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CORRESPONDENCE

Eye drop performance at high altitude: an "in-flight" problem

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To the Editor:

Over 4 billion airplane journeys were made in 2018 [1], many by passengers who regularly wear contact lenses or commonly apply eyedrops for the treatment of glaucoma or management of dry eye disease. Dry eye, a multifactorial disorder of the ocular surface stemming from a loss of homeostasis of the tear film and leading to inflammation, ocular irritation, mucosal dryness, and foreign body sensation [2, 3], is exacerbated in contact-lens wearers, and particularly in low relative humidity environments such as airplane cabins [4]. In-flight cabins present a unique challenge to patients in need of frequent eye lubrication, as high-altitude air is dehydrated upon passing through the airplane's turbine [5]. In addition to low humidity within the cabin, barometric pressure is also reduced to increase airflow during flight [5]. The combination of these environmental factors poses an interesting scenario for frequent fliers and ophthalmologists alike.

Recognizing the variability in eyedrop bottles on the market, our objective was to conduct an in-flight experiment to assess the functionality and drop release of six brands of artificial tears: Lacrifilm® (0.5% carmellose sodium—Genom); Optive® (carmellose sodium, glycerol, sodium hyalunorate—Allergan); Hyabak® (0.15% sodium hyaluronate—Laboratoire Théa); Lacrilax® (0.5% carmellose sodium—Cosmed); Systane® UL (hydroxypropyl guar 8A, polyethylene glycol 400—Alcon); and Hylo Comod® (0.1% sodium hyaluronate—Ursapharm). Five unopened bottles of each brand were opened on land as a control; their performance was assessed at a cruising altitude of 10,000 feet during a national flight and again at an altitude of 35,000 feet during an international flight.

Upon opening, all five bottles from five of six brands—Lacrifilm® (Genom); Optive® (Allergan); Lacrilax® (Cosmed); Systane® UL (Alcon); and Hylo Comod® (Ursapharm)—showed no apparent differences in drop release both on the ground and during flight. However, all five Hyabak® (Laboratoire Théa) bottles presented with an irregular efflux of drops as soon as the caps were opened during flight (Fig. 1). This leakage prevented uniform dosing and application of drops to the eye.

In-flight cabins with low humidity and pressure present a salient need for lubricant drops, especially in patients with contact lenses, dry eye, or other conditions necessitating frequent drop application. We found that while most drop bottles were unaffected during flight, the 0.15% sodium hyaluronate bottles utilizing the ABAK® System presented challenges in drop dispensation and waste of the product. Laboratoire Théa suggests that their filtration system is sensitive to pressure differences, which may explain our observed phenomenon (A. Defemme, Laboratoire Théa Primary Packaging Manager personal communication letter, June 06, 2019). The ABAK® System releases preservative-free drops through a filter that prevents microbial contamination by not allowing external air to enter the bottle once the filtration membrane is moistened, which may result in liquid expulsion until the higher internal pressure is balanced.

While further studies in pressure-controlled environments are needed, this proof-of-concept investigation suggests an under-acknowledged phenomenon relating high-altitude and problems in drop release from bottles with a filtration membrane system. Recognizing the criticality of drop uniformity in suspension eyedrops, we

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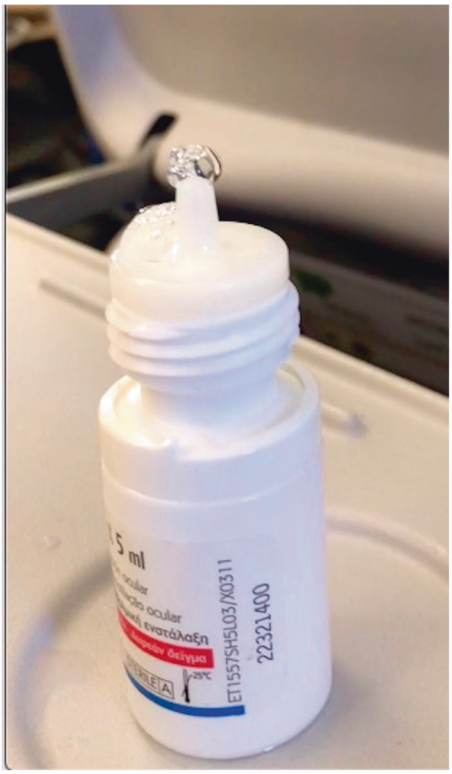

Fig. 1 An "In-flight" problem. The ABAK® System leads to drop efflux and irregular drop dispensation at high altitudes.

recommend that providers and manufacturers warn patients of this "in-flight" phenomenon when applying eyedrops from a filtered system, as well as provide education on environments that may exacerbate common eye conditions.

Compliance with ethical standards

Conflict of interest J.A.P.G.: Consultant for Allergan, MSD, Bausch & Lomb/Valeant, Mundipharma, EMS/Legrand, Shire; Lecture board for Alcon, Allergan, Genom, Bausch & Lomb/Valeant, Pfizer, Mundipharma, Grin, Ofta Vision Health; Grants from FAPESP, Capes, Cnpq.

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