## Challenge Overview

The relationship between community health, and access to health dietary patterns are well established in the literature [1]–[5]. However, many other confounding factors play an important role in the adoption of healthy foods to prevent disease [6]–[8]. Community engagement and cultural influence are critical factors in the sustainability of healthy dietary patterns. Food macronutrients and micronutrients can also play an important role in treatment of disease, in some cases even reversing the harmful effects that led to the development of the disease. However, systemic complexity of system dynamics when developing strategies for healthy community-based food systems can be overwhelming in terms of complexity.

The current study intends to address this complexity by developing an integrated modeling framework. The purpose of this framework is to use it to identify both population & individual level interventions, and then composition of a wholistic strategy that can be deployed and managed in a sustainable fashion by its beneficiaries. To accomplish this, the effort will be divided into 3 sub-projects each with individual aims & objectives to measure progress and adapt future work. In the first and foundation project, we plan to develop an integrated region/culturally specific whole food/agriculture database in combination with a mobile application. The application will be used to engage citizen scientist in sharing and curating healthy receipts that others can discover based on variables associated with an individual health profile. The benefit of this work lies in the development of a unique integration of system dynamic modeling techniques that facilitate the medical value of food micronutrients and composition of individualized recommendations. Application use will further drive both research and the refinement of algorithms to discover better individualized dietary pattern fits to further support engagement.

## Objective 1: Preliminary System Dynamics Model Development [9], [10]

The primary focus of this objective is to capture multi-dispensary expert knowledge of patients, social workers, healthcare professional and other researchers regarding the critical variables and their causal relationships related to HCV treatment adoption.

1. Create initial knowledge domain model to map relevant expert knowledge needed to develop a Causal Loop Diagram for understanding HCV treatment adoption.
2. Develop interview questions and map them to each domain in the knowledge map.
3. Enlist expert volunteers willing to participate in the study by providing relevant expert knowledge.
4. Conduct initial Group Model Building (GMB) session with individual experts to capture content using participatory modeling matrix, compiled answer dataset and free text mapped to knowledge map.
5. Identify gaps in Phase I research and conduct additional treatment barrier literature review that supports expert knowledge, validate findings with experts and map citations to knowledge map.
6. Construct a ‘Combined Causal Matrix’ (CCM) and a ‘Cumulative Polarity Matrix’ (CPM) from the individual matrices developed in step 4.
7. Construction of a ‘Qualitative Preliminary Combined Causal Loop Diagram’ (QPCCLD).
8. Conduct a combined GMB session with all experts and HCV team members to review consolidated material and literature review finds. Capture session recommendations.
9. Update QPCCLD to reflect recommendation from the combined GMB meeting.

***Deliverables:*** *Qualitative Preliminary Combined Causal Loop Diagram, consolidated causal/polarity matrix and supporting material.*

## Objective 2: Data and Conceptual Model Enrichment [11], [12]

The primary aim of this objective is to improve the data warehouse datasets, medical coding framework and conceptual models to facilitate the development of quantitative HCV treatment adoption models.

1. Investigate and identify missing data sources that can be used to validate and extend the (QPCCLD) developed in objective 1, and further quantitative analysis.
2. Investigate, extend, and consolidate the coding system (e.g., ICD, CPT, etc.) developed in phase 1 of the HCV project.
3. Clean, transform, and load discovered data sources into existing health science data warehouse.
4. Investigate ontological data integration methods and develop algorithms to integrate Medicaid data with extended datasets discovered in step 11 & 12.
5. Construction of de-identified data warehouse using Medicaid data from CHFS 2010-2019 combined with other publicly available datasets.

***Deliverables:*** *Extend Health Science Data Warehouse, HCV ontology-based integration algorithms, HCV consolidated coding model and supporting material.*

## Objective 3: Quantitative System Dynamics Model Development

The primary focus of objective 3 is to develop a quantitative simulation that can be used to model the dynamic system-level effects of individual static and/or dynamic changes in variable states.

1. Utilize machine learning techniques to quantitatively identify variable relationship metrics, dynamics and additionally previously undetected acyclic variable relationships.
2. Utilize quantitative results in step 15 to develop appropriate differential and structural equations.
3. Develop initial quantitative model to simulate HCV treatment adoption curves to test various policy & practice interventions. Validate against expert (QPCCLD) model.

***Deliverables:*** *Simulation model to test HCV treatment adoption strategies and supporting material.*

## Objective 4: Strategy Model Framework

1. Investigate and develop a computational modeling framework utilizing the HHS Medicaid affinity group [13] HCV template to quantify policy strategy.

***Deliverables:*** *Documented method to quantify policy strategy.*

## Future Work:

* Model extension to estimate provider performance metrics compared to national averages. This could also be integrated with a cost-benefit analysis.
* Model extension to simulate effects of changing population demographics and consumer trends.
* Investigate methods for cyclic discovery & analysis of cyclic pathways given competing goals.
* Model extension for HCV intervention surveillance and tracking progress.
* Model extension to quantify the socioeconomic and long-term outcome probabilities given various elimination strategies.

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[10] J. Elbaz, “Assessing the Risk of HIV and Hepatitis C among Internally Displaced Persons in Georgia,” *Ann. Glob. Health*, vol. 86, p. 66, Jun. 2020, doi: 10.5334/aogh.2671.

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[12] “Medicare Fee-For-Service Public Provider Enrollment - Centers for Medicare & Medicaid Services Data.” https://data.cms.gov/provider-characteristics/medicare-provider-supplier-enrollment/medicare-fee-for-service-public-provider-enrollment (accessed Jan. 12, 2023).

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