

## Design and Development of An Electronic Medical Record System For Maternal and Child Health and Dental Clinics at Camar Mandiri Primary Clinic, Jember

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### ABSTRACT

Camar Mandiri Primary Clinic, particularly the Maternal and Child Health (MCH) and Dental outpatient units, has not yet implemented an Electronic Medical Record (EMR) system; consequently, patient registration and data recording are still performed manually. This condition is not in line with the Indonesian Ministry of Health Regulation No. 24 of 2022. This study aims to design and develop a web-based outpatient EMR system to improve service efficiency in the MCH and Dental clinics at Camar Mandiri Primary Clinic. This study employed a Research and Development (R&D) approach. Data were collected through observations and interviews involving two medical records staff, one dentist, one midwife, one pharmacist, and the clinic head. The system was developed using the waterfall method, which includes system flowcharts, context diagrams, Data Flow Diagrams (DFD), and Entity Relationship Diagrams (ERD). Data were collected through observation and interviews. The result is a web-based outpatient EMR system for the MCH and Dental clinics at Camar Mandiri Primary Clinic. Black-box testing results demonstrate that the system aligns with user needs, is user-friendly, and adequately supports clinical examination and reporting functions. Future development is recommended by adding more comprehensive and complex features, particularly modules related to pharmacy services and cashier management.

**Keywords:** Clinic; Electronic Medical Record (EMR); Waterfall

### INTRODUCTION

Regulation of the Minister of Health No. 9 of 2014 states that clinics, as one of the healthcare service institutions providing primary-level care, function to improve the overall health status of the community and are designed to be easily accessible to the public (1). Clinics, as healthcare service providers, are required to properly organize and maintain medical records. Regulation of the Minister of Health No. 24 of 2022 stipulates that Electronic Medical Record (EMR) must be implemented in all healthcare facilities to improve the quality of healthcare services and to realize the administration and management of integrated, electronic-based medical records (2). The implementation of EMR should at least include patient registration, data distribution, clinical information entry, information processing, data input, data storage, and quality assurance activities.

Based on a preliminary study conducted by the researchers, the Maternal and Child Health (MCH) Clinic and Dental Clinic at Camar Mandiri Primary Clinic use the P-Care application for patient registration for both BPJS-insured and general patients. However, the medical examination histories of both BPJS and general patients are recorded only in manual medical record forms. This condition results in a high risk of record loss and contributes to an increasing volume of physical medical records, despite the relatively high number of patient visits each month. The patient visit data are presented in the following table.

**Table 1. Patient Visits at Camar Mandiri Primary Clinic**

Month	Clinic			Number of Patients
	General Clinic	Dental Clinic	MCH Clinic	
July	1808	345	69	2222
August	2109	298	67	2474
September	2044	305	74	2423

Month	Clinic			Number of Patients
	General Clinic	Dental Clinic	MCH Clinic	
October	2046	338	47	2431
November	1851	286	56	2193
December	2140	302	67	2509
<b>Total</b>				<b>141.252</b>

Table 1 shows that the high number of patient visits to the Maternal and Child Health and Dental clinics is not proportional to the availability of registration staff, as only one registration officer is assigned. This imbalance may result in long queues and extended waiting times. Observational findings indicate that the patient registration process takes approximately 13 - 15 minutes, which does not meet the Minimum Service Standards, where the outpatient registration waiting time should be  $\leq 10$  minutes. Registration waiting time has a significant impact on patient satisfaction; shorter waiting times tend to increase patient satisfaction, whereas longer waiting times may lead to dissatisfaction with healthcare services (3).

In addition, no protective folders are provided for the medical record forms of general patients. Medical records should be equipped with protective covers to maintain the integrity and proper arrangement of forms and to prevent documents from becoming detached or torn. This condition reflects the weaknesses of a manual medical record management system that relies heavily on physical documents. Therefore, a web-based Electronic Medical Record (EMR) system is required to store patient data digitally in a structured and centralized manner, thereby minimizing the risk of document loss or damage and enabling authorized personnel to access patient histories at any time (4).

Furthermore, the limited capacity of medical record storage shelves prevents patient records from being properly organized. As a result, filing becomes disordered and several folders protrude from the shelves, potentially causing physical damage to the folders and the loss of important information contained in the medical records (5). Torn medical record folders and forms may result in the loss of medical record numbers and patients' service histories. These issues highlight the need for a web-based system that does not rely on physical storage space, enabling medical record data to be managed efficiently, securely, and with improved retrievability.

The MCH and Dental clinics still perform report data processing manually, including visit reports and physician service statistics. Staff are required to record data manually and subsequently recapitulate it using Microsoft Excel, resulting in duplicated workloads. Therefore, an information system is needed to support staff in processing medical record data more efficiently. Proper medical record data management can produce accurate reports and support decision-making processes. This is further reinforced by systematic data recording, as all information required for effective medical record management is obtained during the documentation process (6).

Based on the identified problems, this study focuses on the development of an integrated Electronic Medical Record (EMR) system for the Dental Clinic and the Maternal and Child Health Clinic to support systematic medical record documentation, efficient data management, and real-time updating of patient information. A well-designed information system can be evaluated by its ability to present accurate and timely information and to be easily accessed anytime and anywhere through internet connectivity. This is consistent with Kholili (2022), who stated that web-based systems offer broad accessibility and enable users to obtain fast and accurate information efficiently (7). Previous studies focused only on designing electronic medical records at the registration unit, without addressing the design of EMR systems in the Maternal and Child Health Clinic and Dental Clinic (8,9). However, these clinics represent essential clinical services that generate critical health data, highlighting the need for an integrated EMR design to support continuity of care, data accuracy, and improved healthcare service quality.

Accordingly, this study seeks to design and implement an Electronic Medical Record (EMR) system to enhance healthcare service delivery at Camar Mandiri Primary Clinic, Jember, with a specific focus on the Maternal and Child Health and Dental clinics.

## METHODS

This study employed a Research and Development (R&D) approach using the waterfall method, which consists of the following stages.

### Requirements analysis and definition

This stage involves identifying problems and analyzing system requirements through data collection using interviews and observations. This stage represents the initial phase of data requirements analysis, conducted through data collection using interviews, observations, and brainstorming, as well as the development of a simple interface design for the proposed system. Following the creation of the interface design, brainstorming sessions were carried out to identify solutions to existing problems and to develop an

initial representation of the Electronic Medical Record (EMR) system based on the designed interface. The resulting interface design was then used as a reference for developing the outpatient EMR system for the Maternal and Child Health and Dental clinics at Camar Mandiri Primary Clinic.

#### **System and software design**

This stage involves the development of the system design, including flowcharts, context diagrams, Data Flow Diagrams (DFD), and Entity Relationship Diagrams (ERD).

#### **Implementation and unit testing**

This stage involves implementing program code or scripts into the software using the PHP programming language, along with the development of the database.

#### **Integration and system testing**

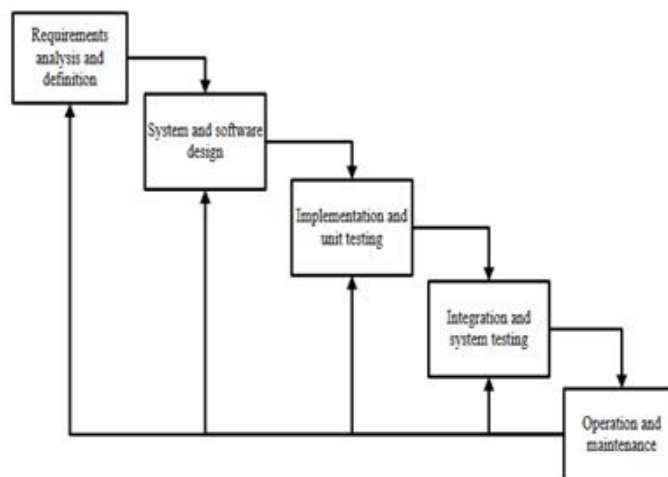
This stage is conducted to minimize errors and ensure that the system outputs meet user requirements by identifying potential errors using the black-box testing method.

#### **Operation and maintenance**

This stage was not carried out in the present study.

Data collection to identify problems and user requirements was conducted through interviews and observations. Interviews were carried out with two medical record staff members, one dentist, one midwife, one pharmacist, and the head of Camar Mandiri Primary Clinic. In this study, observations were conducted at Camar Mandiri Primary Clinic to obtain the primary data required, including patient data, staff data, and diagnostic data, for the development of an outpatient Electronic Medical Record (EMR) system for the Maternal and Child Health and Dental clinics. The research results are presented in the form of figures accompanied by explanatory descriptions.

The tools used for the design and development of the outpatient EMR system included: (1) a laptop; (2) Microsoft Word 2010; (3) Microsoft Visual Studio Code; (4) XAMPP; and (5) PHP version 8.3 using the Laravel framework. The data required for designing the EMR system consisted of: (1) staff data; (2) patient data; (3) diagnostic data; and (4) interview and observation data. This study posed no ethical issues, as evidenced by ethical approval number 546/PL17.4/PG/2024 issued by the Ethics Committee of Politeknik Negeri Jember.



**Figure 1. Waterfall Diagram Method**

## **RESULTS**

### **User Requirements Analysis**

The requirements analysis stage consisted of identifying problems and determining system menu requirements based on user needs. The problem identification revealed that, during the patient registration process at Camar Mandiri Primary Clinic, registration staff were required to manually record patient demographic data on medical record folders, medical record forms, and patient registers using Microsoft Excel, resulting in suboptimal information management. In addition, duplication of medical record numbers was identified. These findings are consistent with the interview results obtained from respondents, as presented below.

*“An electronic medical record system has not yet been implemented; patient registration is still handled manually. As can be observed, having only one registration officer manage various types of patients is clearly overwhelming. In addition, duplication of medical record numbers occurs, particularly during shift changes when data are not always properly saved, resulting in duplicate records.” (Respondent 1)*

*“An electronic medical record system has not yet been implemented. When new patients arrive, we are required to manually write patient identities on folders and multiple forms, and also enter the data into Excel.” (Respondent 2)*

Furthermore, medical examination histories are documented manually using paper-based medical record forms. This approach prolongs documentation time, increases the likelihood of recording errors, and elevates the risk of data loss (10). Consequently, manual documentation is considered inefficient and contributes to incomplete medical records (11–15). The implementation of EMR has been shown to enhance the completeness of medical record documentation (16–20).

In addition, the available medical record storage shelves are insufficient to accommodate the current volume of records. This condition results in poorly organized filing and increases the risk of document damage, as several folders protrude from the storage shelves. Inadequate storage capacity forces records to be stored in overcrowded conditions, leading to disorganized filing and physical damage to medical records (21–24). This finding is supported by the statements of the following informants.

*“Medical records here are still paper-based, and sometimes when they are returned to the shelves, the folders become bent. In addition, several storage racks are already full, causing some folders to protrude from the shelves.” (Respondent 1)*

Based on these issues, the researchers conducted an identification of user requirements. The required system menus for the Maternal and Child Health and Dental clinics were determined based on the interview results. Users indicated the need for a system that can accelerate and simplify their work processes, as well as a system that is easy to understand and does not require extensive time to learn how to operate.

*“If possible, the medical record number should be unified so that it continues from the existing numbering system. The system should include a feature to upload laboratory examination results, allow patients to be recalled in the clinic queue, and enable patient data searches using either the medical record number or national identification number (NIK KTP).” (Respondent 1)*

*“From my perspective, the system should provide a diagnosis dropdown menu integrated with ICD-10 codes, as doctors here assign diagnoses along with the corresponding codes.” (Respondent 5)*

In addition, respondents indicated the need for an examination form integrated within a single interface together with prescription entry to facilitate data input and minimize excessive navigation between pages. The expected outpatient medical record information system should include features such as recalling missed patients in the clinic queue, uploading laboratory test results, and providing a diagnosis dropdown menu integrated with ICD-10-CM codes within the examination module. In the registration module, the system is expected to automatically generate sequential medical record numbers and allow patient data searches using keywords such as the national identification number or medical record number.

### **Electronic Medical Record (EMR) System Design**

At the design stage, the researchers developed the information system design using system modeling techniques, including flowcharts, context diagrams, Data Flow Diagrams (DFD), and Entity Relationship Diagrams (ERD), which were tailored to user requirements identified during the needs analysis.

#### **Flowchart**

A flowchart represents a sequence of processes and their interrelationships using standardized symbols (25–28). Flowcharts can help explain the workflow of outpatient services, starting from patient arrival until the patient leaves the clinic. The following figure presents the flowchart of the EMR system.

The program flowchart of the outpatient Electronic Medical Record (EMR) system for the Maternal and Child Health and Dental clinics at Camar Mandiri Primary Clinic, Jember, consists of several user entities, including registration staff, dentists, midwives, administrators, pharmacists, and the clinic head. The system defines role-based access rights tailored to each user, where registration staff can access only the registration and medical record menus, dentists can access only the dental clinic examination menu, midwives can access only the Maternal and Child Health clinic examination menu, administrators can access all EMR menus, pharmacists can access only the pharmacy menu, and the clinic head is limited to viewing the medical record menu.

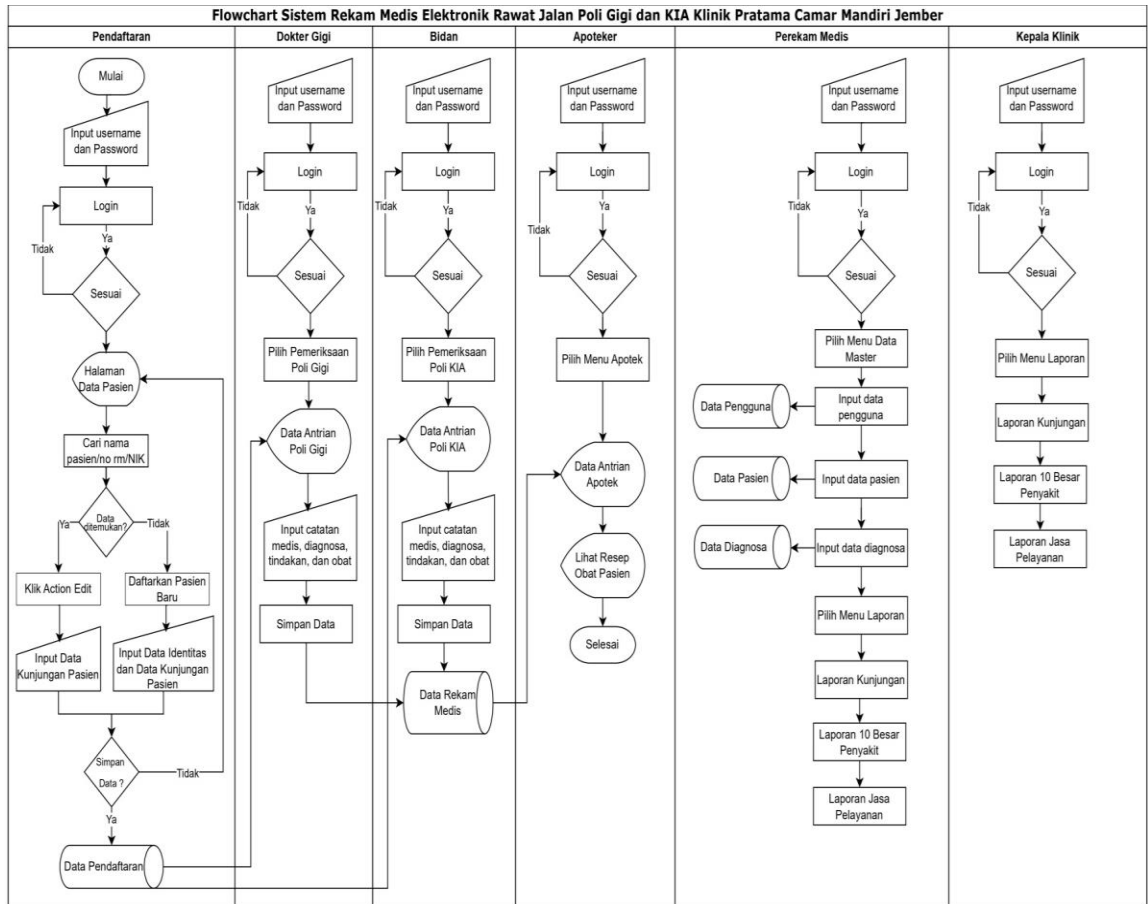


Figure 2. Flowchart of the Outpatient EMR System for the Maternal and Child Health and Dental Clinics at Camar Mandiri Primary Clinic

**Context Diagram**

A context diagram is a high-level diagram that represents an information system by illustrating data flows into and out of the system and between the system and external entities (29–31). A context diagram, also known as a Level 0 Data Flow Diagram (DFD), is used to define the context and boundaries of a system (32,33).

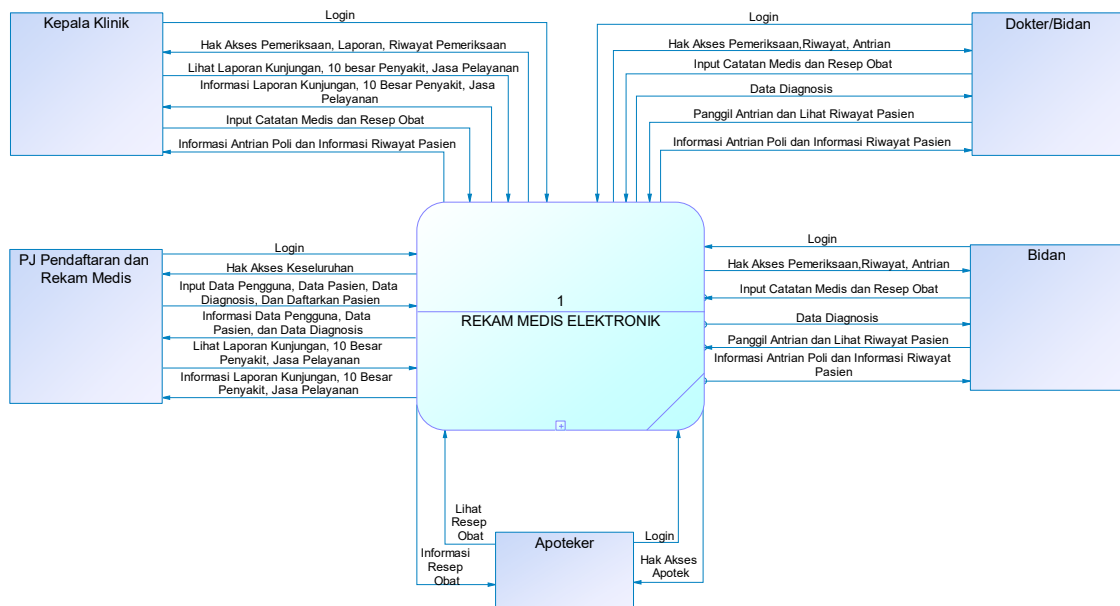


Figure 3. Level 0 Data Flow Diagram (DFD)

A context diagram provides a simplified representation of system inputs and outputs (34). The figure above illustrates the overall processes of the outpatient EMR system implemented in the Maternal and Child Health and Dental clinics, involving six entities: registration staff, dentists, midwives, administrators, pharmacists, and the clinic head. Administrators are responsible for managing medical records and entering master data. Registration staff register patients for examinations and access reports through the medical record menu. Dentists and midwives are responsible for entering patients' examination results and reviewing examination histories. Pharmacists are responsible for preparing medications according to prescriptions entered by dentists or midwives. The clinic head monitors and reviews reports available in the medical record menu.

**Entity Relationship (ERD)**

An Entity Relationship Diagram (ERD) is one of the most commonly used initial models for database design. Sihoang et al. (2021), as cited in Yanto et al. (2024), stated that an ERD is a model used to represent data within a database based on database objects and the relationships among them (35). The following figure illustrates the ERD of the EMR system for the Maternal and Child Health and Dental clinics at Camar Mandiri Primary Clinic, Jember.

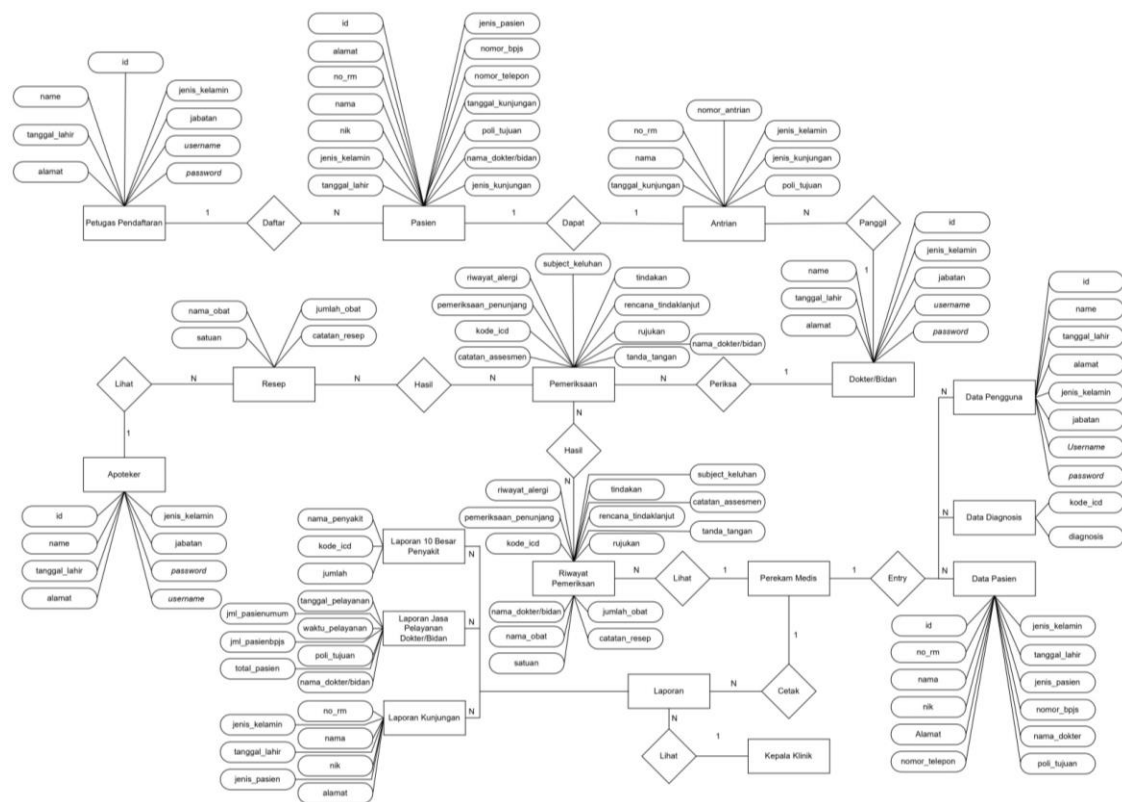


Figure 4. Entity Relationship Diagram (ERD)

The ERD design is used to represent entities and the relationships among their attributes within the application and the database, ensuring proper integration between both components and forming a unified information system that can be effectively utilized (36). The designed ERD includes six user tables, consisting of registration staff, patients, dentists/midwives, pharmacists, medical record officers, and the clinic head. Each user is able to access the EMR system according to access rights defined by the administrator.

**Electronic Medical Record Implementation**

The implementation stage is the phase in which system coding is carried out based on the previously designed system architecture (37). This stage describes the design process and provides an explanation of the system implementation using the PHP programming language with the Laravel framework and a MySQL database.

### Initial Interface of the Electronic Medical Record (EMR) System



Figure 5. Initial Interface of the Outpatient EMR Website at Camar Mandiri Primary Clinic, Jember

The figure above shows the initial interface displayed when accessing the outpatient EMR website of Camar Mandiri Primary Clinic, Jember. To access the system, users must select the login option, which will then direct them to the login page.

### EMR Login Interface

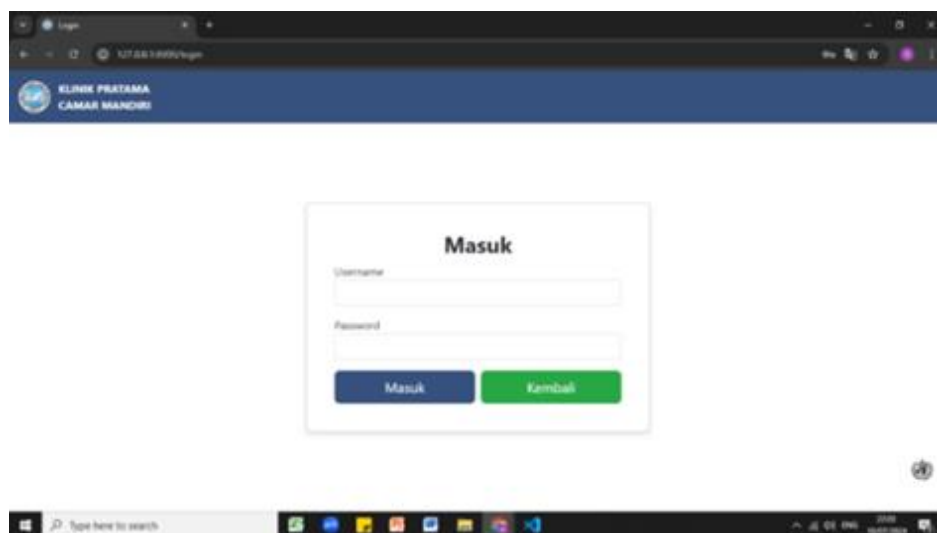


Figure 6. Login Page

The login page is used to access the system. Users are required to enter a username and password that have been assigned according to their access rights stored in the database. When the entered username and password match the database records, users are granted access to the system in accordance with their assigned roles.

### EMR Dashboard Interface

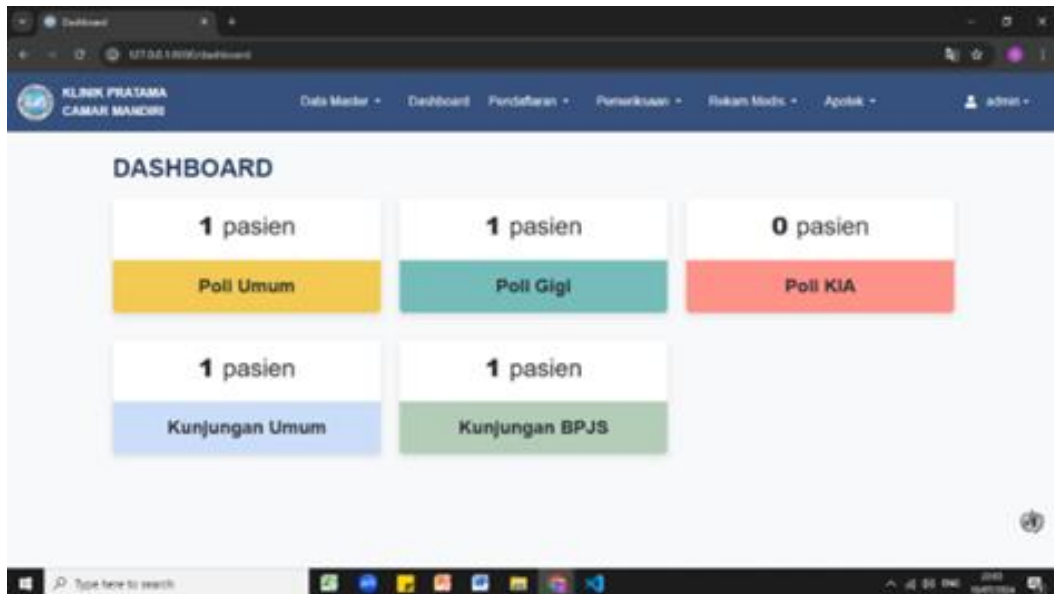


Figure 7. Dashboard Page

The dashboard page is displayed after the user successfully logs in using a valid username and password. The dashboard presents information on the number of daily patient visits based on the target clinic and type of visit. A sidebar menu is available at the top of the interface, and menu items can be accessed according to the user's assigned access rights.

### EMR User Data Interface

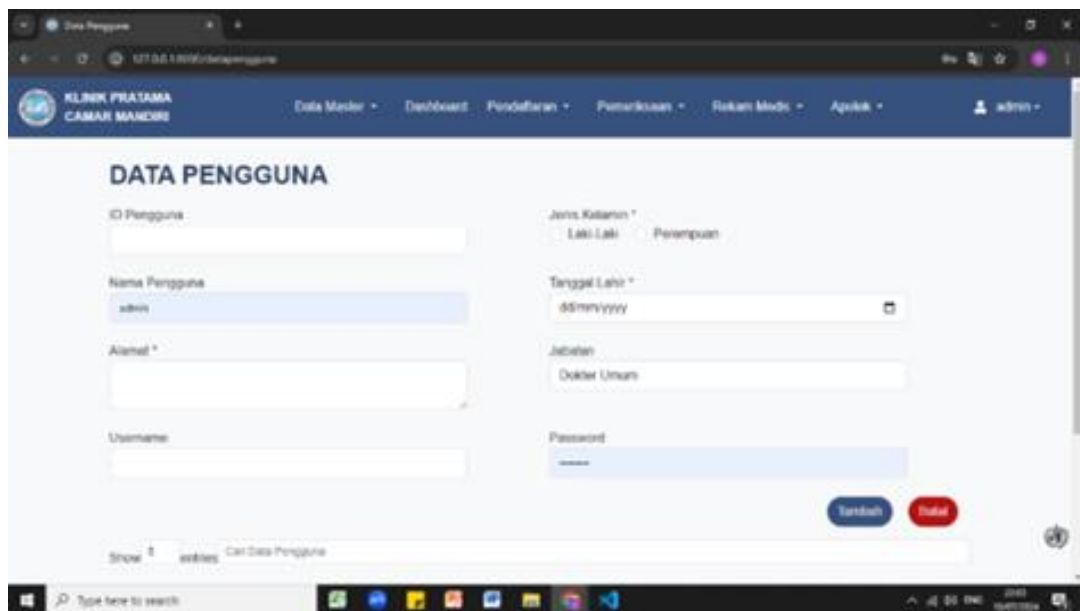


Figure 8. User Data Page

The user data page displays the master data of system users who are authorized to access the system according to predefined access rights. Administrators are able to add new users based on the required access levels. Each user is assigned a username and password, which must be remembered in order to access the outpatient EMR website.

### EMR Patient Data Interface

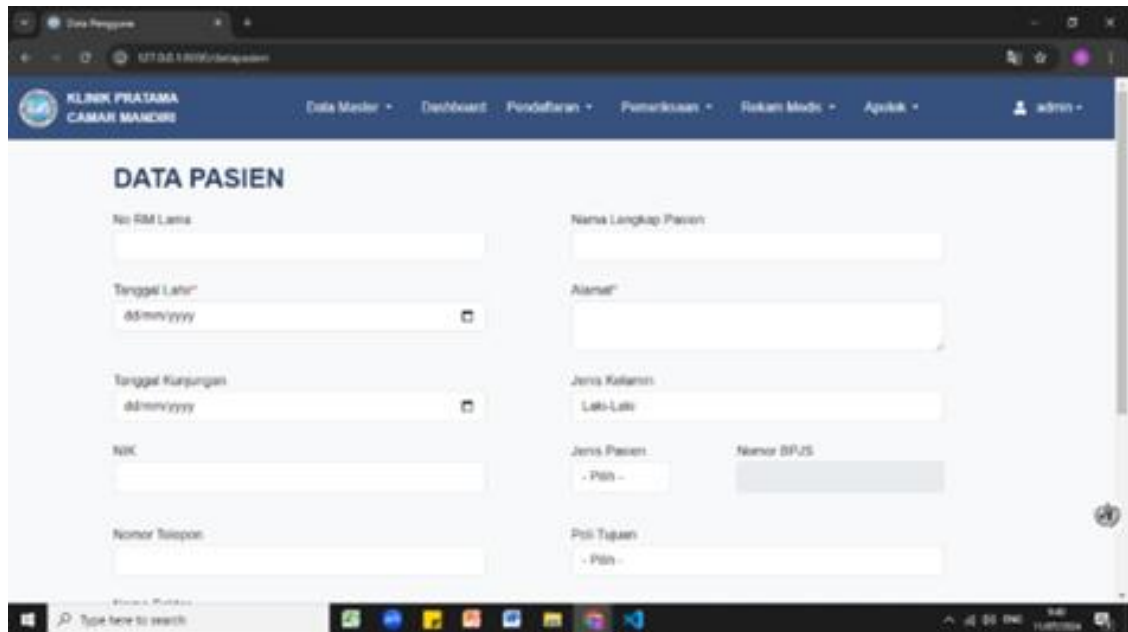


Figure 9. Patient Data Page

The patient data menu contains patient information registered at Camar Mandiri Primary Clinic, Jember. Patient data displayed on this page can be added, edited, or deleted as needed. This page can only be accessed by administrators.

### EMR Diagnosis Data Interface

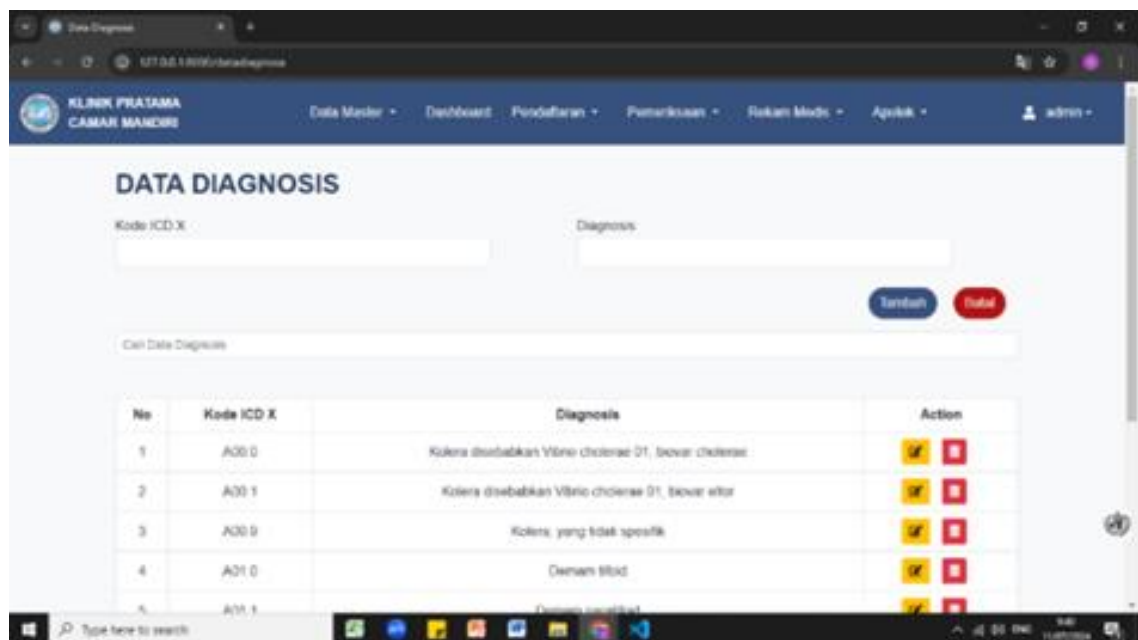
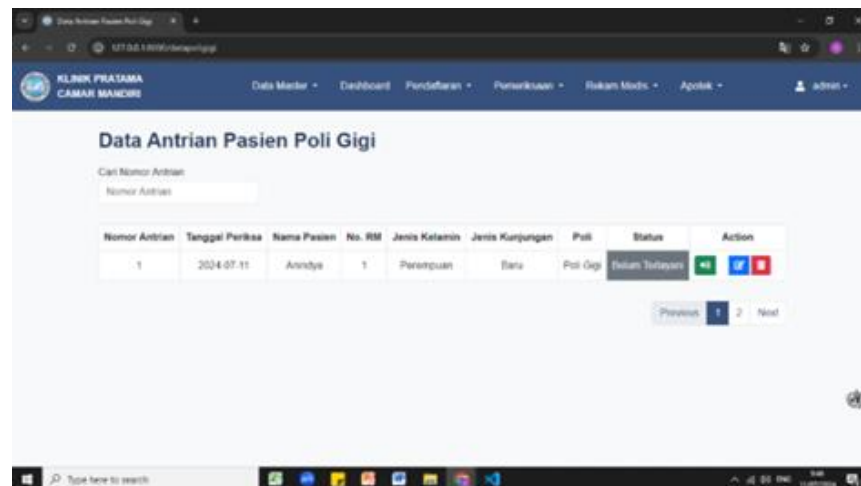


Figure 10. Diagnosis Data Page

The diagnosis data menu displays the list of diagnoses available at Camar Mandiri Primary Clinic, Jember. The existing diagnosis data serve as a reference for physicians when assigning diagnoses to patients. When a doctor or midwife enters a diagnosis code in the examination form, the corresponding diagnosis is automatically displayed based on the entered code.

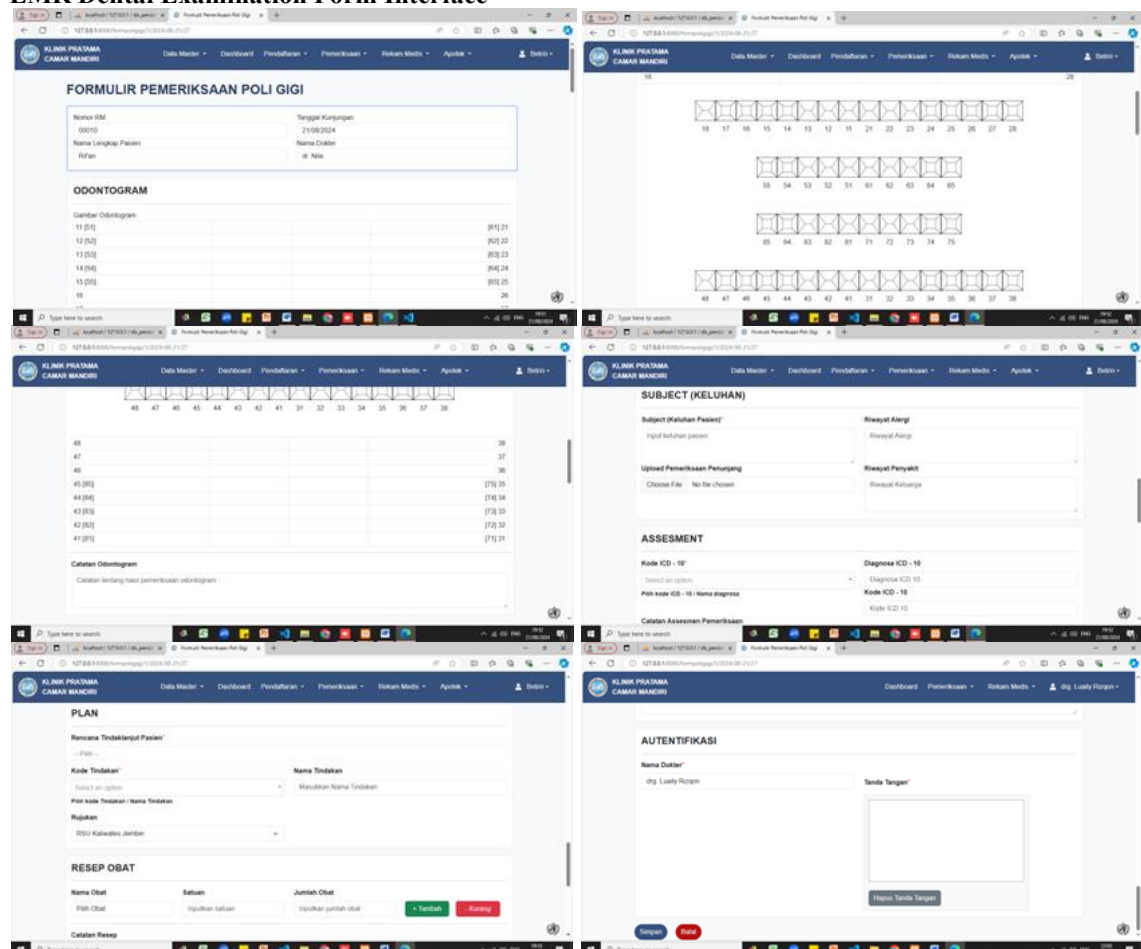
**EMR Examination Menu Interface**



**Figure 11. Examination Menu Page**

The clinic queue display presents a list of patients waiting for examination according to the designated clinic. The queue list includes queue number, examination date, patient name, medical record number, gender, target clinic, and service status, which consists of not yet served, in service, and service completed, as well as action options including call queue, edit, and delete. Doctors or midwives can call patients according to the existing queue order by selecting the sound icon in the action column. When the patient is present, the doctor or midwife can select the edit action to enter the patient’s examination results into the examination form according to the respective clinic.

**EMR Dental Examination Form Interface**



**Figure 12. Dental Examination Form Page**

The dental examination form can only be accessed by dentists and administrators. This form includes an odontogram image used to mark the teeth complained of by the patient; a subjective section containing the patient’s chief complaint, allergy history, and medical history, as well as an option to upload supporting examination results; an assessment section consisting of ICD-10 codes and clinical assessment notes; and a plan section that includes follow-up plans, procedures provided to the patient, and referral information. The prescription section contains the medication name, dosage unit, quantity, and prescription notes. Finally, an authentication section is provided, including the dentist’s name and signature. Once the dentist completes the examination, the form can be saved; however, if any required fields are left empty, the system will return the form to the section where the data have not been completed.

### EMR Maternal and Child Health (MCH) Examination Form Interface

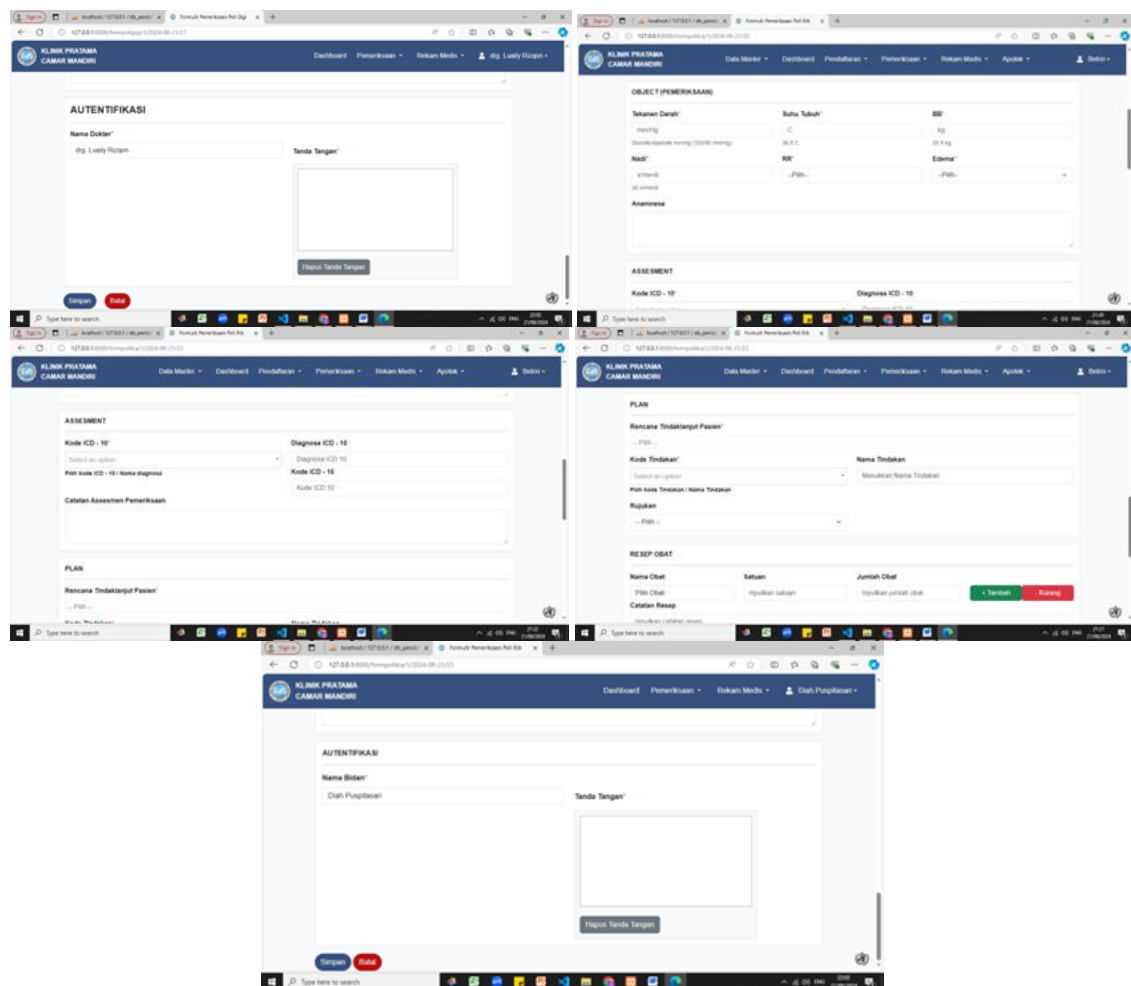


Figure 13. MCH Examination Form Page

The MCH examination form can only be accessed by midwives and administrators. This form includes a subjective section containing the patient’s chief complaint, allergy history, medical history, and an option to upload supporting examination results; an objective section comprising blood pressure, body temperature, body weight, pulse rate, respiratory rate, edema status, and anamnesis; an assessment section containing ICD-10 codes and clinical assessment notes; and a plan section that includes follow-up plans, procedures provided to the patient, and referral information. The prescription section consists of medication name, dosage unit, quantity, and prescription notes. Finally, an authentication section is provided, including the midwife’s name and signature. Once the midwife completes the examination, the form can be saved; however, if any required fields are left incomplete, the system will return the form to the section where the missing data need to be completed.

### EMR Pharmacy Menu Interface

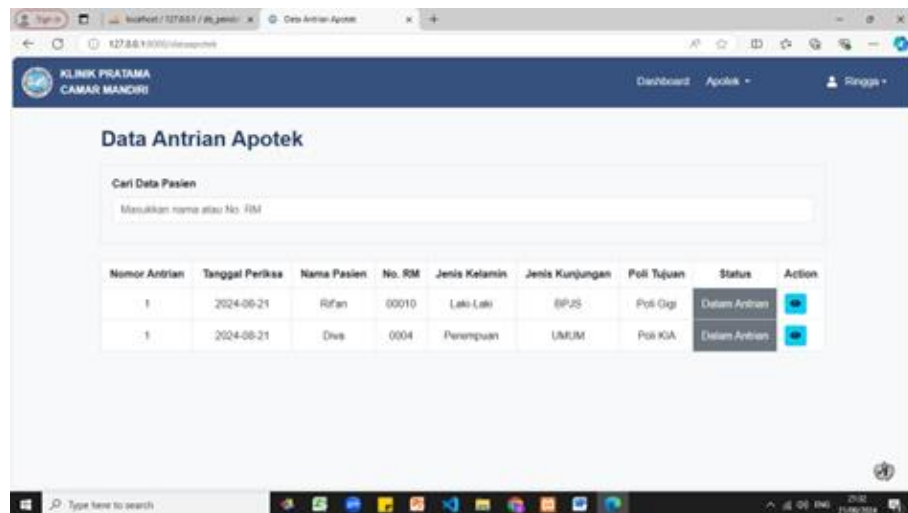


Figure 14. Pharmacy Menu Page

The pharmacy menu interface displays a queue of patients whose clinical services have been completed and who are waiting for their medications to be prepared. The queue list includes the queue number, examination date, patient name, medical record number, gender, type of visit, target clinic, patient service status, and available actions. When the pharmacist wishes to view a patient’s prescription, the pharmacist can select the eye icon in the action column, which will display the prescription details as shown in the figure below.

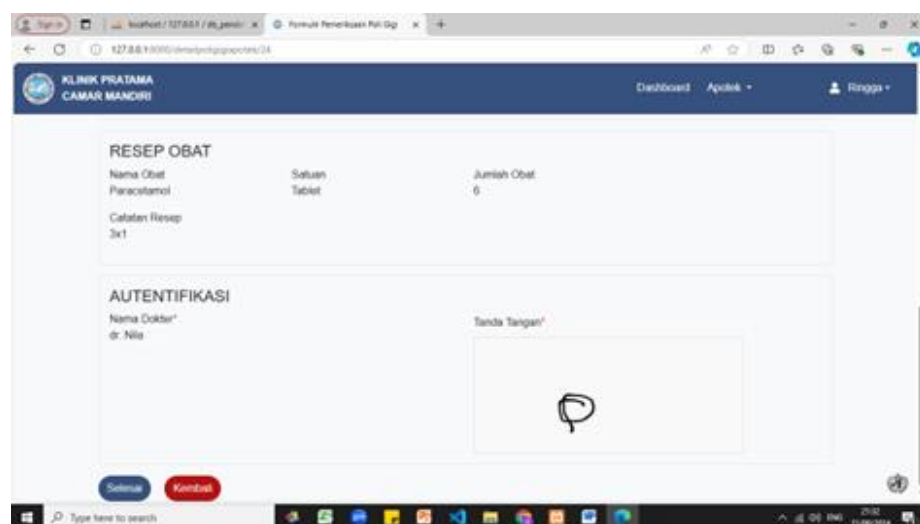


Figure 15. Prescription View Page

The figure above shows the interface displayed when the pharmacist reviews a patient’s prescription prior to medication dispensing. This page presents the patient’s examination history and prescribed medications. Once the pharmacist has completed medication preparation, the process can be finalized by selecting the “complete” option.

## DISCUSSION

### Electronic Medical Record (EMR) Testing

Testing in this study was conducted using the black-box testing technique. Black-box testing focuses solely on functional requirements and the conformity of system components with specified system requirements, without examining system design or source code. The following are the results of EMR testing for the Maternal and Child Health and Dental clinics at Camar Mandiri Primary Clinic, Jember. All core system features were successfully validated, including:

1. Login: All users (administrators, dentists, midwives, and pharmacists) were able to log in using valid credentials.
2. Master Data: Functions for adding, editing, deleting, searching, and displaying user, patient, and diagnosis data operated as expected.
3. Clinic Examination: In both the Maternal and Child Health and Dental clinics, the system successfully displayed patient queues, supported queue number searches, enabled patient calling, allowed entry of examination results, facilitated the upload of supporting examination files (PDF), and stored examination records properly.
4. Pharmacy: Pharmacists were able to view patient queues and prescriptions entered by dentists or midwives.
5. Patient service histories were displayed accurately.
6. Visit reports could be generated based on overall data, date, and target clinic, and exported in Excel and PDF formats.
7. Top ten disease reports and service fee reports were accessible based on selected parameters (date, clinic, and medical personnel) and exportable to Excel and PDF formats.

Discussions with healthcare professionals (dentists, midwives, and pharmacists), administrators, and the clinic head indicated that the system met user requirements, was easy to understand, and effectively supported clinical examination and reporting functions. This ease of use enables healthcare professionals to follow service workflows without increasing their workload, while also improving the consistency of medical record documentation.

Furthermore, the integrated EMR system supports clinical reporting functions for both internal purposes and routine reporting requirements of healthcare facilities. Rapid data access and the ease of updating patient information facilitate the availability of accurate and continuous data. Consequently, the implementation of the EMR system in the Dental Clinic and MCH Clinic is expected to contribute to improved work efficiency, enhanced quality of medical record documentation, and better clinical and managerial decision-making.

## CONCLUSION

User requirements related to the Electronic Medical Record (EMR) system were carefully and thoroughly identified. The process design, database structure, and user interface were developed based on the results of the requirements analysis. The resulting design was subsequently evaluated by involving prospective users to obtain feedback on the proposed system. The main required features included the ability to recall missed patients, upload laboratory examination results, provide a diagnosis dropdown integrated with ICD-10 codes, automatically generate sequential medical record numbers, and enable patient data searches using either the national identification number or medical record number. System testing was carried out involving end users to verify that the system functioned as expected. Black-box testing was applied, and demonstrate that the system aligns with user needs, is user-friendly, and adequately supports clinical examination and reporting functions. Future development is recommended by adding more comprehensive and complex features, particularly modules related to pharmacy services and cashier management.

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