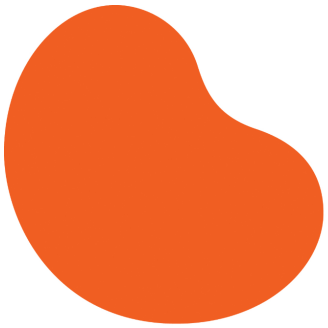

National Kidney Foundation® of Utah and Idaho

System Analysis and Design

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Executive Summary

This report aims to provide a solution to preventing kidney diseases and improving the health of individuals affected by them. We have designed a web application that allows kidney disease patients to track their daily food intake and monitor serum levels in regard to kidney health. Diagrams have been provided to visualize how the proposed system will operate, including Domain Class Diagrams, Use Cases, System Sequence Diagrams, and Wireframes.

The website allows users to track their nutrition intake by adding meals like a food diary. There is a CRUD page for users to enter personal information (age, gender, height, weight, kidney stage, comorbidities, etc.), add meals including food details to the food journal, add food to the database, and add serum levels. The website will display the daily macronutrient and micronutrient intake based on the food description and notify users if their nutrient intake exceeds the recommended levels that are calculated based on their personal information. We have also included multiple dynamic visualizations on the website that display the daily macronutrient and micronutrient intake. We also included a line graph of logged serum levels over time.

Business Background

The National Kidney Foundation (NKF) is a voluntary health organization in the United States—with over 30 local offices across the country. The organization's goal is to counteract kidney and urinary tract diseases, enhance the health and well-being of individuals and families affected by these diseases, and increase the opportunity of all

organs for transplantation. NKF is the biggest, most far-reaching, and long-established organization dedicated to the awareness, prevention, and treatment of kidney disease in the United States.

Business Case

Kidney and urinary tract disease in the United States has proven to be a prominent health crisis as thirty-three percent of the population is at high risk. With few treatment options, many Americans have limited options to overcome the disease and live healthy lives. While uncommon, it is possible for up to 90 percent of kidney function to stop before symptoms arise. Thus it is evermore important to maintain a healthy lifestyle and keep track of kidney function to prevent disease. It is estimated that over 8 billion dollars are spent on Chronic Kidney Disease(CKD) by Medicare each year. Kidney transplants are one of the principal treatments of CKD, but with wait lists of up to 12 years long, they fail to address the growing needs of patients worldwide. These long wait times perpetuate the severity of the disease over time, creating a greater need for a practical solution. End-stage renal disease(ESRD), a more severe type of kidney disease, is commonly treated with dialysis. While it helps patients improve their kidney health, dialysis only mimics 10 to 15 percent of normal kidney function, and after 5 years of treatment, the death rate is 50 percent. Thus, those who participate in dialysis have limited health and ever-growing risk of death over time.

While professionals work hard to treat patients with ESRD, the treatment process is unsustainable and timely. Statistics show that half of ESRD cases could have been

prevented through diet and lifestyle improvements. A viable solution to prevent kidney and urinary tract disease is to help patients track their food intake and monitor serum levels with the help of a web application.

The web application we created dynamically updates the daily macronutrient amounts and gives patients the option to record serum level logs when their blood is tested. On the journal page, patients can record meals and review overall macronutrient and micronutrient intake through graphs and visualizations. A serum level page allows users to log their serum levels and view their progress over time with a line graph. Through information entered by the user, the web application provides customized target amounts for each nutrient and alerts the patient when they are exceeded. These features help users understand how their diet compares to the recommended diet by medical professionals.

Feasibility

We have assessed the risks of three main areas: financial, technical, and operational feasibility.

Financial Feasibility: Low Risk

The project presents a low financial risk to the National Kidney Foundation due to the low cost and high potential benefit it presents. The proposed solution involves providing an accessible web application to patients that reduce the need for treatment such as dialysis and kidney transplants. The small economic risk presented comes from potential system errors that may occur as the new system is implemented.

Technical Feasibility: Low Risk

There is low risk in terms of technical feasibility. The proposed system is simple and does not call for complicated integrations with other data systems. A small amount of risk comes from integrating other medical information based on the stage of kidney disease, additional comorbidities, gender, weight, and much more for more complex medical analysis; however, based on the fact that the project is technologically simple the margin for error is small.

Operational Feasibility: Low Risk

The proposed system to the organization presents a low risk. It is possible that the employees of the National Kidney Foundation require time to implement the new system for patients across the nation and a delay in time may arise after the new systems and processes are implemented. This is expected due to the time it will take the organization and employees to adapt to the new processes.

Based on our analysis of financial, technical, and operational feasibility, we believe the proposed system outlined later in this report presents a great opportunity for the National Kidney Foundation to enhance operational productivity in various aspects of its organizational process.

Project Scope

With the organization's best interest in mind, implementing the proposed system wIll help them reduce the risk of kidney disease in three distinct ways:

1. **Manage daily macronutrient and micronutrient intake**

   There is no operating system currently that manages kidney patient's nutrient intake which can significantly affect kidney health. The proposed system will simplify the process of improving and maintaining the health of kidney disease patients across the nation by providing a convenient resource that personalizes the organization's education efforts.

2. **Keep a record of serum levels**

   There is no system currently that handles serum level readings of kidney patients. The proposed system will allow users to readily record data and access them as needed.

3. **Minimize the need for dialysis and kidney transplant treatment**

   A large portion of patients suffering from kidney disease could have prevented End-Stage Renal Disease(ESRD) which requires treatment such as dialysis and kidney transplant. The proposed system allows patients to prevent ESRD by monitoring levels associated with kidney health.

Proposed System

Domain Class Diagram

The first diagram shown is the domain class diagram. This diagram represents the structure of the system and how each object interacts with each other. When a patient enters information into the system(name, age, weight, etc), their basic information is stored in the patient class. Each patient has a unique ID that identifies them as a patient. The patient inputs their personal information into the system. The system records the information and provides meal recommendations associated with the patient information. When food is added to the meal, a line item is created on the meal log and the macronutrient and micronutrient levels are calculated. When the patient adds serum level by selecting serum type, serum level is recorded with the patient's ID and the date.

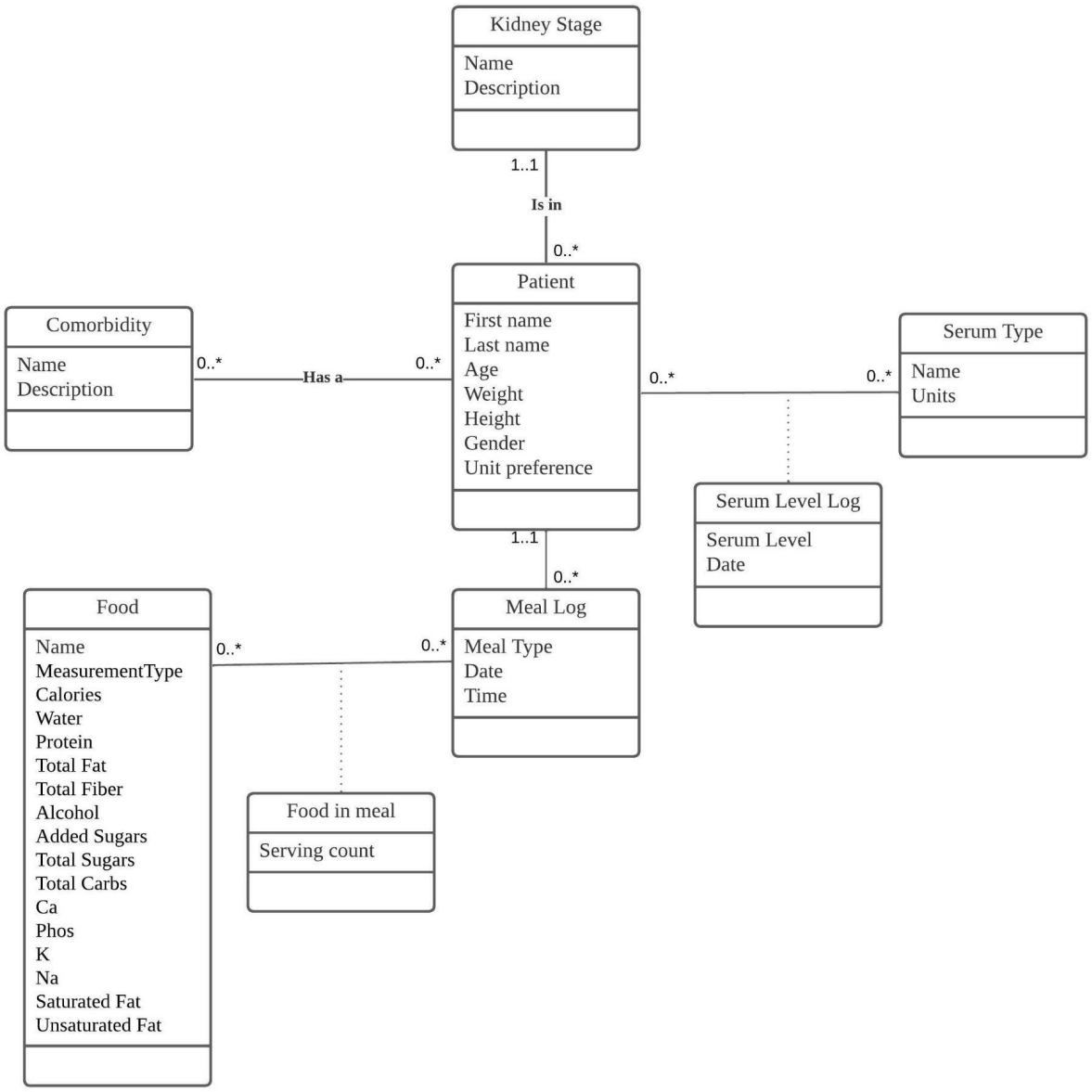
In short, the proposed system is as follows:

- User accesses the nutrient and serum level tracking website
- User enters personal information and chooses kidney stage and comorbidities
- Customer creates meal logs by adding food and its details to meals
- Recommended meal types are displayed for the user
- Customer adds any food that is not in the database with its nutrient details
- System keeps track of each patient's meals and nutrients associated with it
- Dynamic visualizations display the data and shows alerts for excess nutrient intake
- User adds serum levels in the serum log
- Line graph visualizes the data dynamically
- User can add serum types not included in the database
- User can edit any information entered in the website

We have included a detailed domain class diagram with all data that will run through our proposed system with the figure below. All data stored in the proposed system is listed here:

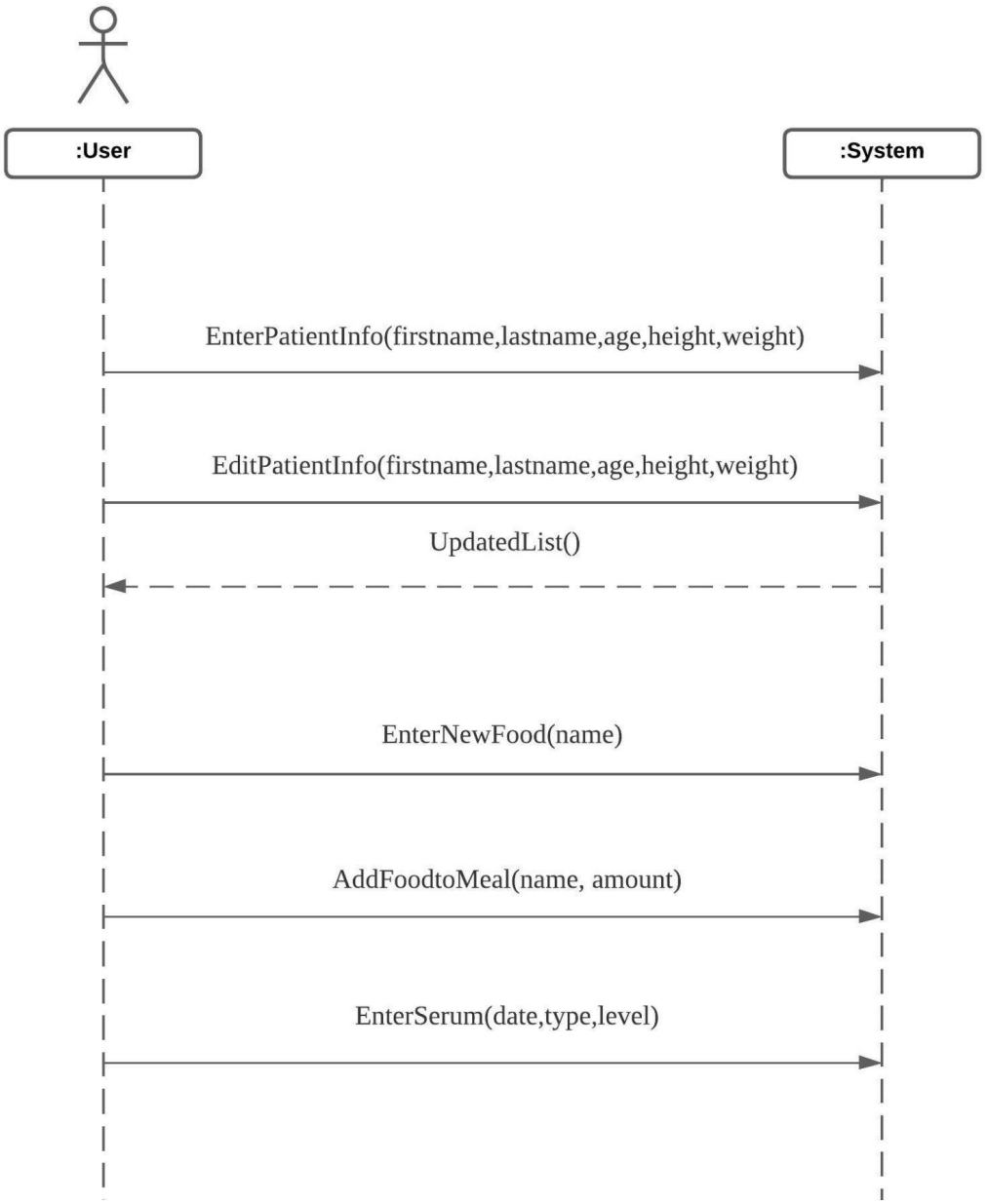
At the center of all system activity is the Patient. The Patient is a user, and the attribute we will track in the proposed system for users is their full name, age, weight, height, gender, and unit preference. Regular users have several use cases in the system: Logging meals and serum levels, Entering personal information, Adding food, and Accessing graphs to monitor levels. Users record the meals they have consumed and add serum levels when they get tested. Users also submit requests for additional food and serum types that are not included in the database.

Adding food to meals includes details about the food such as Name, Measurement type, and various micronutrient amounts. The system receives the request and creates a meal log with the food item. The system may aggregate several food requests into a single meal, but records each meal as a separate log according to meal type. Hence, a food request is associated with many meals. An adding serum level request to the serum log includes information about the serum such as serum level and date. A meal is created by exactly one patient; if more than one meal is created, the meal logs are made and recorded separately. Each patient can have many comorbidities, but at least one kidney stage. Each field in the proposed system is represented in our domain class diagram below.


Kidney Stage
Name
Description
1..1
Is in
0..*
Patient
First name
Last name
Age
Weight
Height
Gender
Unit preference
Comorbidity
Name
Description
0..*
Has a
0..*
0..*
0..*
Serum Type
Name
Units
Serum Level Log
Serum Level
Date
1..1
0..*
Food
Name
MeasurementType
Calories
Water
Protein
Total Fat
Total Fiber
Alcohol
Added Sugars
Total Sugars
Total Carbs
Ca
Phos
K
Na
Saturated Fat
Unsaturated Fat
0..*
0..*
Meal Log
Meal Type
Date
Time
Food in meal
Serving count

System Sequence Diagram

The system sequence diagram illustrates the interaction between a user and the proposed system for entering and editing personal information, adding new food, adding and editing meal logs, and adding serum level readings to serum level logs. There is a Logging Form to audit nutrient levels, add food to meal logs, and remove food from the meal log. Data from the Logging Form will be sent to the system.



Use Case

View Report Use Case

Use Case	User access nutrient intake graph
Actor	User (patient)
Use Case Overview	User has eaten a meal and logged the food details into the website. The system calculates the various nutrients consumed and displays them through dynamic visualizations. The user monitors different nutrients that are either lacking or excess in amount and modifies his/her diet accordingly.
Subject Area	Health
Actor(s)	The user
Trigger	User wants to monitor levels associated with kidney health
Precondition 1	User has eaten meals
Precondition 2	User entered food details into meal logs

Use Case Diagram

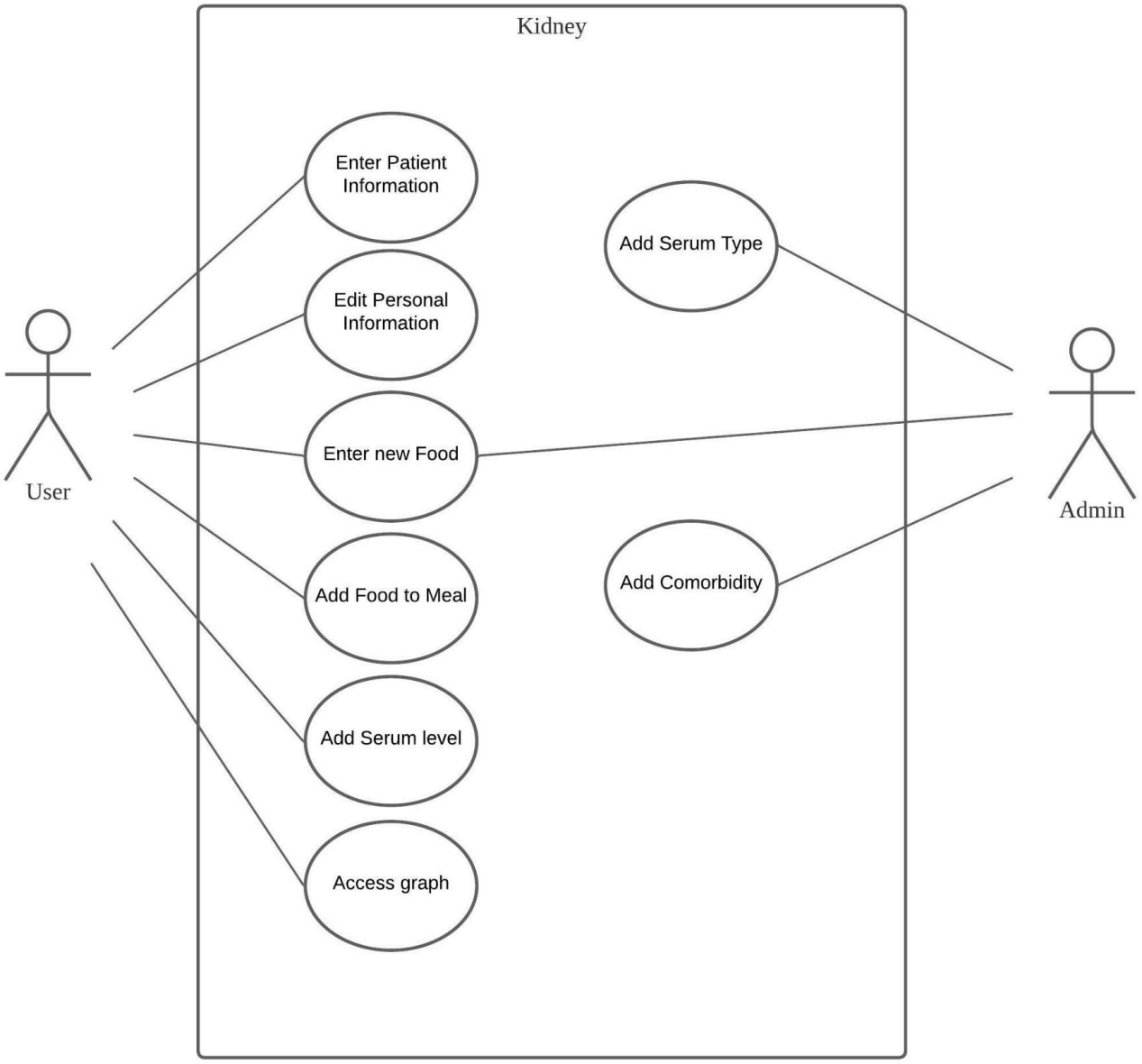
The next diagram shown is a use case diagram, showing the actors(patient and admin) and a simplified version of the activities or roles that they play in recording meal logs and serum logs in the system. As shown above, the admin's responsibility in the system includes:

1. Admin adds serum type
2. Admin adds comorbidity
3. Add new food to the database

The patient's responsibility includes:

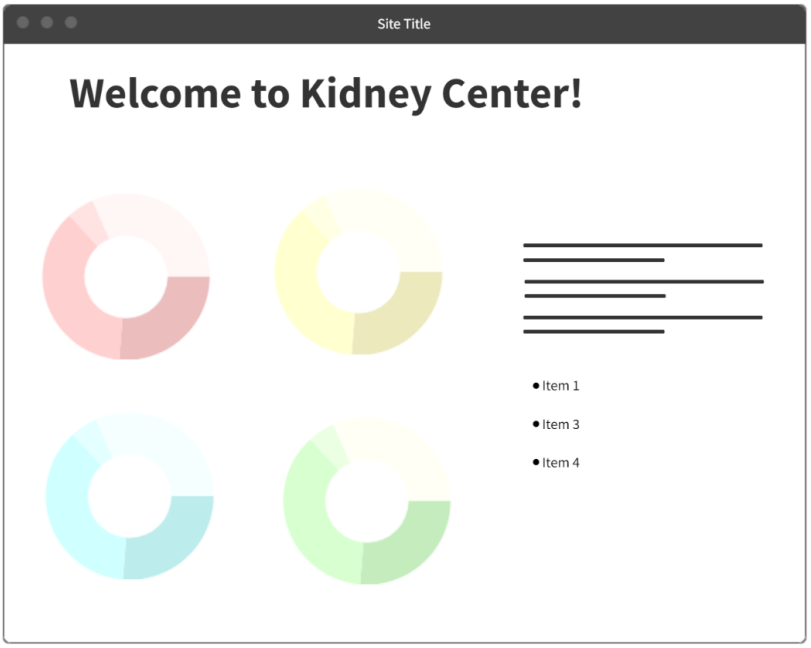
1. Enters personal information
2. Edits personal information
3. Enters new food
4. Adds food to the daily journal.
5. Adds serum levels
6. Accesses graph

Through these steps, the actors can transition from one step to another creating the process of subscriptions from start to finish.

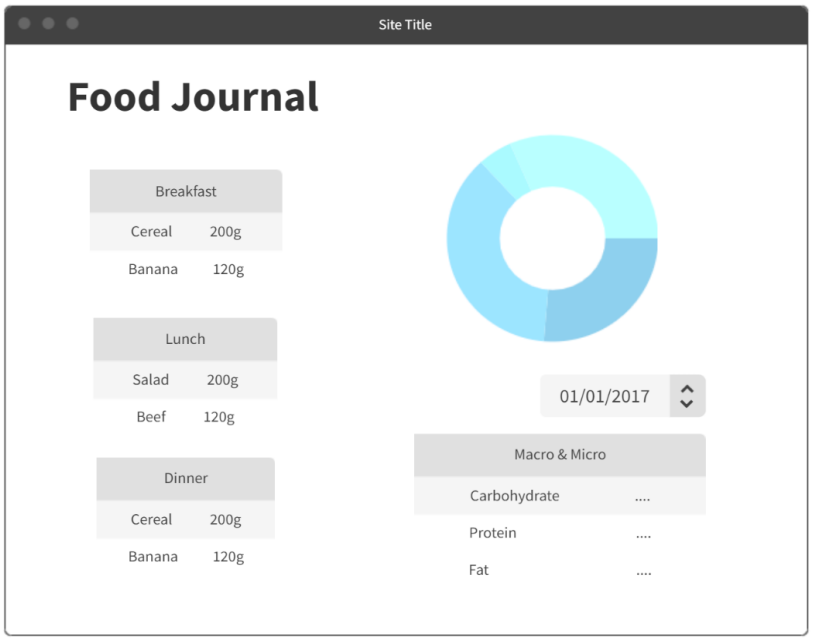

Kidney
Enter Patient Information
Edit Personal Information
Enter new Food
Add Food to Meal
Add Serum level
Access graph
Add Serum Type
Add Comorbidity
User
Admin

Wireframes

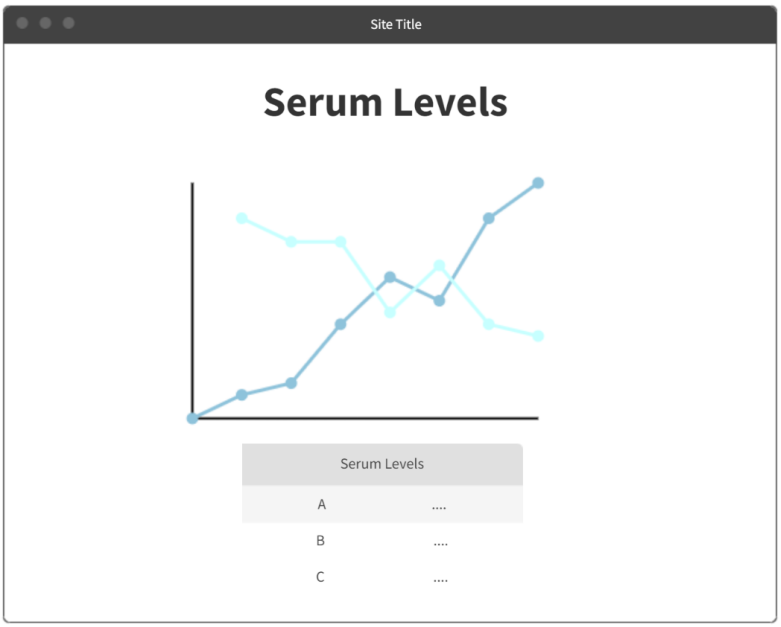
1. Homepage



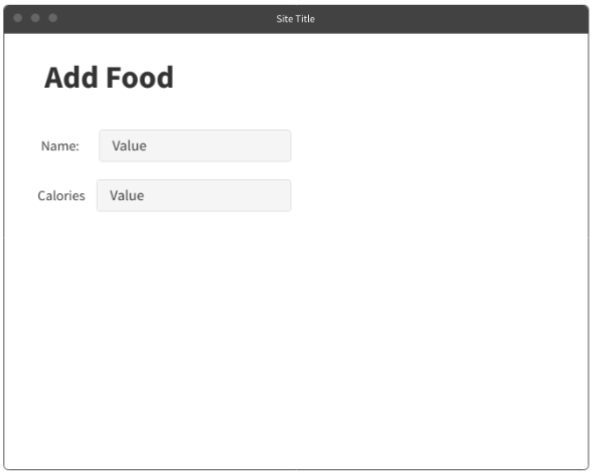
2. Journal Page

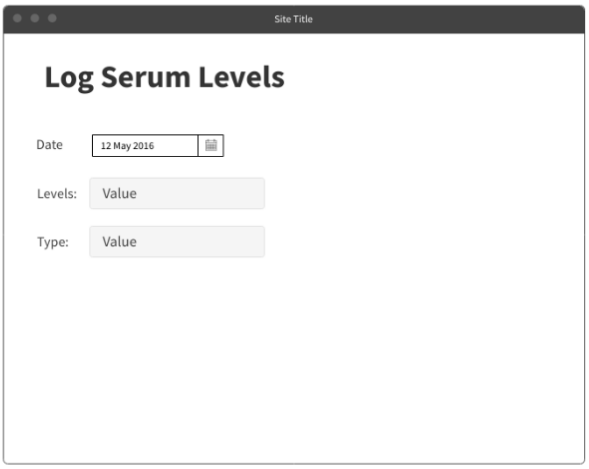


3. Serum Page



4. Adding Food/ Serum levels





Conclusion

As stated earlier, the main objectives of these proposals were to keep a more detailed record of patient's daily food intake and monitor levels in regard to kidney health, improve the health of individuals and families affected by kidney disease, increase the availability of all organs for transplantation, minimize reliance on dialysis and transplant treatments, and improve the health of individuals and families affected by kidney disease.

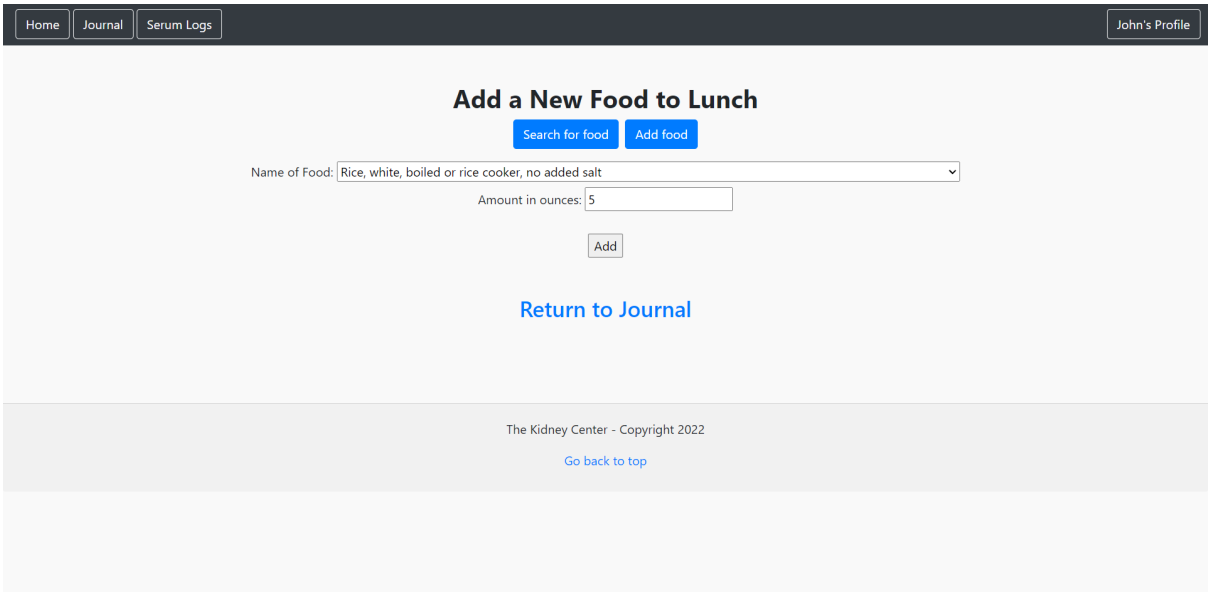
Implementing these proposed systems or a combination of these proposed systems can help these four distinct aspects. Implementation will help manage patients conveniently manage kidney health and prevent End-Stage Renal Disease through diet and lifestyle changes. It will also improve the organization as the job of keeping track of patients' nutrition intake and serum levels will be done individually and all of the information can be found in the system. The proposed systems also take duty off the patient as it does not require a manual calculation on recommended macronutrient and micronutrient intake.

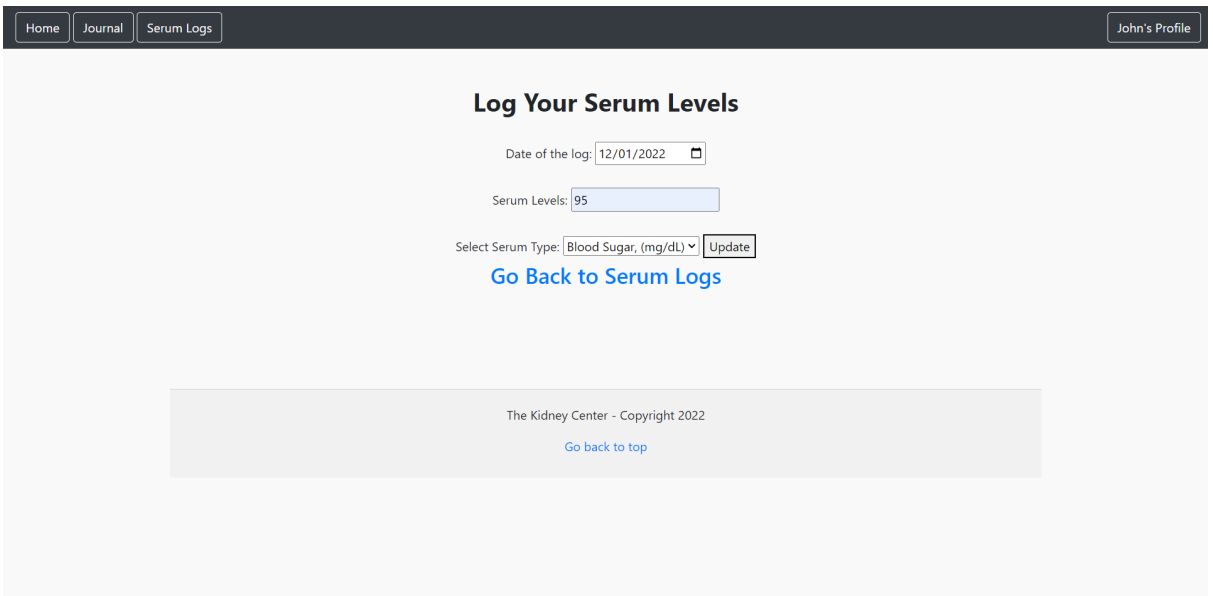
Lastly, this system will help enable clear documentation of past meal logs and serum levels and will help as the organization strives to reduce the risk of kidney disease across the nation. In future implementations, Medical professionals can integrate recommendations based on the stage of kidney disease, additional comorbidities, gender, weight, and much more.

Appendices

a. Adding food and serum level view

The process for adding meal logs and serum levels are shown through screenshots of the website to help visualize the process.





b. Entity-Relationship Diagram