Cytelligence

A Wearable Aptamer-Based Biosensor for Proactive Psoriasis Symptom Management

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Introduction

- Autoimmune disease affects over 300 million people worldwide, with psoriasis affecting 125 million
- Psoriasis causes patients to have painful and noticeable skin lesions, significantly altering quality of life
- Treatment plans are often reactive rather than proactive, leading to unpredictable flare-ups

Science of Psoriasis

- Psoriasis acts through an inflammatory feedback loop
- Studies have shown that proactive treatment of psoriasis beats reactive treatment plans
- By continuously monitoring IL-17 in the dermal interstitial fluid (dISF), flare-ups can be predicted

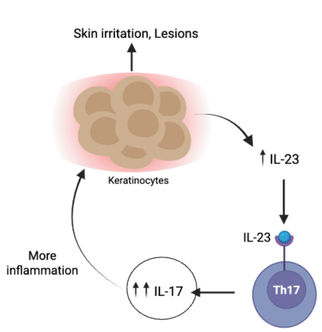

Figure 1: Schematic of psoriasis inflammatory feedback loop

Usability & Stakeholders

- When a patient is prescribed Cytelligence, their biomarker baseline and flare-up concentrations will be calibrated
- The medical provider and patient will establish a plan to follow when Cytelligence alerts them of a flare-up
- Cytelligence will therefore cause earlier intervention of symptoms, reduced uncertainty, and better communication with medical providers
- Effective commercialization requires aligning the needs of four key stakeholders: patients seeking earlier intervention, dermatologists needing continuous data, health systems reducing costs, and Cytelligence as the manufacturer

End User: Patients | Prescriber: Dermatologists | Institutional Buyer: Healthcare Systems | Manufacturer: Cytelligence

References

Engineering Design and Manufacturing

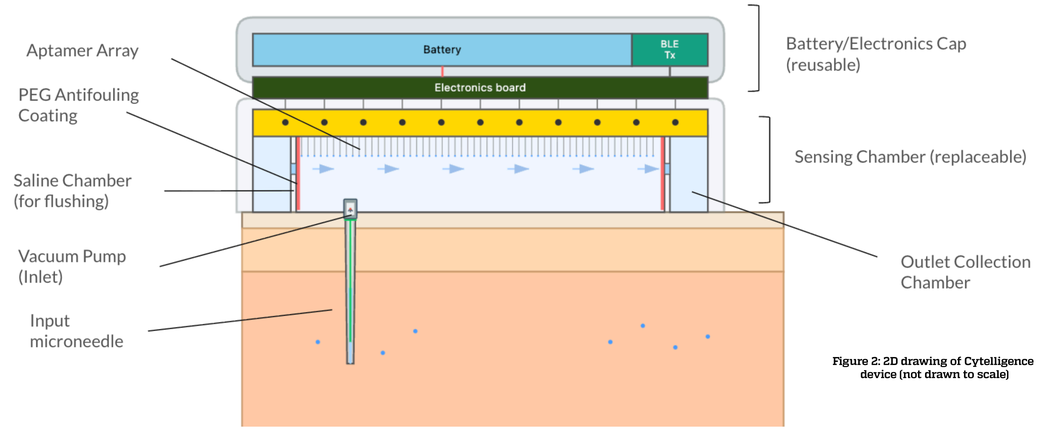

Figure 2: 2D drawing of Cytelligence device (not drawn to scale)

Design Specifications:

Battery Cap: 35mm x 20 mm x 5 mm
Sensing Chamber Housing: 35 mm x 20 mm x 2.5 mm
Fluid Cavity: 6 mm x 3 mm x 0.125 mm
Saline Chamber: 240 uL
Outlet Collection Chamber: 340 uL
Fluid Cavity: 2.25 uL

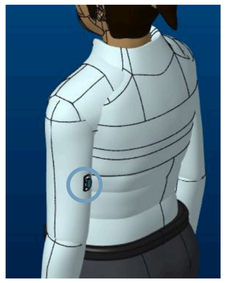

Figure 3: Device (over clothes for show) on patient for scale

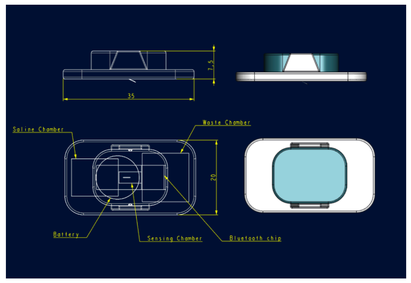

Figure 4: Device CAD drawing (to scale, sizes in mm) with electronics and sensor compartments attached

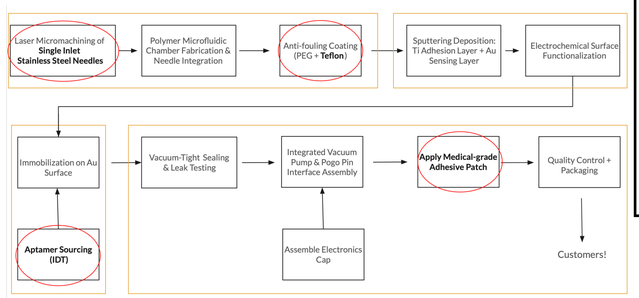

Figure 5: Manufacturing flow diagram (including outsourced components where indicated)

ChemBE Modeling

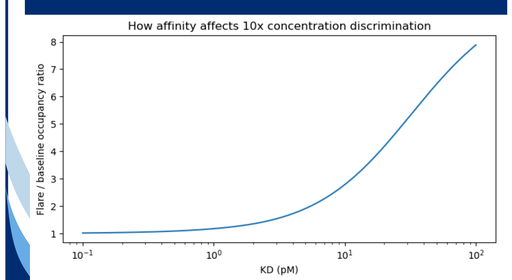

Figure 6: Varying aptamer affinity for IL-17 changes the flare/ baseline occupancy ratio

Transport of IL-17A and ISF

- Able to fill 250 uL chamber within 2 hour sampling period
  - Max total flow rate of 0.60 uL/min (through tissue and needle - series)
- Pe = 607.30, convection dominant system
- Flow is tissue limited (not needle)

$$Q = \frac{\Delta P \pi r^4}{8 \mu L}$$ *Hagen Poiseuille: flow within needle modeled as laminar flow within pipe (Newtonian)*

$$Q = \frac{-kA\Delta P}{L}$$ *Darcy: Flow within dermal extracellular matrix (ECM) modeled as flow through porous media*

Aptamer Kinetics Modeling

- Design Conclusion:
  - KD = 25.0 pM
  - K_on = 8.402*10^3
  - K_off = 2.1*10^-4 1/s
- Binding capacity of 100,000,000 sites per aptamer type
- Reversible binding (1 event per aptamer site)

Financial Analysis

Table 1: 10 year cumulative cash flow and cost projections (millions of dollars) assuming Cytelligence is part of a larger biotech company

($M)	Year 1-3	Year 4	Year 6	Year 8	Year 10
Revenue	–	$600	$2,400	$5,400	$9,000
Cost of goods sold	–	$330	$990	$1,980	$1,980
R&D	$800.00	–	–	–	–
Capital	$3	–	–	–	–
Operating	$30.50	$270	$1,080	$2,430	$3,240
Cash Flow	($833)	($500)	$330	$990	$1,980
CUMULATIVE Cash Flow	($833)	($1333)	($673)	$807	$3,757

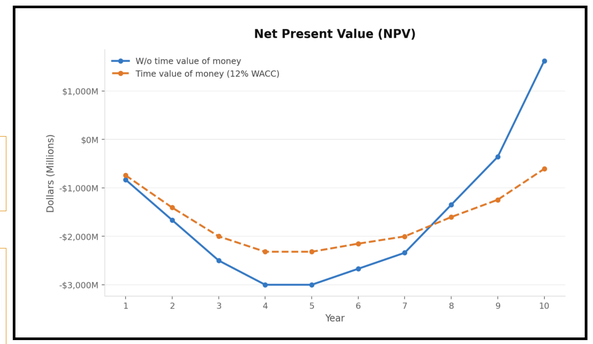

Figure 7: NPV of Cytelligence for 10 years with and without time value of money (12% WACC)

Conclusion

Cytelligence will provide patients a shift from reactive psoriasis treatment to proactive disease management through real-time biomarker monitoring using a wearable microneedle biosensor.

Key takeaways:

- Continuous molecular-level monitoring may allow earlier prediction of psoriasis flare-ups before visible symptoms appear.
- A simple, wearable design enables long-term tracking without disrupting daily life.
- This approach could support more timely clinical decisions and improved patient outcomes in chronic autoimmune disease management.

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