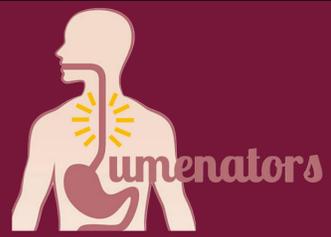


E-Lumenate: Optimizing Treatment of Eosinophilic Esophagitis Using an Internal Phototherapy Device

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Introduction

Eosinophilic esophagitis (EoE) is characterized by chronic, immune-mediated inflammation in the esophagus, leading to eosinophilic infiltration and tissue remodeling [1]. EoE has increased 5-fold since 2009, and about 1 in 700 people in the United States suffer from this disease. Current interventions are limited and include diet modification and medications, such as PPIs and glucocorticoids [2]. The purpose of E-Lumenate is to incorporate the novel use of phototherapy to inflamed regions of the esophagus for the treatment of EoE, targeting cytokines such as IL-33 and IL-13 that play critical roles in triggering eosinophilic infiltration, basal zone hyperplasia, epithelial barrier dysfunction, and progressive tissue dysfunction [3].

Mission Statement

Our mission is to advance patient comfort and quality of life through an innovative, convenient, and low-maintenance phototherapy solution for Eosinophilic Esophagitis

Project Timeline

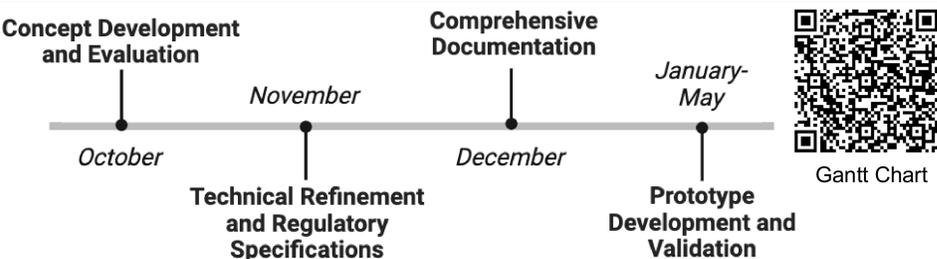


Figure 1. Project Planning and Timeline. Breakdown of E-Lumenate project milestones over the course of a year.

Design Inputs and Product Specifications

Customer Need	Metric	Customer Need	Metric
Tissue safety*	Maximum tissue temperature rise	Reasonable cost**	Cost per device
UV dosage accuracy*	UV output deviation from target	Non-Uniformity of Irradiance*	Variation in UV intensity across the treatment area
Ease of insertion**	Insertion success rate on first attempt	Compatibility with PPE*	Device usability while wearing PPE
Battery life**	Therapy duration per charge	UV placement accuracy*	Deviation of UV exposure from target location
Sterilization*	Number of re-sterilization cycles tolerated	Intra-animal tolerance*	Visible irritation or injury post treatment
Treatment time**	Duration of therapy session	Insertion time**	Time to insert and position the device
Catheter Diameter**	Outer diameter	Flexibility**	Flexural modulus
Reliability*	Device failure rate per 100	Temporal instability*	Fluctuation of UV intensity
Mobility**	Device weight	Length**	Total length; emission zone length

A single asterisk () indicates a higher priority, and two asterisks (**) indicate that tradeoffs may be acceptable.*
Bolded metrics represent essential needs

E-Lumenate Concept and Design

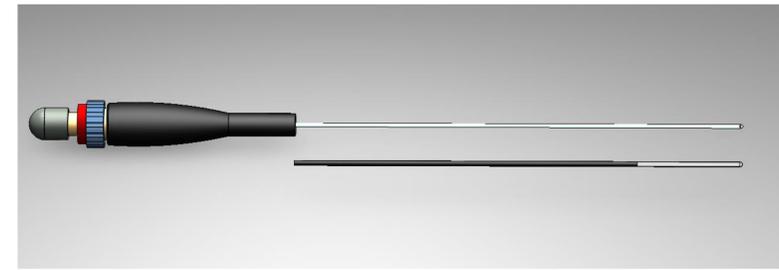


Figure 1: The CAD design shows the flexible, thin catheter optimized for comfortable trans nasal insertion, with an internal light diffuser that delivers controlled UV exposure directly to the inflamed esophageal tissue.

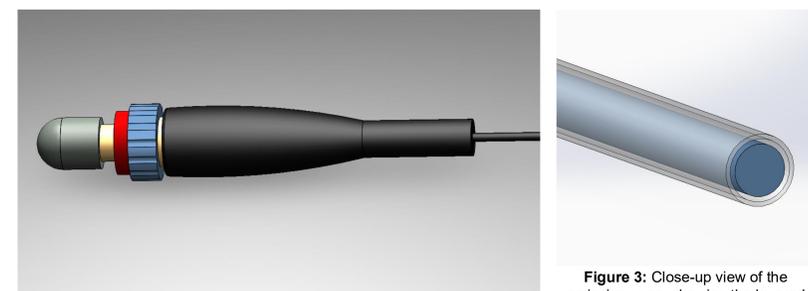


Figure 2: Close-up of the control and power interface, which connects to an external power source and allows clinicians to set UV dose and exposure duration for precise, repeatable treatment delivery.
 Figure 3: Close-up view of the emission zone, showing the layered structure of the catheter and integrated diffuser.

Technical Modeling

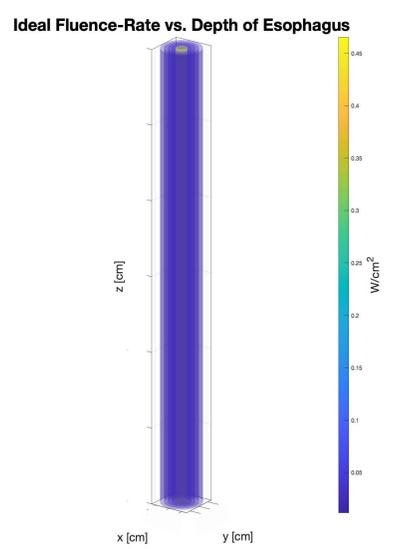


Figure 4: Visualization of a conceptual model illustrating how output intensity may appear across the length of a cylindrical region. Image represents a simplified design in progress.

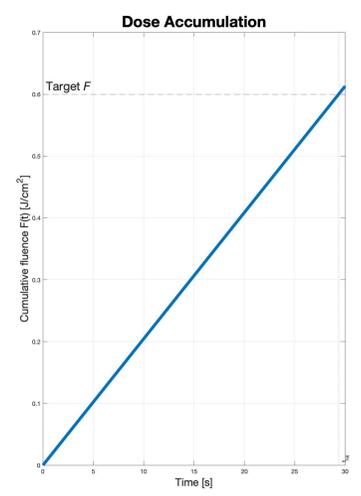


Figure 5: Plot showing an example of how a measured dose accumulates over time. Graph reflects a basic linear trend for demonstration purposes.

Beer-Lambert's Law:

$$T_{bulk}(\theta) = \exp(-\mu_{a,fill}l_{fill}(\theta))\exp(-\mu_{a,c}l_c(\theta))$$

Market and Manufacturing Costs

EoE Market Context

- Estimated EoE Market Size: ~\$7.6 billion by 2034 [4]
- Prevalence: Affects ~1 in 700 people in the U.S. annually [5]
- Market Trend: Increasing demand for minimally invasive, local-effect treatments

Current Treatment Costs (List Price)

- Dupilumab Injection (Dupixent): \$3,993.36 USD per carton [6]
- Endoscopic Dilation: National average ~\$2,700 [7]
- Corticosteroid Therapy (Budesonide): Median cost ~\$2,316 per quarter [8]

Projected E-Lumenate Device Costs

- Cylindrical Optical Fiber and Diffuser: \$500 per unit (sterilizable)
- Catheter: \$250 per unit (disposable)
- UV/Power Module: \$1,000 (sterilizable)
- Projected Selling Price: \$250 per session

Value Proposition

- 80-95% lower annual cost than biologics (e.g., Dupixent)
- Enables office-based outpatient use, reducing hospital costs
- Minimally invasive, local phototherapy, with rapid symptom relief.

Future Work

- In vitro study to confirm UV effectiveness and determine appropriate dosimetry
- Prototyping
- Prototype Verification and Validation
- Complete Patent(s) Application
- Future Marketing

References



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