Blood Test Results Filing

System Analysis and Design

CS-338 Section A

Sacred Heart University

5151 Park Avenue, Fairfield CT

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1.0 Introduction to the Application

1.1 Abstract

This blood test result filing application is a database application designed for medical records management. The main functions are entry and viewing of patient details and blood test results, as well as external uploading of test result images and data extraction using OCR (Optical Character Recognition) OCR technology is used to automatically read and digitize text information from images.

The application is built using the Flask framework, with Azure as the database and SQLAlchemy as the ORM (Object Relation Mapping). An intuitive web-based interface allows users to easily enter and retrieve information.

The goal is to digitize and efficiently use external data to help physicians make the best choices for their patients. It aims to improve the accuracy of information management and reduce the workload at medical institutions. Overall, the system supports medical operations and contributes to improving the quality of patient care.

2.0 Preliminary Investigation Phase

2.1 Summary of Problems, opportunities, and/or Directives

Current medical record systems lack integration of data from external sources, which affects data access and patient care efficiency. Proper data entry, rather than simply storing files, will benefit data analysis. The integration of data entry and OCR technology will enable the digitization of test results and improve physicians' diagnostic efficiency.

The project aims to reduce the workload of healthcare professionals with an intuitive and efficient interface and high data processing capabilities. The system was developed to address the challenges of completeness and accessibility of patient information due to current system limitations in filing external data compared to internal data. The system aims to quickly and accurately process patient blood test data and add it to an internal database, making the data visible and usable and assisting medical staff in decision making.

2.2 Statement of Preliminary Scope

This blood test result filing application was developed to streamline the medical records management process. One of its main functions is to manage patient information and test results. Basic patient information and blood test result details are stored in digital format within the medical record database for easy access. It also provides an intuitive interface for entering, updating, and retrieving test results through the use of HTML forms.

The second feature is the integration of image upload and OCR technology. Image files of blood test results are uploaded and text data is extracted using OCR technology. The extracted data can be copied, which is expected to reduce manual entry errors. Another function is data

visualization. It allows external data to be managed in the same way as internal data, enabling quick and accurate diagnosis and understanding of patient conditions. It also analyzes outliers in the data and visualizes them by color.

2.2.1 What type of data describes the system being studied

- Patient Information: This data includes Personal information about the patient (name, age, gender, etc.), medical history and diagnostic information. The data is stored in Electronic Medical Record database systems.
- Blood Test Results Data: This data includes results of blood tests, such as numerical value and text descriptions. the attributes of the player character, such as health, stamina, and magic points. This data could be stored in database as numerical value, text, or digital format (PDF or image files).
- Image Files: Scanned images or digital photographs of blood test results. These images could be uploaded in JPEG, PNG, or other formats and used for OCR processing.

2.2.2 What business processes are included in the study?

My application utilizes the following business processes:

- System Design
- Database Management
- Software Engineering
- User Interface Design
- Quality assurance

2.2.3 Interface with Users

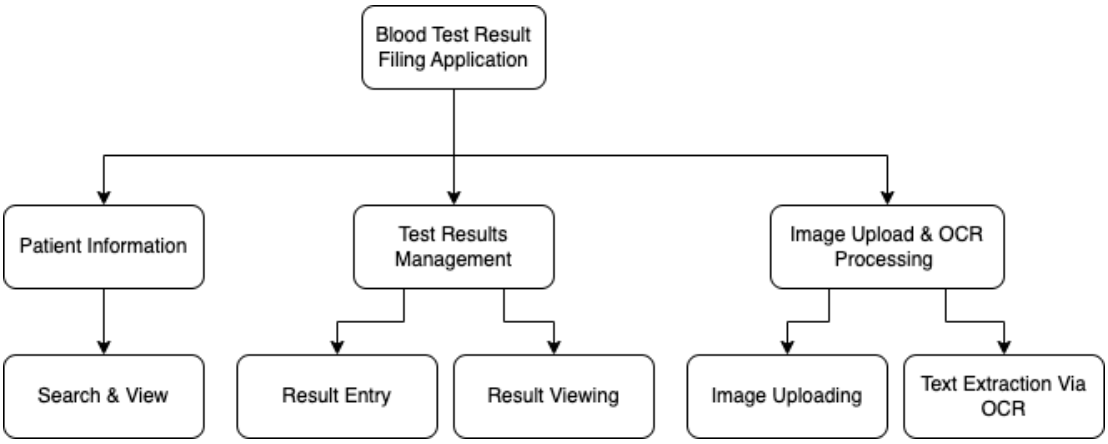
The app interfaces with physicians and medical staff through the following means: the user's input via web-based forms, clicks, or search bars; visual cues such as color-coded test results, and images placed next to input forms. Additionally, OCR functions as an input assistance tool.

3.0 Problem Analysis Phase

3.1 Sample data model:

The data model of my app includes information such as the patients' basic information, descriptions and values of the test results, images such as scanned blood test results, and text data extracted by OCR process.

3.2 Functional decomposition diagram of current system



3.3 System Interfaces

3.3.1 Locations served by the system:

The application is designed to be accessed on a computer or tablets with the player controlling the character through keyboard and mouse inputs.

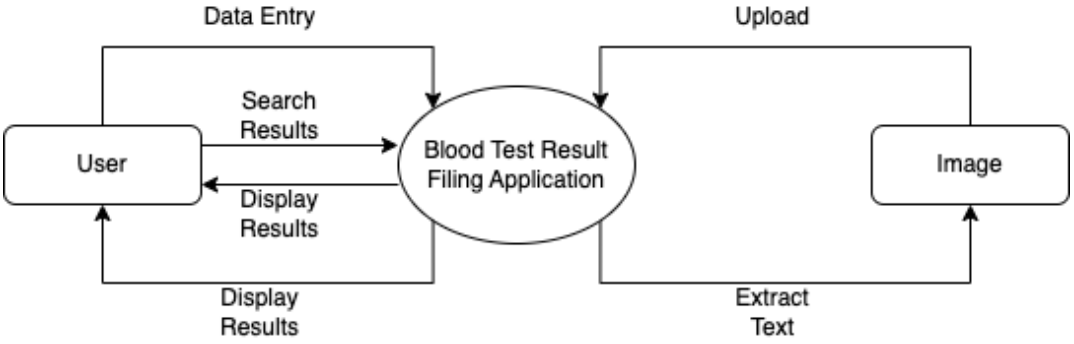
3.3.2 Users served by the system:

The application is intended for users in medical facilities, such as doctors and medical staff.

3.3.3 Other systems it interacts with, if any:

The application could interact with Electric Health Record system.

3.3.4 Context diagrams of current system



4.0 Requirements Analysis Phase

4.1 Identify requirements

4.1.1 List, describe, and defend functional requirements

Functional	Requirements	Priority
Inputs	● Patient data entry (personal info, test results, images)	1
Outputs	● Test results reporting (display and printout of results) ● Notification system (alerts for abnormal results)	1
Processes	● Search and retrieval of patient records ● Data Entry ● OCR processing (text extraction from scanned images)	1
Storage	● Application uses data stored in database ● Secure patient data storage (encryption, access control)	1
Control	● User authentication and authorization (access based on roles and permissions) ● Data validation and error checking (ensure accuracy of data entry and OCR results) Compliance with medical data standards and privacy laws	1

4.1.2 List and defend non-functional requirements

Performance:

- The system should have a fast, responsive response time, allowing medical staff to retrieve and process data quickly.
- Loading times for test results should be minimized, reducing user wait times.
- Optimized for different network environments and computing devices to provide flexibility for operation in various medical facilities.

Ease of use:

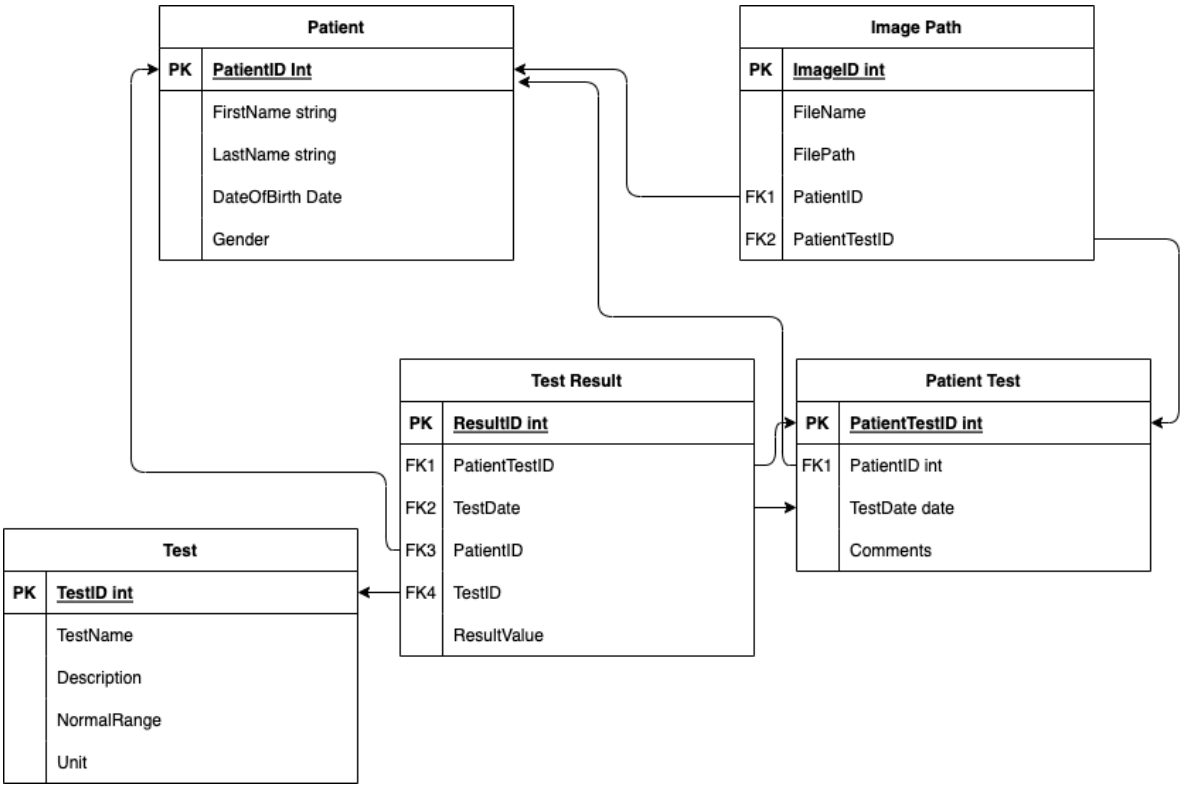
- The system controls should be intuitive and allow medical staff to learn how to operate the system in a short period of time.
- The user interface should be simple and easily navigable.
- The system should provide clear instructions and feedback to help users understand the mechanism and purpose of the system.
- Accessibility should be kept high so that medical staff with varying expertise can use the system.

Reliability:

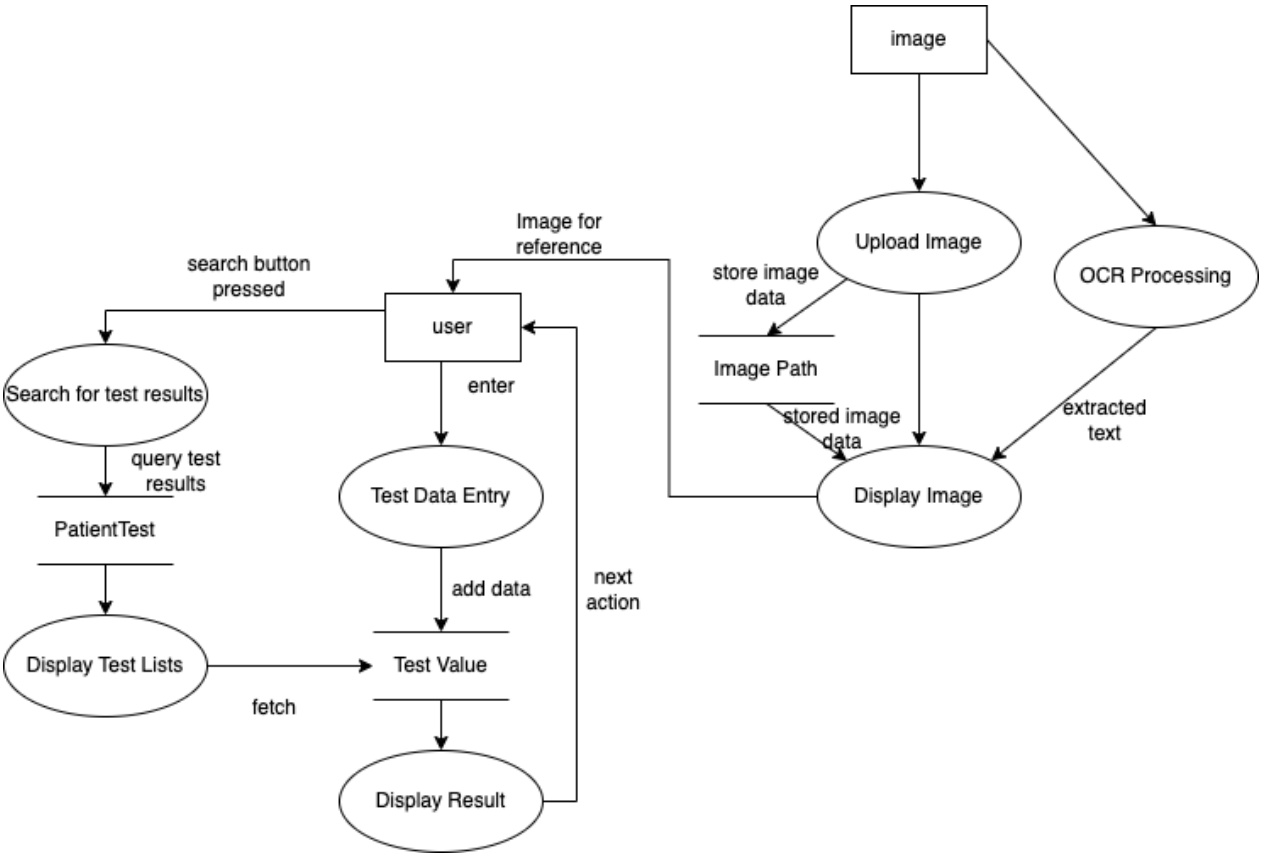
- Ensure data integrity and accuracy and prevent medical decisions based on incorrect information.

4.2 Analyze functional requirements using system modeling approach

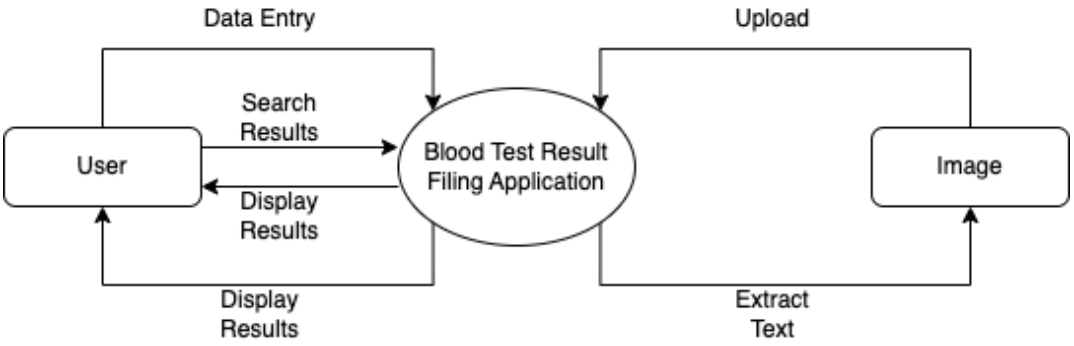
4.2.1 Construct preliminary data model - Entity Relationship (ER) diagram



4.2.2. Construct preliminary process model - Data Flow diagram (DFD)

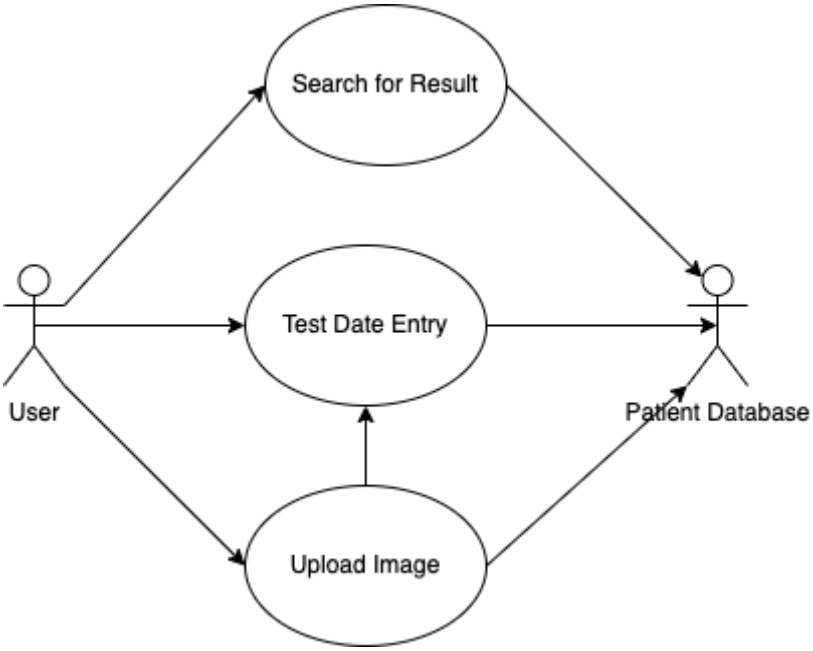


4.2.3. Construct preliminary Interface model - Context diagram



5.0 Design Phase

5.1 Use Case model diagram with Use-Case Narratives



5.2 Data dictionary of all the attributes

Table	Attributes	Data Type	Primary Key	Null	Description
Patient	PatientID	int	yes	no	patient's ID stored in EHR
	FirstName	varchar(50)		yes	patient's first name
	LastName	varchar(50)		yes	patient's last name
	DateOfBirth	date		yes	patient's date of birth
	Gender	char(1)		yes	patient's gender (m/f)
Test	TestID	int	yes	no	ID of test component
	TestName	varchar(100)		yes	name of test component (i.e. Glucose)
	Description	text		yes	description of test component
	NormalRange	varchar(100)		yes	normal range of test component

	Unit	varchar(10)		yes	unit used in normal range
PatientTest	PatientTestID	int	yes	no	identifies a series of test components tested on the same day, auto increment
	PatientID	int		no	references Patient table
	TestDate	date		no	
	Comments	text		yes	comments (objective of the test, etc)
TestValue	ResultID	int	yes	no	ID of patient's test result for each component, auto increment
	PatientTestID	int		no	references PatientTest table
	TestID	int		no	references Test table
	PatientID	int		no	references Patient table
	TestDate	date		no	references PatientTest table
	ResultValue	deimal(10,2)		no	result value for each component
ImagePath	ImageID	int	yes	no	ID for an image, auto increment
	FileName	varchar(255)		no	file name of the image
	FilePath	varchar(255)		no	file path
	PatientID	int		no	references Patient table
	PatientTestID	int		no	references Patient Test table

5.3 Design the system interface for each model include the following

Model Name	**Test Results Search Module**
Parameters passed	PatientID
Description of module function	Retrieve and display the patient's previous test results.
Input	PatientID
Output	Patient Test List

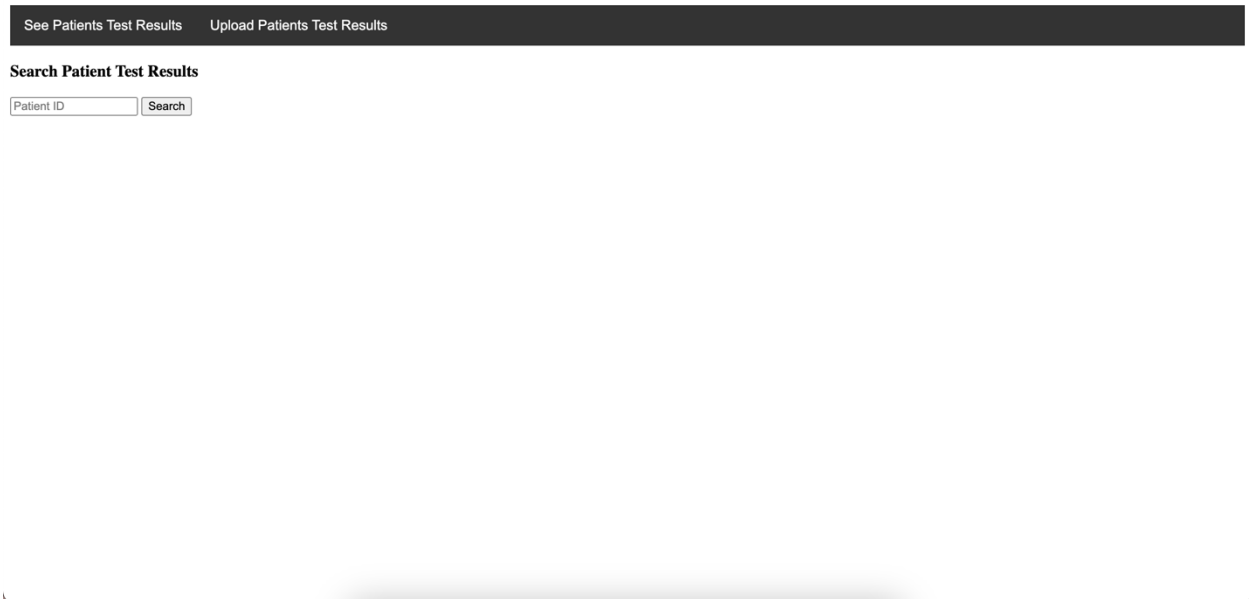
Called module name	None
Screen layout	HTML Form
Algorithms	Using the patient ID, search the PatientTest table to retrieve a list of all test results of the patient. The list is returned to the user interface.
Error messages and meaning	"No Test Result found”: This error message appears when the patient does not have any results.
Model Name	**Image Upload and OCR Processing Module**
Parameters passed	Uploaded Image File
Description of module function	Stores the paths of uploaded images in the database. Extract text information from images and reflect it in the user interface.
Input	Uploaded Image File
Output	text extracted by OCR, File Path
Called module name	Database Storage Module
Screen Layout	Display the image on the left side, overlay red transparent text on the image.
Algorithms	Uploaded images are stored by the system in temporary storage. The saved image is sent to the OCR processing module for text extraction. The OCR module analyzes image data, recognizes text in the image, and converts it into digital text data. The text data is sent to the user interface along with the image.
Error messages and meaning	" Failed to load image": This error message appears when the image format is not supported or some error occurred in uploading.
Model Name	**Database Storage Module**

Parameters passed	Patient Information, Test Results Data, File Path
Description of module function	This module stores patient information, test results, and file paths received from the application into a database. It manages data storage and updating.
Input	Patient Information, Test Results Data, File Path
Output	Success or failure status of the save process
Called module name	Display Result Module
Screen Layout	None
Algorithms	Receives input data and verifies that the data type and structure match the database schema. Initiates a transaction and inserts or updates the data into the appropriate tables. Commits the transaction if all data operations succeed, rolls back if problems occur.
Error messages and meaning	"Database error: save failed." - This is displayed when there is a connection failure to the database or an error during the save process. "Database error: invalid data format." - This is displayed if the input data does not conform to the database schema.
Model Name	**Display Result Module**
Parameters passed	PatientTestID
Description of module function	This module retrieves the test results requested by the user and displays them in the appropriate format. This includes highlighting of abnormal values.
Input	PatientTestID
Output	Formatted test result data
Called module name	None

Screen Layout	Table, Color coding to highlight abnormal values
Algorithms	Acquire inspection result data based on user requests. Display test results to the user interface in the form of a table. Values outside the normal range are color coded or marked for easy identification.
Error messages and meaning	"No inspection result found" : This message is displayed when the data corresponding to the specified inspection ID does not exist in the database. "Failed to display data" : Displayed when data was successfully retrieved but an error occurred during the display process.

6.0 Sample of working interface, or diagram of your designed interfaces.

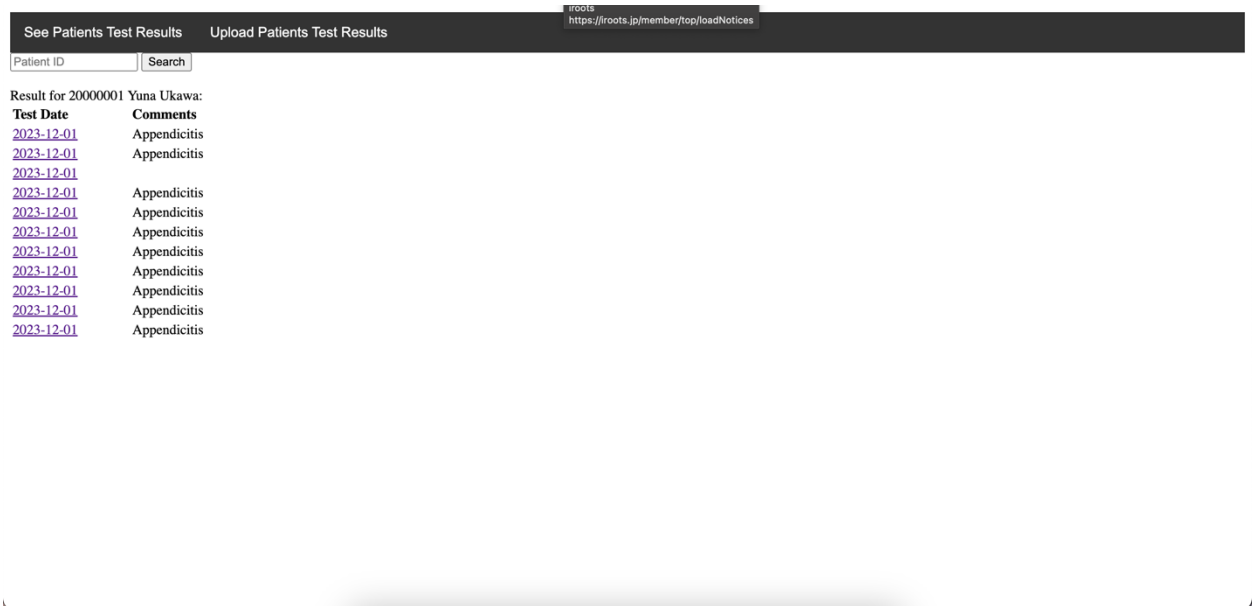
6.1 Please demonstrate your interface



Index Page

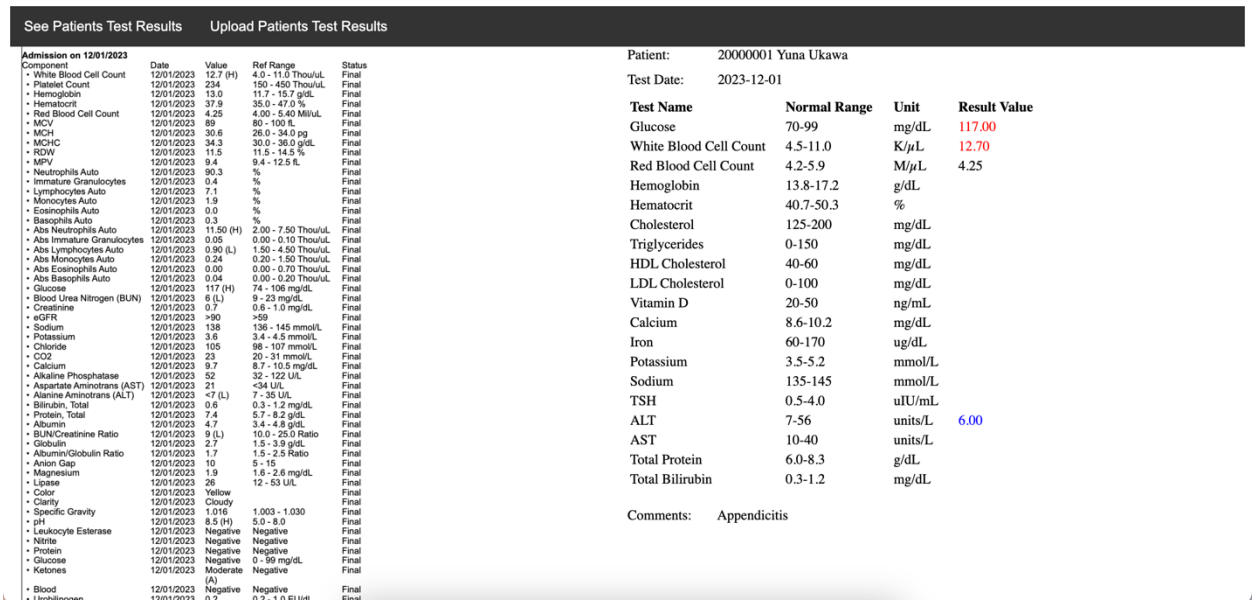
Enter Patient to search Test Results

Navigation Bar on the top



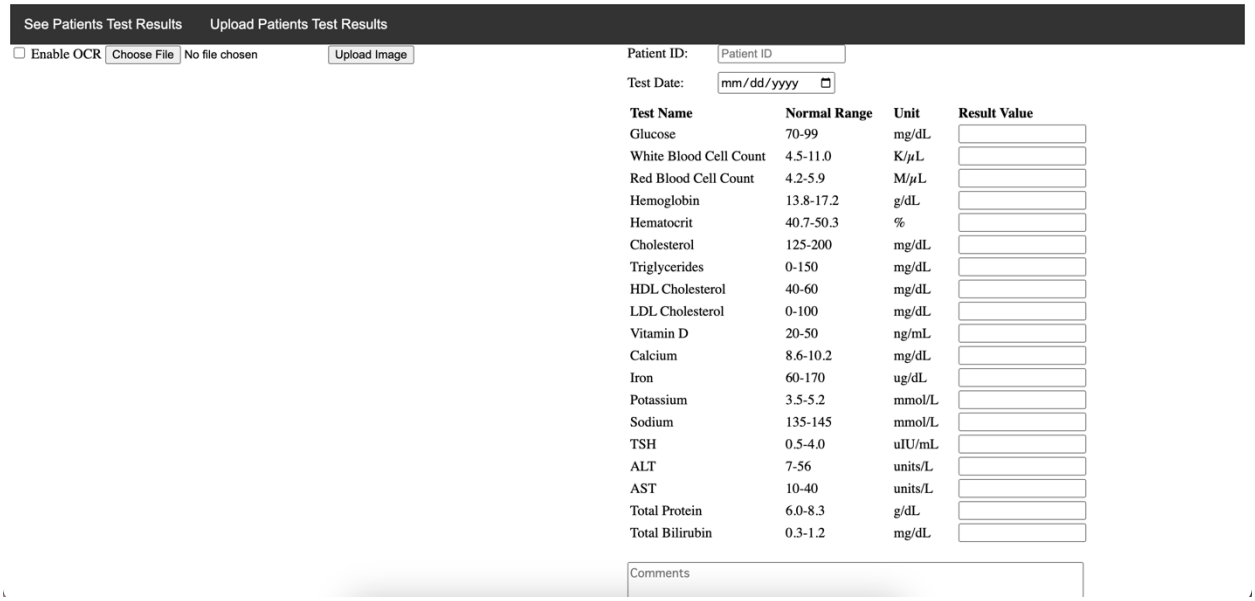
Result List is displayed

Click Test Date to see the results



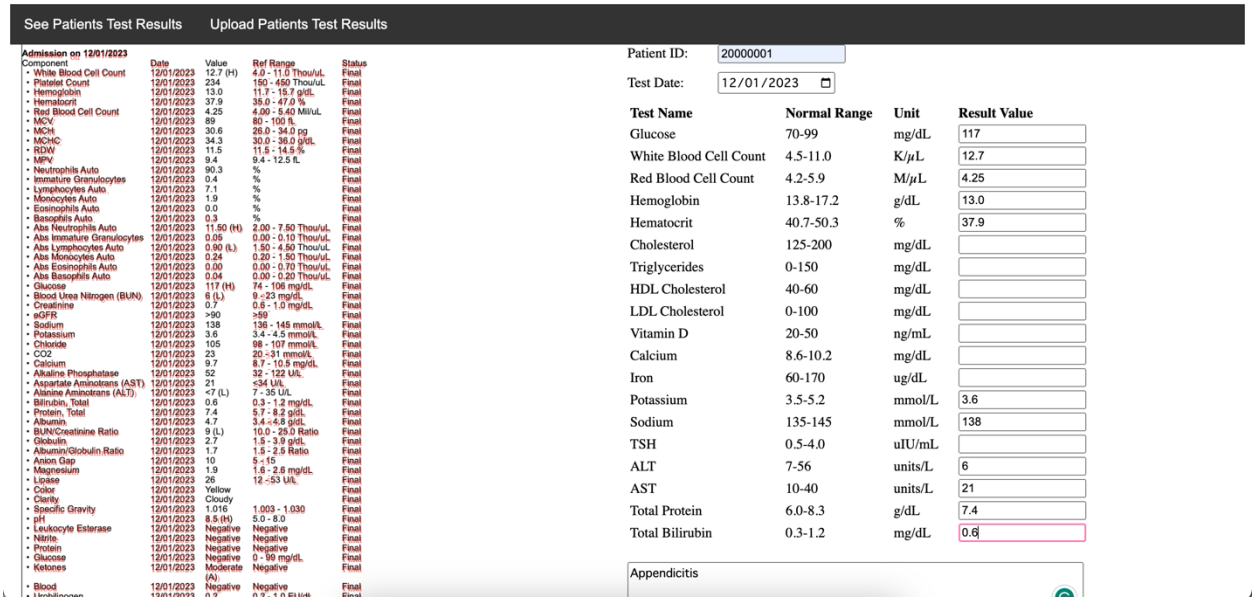
Added Image and Result Values are displayed

Now Input New Data

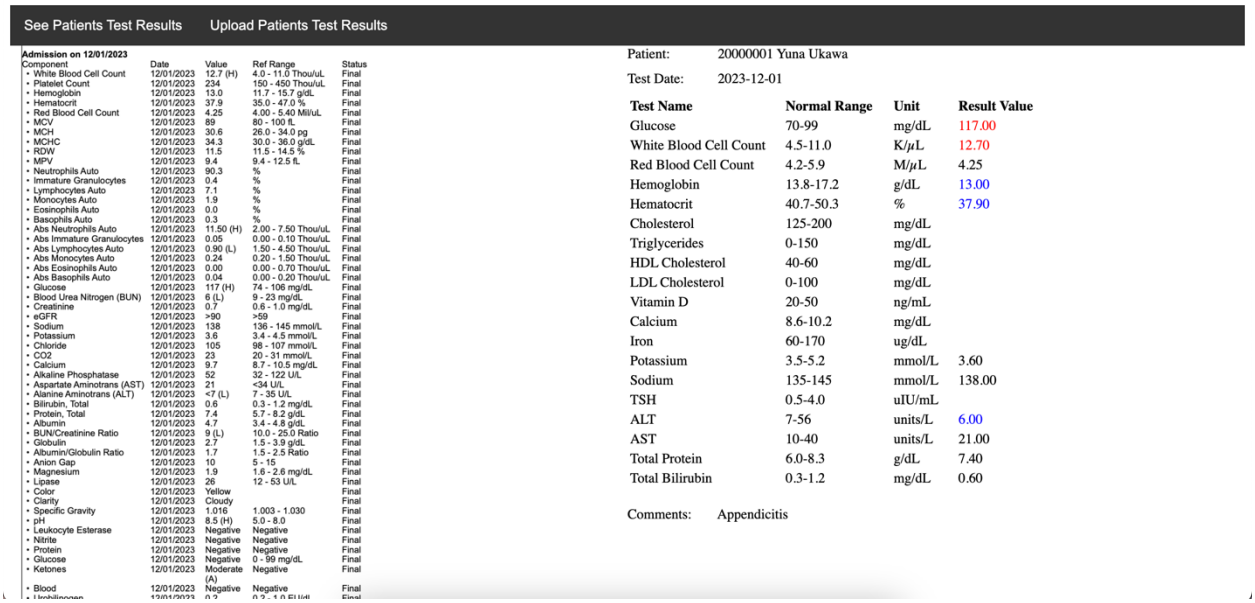


On the left side, you can temporary upload the image for reference.

There is an OCR option.



After you upload the image and used OCR, you can copy the values on the image and paste on the result value fields on the right. The red trasnparent texts are extracted by OCR.



See Patients Test Results Upload Patients Test Results

Admission on 12/01/2023

Component	Date	Value	Ref Range	Status
• White Blood Cell Count	12/01/2023	12.7 (H)	4.0 - 11.0 Thou/uL	Final
• Platelet Count	12/01/2023	234	150 - 450 Thou/uL	Final
• Hemoglobin	12/01/2023	13.0	11.7 - 15.7 g/dL	Final
• Hematocrit	12/01/2023	37.9	35.0 - 47.0 %	Final
• Red Blood Cell Count	12/01/2023	4.25	4.00 - 5.40 Mil/uL	Final
• MCV	12/01/2023	89	80 - 100 fL	Final
• MCH	12/01/2023	30.6	26.0 - 34.0 pg	Final
• MCHC	12/01/2023	34.3	30.0 - 36.0 g/dL	Final
• RDW	12/01/2023	11.5	11.5 - 14.5 %	Final
• MPV	12/01/2023	9.4	9.4 - 12.5 fL	Final
• Neutrophils Auto	12/01/2023	90.3	%	Final
• Immature Granulocytes	12/01/2023	0.4	%	Final
• Lymphocytes Auto	12/01/2023	7.1	%	Final
• Monocytes Auto	12/01/2023	1.9	%	Final
• Eosinophils Auto	12/01/2023	0.0	%	Final
• Basophils Auto	12/01/2023	0.3	%	Final
• Abs Neutrophils Auto	12/01/2023	11.50 (H)	2.00 - 7.50 Thou/uL	Final
• Abs Immature Granulocytes	12/01/2023	0.05	0.00 - 0.10 Thou/uL	Final
• Abs Lymphocytes Auto	12/01/2023	0.90 (L)	1.50 - 4.50 Thou/uL	Final
• Abs Monocytes Auto	12/01/2023	0.24	0.20 - 1.50 Thou/uL	Final
• Abs Eosinophils Auto	12/01/2023	0.00	0.00 - 0.70 Thou/uL	Final
• Abs Basophils Auto	12/01/2023	0.04	0.00 - 0.20 Thou/uL	Final
• Glucose	12/01/2023	117 (H)	74 - 106 mg/dL	Final
• Blood Urea Nitrogen (BUN)	12/01/2023	6 (L)	9 - 23 mg/dL	Final
• Creatinine	12/01/2023	0.7	0.6 - 1.0 mg/dL	Final
• eGFR	12/01/2023	>90	>59	Final
• Sodium	12/01/2023	138	136 - 145 mmol/L	Final
• Potassium	12/01/2023	3.6	3.4 - 4.5 mmol/L	Final
• Chloride	12/01/2023	105	98 - 107 mmol/L	Final
• CO2	12/01/2023	23	20 - 31 mmol/L	Final
• Calcium	12/01/2023	9.7	8.7 - 10.5 mg/dL	Final
• Alkaline Phosphatase	12/01/2023	52	32 - 122 U/L	Final
• Aspartate Aminotrans (AST)	12/01/2023	21	<34 U/L	Final
• Alanine Aminotrans (ALT)	12/01/2023	<7 (L)	7 - 35 U/L	Final
• Bilirubin, Total	12/01/2023	0.6	0.3 - 1.2 mg/dL	Final
• Protein, Total	12/01/2023	7.4	5.7 - 8.2 g/dL	Final
• Albumin	12/01/2023	4.7	3.4 - 4.8 g/dL	Final
• BUN/Creatinine Ratio	12/01/2023	9 (L)	10.0 - 25.0 Ratio	Final
• Globulin	12/01/2023	2.7	1.5 - 3.9 g/dL	Final
• Albumin/Globulin Ratio	12/01/2023	1.7	1.5 - 2.5 Ratio	Final
• Anion Gap	12/01/2023	10	5 - 15	Final
• Magnesium	12/01/2023	1.9	1.6 - 2.6 mg/dL	Final
• Lipase	12/01/2023	26	12 - 53 U/L	Final
• Color	12/01/2023	Yellow		Final
• Clarity	12/01/2023	Cloudy		Final
• Specific Gravity	12/01/2023	1.016	1.003 - 1.030	Final
• pH	12/01/2023	8.5 (H)	5.0 - 8.0	Final
• Leukocyte Esterase	12/01/2023	Negative	Negative	Final
• Nitrite	12/01/2023	Negative	Negative	Final
• Protein	12/01/2023	Negative	Negative	Final
• Glucose	12/01/2023	Negative	0 - 99 mg/dL	Final
• Ketones	12/01/2023	Moderate (A)	Negative	Final
• Blood	12/01/2023	Negative	Negative	Final

Patient: 20000001 Yuna Ukawa

Test Date: 2023-12-01

Test Name	Normal Range	Unit	Result Value
Glucose	70-99	mg/dL	117.00
White Blood Cell Count	4.5-11.0	K/µL	12.70
Red Blood Cell Count	4.2-5.9	M/µL	4.25
Hemoglobin	13.8-17.2	g/dL	13.00
Hematocrit	40.7-50.3	%	37.90
Cholesterol	125-200	mg/dL	
Triglycerides	0-150	mg/dL	
HDL Cholesterol	40-60	mg/dL	
LDL Cholesterol	0-100	mg/dL	
Vitamin D	20-50	ng/mL	
Calcium	8.6-10.2	mg/dL	
Iron	60-170	ug/dL	
Potassium	3.5-5.2	mmol/L	3.60
Sodium	135-145	mmol/L	138.00
TSH	0.5-4.0	uIU/mL	
ALT	7-56	units/L	6.00
AST	10-40	units/L	21.00
Total Protein	6.0-8.3	g/dL	7.40
Total Bilirubin	0.3-1.2	mg/dL	0.60

Comments: Appendicitis

Result values higher than the normal range are shown in red, and values lower than the normal range are shown in blue.