Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Limiting plastic waste in dry eye practice for environmental sustainability

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The COVID-19 pandemic and new normal have forced a rethinking of processes in ophthalmic services and severely impacted dry eye and ocular surface practice. Climate change, civic, equality, and environmental issues have also emerged, and made the world more volatile, uncertain, complex, and ambiguous [1–3]. The dry eye physician of the future will need to be aware of *global* and *sustainability* issues. Here, we focus on environmental and sustainable solutions that aim to future proof dry eye practice and how to raise their awareness.

The effects of the environment on the ocular surface have been described [4]. Increasingly, the world is becoming aware that non-eco-friendly practices can threaten environmental sustainability and contribute to global warming and climate change. However, recycling rates remain low despite increasing awareness amongst the global community. In 2016, the US produced 46.3 million tons of plastic trash (287 pounds per person per year), of which the Environmental Protection Agency estimates that just 8.7% of discarded plastic was recycled. Similarly, 868,000 tonnes of plastic waste was produced in Singapore, of which only 4% was recycled (data released by National Environmental Agency, Singapore).

Pandemic era practices have increased the use of plastic disposables. These include higher volumes of gloves, masks, disposable drapes, medication vials, and consumables related to treatment procedures, e.g. tips for blephEx microabrasion, tapes for lipiflow thermopulsation, and vials of local anesthetic. Dry eye patients who utilize several vials of unidose preservative-free eyedrops dispose of significant amounts of plastics daily. Each empty bottle of eyedrops with a 10 mL capacity typically weighs 6.5 g but a single disposable vial, when emptied, weighs 1 g. Use of four such vials daily generates approximately 120 g of plastic waste in a month; an additional 113 g more than the use of monthly bottles. Assuming that 200 million people globally use these preparations, they would discard 22,600 tonnes of additional plastics per month solely from artificial tears. This is equivalent to one-third of the monthly plastic waste generated in a country like Singapore.

Take another example of some who used artificial tears for dry eye but using it rather infrequently in an adhoc manner. Using the Hylocomod system (multi-dose preservative-free), the amount of plastic waste after 300 drops would be 20 g. In the case of 150 vials of unidose eyedrops which supplies 300 drops, the plastic waste would be 150 g or *7.5 times* greater.

Even though a large proportion of plastics used in the manufacture of these vials can be theoretically recycled, there is little financial incentive to recycle plastics because it is cheaper to manufacture most plastics from scratch [5]. In practice, sorting of plastics is performed manually; at least in part, and many facilities are unable to cope with the volume, with preference for sorting going to larger items like shampoo bottles. As a result, most of these plastics likely ended up as part of landfill or being incinerated.

Plastics in the environment are subsequently broken down by weathering elements and micro-organisms into smaller micro- and nanoplastics. These particles are light, indestructible and able to travel long distances. Traditional wastewater treatment processes are unable to filter these, which are subsequently introduced into rivers, oceans and fresh waterways. Multiple human exposure routes have been identified, with microplastics retrieved from lung and human placental tissue. Reported toxic effects of micro- and nanoplastics include inflammation, oxidative stress and apoptosis [6,7]. There are several initiatives that may immediately reduce our plastic waste output.

The use of unidirectional valves and multi-dose preservative-free eyedrops is a significant advance that can counter wastage. A major advantage of these containers is the ability to use them for three to six months without risk of contamination [8]. The above calculations also suggest that use of multidose bottles compared to single-use vials can markedly reduce the amount of discarded plastics. Recycling and upcycling initiatives may further reduce plastic waste.

For the same reasons mentioned above, clinics should reconsider using disposable unit doses of amethocaine, tetracaine, fluorescein and

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similar eyedrops. Single use tetracaine should be perhaps limited to special circumstances, for example when evaluating patients on the first day after intraocular surgery.

In the original blephEx microabrasion procedure, a single disposable tip is used on each of the eyelids, requiring four tips per treatment per patient. Currently, clinics have reduced the disposable use by half, simply by sharing the same tip for the upper and lower eyelid of the same eye.

Awareness of climate change can be raised via technology-enhanced learning (TEL) in the form of distance or *distributed learning*. Electronic internet databases and teaching materials, such as Tear Film and Ocular Surface Society, Santen Vision Academy, and Alcon Experience Academy can also play an important role. Global *collaborations* provide free sharing of medical education resources, especially with modifiable multi-media units that allow customisation to geographic regions. This is the concept of 'globalization', where global experience is applied to local practice. An example is the brick portal alliance which currently has more than 1.4 million members from over 100 countries. These efforts, while acknowledging contributors, avoid reinvention of the wheel, and greatly impact countries with limited resources [9].

While we try to raise awareness, certain factors do affect human behavior. Inherent inequality of healthcare resources exists in different geographic regions. In third world countries, infrastructure for collection, reuse and recycling is often insufficient or lacking, making it harder to manage plastic waste. In addition, implementation of waste management programs requires political capacity and technical infrastructure from national to the local level, and empowerment of local communities is necessary to ensure a complete waste management supply chain [10].

The pandemic has compelled practitioners to adopt *new paradigms* to manage dry eye. A sustainable, eco-friendly, and socially-aware community includes patients, healthcare practitioners, institutions and manufacturers serving as key stakeholders. Physicians should review their practice in the light of these issues.

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