CDSS Project

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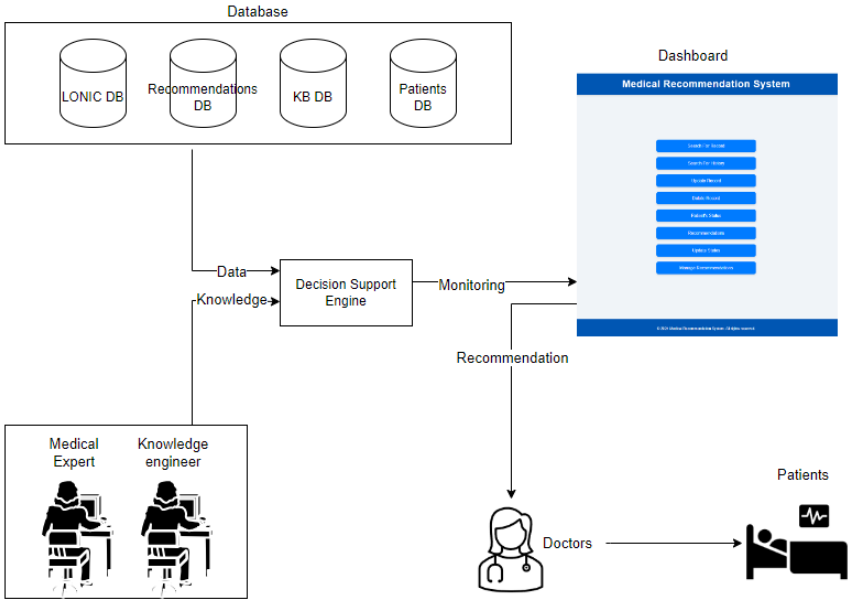
Introduction:

This project introduces a CDSS designed to assist doctors in managing patient care and obtaining treatment recommendations. The system centralizes patient management, providing doctors with easy access to medical records, patient histories, and personalized treatment recommendations. It features search capabilities, allowing users to find specific records, view patient history, update and delete records, and track patient status over time. The system offers a centralized dashboard where doctors can monitor all their patients and receive real-time recommendations, making it easier to oversee and manage patient care. Additionally, the system allows users to personalize state cutoffs and customize recommendations as needed, all within an intuitive, user-friendly web application. This interface is designed to enhance access to information and improve the quality of patient care.

The system is designed with databases stored in MongoDB for efficient and scalable data management. The backend is developed using Python and Flask, serving as a platform for processing and handling data requests. The frontend is implemented using HTML, providing an accessible interface for users. The web application facilitates easy data retrieval and management, along with a dashboard to monitor all patient recommendations. For the full code and implementation details, the project is available on GitHub at the following link: https://github.com/shirmash/medical-recommendation-system

Architecture:



The CDSS dimensions:

- **Clinical Domain:** Hematology-Oncology.
- **Actors/Users:** Our CDSS users are hematologists and oncologists who have full access to their patients' medical records. They can access real-time data and updates on hemoglobin levels, hematological states, and systemic toxicity, and receive treatment recommendations. The system provides on-demand recommendations for patients with risky combinations of these states, enabling doctors to effectively monitor and manage their patients' treatment plans.
- **Clinical Settings:** Inpatient.
- **Online/Batch:** The CDSS is an online system. Calculations are performed on the fly, providing real-time recommendations based on the latest patient data. The system maintains high connectivity to the data sources (the patient EHR and the recommendation KB database), ensuring that all relevant information is up to date.
- **CDS type:** Knowledge-driven, treatment-based. The recommendations and state cutoffs are determined based on the KB database. The system provides knowledge-based treatment recommendations to the doctors.
- **Device type:** Computer.
- **GUI/output:** Recommendations are presented in a user-friendly dashboard application, allowing doctors to quickly and easily interpret the guidance provided and make informed treatment decisions without delay.
- **Usability:** To ensure a user-friendly interface, our system is designed to seamlessly integrate into the existing workflow. It allows doctors to scan their patients' database and provide the most up-to-date treatment recommendations when needed. Additionally, it provides an easy-to-use GUI that allows users to view patient history, search for specific records within the database, delete or update records, and update state cutoffs and recommendations. The system centralizes all necessary data for treating a patient, making it a comprehensive tool for managing all existing patients and providing timely treatment recommendations. It integrates smoothly with existing systems, enhancing the overall efficiency and quality of patient care.
- **Personalization:** The system allows doctors to receive personalized treatment recommendations for each patient based on their specific data. Additionally, the system enables each user to customize the system by updating state cutoffs and adding tailored recommendations, further refining the system to better suit their needs and clinical settings.
- **EHR connectivity**: The system offers full integration with the EHR and the workflow. It allows for updating and deleting records as needed and is fully connected to the EHR database, ensuring seamless access to and management of patient information.

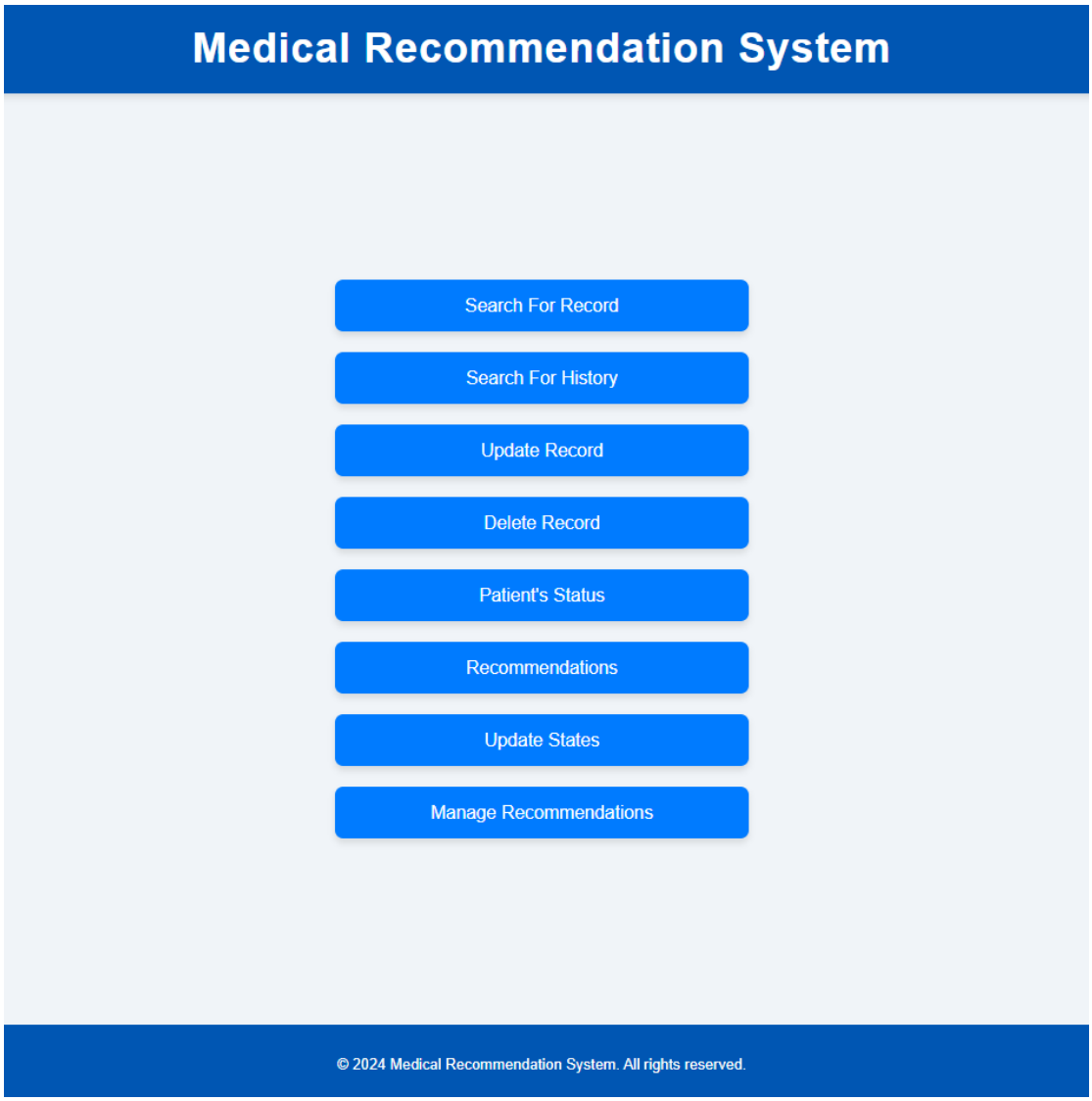
- **Knowledge creation and sharing:** Knowledge base.
- **Implementation:** We created a system that integrates with the patient's EHR and a KB database. The system allows users to search for records, review patient history, update and delete records, and receive updates on patients' status and treatment recommendations. Additionally, it enables adjustments to the state abstractions cutoffs and the recommendations as needed. The data is stored on MongoDB, the backend is implemented with Python and Flask, and the application is presented using HTML.
- **Compliance/Adherence:** To evaluate the system adherence, we will check if the doctors followed the treatment recommendations suggested by the CDSS.
- **Cognitive models/Bias:** To address potential cognitive biases, the CDSS uses predefined recommendations that follow established treatment protocols that support unbiased decision-making. The recommendations and analyses are gender-separated to prevent bias toward a specific gender. Additionally, the recommendations and cutoffs are adjustable, allowing doctors to modify or add recommendations as needed to better handle specific subgroups and further reduce bias.
- **Effectiveness:** Evaluating the system's effectiveness will involve gathering feedback from doctors who have used the system to assess whether it helped them improve patient care and treatment outcomes by following its recommendations. We will also evaluate whether the system enabled doctors to manage all their patients more efficiently, thanks to the centralized access to patient information and recommendations that the system provides.
- **Evaluation:** The evaluation of the CDSS will include both quantitative and qualitative assessments. Quantitative measures will involve statistical analysis of patient outcomes done based on the recommendations. Qualitative measures will include user satisfaction surveys, usability testing, and feedback from the doctors.
- **Regulation:** The CDSS will comply with relevant regulations and standards for patient data privacy and security. Additionally, the system will follow clinical guidelines established by professional medical organizations.
- **Economy:** The economic impact of the CDSS will be assessed through a cost-benefit analysis. The analysis will consider the costs associated with system implementation, maintenance, and training for healthcare providers.

User Manual

This User Manual provides detailed instructions for using the CDSS. It covers essential features, error handling, and step-by-step guidance on how to use each function. The guide is designed to help you efficiently manage and navigate the system.

Table of Contents:

The CDSS Home Page:



How to Retrieve Medical Record

The Search for Record feature allows you to retrieve specific patient data quickly and efficiently.

Step 1: Access the Search for Record Function

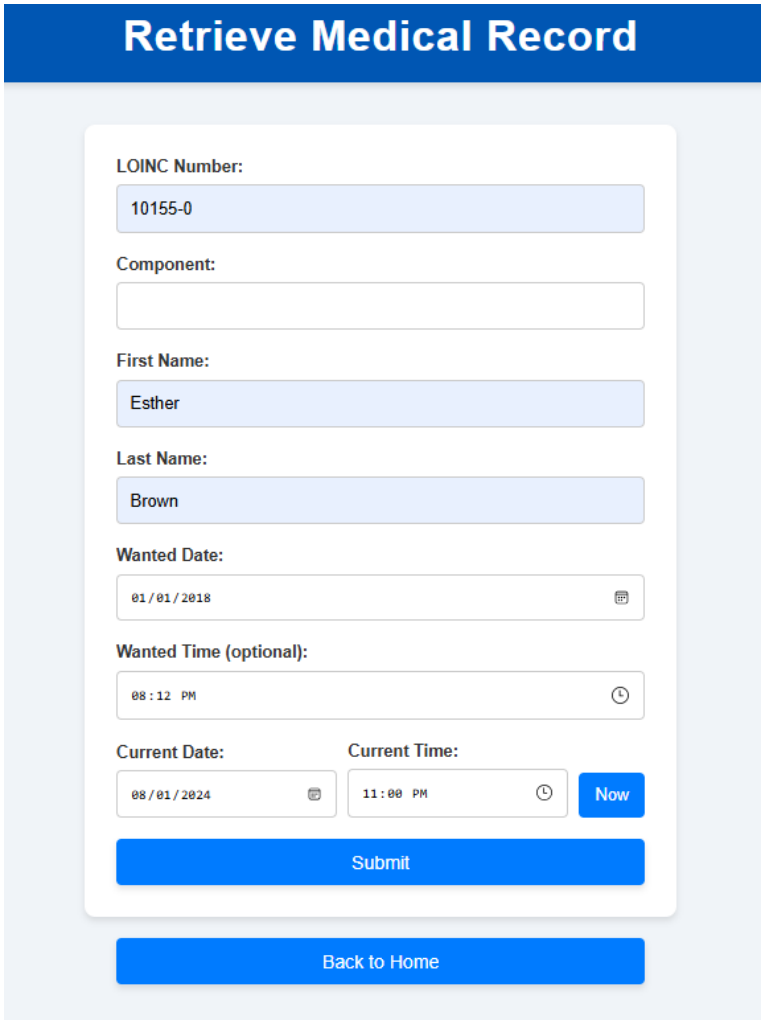
1. Open the system application.
2. Look for the "Search for Record" option in the homepage.

Step 2: Enter Search Criteria

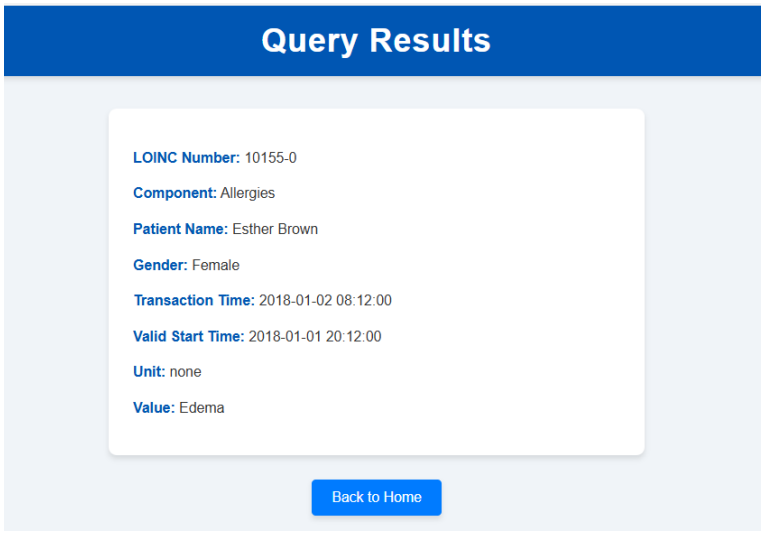
Fill in the following fields in the form:

1. **LOINC Number or Component:**
   - Enter the LOINC number if known.
   - You must enter either the LOINC Number or the Component name.
   - LOINC Number: Enter the LOINC) number if known.
   - Component: Enter the name of the medical test or component you're searching for.
   - Note: You need to fill at least one of these two fields, you can also enter both if they are matching, if you enter unmatching the search will be based on the LONIC number.
2. **First Name (required):** Enter the patient's first name.
3. **Last Name (required):** Enter the patient's last name.
4. **Wanted Date (required):** Select the date of the medical record you're looking for using the date picker.
5. **Wanted Time (optional):** If you know the specific time of the record, enter it here. If left blank, the system will return the latest record for the selected date.
6. **Current Date (required):** Enter today's date or the date from which you're searching.
7. **Current Time (required):** Enter the current time or the time at which you're searching.

Insertion example:



Result example:



How to Retrieve Medical History

Step 1: Access the Search Function

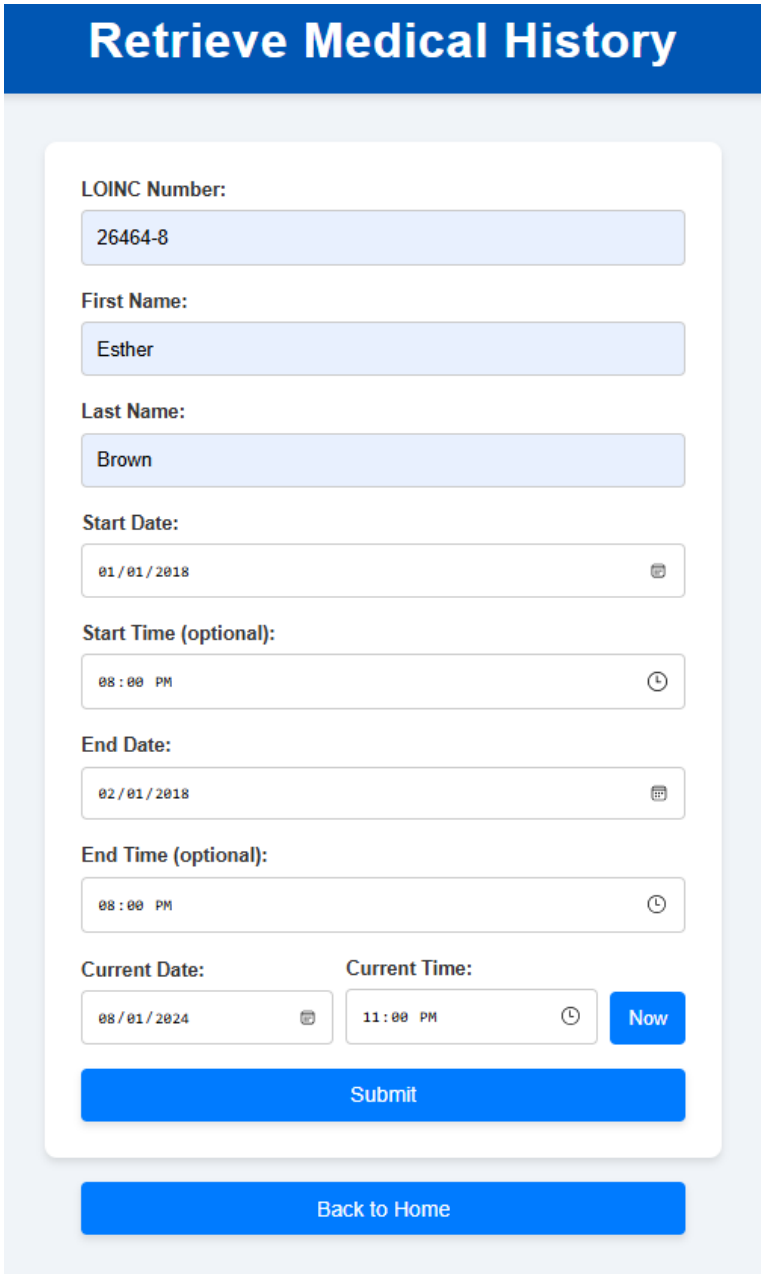
1. Open the system application.
2. Look for the "Search for History" option on the homepage.

Step 2: Enter Search Criteria

Fill in the following fields in the form:

1. **LOINC Number:** Enter the LOINC (Logical Observation Identifiers Names and Codes) number if known.
2. **First Name (required):** Enter the patient's first name.
3. **Last Name (required):** Enter the patient's last name.
4. **Start Date (required):** Select the start date of the period for which you want to retrieve medical history.
5. **Start Time (optional):**
   - If you know the specific start time, enter it here.
   - If left blank, the system will use the end of the selected start date.
6. **End Date (required):** Select the end date of the period for which you want to retrieve medical history.
7. **End Time (optional):**
   - If you know the specific end time, enter it here.
   - If left blank, the system will use the end of the selected end date.
8. **Current Date (required):** Enter today's date or the date from which you're searching.
9. **Current Time (required):** Enter the current time or the time at which you're searching.

Insertion example:



Result example:

Patient History

LOINC Number	Component	Patient Name	Gender	Transaction Time	Valid Start Time	Unit	Value
26464-8	WBC	Esther Brown	Female	2018-01-03 03:00:00	2018-01-02 19:00:00	cells/ml	1475
26464-8	WBC	Esther Brown	Female	2018-01-03 17:16:00	2018-01-03 03:16:00	cells/ml	14499
26464-8	WBC	Esther Brown	Female	2018-01-04 11:25:00	2018-01-03 20:25:00	cells/ml	2024
26464-8	WBC	Esther Brown	Female	2018-01-04 21:25:00	2018-01-04 02:25:00	cells/ml	13620
26464-8	WBC	Esther Brown	Female	2018-01-05 16:15:00	2018-01-04 22:15:00	cells/ml	17480
26464-8	WBC	Esther Brown	Female	2018-01-06 08:12:00	2018-01-05 22:12:00	cells/ml	16878
26464-8	WBC	Esther Brown	Female	2018-01-08 02:42:00	2018-01-06 20:42:00	cells/ml	7345
26464-8	WBC	Esther Brown	Female	2018-01-07 08:41:00	2018-01-07 00:41:00	cells/ml	1339
26464-8	WBC	Esther Brown	Female	2018-01-07 13:47:00	2018-01-07 03:47:00	cells/ml	11319
26464-8	WBC	Esther Brown	Female	2018-01-08 19:28:00	2018-01-07 07:28:00	cells/ml	4792
26464-8	WBC	Esther Brown	Female	2018-01-08 04:19:00	2018-01-07 18:19:00	cells/ml	2466
26464-8	WBC	Esther Brown	Female	2018-01-08 20:48:00	2018-01-07 19:48:00	cells/ml	1905
26464-8	WBC	Esther Brown	Female	2018-01-08 16:19:00	2018-01-08 14:19:00	cells/ml	10225
26464-8	WBC	Esther Brown	Female	2018-01-09 10:06:00	2018-01-09 00:06:00	cells/ml	15809
26464-8	WBC	Esther Brown	Female	2018-01-10 10:11:00	2018-01-09 05:11:00	cells/ml	4904
26464-8	WBC	Esther Brown	Female	2018-01-11 05:02:00	2018-01-09 17:02:00	cells/ml	11039
26464-8	WBC	Esther Brown	Female	2018-01-10 15:42:00	2018-01-10 11:42:00	cells/ml	1061
26464-8	WBC	Esther Brown	Female	2018-01-12 10:23:00	2018-01-10 23:23:00	cells/ml	3712

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How to Update a Medical Record

The Medical Record Update function allows you to modify existing patient records while maintaining historical accuracy. This system implements time-sensitive updates, which means that the effectiveness of any change is based on the current time of the update. When you submit an update, the system uses the provided current time to determine when the new value becomes active. As a result, any queries made with a timestamp before the update time will return the old value, while queries made after the update time will show the new value. This approach ensures that the system maintains a complete history of changes, allowing for accurate tracking and reporting of medical records over time.

Step 1: Access the Update Function

1. Open the system application.
2. Look for the "Update Record" option on the homepage.

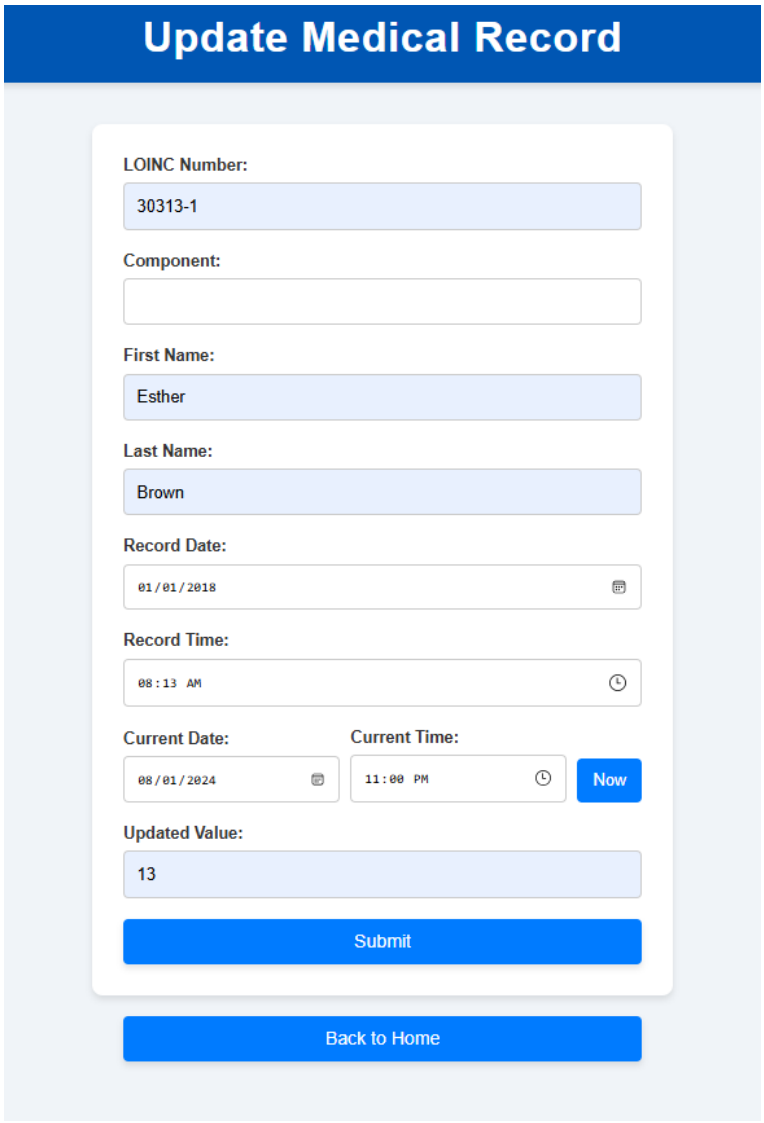
Step 2: Enter Update Information

Fill in the following fields in the form:

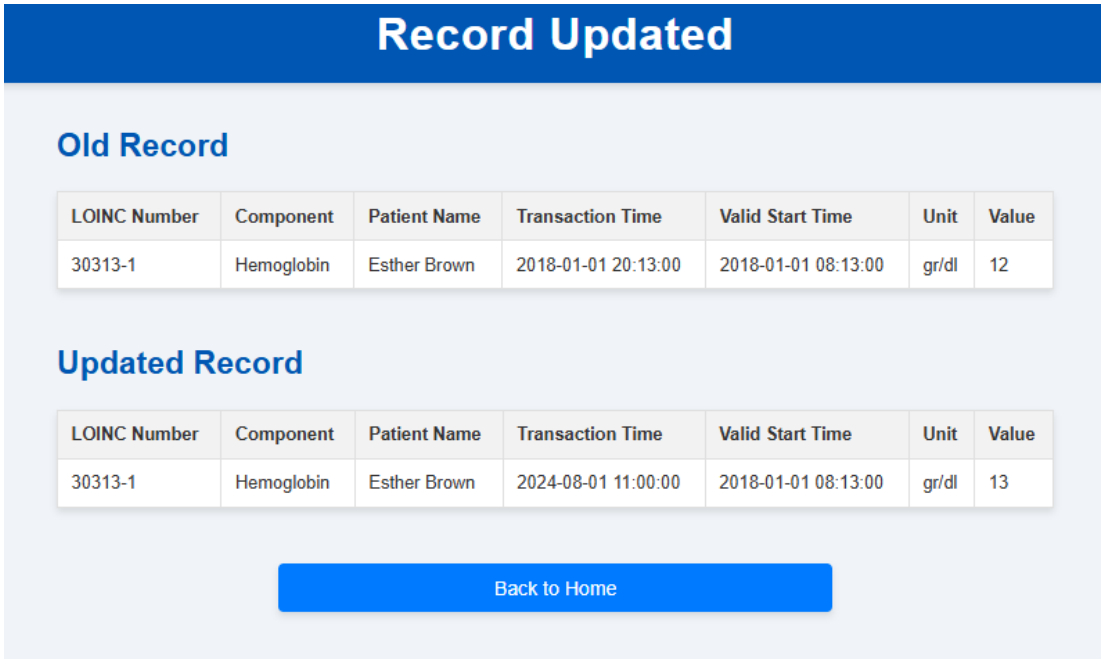
1. **LOINC Number or Component:**
   - Enter the LOINC number if known.
   - You must enter either the LOINC Number or the Component name.
   - LOINC Number: Enter the LOINC) number if known.
   - Component: Enter the name of the medical test or component you're searching for.
   - Note: You need to fill in at least one of these two fields, you can also enter both if they are matching, if you enter unmatching the search will be based on the LONIC number.
2. **First Name (required):** Enter the patient's first name.
3. **Last Name (required):** Enter the patient's last name.
4. **Record Date (required):** Select the date of the medical record you're updating.
5. **Record Time (optional):**
   - Enter the time of the medical record you're updating.
   - If left blank, the system will use the last record of that date.
6. **Current Date (required):** Enter today's date or the date on which you're making the update.
7. **Current Time (required):**
   - Enter the current time or the time at which you're making the update.
   - This date is crucial as it determines when the update takes effect.

8. **Updated Value (required):**
   - Enter the new value for the medical record you're updating.
   - This time is crucial as it determines when the update takes effect.

Insertion example:



Result example:



Record Updated

Old Record

LOINC Number	Component	Patient Name	Transaction Time	Valid Start Time	Unit	Value
30313-1	Hemoglobin	Esther Brown	2018-01-01 20:13:00	2018-01-01 08:13:00	gr/dl	12

Updated Record

LOINC Number	Component	Patient Name	Transaction Time	Valid Start Time	Unit	Value
30313-1	Hemoglobin	Esther Brown	2024-08-01 11:00:00	2018-01-01 08:13:00	gr/dl	13

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How to Delete a Medical Record

The Medical Record Deletion function allows you to remove specific patient record while maintaining the integrity of the historical data. This system implements time-sensitive deletions, which means that the effectiveness of any deletion is based on the current time provided during the deletion process. When you submit a deletion request, the system uses the provided current time to determine when the record becomes inactive. As a result, any queries made with a timestamp before the deletion time will still return the record, while queries made after the deletion time will not include the deleted record. This approach ensures that the system maintains a complete history of changes, allowing for accurate tracking and reporting of medical records over time, even after deletions have been made.

Step 1: Access the Delete Function

1. Open the system application.
2. Look for the "Delete Record" option on the homepage.

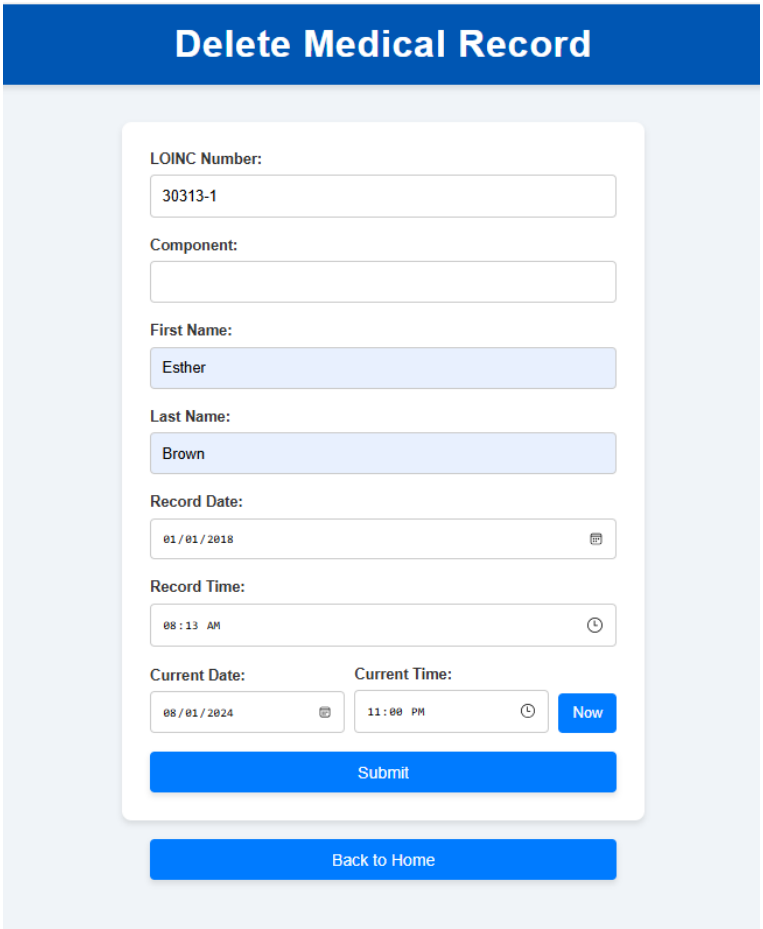
Step 2: Enter Deletion Information

Fill in the following fields in the form:

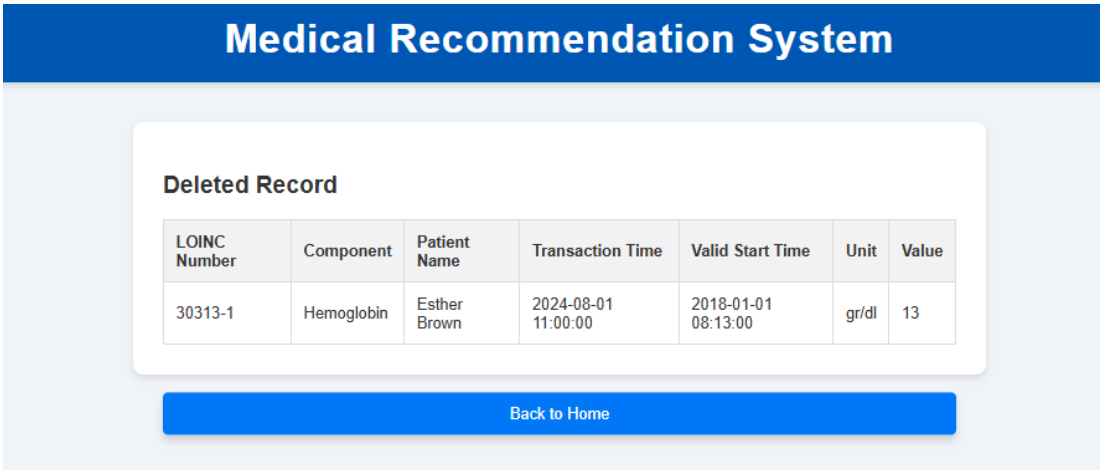
1. **LOINC Number or Component:**
   - Enter the LOINC number if known.
   - You must enter either the LOINC Number or the Component name.
   - LOINC Number: Enter the LOINC) number if known.
   - Component: Enter the name of the medical test or component you're searching for.
   - Note: You need to fill at least one of these two fields, you can also enter both if they are matching, if you enter unmatching the search will be based on the LONIC number.
1. **First Name (required):** Enter the patient's first name.
2. **Last Name (required):** Enter the patient's last name.
3. **Record Date (required):**
   - Enter the time of the medical record you're updating.
   - If left blank, the system will use the last record of that date.
4. **Record Time (optional):** Enter the time of the medical record you're deleting.
5. **Current Date (required):**
   - Enter today's date or the date on which you're making the deletion.
   - This date is crucial as it determines when the deletion takes effect.

6. **Current Time (required):**
   - Enter the current time or the time at which you're making the deletion.
   - This time is crucial as it determines when the deletion takes effect.

Insertion example:



Result example:



How to Find Patient’s Status

The States Data function allows you to find specific patient test results abstractions. This feature does not display raw data, but instead presents abstractions that are created based on domain knowledge. The system retrieves all the patient's records for the selected test and displays the patient's condition over time, providing a meaningful representation of their health status through intervals of abstraction.

Importantly, in hemoglobin and hematological these abstractions are presented as intervals over time (in systemic toxicity it remains as distinct data points). If several data points are mapped to the same abstraction, they will be united into one interval. This means that rather than seeing individual test results, you'll see periods where the patient's condition remained in a particular state or category.

Step 1: Access the States Data Function

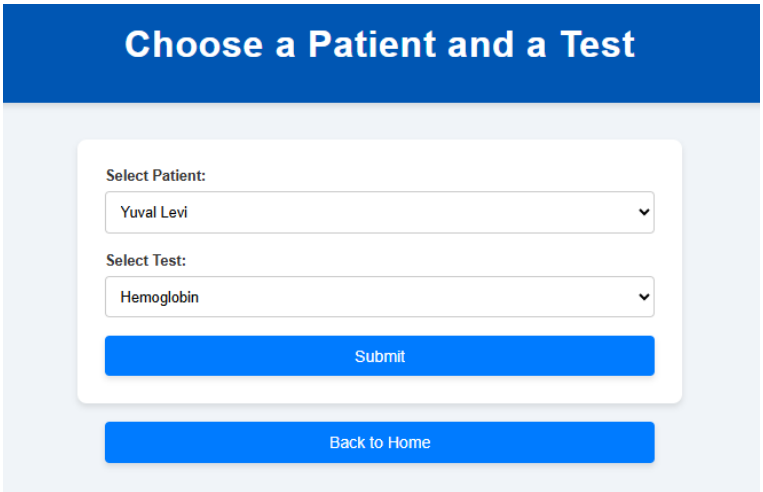
1. Open the system application.
2. Look for the "Patient’s Status" option on the homepage.

Step 2: Enter Query Information

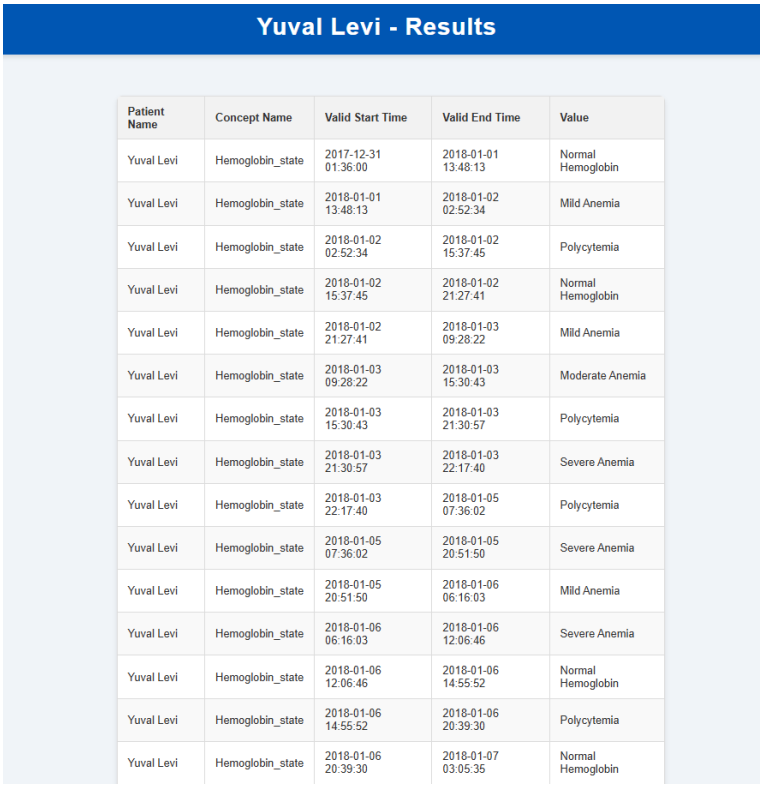
Fill in the following fields in the form:

1. **Select Patient (required):** Choose the patient's name from the list of all patients.
2. **Select Test (required):** Choose the type of test you want to query from the available options:
   - Hemoglobin
   - Hematological
   - Systemic Toxicity

Insertion example:



Result example:



Patient Name	Concept Name	Valid Start Time	Valid End Time	Value
Yuval Levi	Hemoglobin_state	2017-12-31 01:36:00	2018-01-01 13:48:13	Normal Hemoglobin
Yuval Levi	Hemoglobin_state	2018-01-01 13:48:13	2018-01-02 02:52:34	Mild Anemia
Yuval Levi	Hemoglobin_state	2018-01-02 02:52:34	2018-01-02 15:37:45	Polycytemia
Yuval Levi	Hemoglobin_state	2018-01-02 15:37:45	2018-01-02 21:27:41	Normal Hemoglobin
Yuval Levi	Hemoglobin_state	2018-01-02 21:27:41	2018-01-03 09:28:22	Mild Anemia
Yuval Levi	Hemoglobin_state	2018-01-03 09:28:22	2018-01-03 15:30:43	Moderate Anemia
Yuval Levi	Hemoglobin_state	2018-01-03 15:30:43	2018-01-03 21:30:57	Polycytemia
Yuval Levi	Hemoglobin_state	2018-01-03 21:30:57	2018-01-03 22:17:40	Severe Anemia
Yuval Levi	Hemoglobin_state	2018-01-03 22:17:40	2018-01-05 07:36:02	Polycytemia
Yuval Levi	Hemoglobin_state	2018-01-05 07:36:02	2018-01-05 20:51:50	Severe Anemia
Yuval Levi	Hemoglobin_state	2018-01-05 20:51:50	2018-01-06 06:16:03	Mild Anemia
Yuval Levi	Hemoglobin_state	2018-01-06 06:16:03	2018-01-06 12:06:46	Severe Anemia
Yuval Levi	Hemoglobin_state	2018-01-06 12:06:46	2018-01-06 14:55:52	Normal Hemoglobin
Yuval Levi	Hemoglobin_state	2018-01-06 14:55:52	2018-01-06 20:39:30	Polycytemia
Yuval Levi	Hemoglobin_state	2018-01-06 20:39:30	2018-01-07 03:05:35	Normal Hemoglobin

How to Use the Recommendation Dashboard

The Recommendation Dashboard is a tool designed to assist healthcare professionals in patient care. It presents abstracted patient data across multiple test types and presents targeted treatment recommendations based on the combinations of these abstractions. This approach allows for a more comprehensive and nuanced understanding of a patient's health status.

Step 1: Access the Dashboard

1. Open the system application.
2. Look for the "Recommendation" option on the homepage.

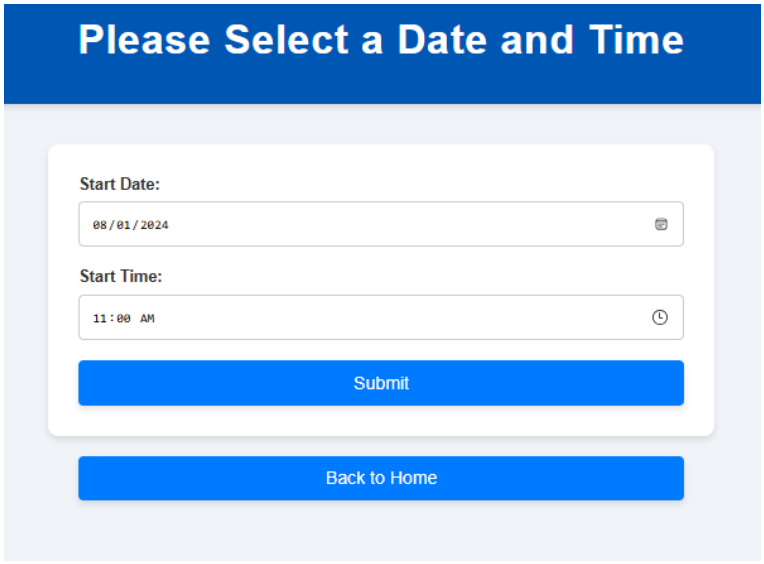
Step 2: Enter Query Information

Fill in the following fields in the form:

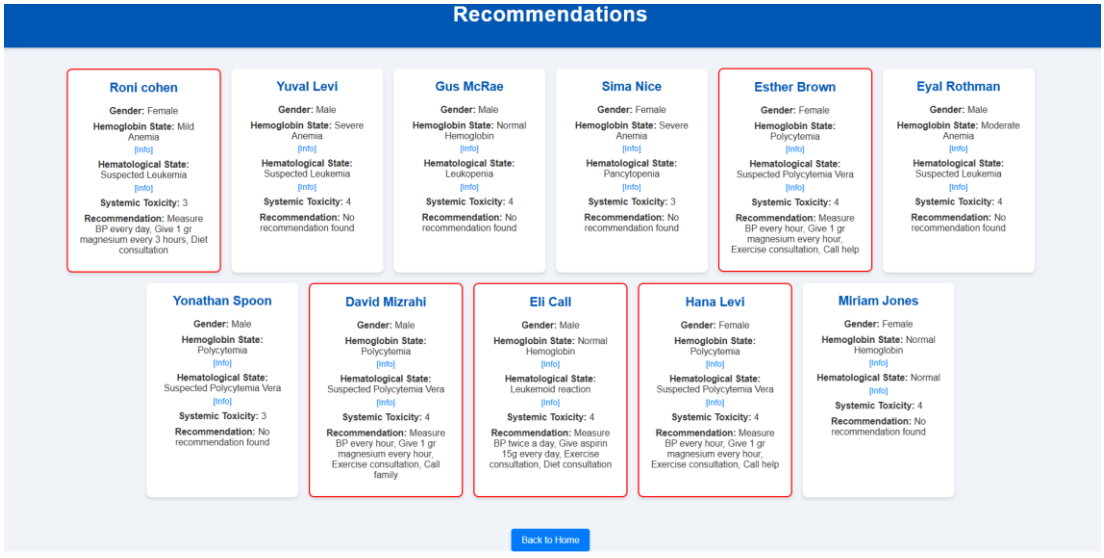
1. Select Date and Time (required):

- **Start Date:** select the desired date for which you want to view recommendations.
- **Start Time:** select the desired time for which you want to view recommendations.

Insertion example:



Result example:



How to Update States

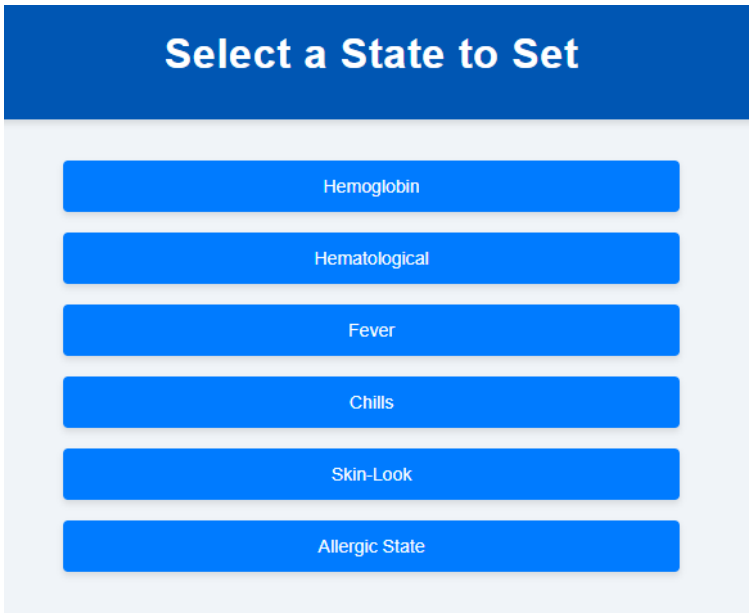
This feature allows you to modify the state cutoff values for the measurements, including Hemoglobin, Hematological, Fever, Chills, Skin-Look, and Allergic-state.

Step 1: Access the Update States Function

1. Open the system application.
2. Click on the " Update States " option on the homepage.

Step 2: Select a Measurement to Update

Select a measurement from the menu that you want to update the state cutoffs for.



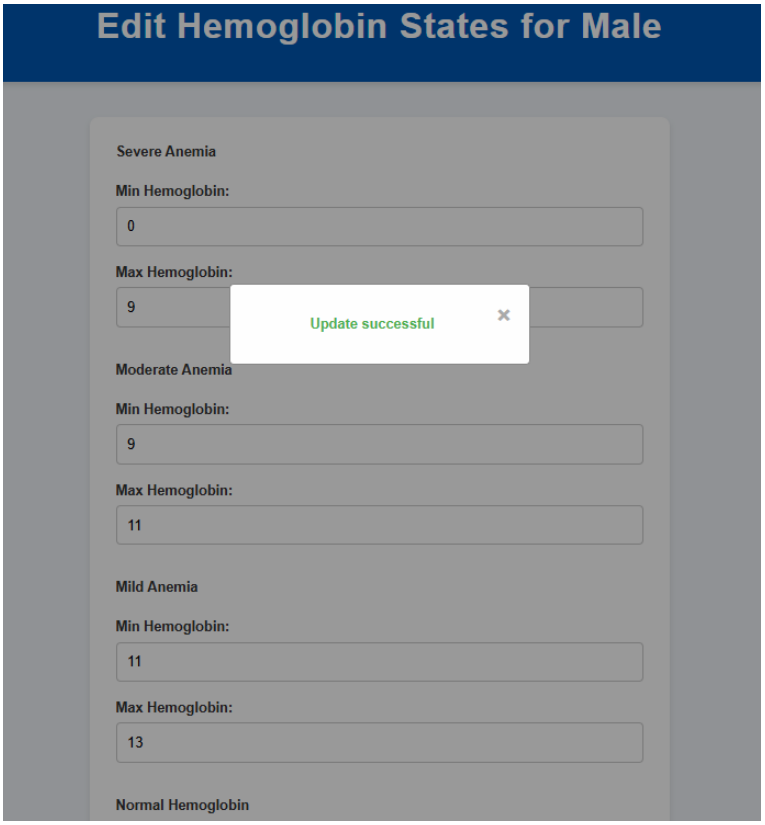
Step 3: Update the States

For gender-based measurements (Hemoglobin, Hematological):

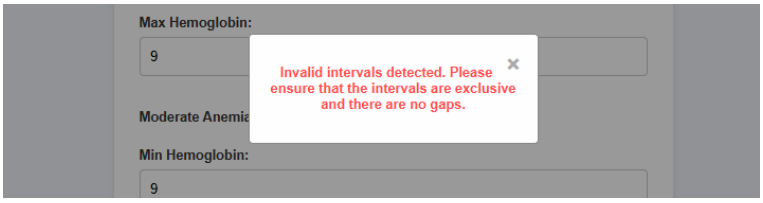
1. Select a gender.
2. For Hematological, also select a Variable.
3. Click "Next".

For all measurements:

4. Adjust the state values as needed. Ensure that interval-based measurements (Haemoglobin, Haematological, and Fever) have exclusive intervals with no gaps.
5. Click "Update".
6. If the states are valid and the changes have been made, an "Update successfully" message will appear.



7. If not, an error message with the problem will be displayed.



How to Manage Recommendations

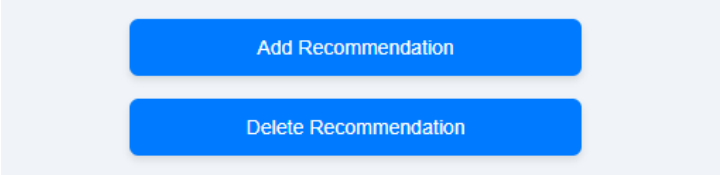
This feature allows you to add, modify, and update treatment recommendations.

Step 1: Access the Manage Recommendations Function

1. Open the system application.
2. Click on the " Manage Recommendations " option on the homepage.

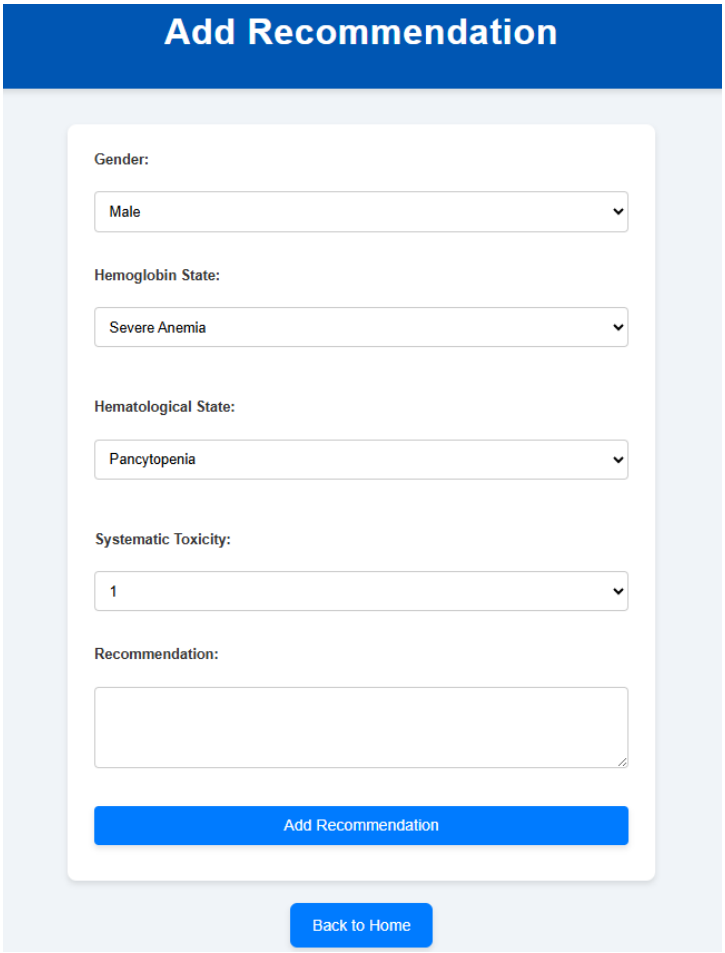
Step 2: Select an Action

Click on the relevant button - Add Recommendation or Delete Recommendation. The Add Recommendation feature also allows you to modify existing recommendations.

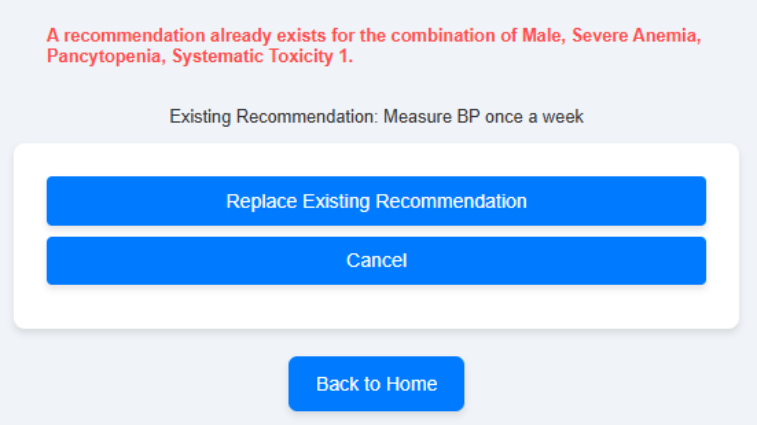


Step 3: Manage Recommendation

Add Recommendation

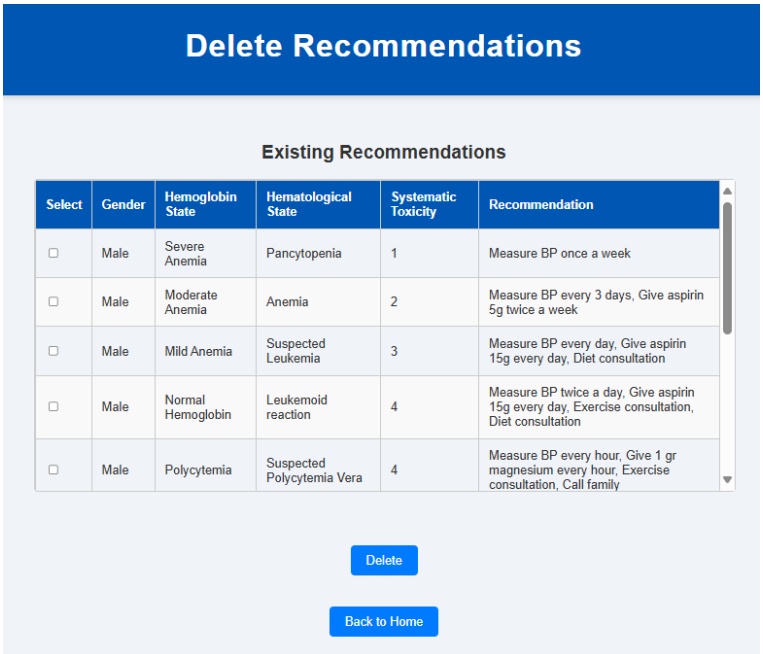


1. Select the corresponding measure states for the recommendation: Gender, Hemoglobin, Hematological State, and Systematic Toxicity grade.
2. Add the Recommendation text.
3. Click on the "Add Recommendation" button.
4. If the recommendation already exists, a message stating "A recommendation already exists for the combination" will appear with the current recommendation. If you want to update the recommendation, click on "Replace Existing Recommendation," otherwise click on "Cancel" to return to the Add Recommendation window.

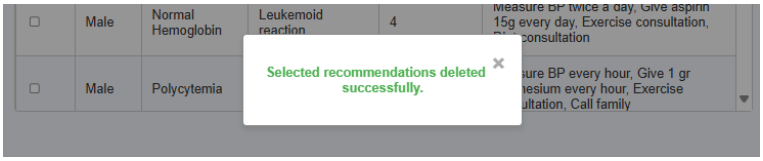


5. When a recommendation is successfully added, a "Recommendation added successfully" message will appear.
6. When done, click the "Back to Home" button to return to the homepage.

Delete Recommendation



1. Upon selecting "Delete Recommendation," all existing recommendations will appear.
2. Select the recommendations you wish to delete from the database.
3. Click on the "Delete" button.
4. A confirmation window will appear, asking, "Are you sure you want to delete the selected recommendations?" **Note that there is no way to restore a recommendation once it is deleted.** If you wish to proceed, click "OK," and a "Selected recommendations deleted successfully" message will appear. If you want to cancel, click "Cancel," and a "Deletion cancelled" message will appear.



5. When done, click the "Back to Home" button to return to the homepage.

Troubleshooting

If you're not getting the expected results:

1. Check the spelling of the patient's name.
2. Verify the date and time format.
3. Ensure you're using the correct medical terminology for the test.
4. If unsure about the exact measurement time, omit it from the query to get the latest result for that date.