

## **Thesis Project Portfolio**

**Development of a Liposomal Formulation for the Transdermal Delivery of Liothyronine**

(Technical Report)

**The Role of Diagnostic Protocols as a Classification System in Diagnosing Hypothyroidism**

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

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In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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## **Sociotechnical Synthesis**

Hypothyroidism describes the underproduction of the two thyroid hormones, triiodothyronine and thyroxine. Over 100 million Americans suffer from hypothyroidism and are treated with solely levothyroxine, the synthetic version of thyroxine (Holtorf, 2014). Fifty-six percent of these patients are unsatisfied with this treatment and studies have shown that patients could benefit from the additional administration of liothyronine, the synthetic form of triiodothyronine (Eligar et al., 2016). However, liothyronine has some holdbacks that have kept physicians complacent despite studies showing the benefits of liothyronine. The motivation of my technical thesis was to improve upon the holdbacks of liothyronine while my sociotechnical thesis aimed to understand how diagnostic classification systems influence physicians and patient outcomes within hypothyroidism. These two projects explore two approaches to improving patient care, one technical and one sociotechnical.

Liothyronine has a short half-life leading to transient peaks and thyrotoxicity. My technical project aimed to begin to overcome the limitations of liothyronine administration through the development of a time-sustained release delivery system. Utilizing a weighted selection criteria system, a liposomal formulation within a transdermal patch was selected based on factors such as hypersensitivity reactions, bioavailability factors, and patient compliance. To demonstrate proof of concept, liothyronine was encapsulated within liposomes, and the liposomes were injected into an ultrasound gel that acted as a permeation enhancer. The formulation was then applied to a skin mimic within a vertical diffusion cell, and samples were collected over 24 hours to analyze the transdermal drug permeation. This project provides a novel approach to address the limitations of liothyronine administration and could have

significant implications for the treatment of hypothyroidism. Further studies are needed to optimize the formulation and delivery system for liothyronine and to evaluate the effectiveness of the transdermal patch for sustained release delivery of liothyronine. This experiment serves as a proof of concept that liothyronine can be delivered transdermally utilizing a liposomal formulation.

My sociotechnical paper contends that the information infrastructure of diagnostic classification systems in hypothyroidism has adverse effects on patient care and diagnosis by hindering proper treatment for symptomatic patients through standardized treatment plans and healthcare professionals' complacency. However, changes in information infrastructure hold the potential for improved care for hypothyroidism patients. The paper encourages healthcare professionals, administrators, medical students, government officials, and researchers to work collaboratively to enhance the diagnostic infrastructure and improve the care and quality of life for hypothyroidism patients. Identified areas for future research, included the effectiveness of different diagnostic tests and treatments and patient education about thyroid health and early detection. The paper concludes that ongoing research and development efforts are needed to continue to improve the information infrastructure and care for hypothyroidism patients.

My technical and sociotechnical projects serve as complementary approaches for improving patient outcomes within hypothyroidism. Accomplishing these projects simultaneously highlights the value in a sociotechnical approach to healthcare challenges. By considering both the technical and social factors in developing a solution to a healthcare challenge such as hypothyroidism treatment, more effective and sustainable solutions that serve patients and healthcare providers alike can be formulated. More specifically, completing these

projects concurrently allowed me to bring a new perspective and social considerations to my technical team when evaluating important social factors for the choice of our delivery method in our weighted selection criteria rubric. If these projects had been done in isolation, I would not have thoroughly considered factors such as patient comfort, cost, self-administration, invasivity, weight of device, and durability. While some of these factors may seem more technical, these factors are based on considerations of patient compliance, making it easier for patients to comply with enhanced care and obtain better health outcomes. Additionally, if I had done these projects in isolation, I would not have been as informed on the technical advancements and the literature of major thyroid health institutions that influence physicians' care for hypothyroidism. Overall, the concurrent completion of these projects was mutually beneficial for each project individually.

#### References:

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Holtorf, K. (2014). Peripheral Thyroid Hormone Conversion and Its Impact on TSH and Metabolic Activity. *Journal of Restorative Medicine*, 3(1), 30. <https://doi.org/10.14200/jrm.2014.3.0103>