

Undergraduate Thesis Prospectus

Assessing Endothelial Cell Behavior in an in vitro PEG-DA Hydrogel Cell Culture Assay of
Idiopathic Pulmonary Fibrosis
(technical research project in Biomedical Engineering)

The Struggle to Diminish Inequities in the U.S. Healthcare System
(sociotechnical research project)

by

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Anna Kittel

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as
defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

In the U.S, how may healthcare access be improved?

High costs of treatment limit access to healthcare in the United States. Of the 28.9 million uninsured Americans, 73.7% are uninsured due to the high cost of insurance and ineligibility for financial assistance. In the U.S., people of color are more likely to be uninsured, resulting in worse healthcare treatment for these groups (Tolbert et al., 2020). Uninsured people are much less likely to seek treatment, contributing to worse overall health among the uninsured.

Assessing Endothelial Cell Behavior in an in vitro PEG-DA Hydrogel Cell Culture Assay of Idiopathic Pulmonary

How may treatment of IPF be improved?

Partnered with Ms. Anna Kittel, we are using an in vitro PEG-DA Hydrogel Cell Culture Assay, provided by Dr. Lakeshia Taite in Chemical Engineering, to assess microvascular cell behavior. This capstone project will be conducted in Dr. Shayn Peirce-Cottler's lab with assistance from Ms. Julie Leonard-Duke in the Biomedical Engineering Department. We will be controlling mechanical and biochemical cues in the assay to mimic disease conditions of IPF lungs.

IPF is a chronic and progressive form of pulmonary fibrosis with an average prevalence of about 3.5 cases per 100,000 people and an average survival of 3-5 years after diagnosis (Barratt et al., 2018). There is currently no known cause or successful treatment for this disease. It entails the formation of scar tissue in the lung due to an excessive wound healing response involving extracellular matrix deposition (Hanumegowda et al., 2012). ECs respond to both mechanical and biochemical cues, such as vascular endothelial growth factor (VEGF), fibroblast

growth factor (FGF), and platelet-derived growth factor (PDGF). It is hard to see how ECs respond to altered IPF levels of growth factors, which are crucial to the microvasculature, in stiff lung tissue.

We are using an established hydrogel EC culture assay with tunable stiffness to study how mechanical stiffness along with VEGF or PDGF+FGF affects EC viability and morphology. PEG-DA hydrogels are prepared with stiffnesses of 20 kPa, 10 kPa, and 2 kPa. The stiffnesses mimic severe IPF, progressing IPF, and healthy lungs. There is no alternative to this hydrogel method, as Lys(alloc)-OH is used as a competitive monomer to change stiffness, making it the viable option (Chapla et al., 2020).

We will use a co-culture of ECs and pericytes to replicate lung microvasculature. The cells in gel will be cultured for around 2 weeks before being immunostained to determine how the cells change. In current studies, it is known that PEG-DA hydrogels can replicate extracellular matrix environments of diseases along with spreading of ECs (Schweller et al., 2015). We hope to understand how the cells change in the microvasculature due to both mechanical and biochemical triggers and how it progresses IPF. This can improve targeted treatment based on growth factors present in the microvasculature.

The Struggle to Diminish Inequities in the U.S. Healthcare System

In the U.S., how are advocacies, health professionals, philanthropies, and others striving to diminish inequities in healthcare access among people of color?

Racial inequities in U.S. healthcare are common. Disparities in care correlate to differences in socioeconomic status, which in turn are often attributable to differences in intergenerational transfer of wealth, access to insurance, and residential conditions (Kirby et al.,

2006). 12% of Black Americans are uninsured in comparison to 9% of White Americans (ASPE 2022). Many advocates strive to reduce the consequent inequities in healthcare.

Researchers have been investigating racial disparities in healthcare. Brown and Hargrove (2013) found that women of color, specifically Mexican American women and Black women, have worse functional health and that, “multidimensional approaches as well as examination of various potential mediators of health disparities provide a better understanding of how health is shaped by multiple social locations.” Daw (2015) found that for healthcare such as transplants, racial disparities “directly influence post-transplant success.” Phelan and Link (2015) found that racial inequities occur in healthcare because racism is a cause of racial differences in socioeconomic status, which leads to healthcare inequity.

One advocacy, the Commonwealth Fund, seeks to improve disadvantaged groups’ healthcare access by “tracking health insurance coverage, affordability, and health outcomes for Black, Latino, Asian, Pacific Islander and Native Americans” (Commonwealth Fund, 2022). They use extramural grants with intramural program development, research, and communication activities to make a difference in healthcare areas of importance. The Commonwealth Fund acknowledges the nation’s embedded racism in the healthcare system, which leads to poorer health outcomes for people of color. It “also highlights policies and practices needed to achieve an antiracist health system that helps people of color to thrive” (Commonwealth Fund 2022). Daphne, a young Black woman from a segregated, low-income neighborhood in New York states that, “I feel like sometimes the system, it’s made for us to stay down.” The advocates emphasize that, “racial and class marginalization hinders people’s ability to exercise adequate control over outcomes that profoundly shape their lives... incorporating voice into policy requires systematically including the perspectives and experiences of oppressed groups most

affected by the policy...policy processes are more equitable when marginalized voices guide them” (Commonwealth Fund 2022).

The American Public Health Association (APHA) “works to advance the health of all people and all communities” (APHA 2022). APHA attributes public health inequities in the U.S. in part to structural racism. An internal policy proposal within APHA calls on the association to “support and fund research focused on addressing structural racism and help develop solutions to mitigate racism within the institutions in the U.S.” (APHA, 2020). In a letter to the U.S. House of Representatives, APHA’s executive director called upon Congress to take action to curtail racial profiling in law enforcement and thereby to relieve the “brutality and violence” that “continue to harm the health of individuals and communities of color, especially Black communities” (Benjamin 2021). To APHA, structural racism is a public health threat: “APHA recommends the following actions by federal, state, tribal, and local authorities... increase investment in promoting racial and economic equity to address social determinants of health... work with public health officials to comprehensively document law enforcement contact, violence and injuries” (APHA 2022).

The California Black Health Network (CBHN) seeks to “ensure that all Black Californians, regardless of their education, socio-economic class, zip code, sexual orientation, gender identity, homelessness, or immigration status have access to high quality and equitable primary and behavioral healthcare, and avoid unnecessarily succumbing to disease” (CBHN 2022). It calls for “cost-effective coverage and value-based care” prioritizing “value, quality of care and patient outcomes” (CBHN 2022). To diminish inequities in infant and maternal mortality, CBHN calls for “policies that would increase access midwifery care and birthing centers ... to increase access to group prenatal and postpartum care” (CBHN 2022).

The National Hispanic Medical Association (NHMA) seeks to reduce racial health inequalities among U.S. Hispanics. “The mission of the organization is to empower Hispanic physicians to lead efforts to improve the health of Hispanic and other underserved populations” (NHMA 2022). In October, the NHMA “submitted the Office of Civil Rights Comments to strengthen Section 1557 of the Affordable Care Act with data on race, ethnicity, language, and gender identity” (NHMA 2022).

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