Publishing

Article

Integrated Electronic Medical Record Design With Nutritional Screening System at NCC's Teaching Factory

Atma Deharja [1*], Muhammad Yunus [2] and Arinda Lironika Suryana [3]

[1] Health Information Management Study Program, Department of Health, Politeknik Negeri Jember, Indonesia; atma_deharja@polije.ac.id

[2] Health Information Management Study Program, Department of Health, Politeknik Negeri Jember, Indonesia; m_yunus@polije.ac.id

[3] Clinical Nutrition Study Program, Department of Health, Politeknik Negeri Jember, Indonesia; arinda @polije.ac.id

* Correspondence: atma_deharja@polije.ac.id

Abstract: One of Politeknik Negeri Jember's Teaching Factories (TEFA) that offers community nutrition services is the Nutrition Care Centre (NCC). The design of electronic medical records (EMRs) for continuous care patients, especially those with non-communicable diseases, is being studied in order to meet the ever-increasing needs of health care, assist patients who require continuous care, and improve the way that modern medical technology serves humans. The Waterfall framework concept is used in the research process, and an electronic medical record system is designed in accordance with the goals and the overall architecture of the system. Black-box testing and white-box testing are then conducted to evaluate the features, dependability, and stability of the designed electronic medical record system. Furthermore, when combined with other research findings, the design's viability is demonstrated. It is evident that the electronic medical record system created for the study's patients who require ongoing care is entirely workable. As electronic medical records continue to develop, there will be more opportunities to research and enhance this system, which will benefit patients and hospitals alike in the long run.

Keywords: Database; EMR's NCC; Waterfall

1. Introduction

EMR's are a manifestation of the increasing use of information technology in healthcare that has become a worldwide trend. The process of converting paper-based health/medical data into paperless electronic medical records marks the start of the digitalization of health services. The foundation for developing a mobile health or e-health system is the Electronic Health Record (EHR) and Electronic Medical Record (EMR). EMR is a digital record that can be easily to store, update and share between health facilities anytime and anywhere. EMR as a digital medical record consists of reports about the patient's health history, conditions, examination results, medications, prescriptions and medical treatments [1]. The implementation of EMR in Indonesia is mandatory in every healthcare facility as stipulated in the Regulation of the Minister of Health of the Republic of Indonesia No. 22 of 2022 [2].

The use of health information systems in view can provide many advantages and benefits for healthcare providers/providers (such as hospitals, clinics, etc). EMR plays an important role in improving the standard of healthcare systems throughout the world [3]. The application of EMR has benefits in three aspects: clinical, information access and economics. EMR facilitates access to clinical information of health history data for advanced patient consultation and reduces medical errors by up to 55%, this is due to

drug allergy warnings, inappropriate dosage or interaction, recommended treatment for specific conditions, or computerized preventive treatment. Furthermore, it has an impact on improving service quality, satisfaction and patient safety. Through the implementation of RME, patient data documentation is computerized, thereby minimizing reading errors and data loss so it can improve the continuity of care, reporting, accuracy, patient evaluation processes and even clinical decision-making processes [4]. Other benefits of EMR include increasing data and information accessibility, improving coordination of care between medical/health care personnel, efficiency of health practices and supporting patient confidentiality as well as cost savings, effectiveness and efficiency of operational costs of care and hospital management. EMR as a combination of several health information systems such as test requests, electronic prescriptions, decision-making systems, digital imaging and telemedicine [5].

The electronic health records also offer nutritionists the ability to track important steps in the delivery of nutrition care that follow the ASPEN nutrition care pathway, including nutrition screening and assessment, nutrition diagnostics, nutrition care plans and related interventions, reassessment of data to determine whether nutritional goals are improving nutritional diagnosis, and nutrition discharge plans for continuous treatment of unresolved nutritional problems. The EHR can provide the nutritionist the resources they need to record nutrition information in both structured and unstructured data, allowing different nutritionist/dietetiens to communicate the dietary history of the patient [6].

In 2003, the *American Dietetic Association* (ADA) recommended a model concept of *Standarized Nutrition Care Process* (SNCP) that ensures quality nutrition care management services and outcomes for all individual patients [7]. SNCP should be implemented in sequence starting with the steps of assessment, diagnosis, intervention and monitoring of nutrition evaluation. These steps are interrelated with each other and are a recurring cycle continuously according to the response/development of the patient. Over the past decade, the academy has successfully pioneered the standardization of terminology to communicate NCPs performed by nutritionists. NCPT has been adopted, implemented and enhanced internationally by professionals and organizations. [8].

The nutrition screening in outpatient care needs to be done to provide proper and prompt nutritional support to avoid adverse effects and support the success of treatment so as to avoid further disease complications, reduce the cost of treatment and the length of hospitalization [9]. One of the screening methods is SGA (*Subjective Global Assesment*). SGA consists of a health history and physical examination. The validity of SGA to identify the risk of malnutrition in outpatient care has been confirmed [10].

One of Polije's Teaching Factory locations that offers community nutrition services is the Nutrition Care Centre (NCC). The patients can check their nutritional status, blood sugar, uric acid, cholesterol, body water content, protein and minerals using a protein detector. Furthermore, nutritionists offer services pertaining to fulfilling nutritional requirements in a balanced manner and averting non-communicable illnesses. SNCP has been introduced by NCC nutrition services for patients receiving outpatient care.

However, the nutrition screening process at the NCC has not been performed optimally, although the function of this process is essential to map the nutritional status of the patient visiting before receiving further action, especially to identify early patients at risk of malnutrition so that nutritional intervention can be given to improve nutrition status further. Screening results may indicate that no nutritional intervention is needed.

Previously, the NCC had an accessible RME (e-NCC) system, which was a development of previous research by a team of researchers [11]. In the midst of the advances of information and communication technology, implementation of nutrition screening is required that is integrated with the RME system as a decision support system. The aim of this research is to design and implement a patient nutrition screening system that is integrated with the previously developed RME system. The research focuses on the patient nutrition screening process in mapping nutrition status as an initial step of

implementation of RME in NCC. The system is a form of innovation that can later be used as a clinical decision support system for nutritionists at NCC. The health data is useful for screening PTM risk factors and as a clinical decision support for doctors/counsellors so that it is expected that cases of PTM in the productive age group can be reduced.

2. Materials and Methods

The study was carried out at Polije's NCC Teaching Factory from July to September of 2023. Interviews, observations, documentation, and literature study methods were used to collect data. Informants included seven nutritionists, three administrators, the head of the laboratory, and NCC officials. The research design was Research and Development (R&D), and the methodology for developing an electronic medical record information system was the System Development Life Cycle (SDLC) method with waterfall modelling.

This method describes a systematic and sequential approach to software development, starting with the specification of user needs and continuing through the stages of planning, modeling, construction, and deployment, ending with support for the complete software produced [12]. The stages of the waterfall method include requirements, design, implementation, verification, and maintenance (Figure 1).
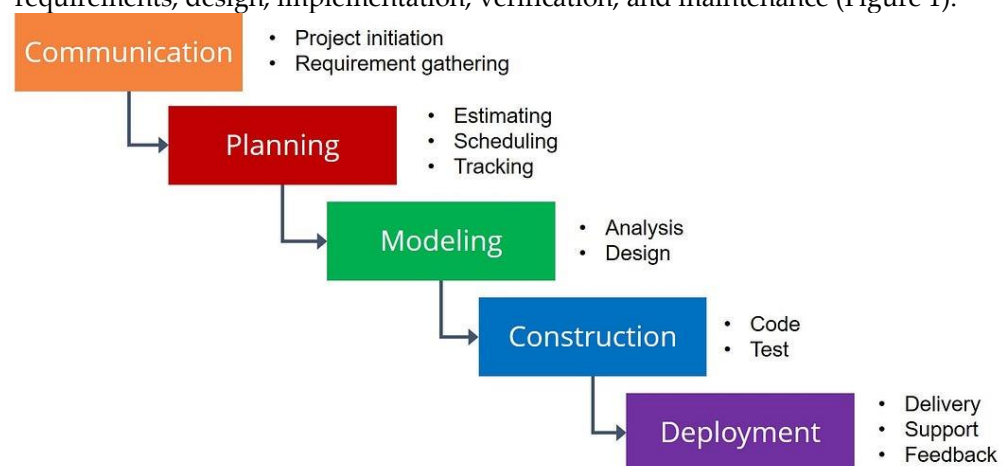
Figure 1. Waterfall Method [13]

1. Communication

    This phase is an analysis of software needs. Researchers communicate with users to understand the expected software and its constraints. The researchers interviewed users to determine whether the medical records needed the addition of nutrition screening development features based on the health information system. Data is obtained through surveys, interviews, or live discussions. The information is analyzed to get the data the user needs. Users are 7 nutritionists and 3 NCC administrators. At this stage, data collection is also done in the form of a document screening format using the SGA method.

2. Planning

    It's an advanced process of the communication stage, where the need analysis begins. Researchers examined patient nutritional status screening through observations and documentation to evaluate system needs. The head of the laboratory and staff were interviewed to discuss user expectations about the development of nutrition screening systems, including planning. After the interview was conducted, system variables such as patient identity, anthropometric data, dietary intake data, physical examination data and nutrition-related history were collected.

3. Modeling

    At this stage, software requirements documents are created and translated into predictable software designs before encoding, and the next focus of the process is data

structure design, software architecture, interface representation, and procedural details. (algoritma). The design results are database table structure, ERD, DFD, and application interface.

4. Contruction

The stage of code making, or coding, and the handling of software to improve the use of computers is known as construction. At this stage, the system is tested to ensure that it fully or partially meets the requirements. Testing can be categorized as a test system (executed on a specific code module), a test unit (execured on a particular module) and a test reception. (dilakukan dengan nama pengguna untuk memastikan apakah semua kebutuhan pelanggan telah dipenuhi). The results of the patient's nutrition screening tests are put into the system for testing.

5. Deployment

This is the last step in the software development process. Systems that have been completed after analysis, design, and encoding can be used by users with routine maintenance. Users were trained by researchers on how to use a nutrition screening recording system.

3. Results and Discussion

3.1 System Investigation

In this study, the system investigation step came first. This phase involved interviewing with and observing the NCC Head and other officers. Interview and observational data demonstrate that patient examination results were manually recorded and reported. As a result, less useful data and information are obtained, particularly when supporting NCDs. An illustration of a patient examination record from the NCC is provided in Figure 2.

Figure 2. Paper-based Patient Examination Record in the NCC

The findings are consistent with earlier research by Damayanti et al., which found that maintaining data fidelity in a paper-based system is quite complex because of the system's short lifespan caused by space constraints [14].

Furthermore, a few of the medical professionals, especially the physicians, stated that entering data on a computer may resemble writing on paper and that practice and instruction could improve typing speed [11]. Thus, the creation of computer-based information systems would speed up data retrieval and storage, allow for intelligent processing, or compile data to deliver timely and accurate benefits to patients.

3.2 System Analysis

Different perspectives of complex things are produced by system analysis based on the relevant question. Theories about data flow, workflow, and the usage of information processing tools that are pertinent to software engineering are frequently the focus of information system analysis. However, the produced CDSS might not be employed very

often in the medical field, particularly in laboratories or clinics, or in factories that produce education, like the NCC [15]. In order to guide system design, researchers determined user needs, data sources, and information during the system analysis phase. Users—in this example, officers—needed the EHR system as a CDSS to support their daily work, according to the findings of the system analysis. Research indicates that CDSS probably enhances clinical guideline adherence.

A CDSS for obstetrics, for instance, might greatly improve the documentation of the indications for labour induction and estimated foetal weight by incorporating an improved prompting system. This would immediately increase the quality of clinical documentation. Since EHRs have made shared decision-making between patients and clinicians possible, CDSS may be the best tool for the job [16]. In particular, it may help remove information gaps that prevent individuals from participating fully in their healthcare.

Table 1. Monitoring and Documenting the Medical Status of Patients in the TEFA NCC

1.	No
2.	Medical record number
3.	Patient name
4.	Address
5.	Age
6.	Assessment
7.	Diagnosis
8.	Intervention
9.	Counselor name
10.	Test date

According to the NCC officers, a visit and examination report type might be added to the EHR system and produced once a month. The officers and administrators also want a decision-making function in the system.

3.3   System Design

The project's analytical stage resulted in the creation of a web-based information system to assist and support the midwives in their role as programme implementers. A storyboard, along with an outline and explanation of the system, were created. To evaluate the quality of system modules, instruments, software, and modules were developed and decided [17]. Using a local web server (PHP), the researchers developed this system and executed it directly on the device. Figure 3 shows an overview of the EHR design.
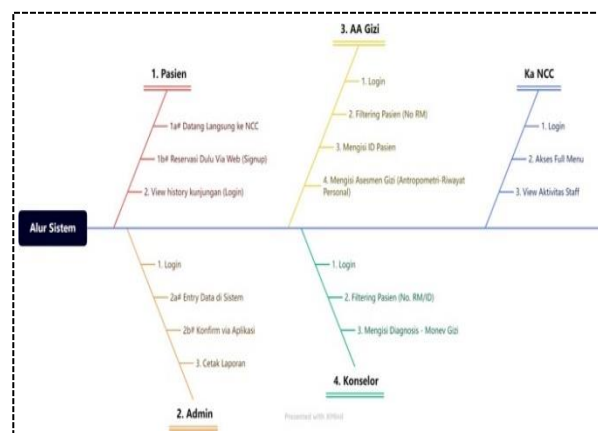
Figure 3. EHR's System Diagram

The NCC system flow, including each user's function within the programme, is illustrated in Figure 3. Five users of the system were shown in Figure 3: the patient, the administrator, the nutritionist, the counsellor, and the head of NCC TEFA. Depending on their requirements, each of them had authorization access to the system. Through the website, patients could use the system to schedule an appointment. The administrators would enter the patients' information for new visits or look up the history information for follow-up visits if the patients arrived at the NCC directly. Additionally, the NCC admin may log in, validate patients' reservations, input patient data into the system, and print reports.

The nutritionists had the ability to access the system, fill in the patient's ID, select the individual's medical records number, and enter the findings of the nutrition evaluation. Additionally, by logging into the system, the nutrition counsellors can filter a patient's medical record number and provide a diagnosis based on nutrition monitoring and assessment. Additionally, the Head of TeFa NCC had complete access to the system, allowing them to monitor the officers' actions.
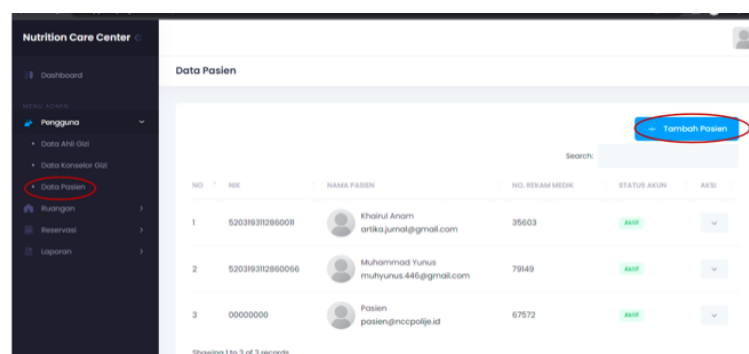

Figure 4. Insertion of Medical Information

The users then chose the patient data entry menu after logging into the system. After patients entered their data and selected the search button in the patient data menu, data would automatically appear.

Figure 5. Entry of Examination Data

The NCC officers then investigated and assessed the patients' nutritional state, taking into various variables including anthropometry, in-body values, biochemistry, clinical physical examination, allergy history, and personal history. The officers then enter the assessment results into the NCC system.

Figure 6. Findings from the Testing Procedure

A critical step in determining the patients' nutritional state is the diagnosis entry. The NCC system would be used by the nutrition counsellor to assess the patients' diagnostic findings. In the case that the patient's state of health was improved and prevention measures were recommended by the nutrition counsellor, the patient's NCD status would be indicated by the system. Finally, the officers saved the patient examination data from related instances for their own reference. It would be of great use to nutrition counsellors in assessing and deciding patients' nutritional status. According to the guidelines, prior study has demonstrated that health information technology offers a number of significant advantages with respect to the effectiveness and fineness of service delivery. Preventive measures, greater control and monitoring, a decrease in pharmaceutical errors, and a reduction in the likelihood of overuse or unneeded services are some of these advantages [14]. Moreover, an electronic health recorder or computerised provider for order entry in a system generally integrates the decision support function [18].

3.4 System Implementation

During the implementation stage, responders were used to test prototypes [19]. Ten responders, NCC officers, as well as the Head of TeFA NCC, were given access to the web-based technique by the researchers. The system was then used by the users. The socialisation and training for the system were carried out by researchers. According to the authorities, this information system did a great job of entering test data into the NCC.

Users offered suggestions on how to make the data entry form improved during the system's deployment. The system must be improved by researchers and programmers in response to input from outside trials. The goal of the system evaluation is to create a superior system that satisfies user needs [18].

4. Conclusions

The addition of nutrition screening features to electronic medical records is designed to make it easier for nutritionists to manage healthcare data so that malnutrition risks are identified before patients obtain standard nutritional care in the NCC. Patient examination data is stored for subsequent analysis with a system that supports decision-making on malnutrition risk using SGA methods to help nutritionists determine diagnosis and nutritional interventions. In order to determine whether nutrition screening elements have been continuously integrated into previously created EHR systems, researchers in the future will need to conduct periodic monitoring. The officer must also convey the challenges associated with utilising the EHR system. The findings indicate how well the NCC has integrated nutrition screening aspects, while there is still a lack of integration with other healthcare facilities. In order to prevent patient data from being unavailable or inaccessible, future studies should concentrate on information system development analysis to support data integration between NCC and other healthcare facilities.

References

[1] M. Anshari, "Redefining Electronic Health Records (EHR) and Electronic Medical Records (EMR) to Promote Patient Empowerment," *Int. J. Informatics Dev.*, vol. 8, no. 1, pp. 35–39, 2019, doi: https://doi.org/10.14421/ijid.2019.08106.

[2] Kemenkes, "Peraturan Menteri Kesehatan RI No 24 tahun 2022 tentang Rekam Medis," 2022.

[3] D. R. A. Tiorentap, "Evaluasi Manfaat Penerapan Rekam Medis Elektronik di Negara Berkembang : Systematic Literature Review," *Indones. Heal. Inf. Manag. J.*, vol. 8, no. 2, pp. 69–79, 2020.

[4] G. Deimazar, M. Kahouei, A. Zamani, and Z. Ganji, "Health information technology in ambulatory care in a developing country," *Electron. Physician*, vol. 10, no. 2, pp. 6319–6326, 2018, doi: 10.19082/6319.

[5] B. Dutta and H.-G. Hwang, "The Adoption of Electronic Medical Record by Physicians : A PRISMA-compliant Systematic Review," *Medicine (Baltimore).*, vol. 99, no. 8, p. e19290, 2020, doi: 10.1097/md.0000000000019290.

[6] C. E. Kight *et al.*, "Consensus Recommendations for Optimizing Electronic Health Records for Nutrition Care," *J. Acad. Nutr. Diet.*, vol. 120, no. 7, pp. 1227–1237, 2020, doi: 10.1016/j.jand.2019.07.018.

[7] S. Susetyowati, H. Hadi, A. H. Asdie, and M. Hakimi, "Implementation of Standardized Nutrition Care Process Algorithm Nutritional Screening-Based," *J. Gizi Klin. Indones.*, vol. 11, no. 1, pp. 20–30, 2014, doi: 10.22146/ijcn.18880.

[8] W. I. Swan *et al.*, "Nutrition Care Process (NCP) Update Part 2: Developing and Using the NCP Terminology to Demonstrate Efficacy of Nutrition Care and Related Outcomes," *J. Acad. Nutr. Diet.*, vol. 119, no. 5, pp. 840–855, 2019, doi: 10.1016/j.jand.2018.10.025.

[9] Wijayanto and H. W. Subagio, "Perbandingan Skrining Gizi Kariadi (SGK) dengan Subjektive Global Assessment (SGA) pada Pasien Rawat Jalan Rumah Sakit Dr Kariadi (RSDK) Semarang," *J. Nutr. Heal.*, vol. 5, no. 1, pp. 45–49, 2017, doi: 10.14710/jnh.5.1.2017.45-49.

[10]   J. Abbott, L. Teleni, D. McKavanagh, J. Watson, A. L. McCarthy, and E. Isenring, "Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF) is a Valid Screening Tool in Chemotherapy Outpatients," *Support. Care Cancer*, vol. 24, no. 9, pp. 3883–3887, 2016, doi: 10.1007/s00520-016-3196-0.

[11]   A. Deharja, M. Yunus, and M. W. Santi, "Electronic Health Records Design in the Nutrition Care Center of Teaching Factory at Politeknik Negeri Jember, Indonesia," *Int. J. Heal. Inf. Syst.*, vol. 1, no. 1, pp. 47–54, 2023, doi: 10.47134/ijhis.v1i1.6.

[12]   A. A. Wahid, "Analisis Metode Waterfall Untuk Pengembangan Sistem Informasi," *J. Ilmu-ilmu Inform. dan Manaj. STMIK*, pp. 1–5, 2020.

[13]   R. S.Pressman, *Rekayasa Perangkat lunak : Pendekatan Praktisi*. Yogyakarta: Penerbit ANDI, 2012.