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Design of an Emergency Medical Initial Assessment Completeness Information System Using the Waterfall Method at X Bandung Hospital

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Abstract: Emergency services require rapid and accurate patient assessment, usually using systematic approaches such as ABCDE (Airway, Breathing, Circulation, Disability, Exposure) and AMPLE (Allergies, Medications, Past medical history, Last oral intake, Events leading to illness/injury). This research aims to design and implement a web-based information system to improve the completeness and accuracy of initial medical assessments in emergency departments, overcoming problems in manual documentation practices. The system is developed using the Waterfall method, with Flask (Python) for the backend, HTML/CSS/JavaScript for the user interface, and SQLite for database management. The implemented system features an easy-to-use interface with login modules, patient registration, digital assessment forms, real-time completeness validation, and PDF exports. The test confirms functional reliability, with successful results in data input, validation, and reporting (100% success rate). Web-based systems significantly improve the completeness, readability, and accessibility of emergency medical assessments. By integrating structured digital forms and automated validation, the system reduces documentation errors and improves workflow efficiency.

Keyword: Information System, Medical Initial Assessment, Emergency, Flask, Completeness Validation

INTRODUCTION

Emergency services require a quick and accurate response in handling patients, one of which is through a complete and systematic initial medical assessment. However, in practice, filling out assessments in the Emergency Installation (IGD) is still often done manually, which causes data incompleteness and complicates the evaluation and reporting process. The assessment process aims to identify life-threatening medical conditions and determine treatment priorities (Apriani & Ulfah, 2023). However, in practice, recording information during the initial assessment is often done manually, which can lead to a variety of problems.

Incomplete, illegible, or poorly documented records can result in errors in diagnosis and treatment, which can ultimately jeopardize patient safety (Yunengsih, 2024).

Manual recording in initial assessments in the emergency room often faces several problems. One of them is data incompleteness, where important information that is not recorded can result in the loss of the clinical context necessary for decision-making (ANDINI, Sri Wulandari, & Agustyarum Pradiska Budi, 2024). Additionally, poor readability of handwriting can lead to confusion among medical personnel involved in patient care. Unstructured documentation also makes it difficult to access and analyze information, which is important for process improvement and evaluation of results (Deharja & Swari, 2017).

The concept of initial medical assessment, which often uses the ABCDE (Airway, Breathing, Circulation, Disability, Exposure) and AMPLE (Allergies, Medications, Past medical history, Last oral intake, Events leading to present illness/injury) approaches, is a widely recognized method in the management of emergency patients (Thim, Krarup, Grove, Rohde, & Løfgren, 2012). The ABCDE approach helps medical personnel to systematically evaluate a patient's condition and identify issues that require immediate treatment. Meanwhile, AMPLE provides a framework for collecting relevant medical histories, which is crucial in determining appropriate treatment measures.

The medical documentation standards set by the Hospital Accreditation Commission (KARS) and the regulations of the Minister of Health (Permenkes) are also important references in the development of this information system (KARS, 2018). These standards govern how medical information should be recorded, stored, and managed, ensuring that all patient data can be accessed securely and in accordance with applicable regulations. By following these standards, the information systems developed will not only meet clinical needs, but will also comply with existing legal provisions, thereby increasing trust and safety for patients and medical personnel (Monica, Pujilestari, & Nopiyanti, 2023).

The information system in the hospital emergency room is a vital component in supporting the speed and accuracy of initial medical assessments. Various studies have developed electronic-based systems with the Waterfall approach, such as those conducted by Nurhidayah (2022) and Putri et al. (2023), which show that digitization of initial assessment forms is able to improve the completeness and efficiency of medical records. However, there are still many hospitals that have not implemented this system optimally, especially in the context of meeting national accreditation standards.

A study by Solomon et al., 2023 shows that the integration of CDSS with a digital assessment system is able to improve the accuracy of early diagnosis and significantly lower the rate of medical errors. In addition, Mobile Health (mHealth)- based approaches and Cloud Computing are now being adopted to enable real-time and collaborative data recording between medical personnel, even in emergency situations.

This research aims to design an information system that can support the completeness of initial medical assessments in the emergency room. This system is expected to improve the accuracy and speed of data recording, as well as ensure that all important information is properly recorded and accessible to medical personnel. With an integrated system, it is hoped that it can reduce the risk of errors in patient handling due to inadequate recording. This research will be focused only on the design stage that has not been integrated with the hospital database so that the main focus is on the development of the completeness of the initial assessment of emergency medical with this limitation, the research is expected to be carried out in depth and focused on critical aspects in handling emergency patients.

METHOD

1. System Development Methods

In this study, the Waterfall method was used for system development. This method has a structured and sequential workflow. It is considered the most efficient for simple testing on python-flask web applications and is integrated in its codification to very effective maintenance and evaluation (Madiah et al., 2024).

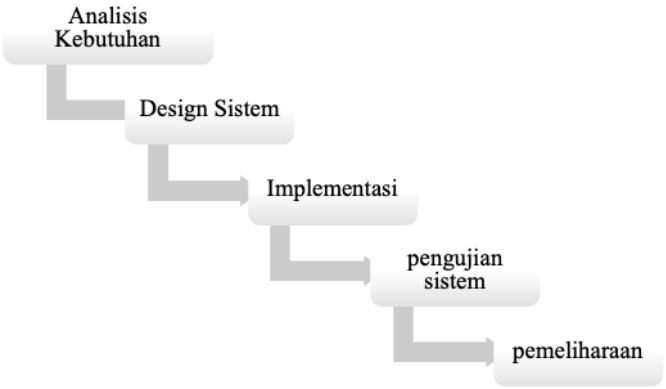


Figure 1. Waterfall Method

1) Needs Analysis
   At this stage, gather all the information about the system's needs from conditions in the field and direct input from users, such as doctors and nurses in the emergency room.
2) System design
   After understanding its needs, proceed to design the system workflow, and the database structure.
3) Implementation
   The development of the system was carried out using Python with the Flask framework for the backend, and HTML/CSS/JS (with the help of bootstrap and Tailwind) for the frontend, Development using SQLAlchemy, SQLite for the database (Chauhan, Singh, Verma, Parasher, & Budhiraja, 2019).
4) System Testing
   The system is tested using the black box method to check functionality, to ensure the system is performing as expected System functionality validation (form, print, recap).
5) Maintenance
   Once the system is complete, the bug fixes in the test take place.

2. Data Collection Techniques

The data used to build this system is collected in several ways:

1) Interview
   Conduct direct interviews with emergency room medical personnel (doctors, nurses, and medical staff) to understand the flow of initial assessment completeness and what is needed from this system.
2) Observation
   Observe firsthand the completeness of the initial medical assessment process in the emergency room, especially how data is recorded and managed.
3) Document Study
   Examine various forms of medical assessment such as ABCDE and AMPLE, as well as regulations or guidelines that are standard in emergencies.

3. Tools Used

The tools and software used for designing and coding backends, frontends, and deploymet testing use local host flasks in the latest version of Visual Studio Code application terminal and python version 3.2.

Table 1. Tools and components used.

Component	Tools/Framework
Backend	Python Flask
Frontend	HTML, Tailwind CSS, Bootstrap, JavaScript
Database	SQLite
PDF Export	xhtml2pdf
Editor	Visual Studio Code
Version Control	Git & GitHub

Source: Research data

4. User Interface Design (UI/UX)

The system display is made as simple as possible so that it is easy for medical personnel to use. Some of the main components include login and registration, emergency room patient dashboard, and automatic assessment completeness indicators, patient info (automatic RM NO, NIK, Name, Date, Address), initial medical assessment form (ABCDE, AMPLE, completeness check), assessment and visit history, save button and print PDF by clicking on patient assessment.

5. System Schematics and Architecture

The system is designed as a web application based on the Client-Server architecture. The plot is more or less like this. The front-end runs on the user side, built using HTML, Tailwind CSS, and Bootstrap for application web responsiveness. The back-end handles the main logic, and database communications, built with Flask. The database stores patient, assessment, and user data. Export PDF data from the assessment.

RESULT AND DISCUSSION

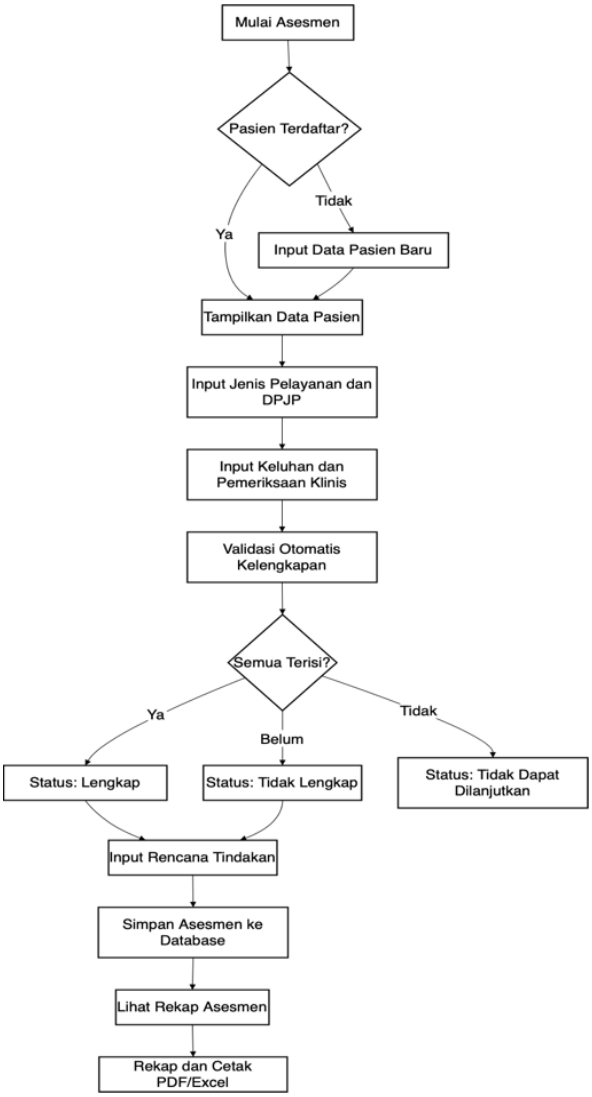
1. Needs analysis

The information system designed in this study focuses on the process of completing medical initial assessment documentation in Emergency Care. The main problems identified in the field include numerous incomplete forms, illegible handwriting, and the absence of a tracking system to verify whether assessments have been properly conducted. Based on these issues, the system is designed to allow medical personnel to directly fill in assessments through a simple web interface, with automatic indicators to ensure data completeness.

2. System Planning Overview

1) Flowchart

Flowcharts visually and logically describe the flow of the initial medical assessment process. In this system, the flow starts from filling in patient data by the officer, followed by filling out the medical assessment form, then the system processes inputs and validates to determine the status of assessment completeness and triage color.



Source: Research data

Figure 2. Emergency Medical Initial Assessment System Flowchart

2) Diagram Context

The Context Diagram illustrates the interaction between the emergency room's initial medical assessment completeness information system and external entities, namely patients, medical personnel, and doctors. The patient provides the initial data, the medical officer inputs the assessment into the system, while the doctor validates the assessment and accesses the report. The system stores and manages data in one centralized database to produce complete and validated assessment outputs (Abdussalaam & Oktaviani, 2020).

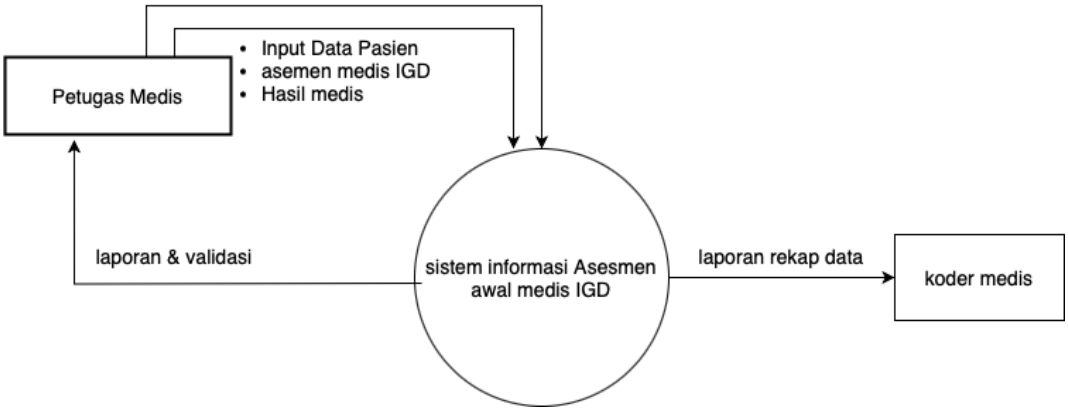


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Figure 3. Emergency Medical Initial Assessment System Context Diagram

3) DFD Level 0

DFD Level 0 describes the main data flows in the system, starting from patient registration, filling out assessments by officers, validation by doctors, to data storage and report creation. Each process is directly connected to a database that stores patient information, emergency room assessments, and medical outcome history and validation. This diagram shows how data flows between processes systematically and efficiently (Abdussalaam & Badriansyah, 2021).

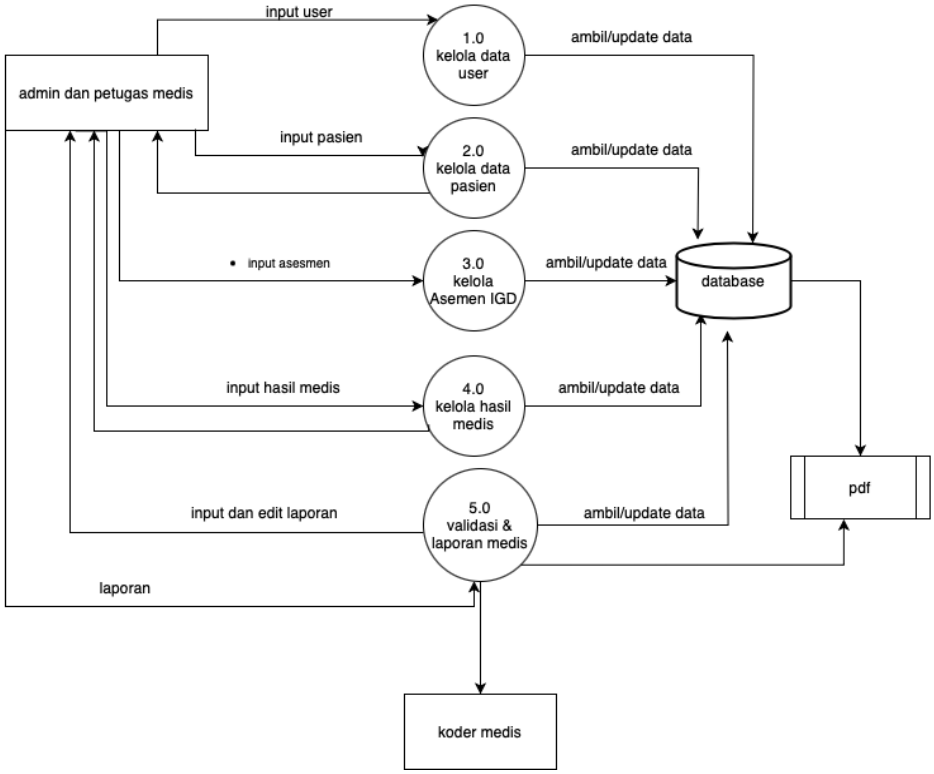

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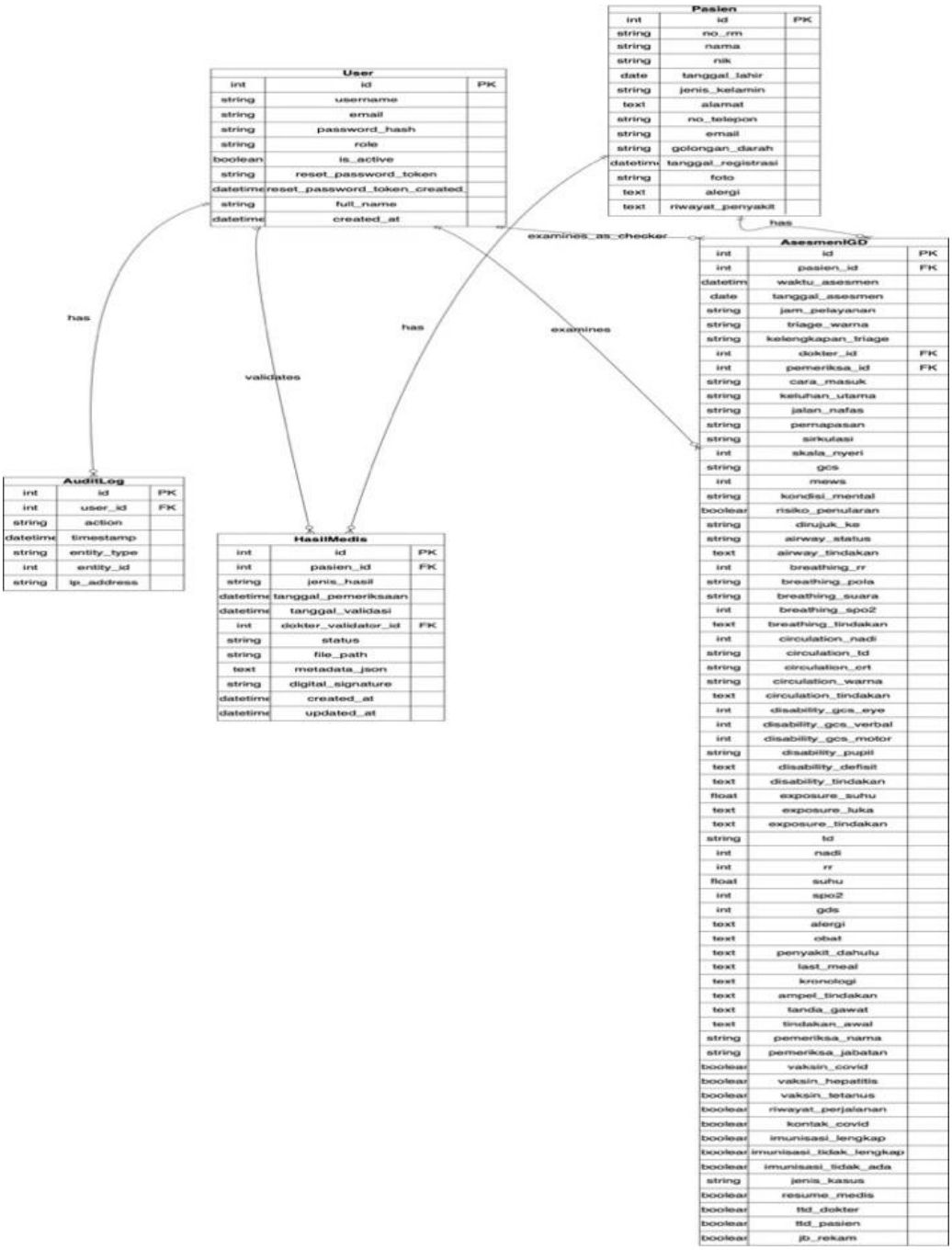
Figure 4. DFD Emergency Medical Initial Assessment System

4) Entity Relationship Diagram (ERD)

Entity Relationship Diagram (ERD) to describe the entities involved and their relationships. Based on the results of the needs analysis, five main entities were designed, namely, Patients, Medical Results, AuditLog, and IGD Assessment. The User entity stores

data on system users, such as doctors, administrative officers, or validators. Users have one-to-many relationships with AuditLog, Medical Results, and IGD Assessments because one user can perform various actions and validations. The Patient Entity stores patient information, such as name, NIK, and medical history. Patients have a one-to-many relationship with Medical Results and IGD Assessment, because one patient can have a lot of data on examination and assessment results.



Source: Research data

Figure 5. ERD Emergency Medical Initial Assessment System

The Medical Results entity stores medical examination information (lab/radiology/etc) that is connected to the patient and can be validated by a physician (dokter_validator_id) who is part of the User entity. The AuditLog entity logs every important activity of the user in the system, including time, IP, modified entities, and action types (add, edit, delete). The IGD

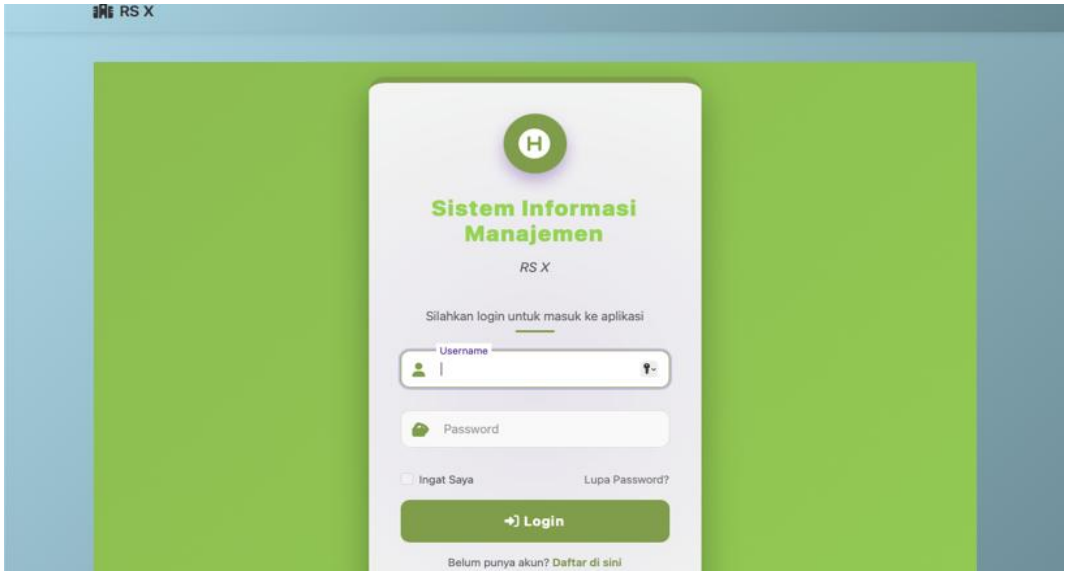
Assessment Entity stores patient assessment data in emergency facilities with a triage scheme and condition recording based on the ABCDE (Airway, Breathing, Circulation, Disability, Exposure) approach.This assessment also records the examiner and the doctor who handles it. ERD diagrams show the logical interconnectedness between entities and support the efficiency of structured and secure data management.

3. The Use of Flask (Python) in System Development

Flask is a lightweight and flexible Python framework, developing modular information systems such as the completeness of medical initial assessments. Flask allows for quick and efficient development without complex boilerplate code (Ghimire, 2020). With the integration of SQLAlchemy, data management becomes more structured. The advantages of using Flask are micro-architectures that facilitate the separation of system modules (login, assessment, recap, print). Quick integration with template engine (Jinja2) and database system (SQLite), Easy to develop into a REST API when needed, Supports basic security (login, session, CSRF) (Evan & Saian, 2023). The implementation of Flask Usage Technology can simplify the assessment input and validation process, Improve the efficiency of assessment filling and analysis time, facilitate local deployment without internet dependence, Good scalability for the addition of advanced features (analytics dashboard, digital signature, document upload) (Ayotomiwa, Ajayi Oluwabukola, Jesse, & Emmanuel, 2025).

4. Implementation

The login page is the main gateway to system access, where users (doctors, nurses, or admins) authenticate before they can log in to the system. The display is minimalist and responsive to make it easy to use on a variety of devices, including emergency room computers or tablets. Main Functions - Verify users based on usernames and passwords registered directly by administrators, Prevent unauthorized access to patient data and medical assessments, Direct users to the emergency room dashboard after successful login.



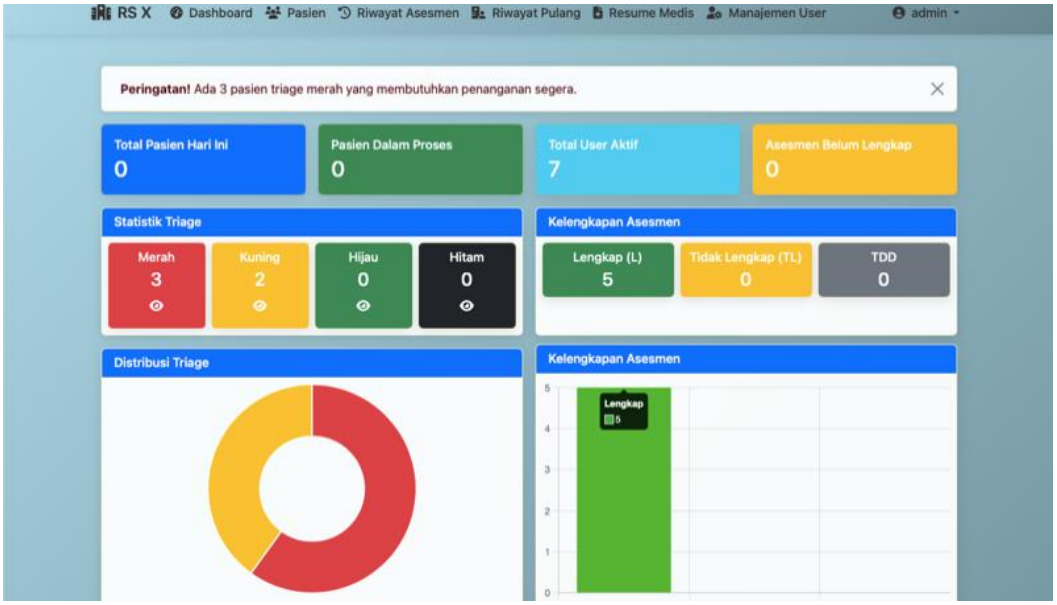
Source: Research data

Figure 6. Login Page Interface

Features include Username/email + password input form, Action Login Button to send login data to the Flask backend. Automatic Error Message Appears if the login fails (example: "Password incorrect" or "user not found"), Redirect to the Dashboard after successful login. Additional options if enabled, Security Applied Password is stored in the form of a hash (bcrypt) in the database, System uses session Flask to store login status, Login

can only be done by users who are already registered and active in the database (Chauhan et al., 2019).

The dashboard is the main page after login, which provides a concise and real-time overview of the condition of the hospital's emergency room. Its function is not only to display data, but also as a monitoring and control tool for ongoing assessment activities.



Source: Research data

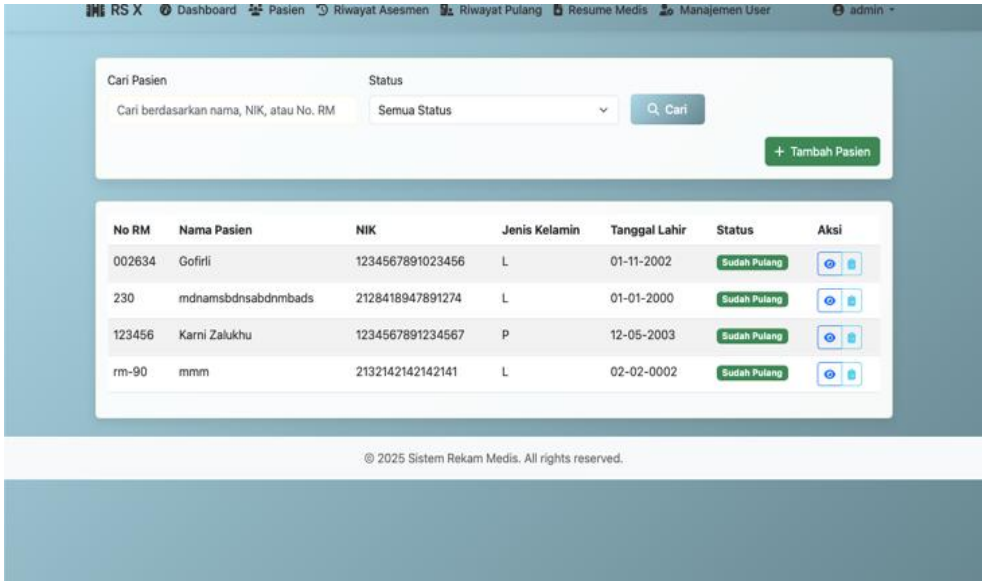
Figure 7. Dashboard Page

Table 2. Expected functions and benefits

Function	Benefit
Triage visualization	Simplifies identification of patient condition
Real-time update	Speeds up medical team response
Completeness statistics	Improves accuracy and accountability of data input
History & activity log	Facilitates error tracking or performance evaluation
Data export	Eases preparation of medical and administrative reports

Table 2 explains the features of each function based on the dashboard page, with this it is hoped that the function of each visual on the dashboard page can be useful well and can help the hospital in the implementation of initial medical assessments.

Patient List page on this page you can add patients by taking action to add patients by pressing the Add Patient button on the right, after that the patient filling form can be filled in and after filling everything will be automatically listed in the Patient List column.



Source: Research data

Figure 8. List of patients

The main view is divided into several panels, each of which displays a different group of information This section is located at the top left of the page, displaying basic patient data such as, Patient name, Medical Record Number (RM), Action button in the form of Edit and Delete patient data.

The patient details page is one of the core parts of the system, which is designed to display all important information related to the patient in one concise and easy-to-read view. This page is accessed after selecting one of the patients from the list available in the list of patients and on the dashboard page. On the patient detail info page after pressing the eye action button on the right, there is some info including Contact, Address and further patient info on this Panel contains the patient's domicile address and contact information (phone and email).

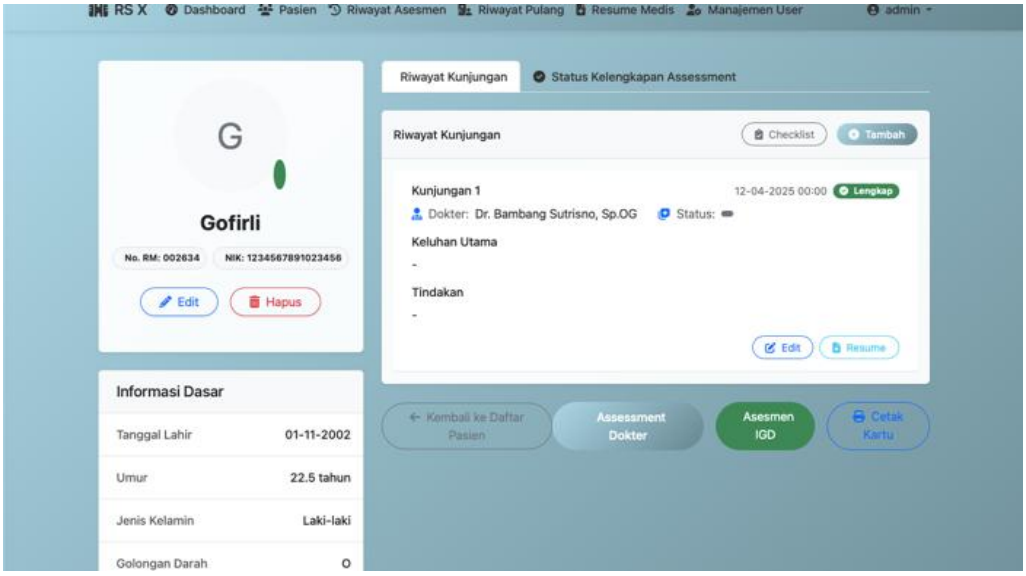


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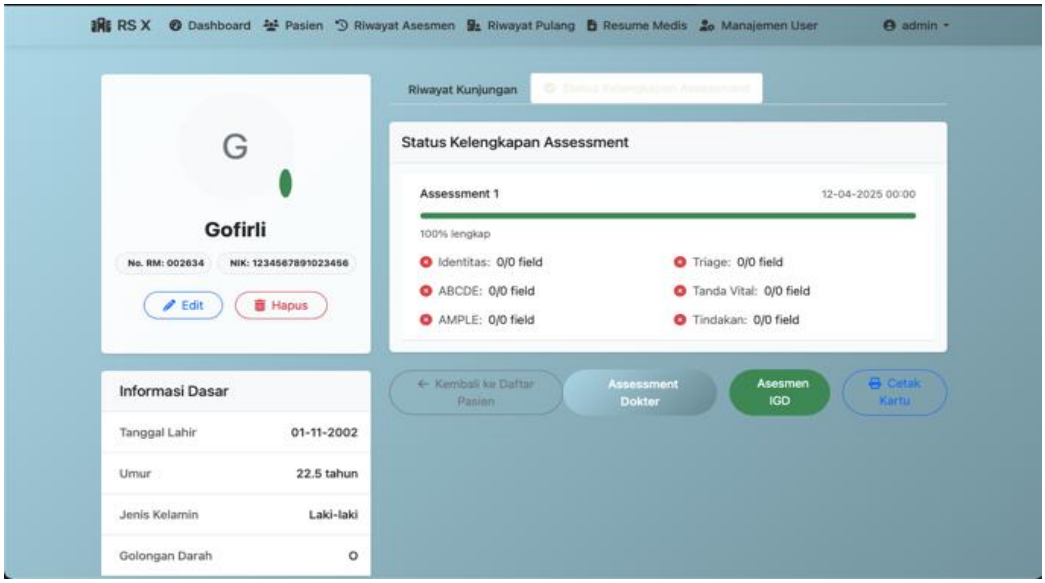
Figure 9. Patient Details Page



Source: Research data

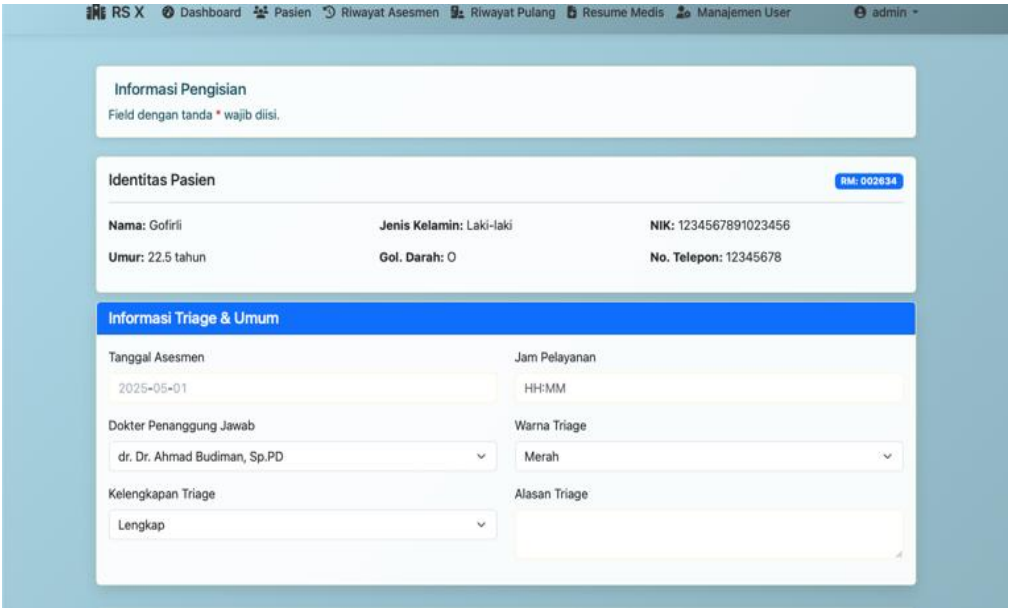
Figure 10. Charging status on patient details

The patient's initials are also visualized in the form of a blue circle instead of a profile photo, which facilitates quick visual identification. Basic Information This panel presents important data such as Population Identification Number (NIK), Date of Birth and Age of the Patient, Gender, Blood Type This data is important as a basis for initial medical decision-making, and is used in the assessment input process and internal reporting of hospitals. With this, the potential for lagging or undocumented assessments can be minimized.

From this page, users can monitor the completeness of the assessment, Add new assessments, View the history of patient medical visits, Manage patient identity and contact data. And to download the initial medical assessment report, it can be done by clicking on the assessment column and the results obtained are in the form of a report as a PDF template.

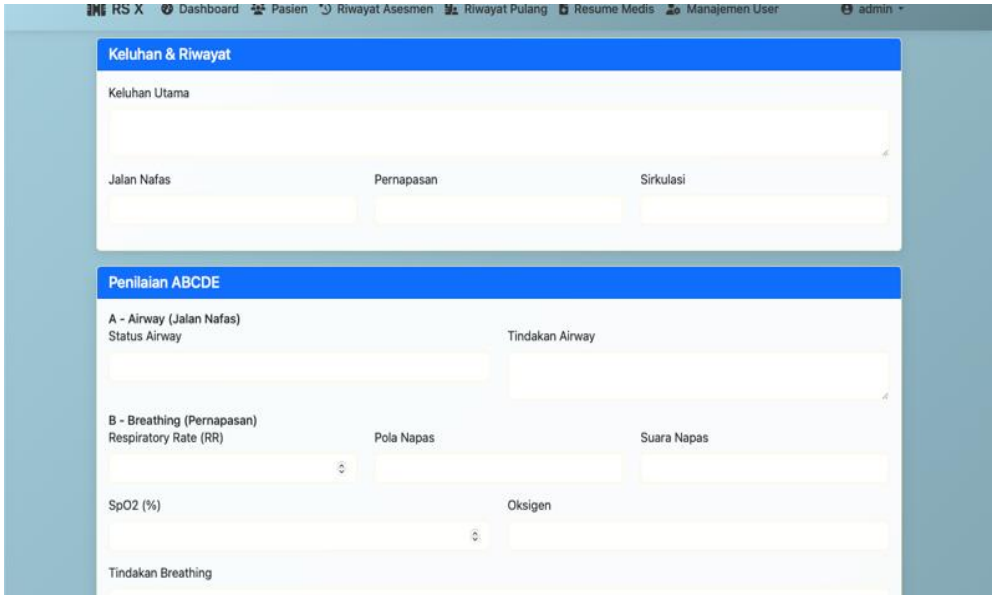
The emergency medical initial assessment form is systematically designed with the ABCDE and AMPLE approaches to ensure that critical emergency patient data can be filled in completely and quickly. This form includes patient identity information such as RM, Name, NIK, Date of Birth, Address, and Gender, followed by service time data which includes the date and time of the patient's arrival, the time the assessment was conducted, and the name of the Doctor in Charge of Service (DPJP).

The triage section contains the patient's main complaints, triage status by color, type of arrival (independent, referral, or ambulance), as well as filling in initial vital signs such as blood pressure, pulse, breathing rate, temperature, and oxygen saturation. Meanwhile, the AMPLE section contains allergy data, medications being consumed, disease history, last food/drinks, and chronology of medical events. All of these forms are built in a web-based system that supports real-time filling with automatic validation and print features for documentation.



Source: Research data

Figure 11. Form for filling out the Emergency assessment completeness check



Source: Research data

Figure 12. Fill out the completeness of the ABCDE Emergency assessment form

The visualization of the form above shows how this system is able to accommodate the documentation needs of emergency medical initial assessments in a comprehensive, structured, and in accordance with emergency service standards. With an informative and easy-to-use form design, it is hoped that the assessment process can take place faster, more accurately, and support appropriate medical decision-making in the critical phase of emergency room services (Cella et al., 2025; Mardiansyah, Hamdani, Rachman, Suciyono, & Sudarsono, 2024)

Table 3. Specification of KGD initial assessment form data

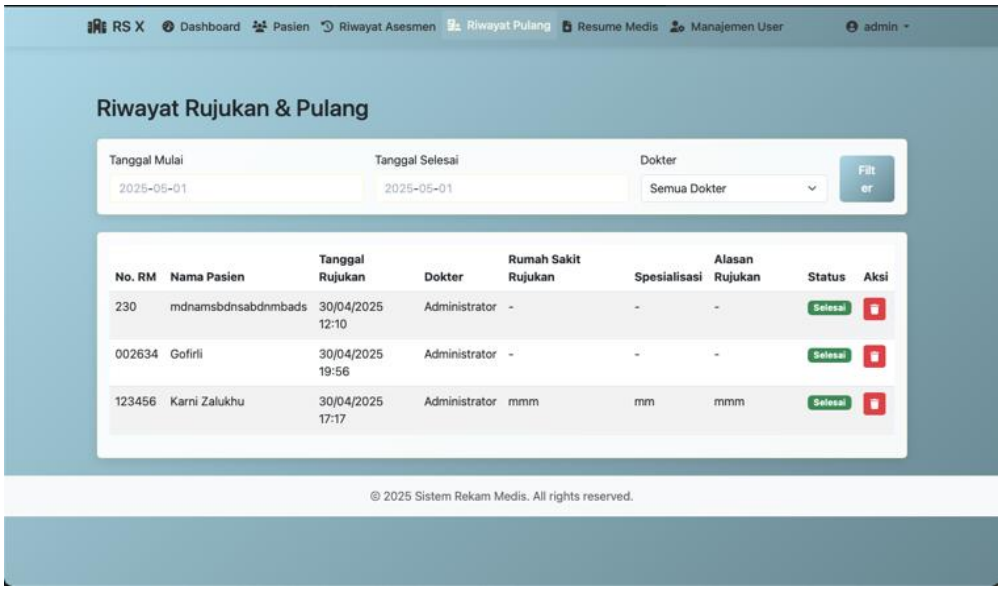
Form	Field / Data	Data Type	Description
Patient Identity	Name	String	Full name of the patient.
	Age	Float / String	Patient's age in years (e.g., 2025.6).
	Gender	String (Option)	Options: Male / Female.
	Blood Type	String (Option)	A, B, AB, O, or "-" if unknown.
	NIK	String	National Identification Number (16 digits).
	Phone Number	String	Patient's active phone number.
Completeness Checklist	Documents and Signature	Boolean	Indicates completeness of documents and signature.
	ER Medical Resume	Boolean	Checklist for ER medical resume.
	Doctor's Signature	Boolean	Checklist for doctor's signature.
	Patient's Signature	Boolean	Checklist for patient's signature.
	JB Recorded	Boolean	Indicates recording status.
Vital Signs	BP (Blood Pressure)	String (mmHg)	Format: 120/80.
	Height	Numeric (cm)	Patient's height in centimeters.
	Temperature	Numeric (°C)	Patient's body temperature.
	Weight	Numeric (kg)	Patient's body weight.
	Pulse	Numeric (bpm)	Patient's heart rate per minute.
	SpO2	Numeric (%)	Blood oxygen saturation.
Assessment Identity	Registration Time	Time (HH:MM)	Patient registration time.
	Date	Date (YYYY-MM-DD)	Date of assessment.
	ER Admission Time	Time (HH:MM)	Time patient entered the ER.
Triage & General	Triage Color	String (Option)	Options: Red, Yellow, Green, etc.
	Triage Completeness	String (Option)	Options: Complete (C) or Incomplete.
	Service Time	Time (HH:MM)	Time patient started receiving care.
	Mode of Arrival	String (Option)	Example: Walk-in, Brought by Family, Ambulance, etc.
	Responsible Doctor	String	Name of the responsible doctor.
Initial Assessment (ABCDE)	Airway (GCS)	Numeric (Scale)	Glasgow Coma Scale (range 3–15).
	Breathing (RR)	Numeric (/minute)	Respiratory rate per minute.
	Circulation (mEWS)	Numeric (Scale)	Modified Early Warning Score.
	Pain Scale	Numeric (0–10)	Patient's pain scale.
	Infection Risk	Boolean	Whether there is a risk of infectious disease (Yes/No).
	Referred To	String	Referral location or facility (if any).
Airway & Breathing Status	Breathing Pattern	String (Option)	Options: Normal, Tachypnea, Bradypnea, etc.
	SpO2 (%)	Numeric	Blood oxygen saturation.
	Breathing Intervention	String (Option)	Example: Nasal Oxygen, Nebulizer, Non-rebreathing mask, etc.
AMPLE History	Allergy	String	Patient's allergy history.

	Current Medication	String	List of medications currently taken.
	Past Medical History	String	Patient's previous illnesses.
	Last Meal	String	Time of patient's last meal.

Source: Research data

In table 3, it is explained that the appearance of the assessment form is divided into 2 main parts: the patient identity form and the medical assessment form (ABCDE & AMPLE). After all the data is inputted, the system will automatically check completeness and provide a notification if there are items that have not been filled, so that the quality of documentation is maintained (Deharja & Swari, 2017).

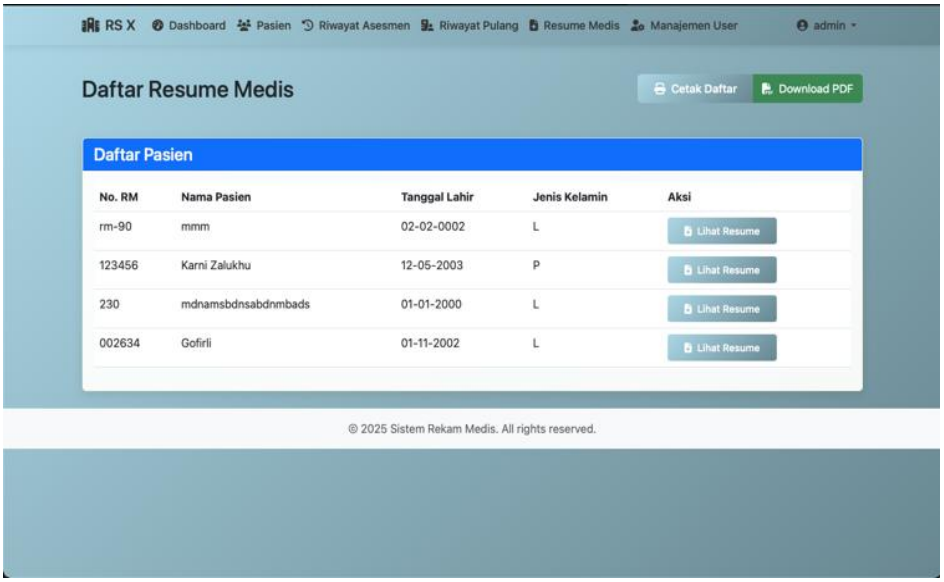
Referral & Discharge History this page displays a list of patients referred or discharged, including information such as medical record number, patient name, date of referral, attending physician, referral hospital, specialty, reason for referral, and status. The data shows some patients with a status of "Completed".



Source: Research data

Figure 13. Return history & visit

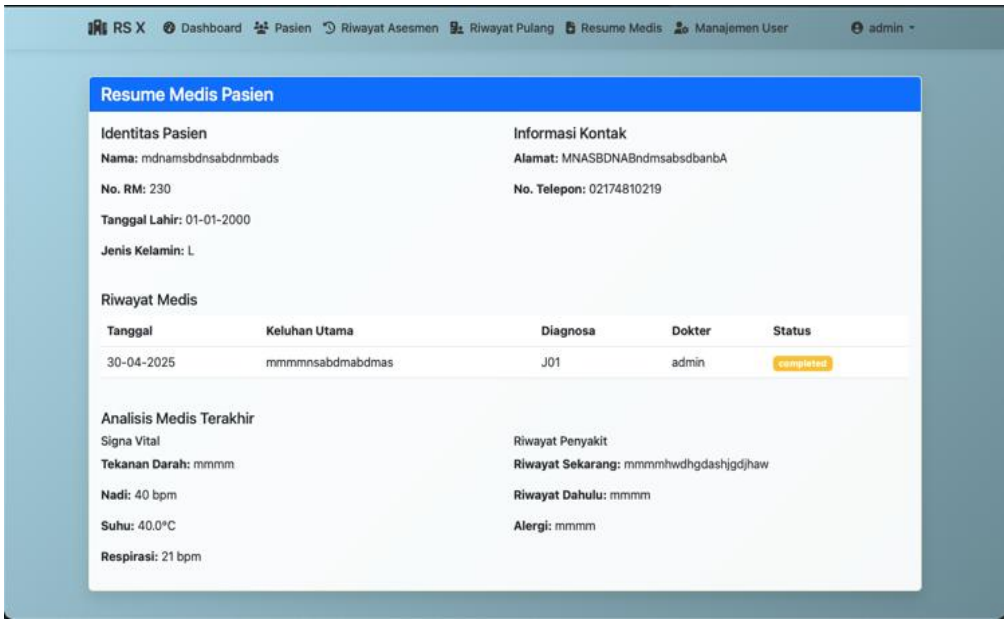
The Medical Resume List presents a list of patients with basic information such as medical record number, name, date of birth, gender, and the option to view the medical resume.



Source: Research data

Figure 14. List of medical resumes

Patient Medical Resume Displays specific patient medical details, including identity, medical history, recent analysis (vital signs), contact information, and disease history. The data displayed contains important patient info.



Source: Research data

Figure 15. Medical resume details

Table 4. Specification of doctor assessment form data

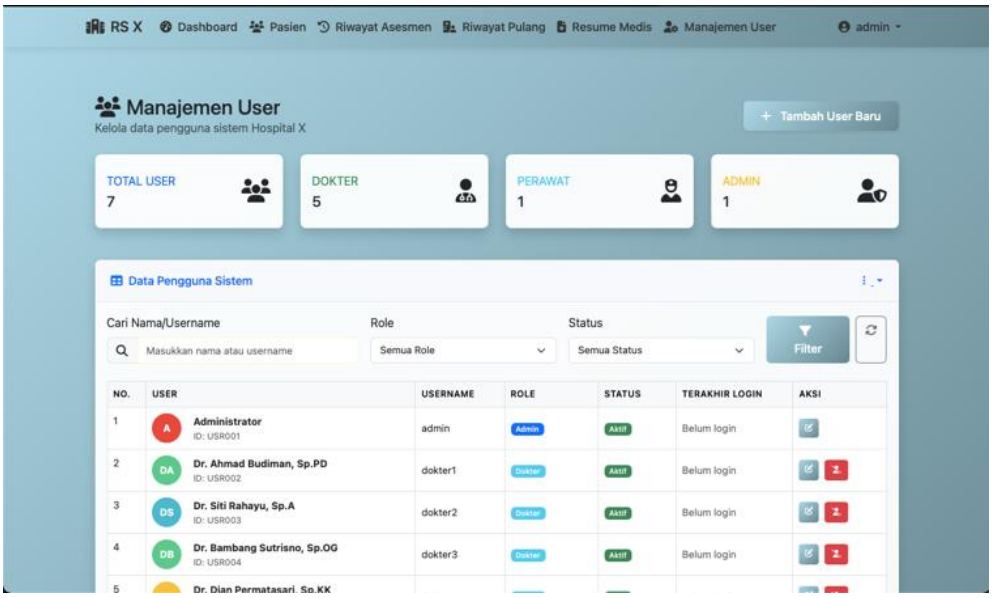
Field Name	Data Type	Length	Validation	Description
id_assessment	UUID / INT	-	Primary Key, Auto Increment / UUID	Unique ID for each assessment
id_patient	UUID / INT	-	Foreign Key to patient table	Patient identity
assessment_date	DATE/TIMESTAMP	-	Cannot be null	Date when the assessment is conducted
chief_complaint	TEXT	1000	Cannot be null	Patient's main complaint

current_medical_history	TEXT		1000	Optional	Description of current illness
past_medical_history	TEXT		1000	Optional	Patient's past illnesses
allergy_history	TEXT		500	Optional, default: "None" if empty	Drug/food allergies
blood_pressure	VARCHAR		7	Format: 'XXX/XX' mmHg	Systolic/diastolic blood pressure
body_temperature	DECIMAL(4,1)	-		Range 35.0 – 42.0 °C	Patient's body temperature
pulse	INT	-		40–200 beats per minute	Heart rate
respiration_rate	INT	-		10–40 breaths per minute	Patient's respiratory rate
physical_exam	TEXT		2000	Optional	Physical examination results
supporting_exam	TEXT		2000	Optional	e.g., lab results, x-ray, etc.
provisional_diagnosis	TEXT		1000	Cannot be null	Initial/provisional diagnosis
follow_up_plan	Checkbox	-		Optional	Plan for control, hospitalization, referral, etc.

Source: Research data

Table 4 is the specification of filling in the doctor's assessment form data which will later be displayed on the medical resume display in real time.

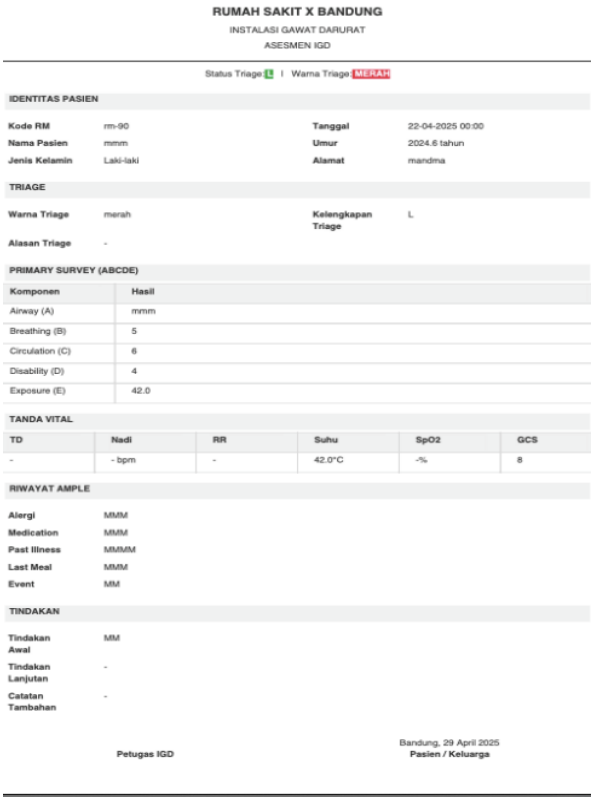
User Management Contains the management of system users, including total users, roles (doctors, nurses, admins), and user lists with details such as username, role, status, and last login time. This page can only be accessed by admins.



Source: Research data

Figure 16. User management

Visualization of pdf results generated from info and patient assessment data form per patient visit and auto-print can be downloaded on the Assessment history page on the pdf print action button.



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INSTALASI GAWAT DARURAT
ASESMEN IGD

Status Triage: L | Warna Triage: MERAH

IDENTITAS PASIEN

Kode RM	rm-90	Tanggal	22-04-2025 00:00
Nama Pasien	mmm	Umur	2024.6 tahun
Jenis Kelamin	Laki-laki	Alamat	mandma

TRIAGE

Warna Triage	merah	Kelengkapan Triage	L
Alasan Triage	-		

PRIMARY SURVEY (ABCDE)

Komponen	Hasil
Airway (A)	mmm
Breathing (B)	5
Circulation (C)	6
Disability (D)	4
Exposure (E)	42.0

TANDA VITAL

TD	Nadi	RR	Suhu	SpO2	GCS
-	- bpm	-	42.0°C	-%	8

RIWAYAT AMPLE

Alergi	MMM
Medication	MMM
Past Illness	MMMM
Last Meal	MMM
Event	MM

TINDAKAN

Tindakan Awal	MM
Tindakan Lanjutan	-
Catatan Tambahan	-

Petugas IGD

Bandung, 29 April 2025
Pasien / Keluarga

Source: Research data

Figure 17. Automated print report PDF template from patient input data

The visualization of PDF prints also shows that digital forms are more structured, clean, and ready to use for legal and clinical needs. Record the results of the initial medical assessment (ABCDE, AMPLE, completeness status, date of visit). Each assessment is directly linked to the patient entity via the RM NO, allowing the system to efficiently display visit history based on the patient. The implementation of relationships between tables also supports the integration between system modules and simplifies the reporting process.

All features are tested without looking at the content of the code, but by giving input and checking the results. Functions such as adding patients, filling out assessments, validating completeness, printing PDFs, and accessing history ran smoothly without errors.

Table 5. Simple test results black box testing

Feature Tested	Input	Expected Output	Actual Output	Status
Login	Valid username and password	User successfully logs in to the dashboard	Successfully logged in and redirected to the dashboard	Valid
Add Patient Data	Complete patient data (MRN, Name, NIK, etc.)	Patient data is saved in the database and displayed in the patient list	Data saved and displayed on the patient page	Valid
Input ABCDE & AMPLE Assessment	Complete assessment data (airway, breathing, GCS, allergy, etc.)	Assessment data successfully saved and can be printed	Data saved and available for PDF print	Valid
Assessment Completeness Validation	One of the assessment fields is left empty	System rejects saving and displays notification “Data is incomplete”	Notification appears and data not saved	Valid
Print Assessment PDF	Double-click on the patient assessment field to “Print PDF” after assessment is completed	Assessment PDF document is downloaded or displayed in preview	PDF file successfully created and displays data according to input	Valid

View Patient Visit History	Enter patient MRN	Previous assessments appear according to date	Assessment history displayed correctly	Valid
Logout	Click logout button	System logs out and returns to login page	Returned to login page	Valid
Prevent Duplicate MRN	Enter patient with an already registered MRN	System rejects and displays warning "MRN already exists"	Notification appears, data not saved	Valid
Access Form Without Login	Directly access assessment form URL without logging in	System redirects to login page	Cannot access form, redirected to login	Valid

Source: Research data

Table 5 explains that all functions are running well. The back-end is developed using the Flask framework, which is lightweight and efficient for web-based system development. The main functions of the back-end include user authentication, assessment data processing, patient data search, and export of assessment data to PDF format. The system is tested to run stably in localhost use scenarios, and can be easily deployed to production servers using additional frameworks such as Gunicorn.

CONCLUSION

The design and implementation of this web-based emergency medical initial assessment information system demonstrate that it effectively supports medical personnel in documenting emergency department assessments through standardized digital forms, automatic validation, PDF reports, and assessment history. The system is user-friendly and can be used without extensive training. Functional black box testing confirmed that all core features login, patient data entry, assessment input, validation, PDF generation, history viewing, logout, duplicate prevention, and access control performed as expected, ensuring system reliability and data integrity.

However, this study is limited to the development stage and has not yet been integrated with the hospital information system. Future work may focus on integration, scalability, and advanced analytics. From a cost–benefit perspective, the system shows potential for improving efficiency by reducing documentation time, minimizing errors, and saving resources in the long term.

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