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Improving the Functionality of the Electronic Health Record System through the Development of the Anesthesia Module

Muhammad Reza Fahlevi[1], Teddie Darmizal[2], Muhammad Affandes[3], Nazruddin Safaat H[4]

[1,2,3,4]Department of Informatics Engineering, Faculty of Science & Technology, Sultan Syarif Kasim Riau State Islamic University, Pekanbaru, Indonesia

Corresponding author: *Teddie Darmizal

ABSTRACT

Background: With the advancement of healthcare technology, the use of Electronic Health Records (EHR) has become more effective, providing benefits such as cost reduction, improved healthcare quality, and enhanced data recording and mobility. To remain effective, EHRs must meet requirements such as data completeness, failure resilience, high availability, and security. Pekanbaru army hospital has adopted EHR since 2022 for several main services, except for the anesthesia service. The anesthesia service still uses paper records, which are inefficient and lag behind other services. The anesthesia process, involving extensive information and coordination, greatly requires an EHR system. The development of an anesthesia module is expected to facilitate anesthesiologists and nurse anesthetists in managing patient medical information and assist in the execution of surgical procedures.

Objective: This study aims to improve the functionality of the electronic health record system (EHRS) in managing medical records in the anesthesia installation service by developing an anesthesia module at the Pekanbaru Army Hospital.

Method: The software development methodology used in this research is Agile Methodology where the process of analyzing user needs, collecting data, implementing the system, and evaluating and validating the system.

Result: The Anesthesia Module that has been built has various features including: anesthesia patient registration, pre-anesthesia patient data recording, anesthesia induction, post-anesthesia, anesthesia reports, and integration with laboratory and radiology systems. Through testing carried out with the black box test technique, 98% of the system functionality runs well and with the user acceptance test technique, 94% of the system functionality can be accepted by users.

KEYWORDS: Anesthesia Module, Electronic Health Record, Operating Room, Hospital Information System

I. INTRODUCTION

Electronic Health Record Systems (EHRs) are collections of patient health data in digital form. EHRs are increasingly being adopted as digital information systems for hospitalization that include both clinical and administrative data. The importance of the interaction between social and technical factors must be considered in the implementation and adaptation of effective strategies in complex and busy hospitals. These systems have great potential to improve the safety, quality, and efficiency of healthcare in hospitals(Tapuria et al., 2021).

The use of EHRs in medical practice has increased significantly in recent years. EHRs offer valuable opportunities to improve health monitoring and evaluate healthcare services, which can lead to improved management and promotion of public health(Kataria & Ravindran, 2020). Research shows that most physicians use the available information to thoroughly assess a patient's condition, assist with clinical decision-making, and facilitate communication between patient care teams(Evans et al., 2014). As of June 2013, three-quarters of physicians in the United States have used EHRs in their practices(Kruse Clemens Scottand Kothman, 2016).

The widespread implementation of EHRs allows for the digital recording of patients and the extraction of useful clinical data. Some accessible secondary applications include quality management, health management, and translational research(Hanauer et al., 2015). All these secondary applications aim to improve patient care(C. P. Friedman et al., 2010; C. Friedman & Rigby, 2013). The quality of healthcare depends on the quality of the data. Therefore, inaccurate data can lead to many errors(Abramson et al., 2011).

With the development of healthcare technology, the use of EHRs has become more effective and provides benefits such as lowering costs, improving the quality of healthcare, and aiding data recording and mobility. To remain effective, EHRs must meet requirements such as data completeness, resilience to failure, high availability, and security(Allard et al., 2010).

Some governments have shown interest in using EHRs because of the expected benefits. For example, in 2004, the United States government decided that most Americans should be connected to an EHR system by 2014(Hesse et al., 2010). The American Recovery and Reinvestment Act of 2009 set aside $19 billion for the digitization of health records in the US. Similarly, the European Union countries plan to have a similar health system by 2015, as per a high-level eHealth conference in 2010. The aim is to create quality and efficient healthcare(Benaloh et al., 2009).

EHR development in Taiwan was initiated by the National Health Informatics Project. Statistics in 2016 showed that 411 out of 496 hospitals (80.4%) and approximately 5,244 out of 9,782 private clinics (53.6%) in Taiwan have been certified as having interoperable EHRs(Wen Hsyien-Chiaand Chang,

2019). In Indonesia, although the implementation of EHRs has not been evenly distributed in all hospitals, it continues to grow along with the advancement of information technology. However, there are several obstacles, such as technical standards, information security, and interoperability between EHRs(Tilaar & Sewu, 2023). The Indonesian Ministry of Health has made it mandatory for every health facility to have an EHR, but standardization of EHR formats has never been passed, and regulations regarding mandatory EHRs are not explained in detail, making medical record integration between health facilities impossible(Emanuel, 2019).

The implementation of EHRs in various hospital departments has many positive impacts, both for hospitals and patients. The survey shows that 66% of respondents prefer EHRs over paper records, with 51% stating EHRs save time, 33.7% saying EHRs store more data, 30.6% citing easier data access, 22.1% stating easier report generation, and 30.3% stating EHRs improve service quality(Oumer et al., 2021).

Pekanbaru Army Hospital, a class D general hospital, has adopted EHR since 2022 with several key modules, except the surgical module. The surgical module still uses paper records, which is inefficient and lags behind other services. The anesthesia process, which involves a lot of information and coordination, urgently needs an EHR system.

Therefore, the development of the anesthesia module is expected to facilitate doctors and anesthesia nurses in patient medical information management and assist the execution stage of surgery patients, thereby improving the quality of health services and care coordination at Pekanbaru army hospital.

II. METHODOLOGY

2.1. Research Design

The research design consists of stages that are integrated with each other. The purpose of research design is to provide an appropriate framework for a study. A very important decision in the research design process is the choice of research approach, as it determines how relevant information will be obtained for a study. However, the research design process involves many interrelated decisions(Jilcha Sileyew, 2020).

There are various models of software development approaches, one of which is the agile model. Agile combines incremental and iterative processes with a primary focus on customer satisfaction. This SDLC model breaks down the entire software development process into smaller, incremental steps(Schramm et al., 2023).

Agile represents a series of iterative and incremental approaches that emphasize adaptability and collaboration with customers. Agile projects are divided into short iterations called sprints, typically lasting 1-4 weeks. Agile emphasizes collaboration between developers, testers, and customers throughout the project(Hossain, 2023). Compared to traditional SDLCs such as Waterfall that require sequential execution of each step, Agile adopts an adaptive approach that allows software development teams to adapt to changing customer needs(Mishra & Alzoubi, 2023).

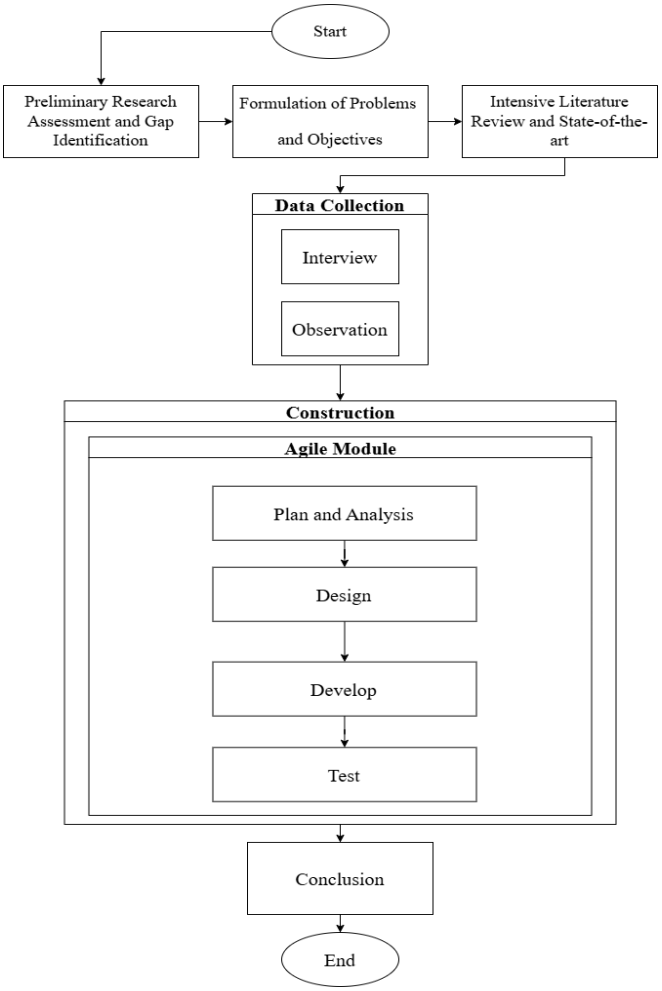

Figure 1 Research Design

2.1.1. Preliminary Research Assessment and Gap Identification

Researchers evaluated and also identified gaps that occurred in the implementation of EHR in anesthesia services. The evaluation was conducted to determine whether surgical services at Pekanbaru army hospital require an anesthesia module. The findings of the evaluation showed that the anesthesia service at Pekanbaru army hospital requires an EHR system.

2.1.2. Formulation of Problem and Objectives

The service of recording medical records in the anesthesia service of Pekanbaru army hospital still uses paper-based methods. Because the recording process is still manual, there are a number of errors, such as losing medical records and difficulties in accessing medical records. Based on the identification of these problems, an anesthesia module is needed to improve the quality of surgical services at Pekanbaru army hospital.

2.1.3. Intensive Literature Review and State-of-the-Art

Anesthesia applications focus on integration with specialized electronic health record networks, allowing anesthesia records to be connected with hospital clinical data stores. This has the potential to improve quality of care, patient safety, and operations management (Herasevich et al., 2014; Matava et al., 2020). Electronic anesthesia records

have a higher level of information completeness than handwritten anesthesia records, supporting document quality improvement and user satisfaction evaluation. In addition, this application can also save time and costs (Alkatheri et al., 2022) The application of the anesthesia module in electronic health records can also improve the analytical process, improve patient identification and registration, reduce programming or transfer errors, and improve response time(Mardani et al., n.d.).

Based on the Decree of the Director General of Medical Services No. YM. 02.03.3.5.2626 concerning the Accreditation Commission for Hospitals and Other Health Facilities (KARS), KARS has assessment standards that hospitals in Indonesia must comply with to ensure the quality, safety, and sustainability of health services. These standards are known as SNARS (National Hospital Accreditation Standards). The application of SNARS to the anesthesia module includes various aspects that must be met by the central surgical installation in the process of service. The 2017 National Hospital Accreditation Standards stipulate that central surgical installation services must meet the standards in the anesthesia and surgical services chapter(Sutoto, 2018).

By considering the information obtained from the literature review and the National Hospital Accreditation Standards, researchers built a system design using these sources as a guide in developing the anesthesia module.

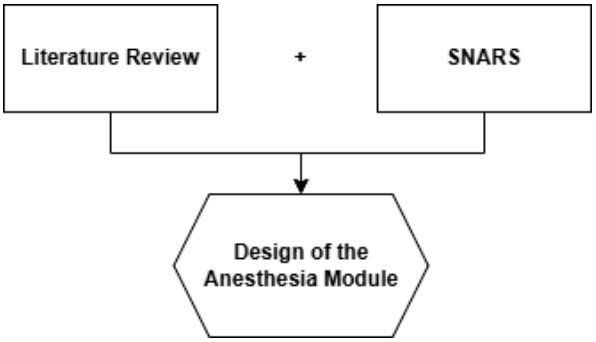

Figure 2 Design of the Anesthesia Module

The anesthesia process is divided into three parts, namely pre-anesthesia, intra-anesthesia, and post-anesthesia. The purpose of pre-anesthesia is to assess the feasibility and preparation of the patient's condition before anesthesia is performed. Intra-anesthesia is the process when anesthesia is in progress. Post-anesthesia is the process that occurs after the patient has completed the surgery process. This post-anesthesia process involves monitoring the patient by the anesthesia team after recovery from anesthesia(Bilal A. Siddiqui; Peggy Y. Kim., 2023).

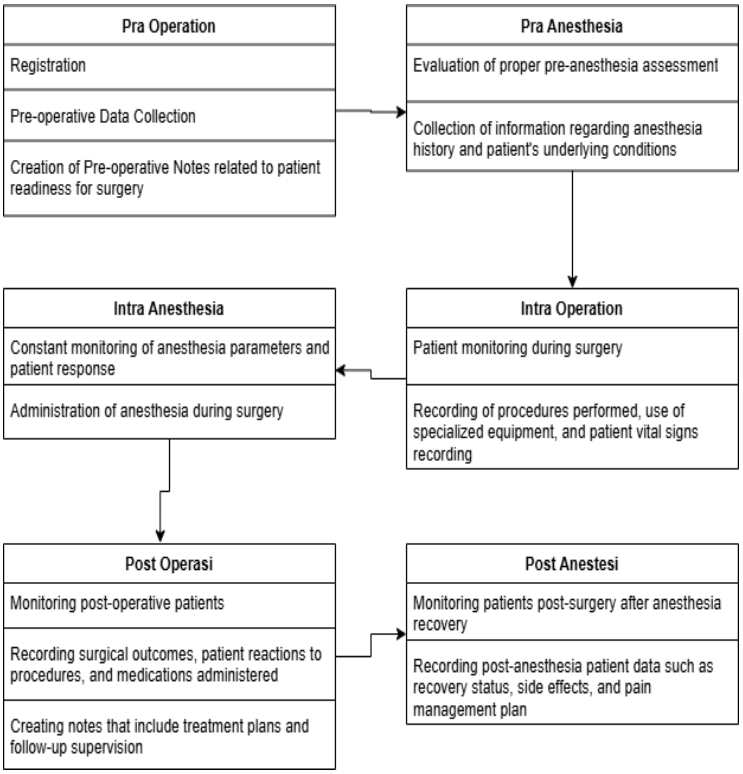

Figure 3 Business Process of the Anesthesia Module

2.1.4. Data Collection

The data collection methods used by researchers include:

1. Interview

   Interviews were conducted with anesthesia doctors and nurses at Pekanbaru army hospital. The purpose of this interview was to obtain information about the workflow of anesthesia services at the hospital. In addition, researchers also collected information about the responsibilities and roles of anesthesia medical personnel, as well as other relevant information.

2. Observation

   Observations were made of the EHR that had been implemented at Pekanbaru army hospital. The purpose of this observation is so that the system being built can be in accordance with the business processes of surgical services at the hospital.

III. RESULT

3.1. Construction

The software development method used in this research is the Agile model. The following are the stages of system design based on the Agile model.

3.1.1. Design

After the data collection process is complete, the use case diagram and class diagram are designed. The purpose of this design is to facilitate researchers in implementing the results of the analysis into the system to be created.

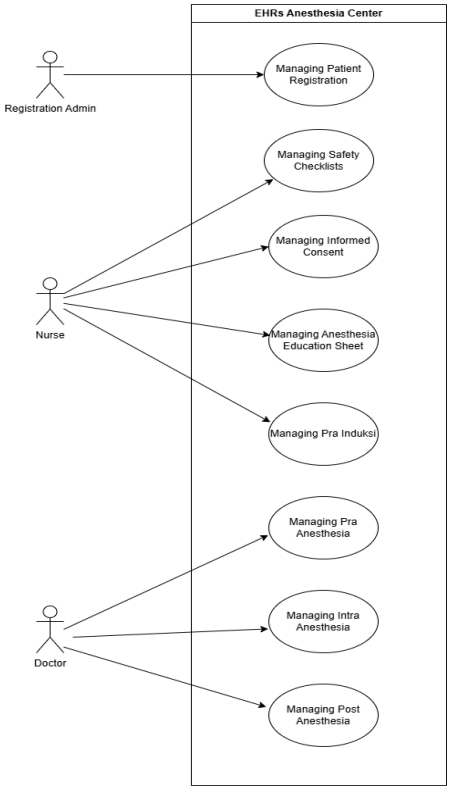

Figure 4 Use Case Diagram

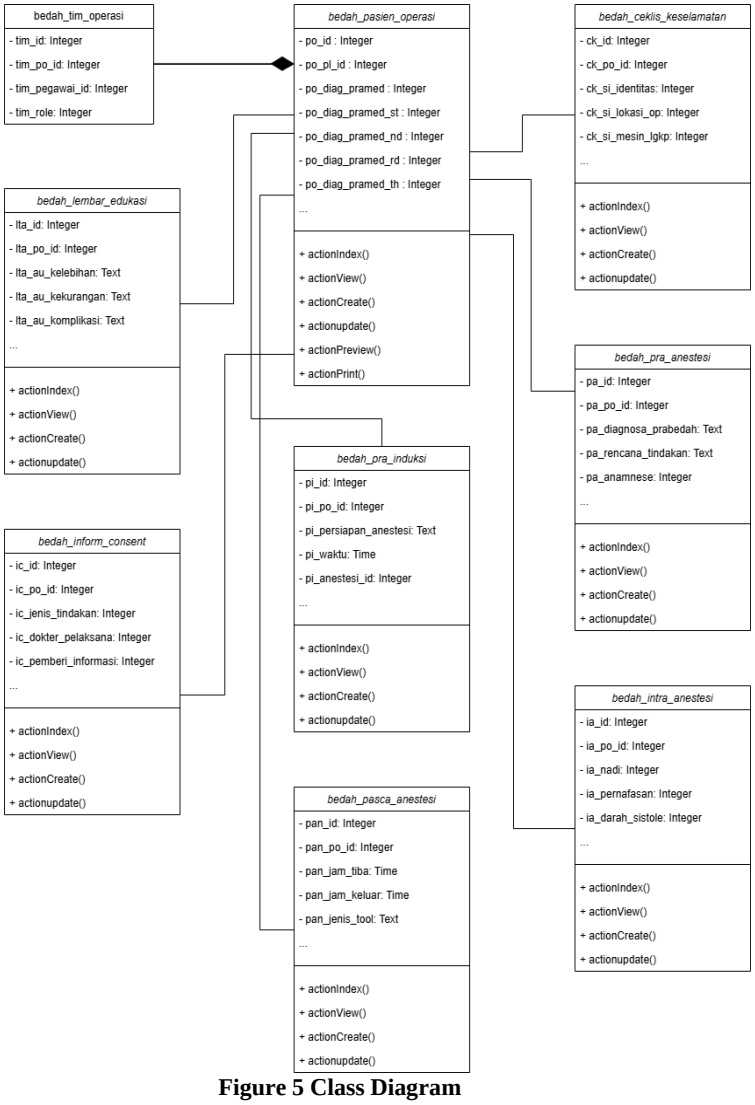

Figure 5 Class Diagram

3.1.2. Develop

In the development stage, the unified modeling language that has been created based on the previous analysis is used as a guide. This stage begins with the construction of the database and continues with the coding stage. The following is a view of the system that has been developed.

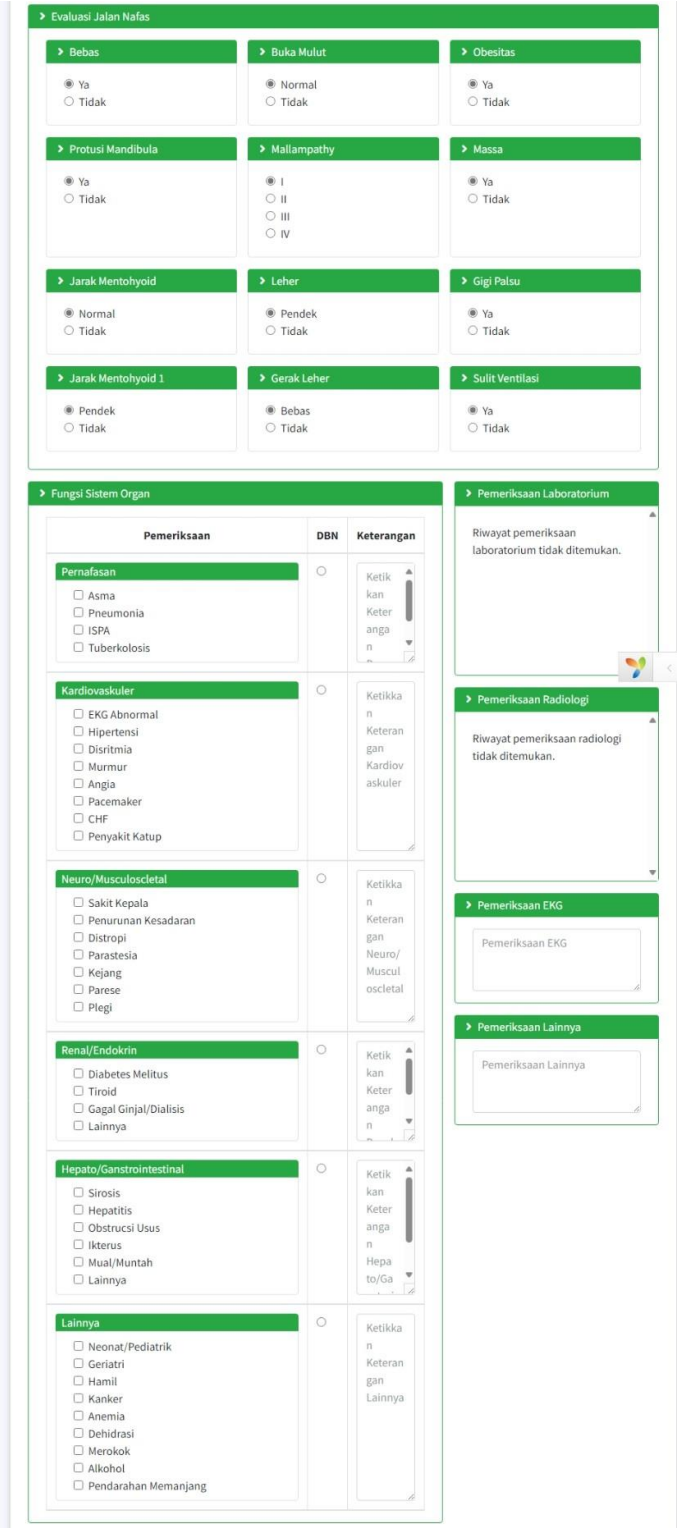

Figure 6 Form Pra Anesthesia

In the pre-anesthesia form, the user can fill in information related to the data that needs to be filled in before performing anesthesia. Such as filling in for pre-surgical

diagnoses, action plans, anesthesia, anesthesia history, and other forms.

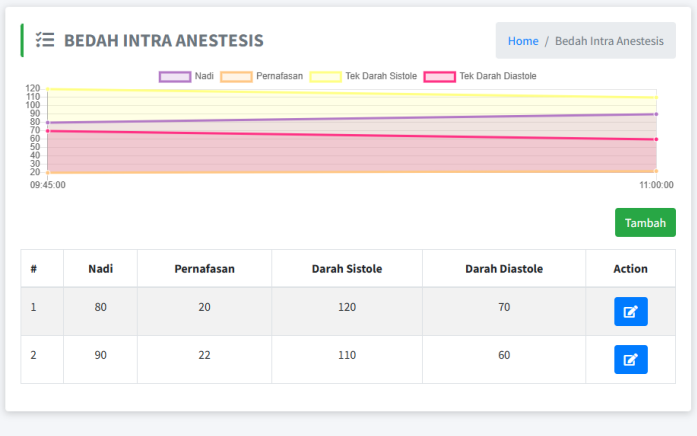

Figure 7 Form Intra Anesthesia

In the intra-anesthesia form, the user can fill in pulse, respiration, systole blood pressure, diastole blood pressure, and time. The addition of time can be done during the anesthesia process.

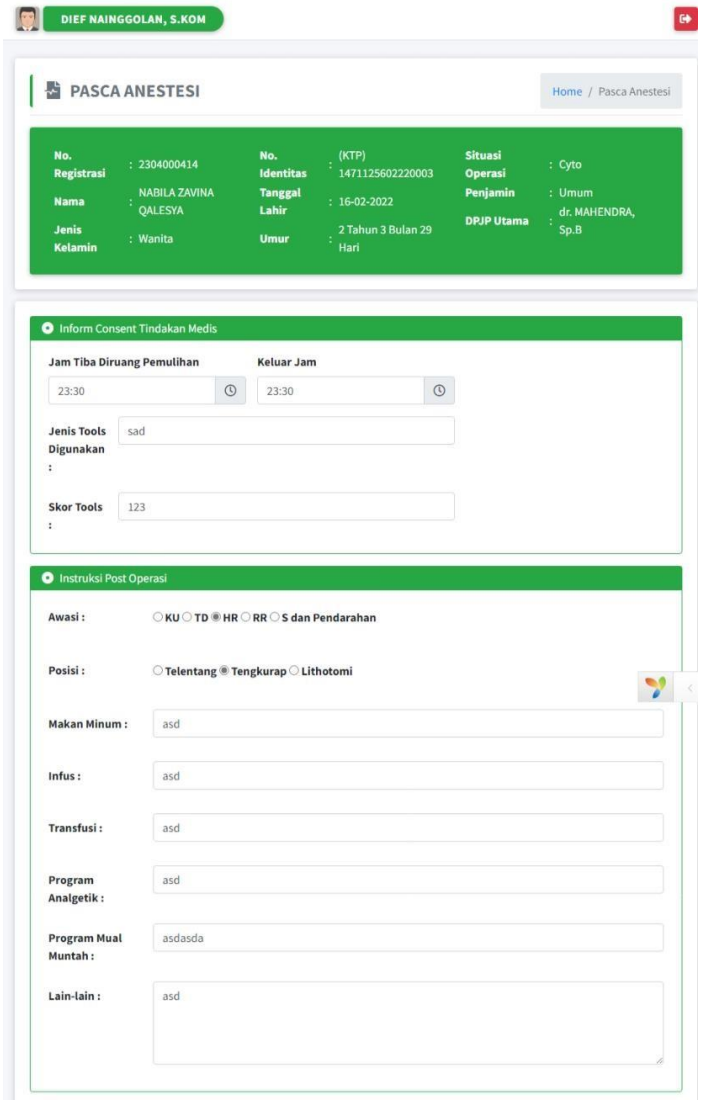

Figure 8 Post Anesthesia

After the anesthesia process is complete, the next stage is post-anesthesia. In the post-anesthesia form, the user can fill in what time the patient comes to the recovery room, what time the patient comes out, and there are also several fields in the postoperative instructions.

3.1.3. Testing

Tested with Blackbox and User Acceptance Testing techniques.

a. Blackbox

Blackbox testing aims to determine whether the system's functionality is in accordance with user expectations. This test was conducted by two users with nine functional systems and 20 test cases. The results show that the system runs 98% in accordance with its purpose and function.

Table 1 Test Case

No	Test Name	Test Case
1	Testing Viewing Patient List	The examiner enters the Identification Number as the username and password in the provided fields, then presses the 'Login' button.
2	Testing Selecting Patient List	The examiner selects the 'Patient List' menu on the system sidebar.
3	Testing Opening Safety Checklist Menu	The examiner selects the list of registered patients.
4	Testing Filling out Safety Checklist Form	The examiner selects the 'Safety Checklist' menu on the system sidebar.
5	Testing Opening Informed Consent Menu	The examiner fills out the available form in the 'Safety Checklist' menu, and after completing all the fields, the examiner presses the 'Save' button.
6	Testing Filling out Informed Consent Form	The examiner selects the 'Informed Consent' menu on the system sidebar.
7	Testing Opening Anesthesia Education Sheet Menu	The examiner fills out the available form in the 'Informed Consent' menu, and after completing all the fields, the examiner presses the 'Save' button.
8	Testing Filling out Anesthesia Education Sheet Form	The examiner selects the 'Anesthesia Education Sheet' menu on the system sidebar
9	Testing Opening Pre-Induction Menu	The examiner fills out the available form in the 'Anesthesia Education Sheet' menu, and after completing all the fields, the examiner presses the 'Save' button.
10	Testing Filling out Pre-Induction Form	The examiner selects the 'Pre-Induction' menu on the system sidebar.
…	…	…

b. User Acceptance Testing (UAT)

The testing mechanism is carried out by demonstrating the program to two respondents, namely nurses and doctors, based on predetermined test cases.

Table 2 Test Result(UAT)

No	Assessment	Number of Doctor Test Cases	Number of Nurse Test Cases	Total Score
1	Very Good	11	15	130
2	Good	7	3	40
3	Neutral	0	0	0
4	Less	0	0	0
5	Very Less	0	0	0
Total		18	18	170

Based on the results of the UAT testing that has been carried out, it can be concluded that the Central Surgical EHR system for the anesthesia module is quite good, with a percentage of 94%.

IV. DISCUSSION

The development of this electronic health record system still requires optimizing the features that are not yet available. There are still many features that can be developed in the electronic health record system for the anesthesia module. Especially in the intra-anesthesia feature, there are many innovations that can be made to maximize functions, such as adding features to check pulse, breathing, and tension by utilizing IoT in detecting them.

V. CONCLUSION

The development of an electronic health record (EHR) for the anesthesia module in Pekanbaru Army Hospital has had a significant impact on the progress of hospital services. The implementation of the system increases the effectiveness and accuracy of the management of medical records. With an integrated system, recording patient data and anesthesia procedures becomes more structured and easily accessible. This can reduce the risk of errors and improve overall patient safety.

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