schuur and Tygerberg hospitals in the Western Cape perform regular transplants, since they can purchase graft materials from abroad. One cornea could be used for a DALK and DMEK.

An improved future for ocular surface care in Southern Africa would include cornea fellowship-trained appointments in the state sector. Preservative-free medications must be made available. We should expand our endothelial research. We need to launch local graft procurement programs and develop corneal banks to prepare our own tissue for DSAEK and DMEK. Ex vivo stem cell culture programs with international collaboration will be important to alleviate the burden of limbal stem cell deficiency in our population.

Europe

Jelle Vehof, Section of Academic Ophthalmology, King's College London, London, UK, and Departments of Ophthalmology and Epidemiology, University of Groninen, University Medical Center Groningen, Groningen, The Netherlands

In September 2019, 34 TFOS European ambassadors met to discuss the needs and challenges of ocular surface care in 25 European countries. The proceedings of that meeting were published in *The Ocular Surface*.[60] At the current meeting, Dr. Vehof cogently integrated the vast and varied information from the European meeting, describing differences among countries in disease prevalence and availability of medical personnel, knowledge, facilities, and diagnostic and therapeutic methods for managing OSD. Unfortunately, space limitations preclude inclusion of his excellent presentation in this report. Dr. Vehof's summary is available on the TFOS website (www.tearfilm.org), and we also refer readers to the original publication.[60]

North America

United States & Canada. *Todd Margolis, Department of Ophthalmology and Visual Sciences, Washington University School of Medicine, St. Louis, MO, USA*

In discussing unique challenges and unmet needs in the management of OSD in the USA and Canada, I should acknowledge that my perspective is influenced by referral bias. For the past 35 years, I have worked in an academic setting, where many patients have been referred for chronic, severe, and often misdiagnosed disease, so my patients do not necessarily reflect the clinical situations common in the general population. With this in mind, I will identify nine areas that I consider to represent unmet needs in the management of OSD and suggest some improvements.

First, I stress the need for good, affordable lissamine green. Lissamine green staining can be extremely valuable for assessing contact lens or punctal plug problems, keratitis sicca, superior limbic keratoconjunctivitis, etc., yet it is often not used. In my experience, some lissamine green strips are not very effective for ocular surface staining. In-office compounding of lissamine green 1% solution is difficult to do and has not been widely adopted, and few compounding pharmacies make the solution. We need an inexpensive and effective formulation of lissamine green for diagnosis of numerous forms of OSD.

Second, we need a safe, inexpensive ocular analgesic. Like patients with headache, most DED patients are uncomfortable. They may not be in danger of losing vision, but they need relief from ocular discomfort. An effective medication is not currently available, and in my opinion, the FDA is unlikely to approve such a medication if it is marketed for DED. It would need to be marketed for ocular discomfort or ocular pain.

A third unmet need is for inexpensive occlusive over-the-counter readers. For instance, onion-cutting goggles can be helpful for maintaining a good tear film and keeping the eyes comfortable, and perhaps a similar device with inexpensive readers built into it to correct refractive errors could be an inexpensive and effective aid for the patient with OSD.

Fourth, we need improved therapies for ocular rosacea. I believe that the main problem in most patients with ocular rosacea is aberrant innate immunity and inflammation. We have to understand and manage the triggers of rosacea. We should also learn from the dermatologists that altering the local microbiome can help reduce the inflammation of rosacea. Certainly, topical metronidazole (to the skin) and oral azithromycin both change the local microbiome and are effective in managing ocular rosacea.

Fifth, we need to better understand the ocular surface microbiome both in health and disease. We know it is pauci-microbial, but this does not mean that it is sterile. We know that there are probably multiple ocular microbial niches on the ocular surface, that the lid margin is probably different from the fornix, which is different from limbus, which is different from cornea. We need to learn more about these niches. We also know that a systemic antibiotic can change the local microbiome on the ocular surface; it has been demonstrated that oral azithromycin causes long-term alteration of the conjunctival microbiome.

Sixth, the functional neurobiology of the ocular surface will be key as we move forward in meeting needs for managing OSD. Ocular surface innervation is complex and topographic. It is not the same in each area of the ocular surface. More than 12 types of sensory nerves plus autonomic nerves innervate the ocular surface, providing a number of afferent and efferent functions, and, currently, confocal microscopy is of no value in identifying the different types of neurons or the functions that they serve. Pain, immunity, wound repair, tear secretion, meibomian gland secretion, and inflammation are all influenced by these nerves. Ocular pain syndromes are often misinterpreted as OSD, so it is critical to obtain an accurate pain history.

Seventh, to manage OSD, we must better recognize iatrogenic disease. We know that medications themselves and the preservatives in medications can be toxic to the ocular surface. Furthermore, patients often traumatize their lids and ocular surface with the tip of their eyedrop bottle. In addition, wiping the ocular surface with facial tissues should be avoided. Facial tissue consists of wood pulp and chemicals and can be quite toxic to the ocular surface, just as it is to the skin of the nose when used frequently.

Iatrogenic trauma is a common complicating factor in neurotrophic keratopathy, and contact lens wear is a frequent cause of iatrogenic OSD. Refractive surgery, corneal surgery, and even cataract extraction can all be triggers for chronic neuropathic pain. Another form of iatrogenic OSD arises from post-blepharoplasty surgery, and other surgical lid procedures, where toxic conjunctivitis (from the medications), conjunctival chalasis, lagophthalmos, MGD, and/or lid imbrication, may be observed.

Eighth, OSD diagnostic errors occur too frequently. Ophthalmologists typically devote little time to the medical history, moving quickly to the slit lamp examination with the room lights off. Stains and tests may be used improperly or inadequately. I believe that it is rare for ophthalmologists outside of the academic setting to perform a Schirmer test, test corneal sensation, properly evaluate TBUT, or determine whether a topical anesthetic eliminates ocular pain. Furthermore, the ophthalmologist rarely everts the upper lid to examine the superior tarsal conjunctiva.

Last, I would like to mention the concept of medicalization of everyday ocular discomfort. This concept was well described in a BMJ editorial: "Over-diagnosis turns people into patients unnecessarily. It identifies pathologies that were never destined to cause harm. Over-diagnosis causes anxiety and other negative consequences; it leads to wasted resources and side effects as a result of unnecessary treatment. Over-diagnosis occurs … when expanded disease definitions over medicalise ordinary life experiences … People with over-diagnosed disease do well, because by definition, their disease was non-progressive … This creates a cycle that reinforces efforts leading to more over-diagnosis … The spurious rise in incidence makes the case for screening more compelling, a phenomenon known as the popularity paradox."[61]

We should give serious thought to medicalization, because it may be that sometimes ocular discomfort is just discomfort and not a disease.

Mexico and Central America. *Alejandro Navas, Institute of Ophthalmology, Conde de Valenciana, National Autonomous University of Mexico, UNAM, Mexico City, Mexico.*

Although I practice in Mexico, my comments about problems and solutions in eyecare pertain also to Central America and the Caribbean, as we train residents and fellows from most of the countries in those regions. Mexico has almost 130 million inhabitants, about 9 million of them in Mexico City. The most common OSDs are DED, allergy, pterygium, keratoconus, infectious keratitis, and cicatricial conjunctival diseases. Our studies, in collaboration with various groups in Mexico, found that risk factors for DED include female sex, smoking, alcohol consumption, and antihypertensive medications.[62]

In a Mexican study, the profile of patients with significant ocular surface damage related to DED includes older-aged women who complain of red eye, and foreign body and burning sensation. Diagnoses of DED, Sjögren syndrome, and glaucoma were also risk factors for significant ocular surface damage, along with long-term use of preserved eye drops and systemic medications.[63]

Methodology for diagnosing DED includes meibography, lipid interferometry, osmometry, and measurement of meniscus height and non-invasive TBUT. We perform these procedures in our facility. For treatment of DED, in addition to a variety of eyedrops and ointments, we use intense pulsed light therapy. We also use a novel liposomal sirolimus suspension patented by Mexican colleagues. We inject it subconjunctivally in patients with severe and moderate DED. Results, both objective and subjective, are encouraging.[64]

Mexican investigators have been active in investigating causes of OSDs and seeking solutions. Studies on the molecular basis of pterygium development suggest potential targets for its prevention and elimination.[65] Conjunctival autograft is the preferred surgical treatment for pterygium, but the procedure should be improved to avoid complications. In collaboration with colleagues worldwide, we are using simple limbal epithelial transplantation, a relatively new technique, which, through a multicenter and multinational study, is gaining global acceptance.[66] We have also developed a novel technique called *minor ipsilateral simple limbal epithelial transplantation* or *Mini-SLET,* which uses tissue from the same eye of the patient. This approach is being used and expanded by groups around the world with good results.[67,68]

Keratoconus is frequent and severe in Mexico, and is the main reason for corneal transplantation. In one of our case series, corneal hydrops in keratoconus was the reason for almost 20% of pediatric keratoplasties. We see a wide spectrum of the disease, from mild cases to very severe and complex cases. Mexico has been the source of some important contributions to keratoconus management.[69-71] Ours was one of the first groups

to report the use of toric intraocular lenses for mild and non-progressive keratoconus. We also generated the Aztec protocol for keratoconus or keratoconus suspects and Cool Cross Linking for pain management.[72]

To better meet the needs for prevention and management of OSDs, we require more investment in science, research, and technology, and we should incorporate advances in those areas into everyday practice. We must narrow the gap in access to technology and medications between private and public healthcare. Industry and governments should work together to enhance modern science in our nations.

South America

South America (Spanish-speaking countries). *Juan Carlos Abad, Department of Ophthalmology, Antioquia Ophthalmology Clinic-Clofan, Medellin, Antioquia, Colombia.*

There are three regions in Spanish-speaking South America. The northernmost region is Gran Colombia or Nueva Granada, which comprises Venezuela, Colombia, and Ecuador. It is tropical with abundant rainfall, high mountains, two seas, and the source of the Amazon river. The second region is the Incan Empire, which has seaside deserts, high mountains, and low rainfall. It comprises parts of Ecuador, Peru, Bolivia, and Paraguay. The third region is Cono Sur, which includes Argentina, Chile, and Uruguay, and is at a latitude similar to that of Europe. It has changing seasons, high mountains, and extensive plains.

A recent review of the causes of blindness in Latin America concluded that the main cause is poorly managed cataracts, followed by macular degeneration; a summary of causes by country is shown in Table 3.[73]

Table 3. Causes of bilateral blindness (presenting VA <3/60 in better eye) in eight surveys (%)

Cause of blindness	Peru (n = 193)	Argentina (n = 49)	Brazil (n = 44)	Cuba (n = 65)	Venezuela (n = 74)	Guatemala (n = 198)	Mexico (n = 57)	Chile (n = 47)
Refractive error	1	6	2	0	4	2	0	2
Cataract, untreated	87	47	41	51	68	81	67	57
Aphakia, uncorrected	0	0	0	1	0	2	0	0
Total curable	88	53	43	52	72	85	67	59
Surgical complications	0	0	7	0	0	1	3	0
Trachoma	0	0	0	0	0	0	0	0
Phthisis	0	2	0	0	1	2	0	2
Other corneal scar	1	0	2	5	3	6	0	4
Total preventable	1	2	9	5	4	9	3	6
Total avoidable	89	55	52	57	76	94	70	65
Total posterior segment	12	44	47	43	25	7	30	34

From Limburg et al, *Br J Ophthalmol* 2008[73]

Over the last 40-50 years, Latin America has been plagued by conflict, largely fuelled by the illegal drug trade. Most of the cocaine in the world is produced in Colombia, Ecuador, and Peru, going from there to Mexico and on to the US, or to Venezuela and on to Europe. The coca fields are protected by landmines, which cause death and severe injuries, including facial and ocular trauma, which has been widely reported by local ophthalmologists in the international ophthalmic journals. Fortunately, the frequency of conflict-related injuries is decreasing.

For the past 10-12 years, Colombia has had a good healthcare system, which is funded by a 12% tax on wages. Care of those with low income, e.g., street vendors and the unemployed, is subsidized. Coverage is generally quite complete, but cosmetic surgery, refractive surgery, intracorneal ring segments, and premium IOLs are not covered. However, poor people can access top-notch medical care, including treatment in the ICU. Patients with chemical burns have special coverage created by a 2013 law, which was further expanded in 2016 and provides modern treatments with a type 1 Boston KPro.

In 2013, Colombia eliminated onchocerciasis (river blindness), but leprosy still exists in some political divisions of the country. It attacks the corneal nerves, produces uveitis, and can result in loss of the lateral third of the eyebrow. There is some trachoma in the southeastern region of the country. Fungal keratitis in Colombia is mostly due to Candida and some Fusarium near the sugar cane plantations. Being equatorial, Colombia experiences intense sunlight, hence a high frequency of pterygium. Ocular perennial allergies also tend to be more common and severe around the equator.

Corneal dystrophies are more common in Latin American countries with substantial German or Italian immigration, like Argentina, Chile, Uruguay, and Brazil. In Colombia, we have a large Mestizo population, so we rarely see a stromal dystrophy. Most of our cases with endothelial damage are caused by phacoemulsification .

The Boston KPro was introduced in Colombia by our group in 1998. Prognosis following Boston KPro surgery varies according to preoperative conditions.[74]

The Pan-American Cornea Society (Pancornea) has 98 members, all of them fellowship-trained, from almost all the countries in the region. An informal survey of members regarding the diagnosis and management of DED identifed two groups. One group followed the TFOS DEWS II recommendations and used keratography or similar devices; this group included clinicians from Peru, Colombia, Chile, Argentina, and Ecuador. The other group, from Paraguay, Venezuela, and Colombia, was more traditional, using only the slit lamp for diagnosis.

According to the Colombian Ophthalmological Society, there are almost 2000 ophthalmologists in Colombia, which has a population of roughly 50 million. This constitutes a rate of 1 ophthalmologist per 25,000 people, about half the rate that exists in the US. Colombia has 3600 optometrists. The society Cornea

Colombia has 120 members, a third of whom have completed formal fellowship training in Cornea and External Disease. The major cities have "Dry Eye Centers," which offer the latest diagnostic and therapeutic modalities, such as tear osmolarity testing, noninvasive TBUT, lipid layer interferometry, intense pulsed light, etc, some of which are covered by private insurance. The major pharmaceutical companies are present in Colombia, and a wide array of lubricants, anti-inflammatories (steroids, cyclosporine, tacrolimus) and blood-derived ocular topical products are available.

Over the past two decades, the Colombian healthcare system has made great progress in providing eyecare for the population, but some inequalities and limitations exist. The government-backed system has longer waiting times for appointments with ophthalmologists and fewer options for management of eye disease than the privately run system. Availability of good eyecare tends to be concentrated in urban settings. Basic OSD therapeutic staples, such as lubricants, and some devices and procedures are not paid for by the government, and the number of well-educated corneal specialists is relatively low.

South America (Brazil). *José A.P. Gomes. Department of Ophthalmology and Visual Sciences, Federal University of São Paulo/Paulista School of Medicine, São Paulo, Brazil*

Brazil is the largest country in South America, encompassing around half of the continent's land area and population and about half of South America's gross domestic product (GDP). Brazil is located on the southern part of the equator, and most of the country has a tropical climate. The Amazon is an extensive region in the northern part of Brazil. Sixty percent of the Amazon forest with its huge biodiversity is located in Brazil. Brazil has mixed ethnicity and a population of more than 200 million people, who live mainly on the coast, where the big cities are located. Brazil differs from other South and Latin American countries, in that its language is Portuguese. It also differs in a number of cultural aspects. Brazil has abundant natural resources, a clean energy matrix, and a large agricultural economy, as well as a dynamic industrial economy. Despite such advantages, a large percentage of the population lives below the poverty line, and social problems are significant. Visual deficiency in Brazil reflects this situation, with non-corrected refractive errors, cataract, glaucoma, diabetic retinopathy, age-related maculopathy, and OSDs being common. Most of the OSDs reflect both the geographic location and socioeconomic characteristics of the country. The climate is predominantly wet and hot, predisposing to certain eye diseases. Infectious diseases and allergic diseases, as well as trauma, are important causes of visual problems in Brazil. As in other developing countries, bacterial, fungal, and parasitic keratitis are common. Often, these infections are secondary to trauma or to other types of diseases, but they may also be related to contact lens wear. Fungal keratitis may

also be related to environmental exposure, as is common with sugar cane workers. Neglected infectious diseases that are typical in tropical areas may also be responsible for OSDs.

Eyecare in Brazil is provided mainly by ophthalmologists and technicians. The public health system provides free eyecare for Brazilians, and many of the eyecare providers are linked to academic centers, which have an important role in ophthalmology training and research. Health insurance plans and private clinics are preferred by patients who can afford the costs. The 2019 census documented more than 20,000 ophthalmologists in Brazil, representing a rate of 1 eye doctor per 9,000 people. This exceeds the number recommended by the WHO (1 ophthalmologist per 17,000 people). However, distribution of these professionals is uneven, with a much higher concentration in the urban areas of the southern, central, and southeastern regions and lower numbers in the rural areas, especially in the Amazon and northeastern regions.

With sufficient commitment of funding and resources, many of the diseases prevalent in the tropical and poor areas of the world could be eliminated. Trachoma, which is found endemically in some areas, especially in the northeastern region, could be mostly eliminated with the WHO-SAFE (**S**urgery **A**ntibiotic **F**acial cleanliness **E**nvironmental improvements) and other strategies from our public system. Leprosy continues to be a problem, with Brazil having one of the highest prevalence rates of this disease worldwide.

Especially in the northern part of Brazil, the Amazon region, which comprises almost 40% of the total area of the country, people live on the rivers. Besides being in direct contact with the rivers, they are subjected to UV light that reflects off the water. Among the diseases typical of this environment is parasitic keratitis, some types of which are still under investigation, e.g., Mansonella and other types of filariasis. Degenerative diseases like pterygium affect a large part of the population. In a joint study between the Federal University of São Paulo and the Federal University of Amazonas, we sought to discover the main causes of visual problems in this part of the world. We found a high prevalence of pterygium -- almost 60% -- in the Amazon region.[75] Pterygium was the cause of 14% of visual problems and 4% of blindness in the Amazon population. Because of the high numbers and severity of pterygia, public health efforts should be devoted to preventing them and providing the best surgical strategies for management.

Brazil has a high prevalence of DED. This relates to multiple factors, including increasing life expectancy, with a growing population of older people who are at higher risk of developing DED. The big cities in Brazil, with their air contaminants and pollution, further contribute to DED. One of our epidemiological studies found the prevalence of DED to be about 13% in the overall population of Brazil.[2] The prevalence varied among regions, with less DED in the northern areas with wetter climates and more DED in the southern regions, where the climate is drier. We are just concluding a study of more than 2000 students at the Federal University of São Paulo and the University of Campinas and have found 34% with

OSDI scores positive for DED. Severe symptoms and/or previous clinical diagnosis of DED were present in 23%. DED was more prevalent in women than in men, and risk factors included use of visual display devices, fewer than six hours of sleep per day, oral contraceptive use, and contact lens wear. This high level of DED in such a young population is of concern, and may become even worse with the COVID pandemic. Brazil is currently second in the world in number of COVID-19 cases and deaths, so many people are working and studying at home, where long periods at the computer in an artificial air environment predispose to worsening of DED.

Interestingly, SJS is common in Brazil, and a few of our centers have partnered with centers in Japan to investigate the high prevalence of SJS in our populations. We characterized patients with an HLA type that predisposes for SJS and toxic epidermal necrolysis after contact with cold medicines.[76] Salivary gland transplantation has been effective for these patients, as have new strategies using stem cell therapy to rehabilitate these eyes.

In summary, Brazil, as other South and Latin American countries, has characteristics of both developed and non-developed worlds. Tropical diseases, such as infection, OSDs, and pterygium are common conditions that should be addressed, and more studies on health and social policies for treatment and prevention are needed.

Closing Comments

Sarah Farrant, Earlam and Christopher Optometrists and Contact Lens Specialists, Taunton, UK

We know that OSD is one of the most common eye diseases and a leading cause of visual impairment when untreated. This TFOS Global Unmet Need meeting gave delegates the opportunity to hear not only about ground-breaking research into OSD but also about how individual countries have very distinct challenges. Many of these challenges are, however, united by recurring themes, such as limited access to clinical care and therapeutics, limited funding and poor general population awareness and education. It is perhaps most striking of all to see the extent of these unmet needs in the prevention and treatment of a wide range of conditions, given that so many of them can be readily managed.

Stefano Barabino, Ocular Surface Center and Department of Ophthalmology, Sacco Hospital, Milan University, Milan, Italy

Many speakers today highlighted the need to have educational programs and registries dedicated to OSDs. There are no registries, for example, in Northern Africa, Europe or the USA that are focused on ocular surface conditions such as DED, pemphigoid, or SJS. There is a need for global guidelines for the

diagnosis and treatment of OSDs, as well as a better understanding of corneal sensitivity and the iatrogenic impact of ocular surface surgery. I congratulate TFOS for giving voice to so many speakers, in order to address the unique challenges and unmet needs for the management of OSDs throughout the world.

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