

CONTROLLED PRECISION MEDICATION DELIVERY

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1. Observations: Wasteful Dispensation, Discomfort, and Clinical Risks

As standard practice, patients are prescribed a regimen of medicated eye drops—typically including a corticosteroid, a topical antibiotic, and a nonsteroidal anti-inflammatory drug (NSAID)—to reduce inflammation, prevent infection, and support healing after surgery. From my personal experience, I noted that a substantial portion of these drops do not reach the intended ocular surface. A significant fraction spills onto the periorbital skin, while another portion drains almost immediately through the nasolacrimal duct into the nasal cavity and oropharynx. I estimate that over 90% of the medication volume is either lost externally or diverted internally—far from its intended therapeutic site.

This inefficiency is not just wasteful but may also provoke adverse effects. The drainage into the nasal mucosa often triggered sneezing and severe rhinorrhea, presumably due to chemical irritation of the respiratory mucosa. These involuntary reactions may be especially concerning immediately post-op, as vigorous head movements or sudden intraocular pressure fluctuations—both consequences of sneezing—could potentially jeopardize the stability of the intraocular lens (IOL). Moreover, the act of instilling drops is often awkward and imprecise, especially for elderly patients or those without caregiver assistance.

An additional concern is the possibility that continuous exposure of the nasolacrimal drainage system to excessive volumes of medication over several weeks may lead to long-term irritation or dysfunction of the tear ducts themselves. While less frequently discussed, persistent overloading of the tear drainage system could potentially disrupt its normal physiology even after treatment ends—resulting in prolonged dryness, congestion, or altered drainage patterns.

2. Background: Anatomy, Absorption, and Punctal Occlusion Challenges

The anatomical link between the ocular surface and nasal cavity via the lacrimal drainage system (specifically, the inferior punctum and nasolacrimal duct) allows any excess topical medication to bypass the eye and enter systemic circulation or irritate nasal tissue.

While the technique of punctal occlusion—pressing on the inner canthus to block tear drainage—can significantly improve drug retention in the eye and reduce systemic absorption, it is poorly understood, rarely demonstrated, and almost never practiced consistently by patients. Even when advised, execution varies and is prone to user error.

In addition, common commercial eye drops bottles lack dosage control, directional targeting, and ergonomic delivery. For older or postoperative patients, self-administration can be particularly inefficient and uncomfortable.

3. Precisely Controlled and Waste-Free Medication Delivery

We propose developing a modern applicator that will:

- Deliver a precisely metered dose,
- Target the conjunctival sac accurately without overflow, and
- Avoid contact with surrounding tissues.

The design will improve therapeutic outcomes by maximizing ocular drug absorption and minimizing systemic exposure and physical discomfort. If successful, the platform may have

applications beyond ophthalmology—including nasal, oral, and other mucosal drug delivery systems.

4. Piezo-Generated Aerosol Wand (PAW)

The key element of the proposed device is a confined and precisely controlled cloud of liquid medicine created by a micro piezo element. The unique feature of the cloud is that it is easily shaped into a desired configuration and confined and maintained indefinitely using our patent-pending technology.

The confined, not expanding into space cloud becomes a wand made of finely dispersed medication. PAW acts as a gentle medication applicator helping to deliver the medication directly in a controllable and comfortable process. The gentle delivery is especially important for using with eyes.

The PAW applicators will be useful in cases where delicate and precise delivery of medication is crucial and mechanical applicators are not convenient, or harmful. They can be used either in the home or medical office environment, or during operations providing precise delivery of any medication in a sterile environment.