Biosensing & Drug Delivery

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Disclosures: Lyndon Jones

Over the past three years members of CORE have received research funding and/or honoraria from the following companies:

- Advanced Vision Research
- Alcon
- Allergan
- Contamac
- CooperVision
- Essilor
- GL Chemtec
- Inflamax Research
- Johnson & Johnson Vision
- Menicon
- Nature’s Way
- Novartis
- Ocular Dynamics
- Oculus
- Safilens
- Santen
- Shire
- TearLab
- TearScience

Update on Technologies

Revolutionary Future Uses of Contact Lenses

Detection of Ocular & Systemic Disease

Wearable Sensor Market

- Market for wearable technology is expected to reach US$ 31.27 Billion by 2020, at annual growth rate of 17.8%
  - smartwatches
  - wristbands
- Major players
  - Adidas; Apple; Fitbit; Garmin; Google; Nike; Samsung; Sony

“Smart” CL System

Technology Overview
J&J; Samsung; Sony; Medella Health

>85 patents since 2012

**CL Monitoring Devices**

**Glaucoma**

- Sensimed Triggerfish®
- "Smart" contact lens with tiny embedded strain gauge to monitor curvature of the eye over a period of 24 hours
- Looks at relative changes in IOP
  - not absolute values
- Silicone-based (Dk~350)
- Thickness ~ 600µm
  - Dk/t ~ 60
- Hypoxia with overnight wear
- Single-use only


**Verily (Google Life Sciences): July 15th 2014**

Potential CL Biosensor Targets

- **Ocular**
  - IOP
  - osmolarity
  - Biomarkers
    - dry eye disease etc
- **Systemic**
  - diabetes
  - cancer markers
  - blood pressure
  - neurological disorders
  - heart rate
  - kidney function
  - ovulation

**Topical Drops**

- >95% of current market for disease management
  - poor insertion technique in >50%
  - over-slip
  - poor compliance in 50%
  - rapid tear flow drainage
  - drug diluted by blinking
- Substantial systemic absorption
- <5% of drug gets to target
What about using CL?

- Soaked CL should release drugs much slower
- First suggested in original Wichterle hydrogel patents in 1960’s ¹
  - first published manuscript in 1971 ²
- 93% of surveyed clinicians would be interested in using a drug delivering bandage CL ³
- Clinical success depends on
  - drug loading
  - drug release
  - affinity between drug and material


Plenty of recent interest...

PubMed search: “drug delivery” + “contact lens” = 308

Long-Term Therapy

- Glaucoma
- Allergy

What diseases may be relevant?

Microbial Keratitis

Management of Severe Abrasions
Why not just use commercial contact lenses?

Topical Drugs & CL Materials

CORE – published 30 papers on this topic. Delivery NOT controlled & too rapid

What slow release technologies have been investigated?

Hydrogel Drug Delivering Concepts

Drugs Under Investigation

- Anti-infectives
- Anti-inflammatory
c- Anti-glaucoma
d- Epidermal growth factor
e- Anti-allergy
  - J&J have already evaluated and reported on 4 trials of a ketotifen-releasing  DO lens (2007-2015)
  - antihistamine/mast cell stabilizer

Clinically Relevant Amounts of Ciprofloxacin Release up to 14 days

Ciprofloxacin Delivery by pHEMA-PLGA “sandwich”

PLGA Films for Glaucoma Management

“Sustained delivery of latanoprost by contact lenses is at least as effective as delivery with daily latanoprost ophthalmic solution”

Vitamin A Diffusion Barriers

THANK YOU