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Original Article

Development and Evaluation of Electronic Medical Record Admission Module in Intensive Care Unit: A Case Study in Iran

Hajar Mardani[1], Azadeh Bashiri[2], Golnar Sabetian[3], Nasrin Shokrpour[4], Farid Zand[5], Mansoor Masjedi[3], Roxana Sharifian[6]*

[1]MSc in Health Information Technology, Student Research Committee, School of Health Management and Information Sciences, Health Human Resources Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Department of Health Information Management, School of Health Management and Information Sciences, Health Human Resources Research Center, Clinical Education Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
[3]Trauma Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
[4]Department of English, Shiraz University of Medical Sciences, Shiraz, Iran
[5]Anesthesiology and Critical Care Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
[6]Department of Health Information Management, School of Health Management and Information Sciences, Health Human Resources Research Center, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract

Introduction: Electronic medical record leads to effective information management. One of the most important sections of electronic medical records is the patient admission module. The aim of this study was to develop and evaluate the patient admission module in Intensive Care Unit.

Methods: This developmental-applied study was conducted in 2021 in 3 steps: 1. Determining the requirements, 2. Designing, developing, and implementing, and 3. Evaluating usability. In the first step, we did the literature review and asked for the expert panel's opinion; in the second step, we used word, and Reactjs, Expressjs programming language, and Mongodb database and Windows server; in the third step, the USE standard questionnaire was used.

Results: Module requirements were classified into two categories: functional and non-functional requirements. Functional requirements address software quality features, and non-functional requirements include general requirements, demographic information, and clinical information. Demographic information was classified into two main categories: patient's demographic information and documented physician information. Clinical information (287 data elements) in 13 main categories included the past history, vital signs, nervous system, respiratory system, cardiovascular system, genitourinary system, gastrointestinal system, hematology, integumentary system, infectious, antimicrobial drugs, problem list, and plan. Also, the results of usability evaluation showed that 87% of the physicians agreed with the use of this module.

Conclusion: Given the trend towards e-health in Iran, the use of electronic medical record admission module in intensive care units can have a significant impact on the complete collection of admission data.

Keywords: Development, Electronic medical record, Admission module, Intensive care, Usability evaluation

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***Correspondence to:**
Roxana Sharifian
Department of Health Information Management, School of Management and Medical Information Sciences, Health Human Resources Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
Email: Sharifianr@sums.ac.ir

Introduction

Intensive care is a vital part of medicine that has a multidisciplinary nature and requires health care professionals in all fields (1). More than 1,200 data are generated daily for the care of each patient in the intensive care unit (ICU), which need an effective information management strategy in the ICU (2). Electronic health record (EHR) is a new technology that is considered as a standard for medical practice in the United States in the 21st century (3); it is a way that patients can benefit from intensive care to achieve complete health (4) and is considered as an essential and effective element in high quality health care systems (5). Medical errors are reduced in cases where the information is recorded in a structured manner, and the care provider's instructions are entered in a default and standard form (6). Electronic medical record (EMR) is a new technology that has overcome many of the limitations of paper records, as well as increased access and retrieval of patient information (7-9).

Modularity facilitates the system maintenance

and evolution (10). An important module of the EMR in the ICU is the patient admission module (11, 12). Patient admission is a set of clinical documents completed by physicians for patients admitted to this ward. Unlike conventional forms, which are organized according to the patient's problems, documentation in the ICU is more comprehensive and complete and is organized in such a way that important information is not lost. At the beginning of the ICU admission form, the patient's demographic information is entered, and then the data are collected based on the body systems (11).

Iran, as a developing country, needs to use new technologies in the health sector. EMRs are an example of these technologies. Iranian hospitals are ready to implement EMR (9). Since intensive care is required worldwide (13), due to the lack of a coherent EMR admission module to collect and manage patient admission data in the ICU in Iran, the development and evaluation of the ICU admission module is of particular importance (11); due to the lack of a coherent EMR admission module in ICU of Shiraz University of Medical Sciences hospital; therefore, the present study was conducted with the aim of developing and evaluating the EMR admission module for ICUs. This module is implemented in Nemazi hospital because this hospital is the largest educational and medical center in southern Iran.

Material and Methods

This applied development study was performed in the following three steps:

Step 1: Determining the requirements of the module: First, the forms of patient admission in the ICU in Nemazi Hospital were reviewed and all the information elements that were recorded for the admitted patients in this ward were extracted. Then, databases such as PubMed, Scopus, Google scholar were searched as the largest abstract and indexing databases in the world from 2000 to 2021, using the following search keywords: ICU admission note, Electronic Medical Record, Patient admission Note, ICU Admission Requirement, ICU Admission Note and Electronic Medical Record. Well-known institutions and organizations such as the Australian and New Zealand Intensive Care Association and the Intensive Care Medical Association were also surveyed, and other intensivist in countries such as Australia, Dubai, and the United States were contacted and forms from these countries were collected for admission to the ICU.

The retrieved articles were reviewed to find the functional and non-functional requirements of the module, and all the requirements were integrated and a separate list for each of them was prepared. Then, these requirements were discussed in the panel of experts (5 intensivists and 2 health information management specialists) in 8 sessions in a calm environment with group thoughts. The experts expressed their opinions, which were reviewed and summarized by the research team; and the approved items were prepared as a set of necessary requirements for the EMR admission module in the ICU.

This set of functional and non-functional requirements was designed in the format of forms, and the initial version of the form was prepared. This initial version was implemented for 1 month in four ICUs of Nemazi Hospital (December 2020), and its results were analyzed to determine the quality, quantity, and completeness of the prototype of the form designed to ensure the collect admission information in the ICU. At the end of the month, the completed forms for patients, along with user comments during 4 sessions, were reviewed in the second session of the expert panel. Then, according to the expert panel, the items were added to the original version and the second version was designed. The second version was implemented on paper for 7 months (January to July 2021) in the ICUs, and the users' comments were transferred to the attending physicians of ICU on a weekly basis; minor changes were made in the form, and the final version was approved.

Step 2: Design, Development, and Implementation: A data dictionary is a collection of information about data that effectively helps us understand the meanings of the data and describes the main information elements and structure of the data; it is known as a list to identify all data in the system (14). Scenario is a powerful tool that has been widely used in the last decade (15, 16). It outlines the complete sequence of processing steps to create a system that properly meets the needs of the users (15). In this step, first a data dictionary was prepared for the set of information elements, and an acceptable range was determined for each information element; then, the script was written.

A web-based platform was then selected to increase communication between the clinical staff and access to the module. This module is based on the Reactjs, Expressjs programming language and uses Mongodb database and Windows server to manage the data. In the next step, a prototype of the module was developed to increase the usability of the module. To launch this module, we used 4 tablets, 4 computers in each of the four sections, as well as personal mobile

Table 1: The set of non-functional requirements for implementing Electronic Medical Record admission module

Requirements	Category	Subcategory	Data elements
Non-Functional	Demographic information	Patient demographic information	First name, last name, national code, medical record number, father name, date of birth, ICU admission date/time, hospital admission date, age, gender, weight, height, ICU name, room No, bed No, hospital admission source, ICU admission source, ICU attending, Referring Service
		Physician Name & Signature	Resident/GP name, Resident/GP date, Resident/GP signature, Resident/GP Stamp, Fellow/Specialist name, Fellow/Specialist date, Fellow/Specialist signature, Fellow/Specialist Stamp, Attending/Physician name, Attending/Physician date, Attending/Physician signature, Attending/Physician Stamp
	Clinical information	Past history	Source of history, present illness, hospital course before ICU admission & significant para clinic result, operating room course, past chronic cardiovascular, past chronic respiratory, past hepatic failure, past chronic condition, past renal failure, past diabetes, childhood illness, psychiatric illness, Injuries, Operations, Hospitalization, allergies, Medication history mane, Medication history dose, Medication history unit, Medication history frequency, Cigarette smoking status , Water pipe smoking status, How many per day?, How many years?, Pack/year, Drug dependency status, Type of drug, Type of opioids, family history
		Vital signs	Blood pressure, Heart rate, Temperature, SpO2, Respiratory rate, mandatory rate, spontaneous rate
		Neurologic system	Neurologic status, Glasgow coma scale, Eye Opening, Best Motor, Best Verbal, sedated on arrival, muscle power (Upper right & left, Lower right & left), reflexes (Upper right & left, Lower right & left), ICP monitoring, How many seizure?, How long seizure?, Type of seizure, Pupils size (right & left), Pupils reaction (right & left), Delirium, RASS score, BPS Score, Facial Expression, Upper Limb, Compliance with Ventilation, Numeric Pain Scale, Plantar reflexes(right & left), Corneal Reflex, Doll's reflex, CT Scan Finding, MRI & MRV Finding, Angiography Finding, CSF result, Pr in CSF, RBC in CSF, Pressure in CSF, Sugar in CSF, WBC in CSF, PMN in CSF, Lymph in CSF
		Respiratory system	Airway, Artificial airway type, Humidification type, Pattern, O_2 Therapy, Supplementary oxygen type, Sup.o2 flow, FiO2, Mechanical ventilation, Mechanical ventilation type, Mode, Setting, Peak pressure, Plateau pressure, Compliance, Resistance, Lung exam (right & left), Last CXR (right & left), Heart, Mediastinum, Bone, Catheters Name, Catheters Position, PH, PaCO2, Anion Gap, $HCO3^-$, PaO_2/FiO2, BE, PaO_2, SaO2, SpO2, Chest CT finding
		Cardiovascular system	Arterial line position, Central line position, Central line type, CVP, Date of Central line insertion, Days of Central line insert, ECG finding, Troponin time, Troponin level, Troponin result, Heart sound, Extremities, Capillary refill, Edematous, Pitting type, Pulse, Sign of DVT, Size difference, Inotropes/Vasopressors name, Inotropes/Vasopressors dose, Significant Echo finding, EF, RV size, IVC Collapsibility/Distensibility, Pericardial effusion
		Genitourinary system	Urine Output, Urine Ketone, Estimate GFR, Catheter type, Renal failure, Hemodialysis frequency, Hemodialysis last time, Peritoneal D frequency, Peritoneal D last time, CRRT duration, CRRT last time, Na, K, Cl, HCO_3^-, BUN, Cr, Glucose, Ca, Mg, P, Imaging finding
		Gastrointestinal system	Abdominal exam, Bowel sound, diet , Reason NPO, Feeding type, Enteral type, Parenteral type, PO type, Tube feeding, Tube feeding type, Tube feeding volume, Tube feeding frequency, Tube feeding residual, Dextrose type, Aminogen type, Intralipid type, Alb, AST, Prot, ALT, Glob, Alk Ph, Total bilirubin, Direct bilirubin, Indirect bilirubin, Endoscopy findings
		Hematology system	Bleeding type, External bleeding site, External bleeding Volume, External bleeding Color, PBS, Plasmapheresis volume, Plasmapheresis frequency, Plasmapheresis last date, Plasmapheresis cycle, Placement fluid, Indication, Retic Count, LDH, Fibrinogen, FDP, D-Dimer, CPK, Ferritin, Hb, WBC, Neu, Lym, HCT, PLT, PT, PTT, INR
		Integumentary system	Pressure Ulcer/Sore Place, Pressure Ulcer/Sore size, National Pressure Ulcer Advisory Panel (NPUAP) Grade
		Infectious	Max/Min Temp, Max/Min Temp type, WBC, CRP, PCT, ESR, Serum Lactate, PCR for, Result of PCR, Toxic Granulation, Shift to the left, Type of culture (Blood, Urine, Sputum/ETT, Surveillance, Wound, Fluid), Site of culture, Result of culture, Date of culture, Microorganism, Time to growth, Sensitivity, Resistance, Intermediate, Quantity, Count, NL flora
		Current Antimicrobials	Type of Antimicrobials (Antibacterial, Antifungal, Antiviral, Miscellaneous), Antibacterial Name, Antibacterial Dosage, Antibacterial Route, Antibacterial Frequency, Antibacterial Duration, Antifungal Name, Antifungal Dosage, Antifungal Route, Antifungal Frequency, Antifungal Duration, Antiviral Name, Antiviral Dosage, Antiviral Route, Antiviral Frequency, Antiviral Duration, Miscellaneous Name, Miscellaneous Dosage, Miscellaneous Route, Miscellaneous Frequency, Miscellaneous Duration
		Problem List	Problem List, Primary diagnosis/impression
		Plan	Plan

phones of the assistants and physicians. Before the full implementation of the module in the ICUs of Nemazi Educational and Medical Center, this software was run on a trial basis in the desired department for a month to examine its implementation problems and weaknesses; full implementation of this system should be done with the least problems and obstacles. During the trial of the software, any discrepancies, suggestions, and comments of the physicians and assistants were recorded by the researcher.

Step 3: Applicability Assessment: In this step, the USE standard questionnaire was used to assess the applicability; its validity and reliability were measured in previous studies (17). This questionnaire is very quick and easy to use which is designed to evaluate the usability of a particular device or product (18, 19) with 30 questions in 4 sections: usefulness (8 questions), easy to use (11 questions), easy learning (4 questions), and satisfaction (7 questions); it is scored based on 7-point Likert scale, ranging from strongly disagree to strong agree. After distributing the questionnaire, the results were analyzed using SPSS version 27 and expressed using descriptive statistics.

Results

In the first stage, based on the findings, 23% of the experts were male, 71% were attending the ICU and had more than 15 years of experience in the ICU. The set of requirements was obtained by combining the results of the literature review, consensus among the experts, and the opinions of end users; then, it was approved by the expert panel. After consensus, the requirements of the module were divided into two categories: functional and non-functional. Non-functional requirements were classified into three main groups: general needs, demographic information, and clinical information. Demographic information was divided into two main subgroups: patient demographic information and documented physician information.

Clinical information consisted of a total of 287 data elements in 13 main categories: past history, vital signs, nervous system, respiratory system, cardiovascular system, genitourinary system, gastrointestinal system, hematology, integumentary system, infectious, antimicrobial drugs, problem list, and plan, each having a sub-category. The highest number of information elements was related to the classification of the nervous system (Tables 1, 2). Functional requirements are shown in Table 3.

Then, the module was designed with a simple user interface. Since the system must be tested in a real environment to determine its performance, this module was run experimentally for a month and all software, logical and semantic errors were identified and fixed during patient admission. Figures 1 and 2 show different images of patient admission information recorded in this module. Users can easily access the patient data. In addition, this module is able to prepare statistical reports and search for the patients' names according to the physician who admitted the patient.

Regarding the number of participants to perform usability using the USE questionnaire, according to research, the number of people between 5 and 25 was desirable (20). According to the expert panel's

Table 2: General requirements of the admission module

This module is part of the EMR modules during independence.
This module is able to receive patient demographic information from the "Computer Provider Order Entry System" (CPOE).
This module can connect to the "Digital Archiving and Communication system" (PACS) and receive imaging information of patients admitted to the ICU.
This module provides access control, accuracy and validity of information entered by the user.
It is possible to have the same patient medical record number in the hospital information system (HIS) and this module.
It is possible for authorized users to view the patient's previous records.
This module can be accessed by authorized users from outside the ward and even from outside the hospital and residents can be monitored by the attending.
There is the ability to read and confirm the information recorded by the treating physician and the attending.
The details of the treating physician or user who has admitted the patient, along with the date and time of registration of the information, can be traced.
It is possible to view the names of patients according to the name of the recipient physician.
It is possible to view the names of patients according to the name of each of the four ICUs.
The user is automatically alerted when data and unauthorized values are incorrected.
It is possible for the physician to record the information of each section of this module separately and without observing the order of the other sections.
The alphabetical list of the patient's medication history in this module is according to the ATC / DDD system proposed by the WHO.
The alphabetical list of antibiotic-resistant microorganisms in this module is according to the HIS list.

Table 3: Performance requirements of the admission module

The module is networked (LAN, WAN).
The module has the ability to define new users.
It is possible to add other modules such as progress note module or patient discharge module.
It is possible to register patient admission information both online and offline.
This module has a suitable guide for all users (specialist assistant, fellowship and attending).
It is possible to enter the module using the doctors' mobile phone.
The module is based on Windows and Android.
Module security is possible by creating multiple layers of data privacy security and controlling user access.
It is possible to provide the level of access to the Fellowship and Attendance Physician of each ICU to verify the recorded information.
It is possible to edit the information registered by users.
It is possible for the user to change the password of the module.
It is possible to track and record the operations performed by users.
It is possible to print the information registered in the module.
It is possible to add blank lines to record some information after printing.
The module has the ability to connect to the "PACS" and the "CPOE".

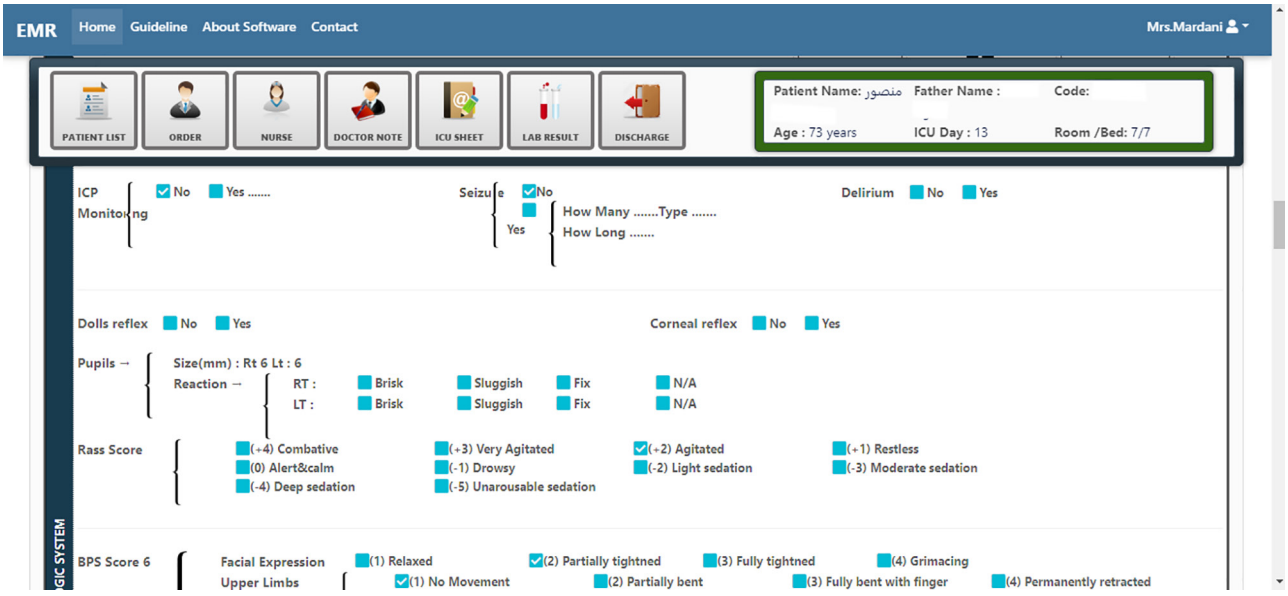

Figure 1: View of the patient's nervous system information record

views, the number of 21 users who had used the EMR admission module in the ICU for three months was sufficient. The results showed that out of 21 system users (9 men and 12 women) who evaluated the module, all were in the age range of 27 to 53 years and were aware of ICDL skills.

The evaluation results also showed that 81% of the users considered the system useful, 87% regarded it as easy to use, 95% considered it easy to learn, and 85% of the users were satisfied with the system (Figure 3). Findings showed that the highest average score was related to ease of learning of this module.

Discussion

Considering the importance of the ICU and need for EMR in our country, we have introduced a patient admission module in the ICU to facilitate the move towards EMR. The expert panel approved 287 data elements for this module in the ICU, based on a review of previous literature; no study has so far obtained this number of data elements in an integrated manner. Fallahnejad et al. reported the data requirements for the electronic documentation of progress note in the general ICU, including 141 structured data requirements (18).

Documenting the patient's treatment process in the ICU is very important (21), and the lack of timely access to data when making decisions is one of the challenges of health care centers (22). ANZICS has categorized the information needs of patients in ICU into three parts: demographic, biochemical, and physiological information (23). In the present study, the requirements of the EMR admission module in the ICUs are divided into two categories:

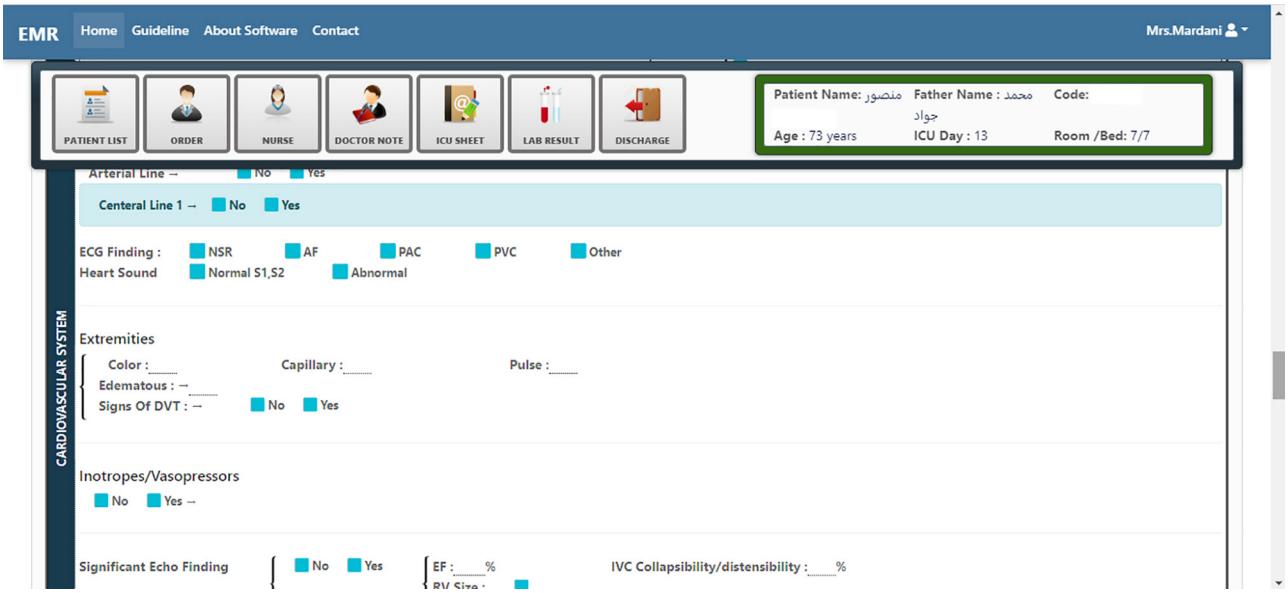

Figure 2: View of the patient's cardiovascular system information record

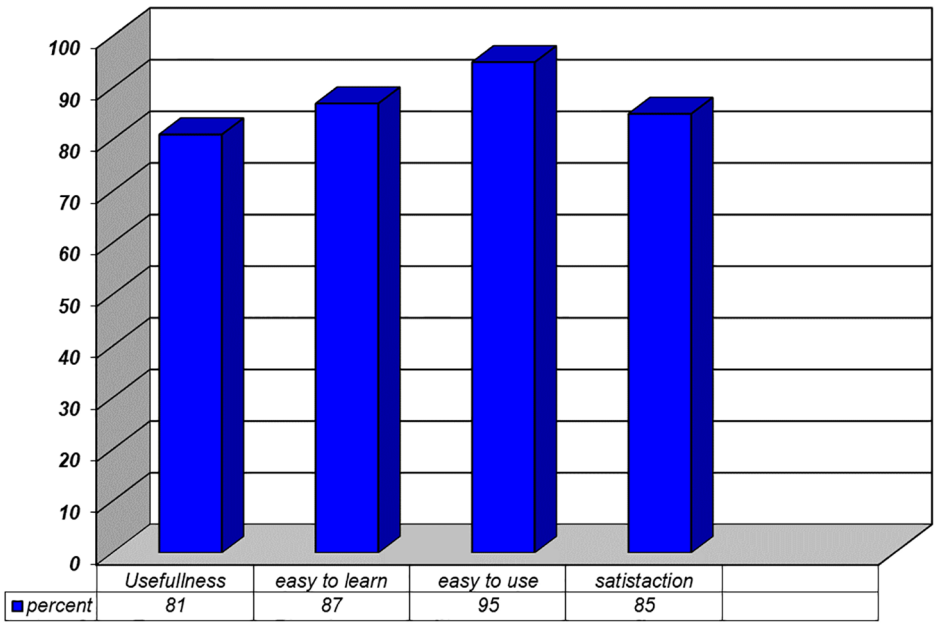

Figure 3: Evaluation results of the Electronic Medical Record admission module

functional and non-functional requirements. Non-functional requirements include three main groups: general needs of system, demographic information, and clinical information that are consistent with Fallahnejad's research (18).

Ahmadi indicated that demographic data was one of the most important and necessary data that is completed by the patient care team before starting treatment in order to identify and follow up the patients. Clinical data provided by patient care providers during patient care improve the patient's treatment process, research and planning, and facilitate the residents' medical education (24). In the study of Tabaghdehi (25) and Jahanbakhsh (26), also the need for identity and clinical data is emphasized.

Goodyear and Mwakyusa stated that structured forms for patient admission improved the documentation and performance of the healthcare staff, thus providing more complete and accurate information (27, 28). In the same line, Rtiza-Ali's study has shown the benefits of structured forms in the management of acute asthma and geriatric medicine (29).

Findings from the implementation of a structured child admission form in a part of a hospital in Kenya showed that the structured child admission form in

this hospital was used by 50% in the first 2 months, but this rate was up to 84% in the last 2 months. The quality of documentation has increased significantly over time (27). In the present study, the use of a prototype structured paper form of patient admission in the first month was different among physicians and assistants, but after a period of necessary training, in the next 7 months, the use of this prototype by physicians and assistants increased significantly.

Lloyd et al. state that novice physicians often do not record important details of a patient's medical history and clinical examination findings when writing medical notes, and the patient's social history, medications, and allergies. Structured forms, on the other hand, help train novice physicians to write clinical notes (28). In the present study, the expert panel has pointed out the ability of this module in training assistants, which facilitates the possibility of complete recording of clinical data by providing structured elements. The module designed for patient admission in the ICU is connected to the Computer Provider Order Entry system, which is currently used in the ICU, and patients' demographic information is obtained from the computer system for entering the physicians' orders. It is also connected to the Picture Archiving and Communication System.

Among the benefits of designing information systems in the ICU are using electronic documentation, managing the patient information, saving time, supporting clinical decisions, improving clinical research, and improving patient care (30). Dargahi argues that the proper design of clinical systems reduces documentation time, increases the length of time for health care personnel to care for patients, establishes a link between patient care information, and reduces medical errors (31). The expert panel in the present study stated that the designed module integrated the patient admission data in the ICU and increased access to the data.

Kusriyanti emphasizes that Malaysian hospitals are ready to implement EMR (32); also, Garavand states that the teaching hospitals of Shiraz University of Medical Sciences are ready to establish EMR (33). Safdari et al. have implemented a web-based EMR for chronic kidney disease. One of the advantages of this system is the availability of information in different places (34). Moreover, in Shahmoradi's research, a web-based module of EHR has been implemented for patients with gastric cancer, which provides access to information in different places (35). The admission module of EMR has been implemented for the first time in the ICUs of Nemazi Educational and Medical Center. This software is web-based and is available to authorized users from the ward systems, doctors' mobile phones, and out of the hospital.

Usability assessment is a key process in health information systems to ensure that the system is able to meet the needs of users (35). Features such as usefulness and ease of use play an important role in the users' use of the system (36). In this study, physicians agreed with the usefulness, ease of use, ease of learning, and satisfaction of the patient admission module in the ICU.

In the regard, the findings of Sadoughi et al.'s study on evaluating the usability of the information system of Mashhad University of Medical Sciences showed that 71.8% of the respondents were satisfied with the system, 64.2% of the users intended to use the system continuously, and 78% of them understood the benefits of the system and believed in the usefulness of the system (36). In the present study, 81% of the users considered the system useful, 87% considered it easy to use, 95% emphasized the ease of learning the system, and 85% of them were satisfied with the system.

The results of designing and evaluating the usability of the diabetes management system in the Persian Gulf region show that the acceptance of this system is high among patients with diabetes (37). Shahmoradi believes that the EHR module designed to improve the care of patients with gastric cancer potentially leads to improved care (35). This is consistent with the results of our research; in the present study, 87% of the users considered the use of this module useful. In another study, the laboratory information system was evaluated heuristically. The results of this evaluation indicate that this system has a large number of usability problems (38); their findings are not consistent with those of the present study.

The results of the evaluation of the electronic admission file system in the Brazilian ICU showed that 92.6% of the physicians used the EMR and prescription system, and 84.6% believed that the electronic system was of better quality and more secure compared to paper records (39). Lin et al. believe that the use of EMR has improved the patient care (40). Despins states that EMR provides access to and makes the retrieval of structured patient information easy (8). In the present study, the expert panel stated that the designed module provided greater safety and higher quality in the clinical documentation of the ICU. Considering the need of our country to EHR and since EMR is on the way to obtain HER (33), patient admission module in ICU is so essential in implementation of EMR.

Conclusion

Therefore, the admission module for EMR in the ICU as a software has been developed and evaluated. This module is a first and important step to create an EMR in the ICU and is suitable to facilitate the complete registration of patient admission in the ICU. It is suggested that the results of this study should be used as a model for designing admission modules in other medical centers. It is also recommended that on a larger scale in the health system, attention should be paid to forming strategic committees and designing a coordinated and localized model of the EMR admission module by surgical, internal medicine, pediatric, neonatal, obstetric, chronic diseases, etc.

One of the limitations of this study is the lack of proper cooperation and quick response from some physician. Since this study was performed simultaneously with the corona virus pandemic in Nemazi hospitals of Shiraz University of Medical Sciences, so the physicians have less time and more workflow, this limitation was removed with repeated follow-ups by the researcher.

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References

1. Ribeiro A, Portela F, Santos M, Abelha A, Machado J, Rua F. Patients' admissions in intensive care units: a clustering overview. *Information*. 2017;8(1):23. doi: 10.3390/info8010023.
2. Pickering BW, Dong Y, Ahmed A, Giri J, Kilickaya O, Gupta A, et al. The implementation of clinician designed, human-centered electronic medical record viewer in the intensive care unit: a pilot step-wedge cluster randomized trial. *Int J Med Inform*. 2015;84(5):299-307. doi: 10.1016/j.ijmedinf.2015.01.017.
3. Ajami S, Ketabi S, Saghaeiannejad S, Heidari A. Requirements and areas associated with readiness assessment of electronic health records implementation. *Journal of Health Administration*. 2011;14(46):71-8.
4. Shahbahrami A, MOAYED RS, Hafezi M. Effective factors in acceptance of electronic health record from employees point of view. *Gums-Med*. 2016;24(96):50-60.
5. Jamieson T, Ailon J, Chien V, Mourad O. An electronic documentation system improves the quality of admission notes: a randomized trial. *J Am Med Inform Assoc*. 2017;24(1):123-9. doi: 10.1093/jamia/ocw064.
6. Khammarnia M, Sharifian R, Zand F, Barati O, Keshtkaran A, Sabetian G, et al. The impact of computerized physician order entry on prescription orders: A quasi-experimental study in Iran. *Med J Islam Repub Iran*. 2017;31:69. doi: 10.14196/mjiri.31.69.
7. Lorenzetti DL, Quan H, Lucyk K, Cunningham C, Hennessy D, Jiang J, et al. Strategies for improving physician documentation in the emergency department: a systematic review. *BMC Emerg Med*. 2018;18(1):36. doi: 10.1186/s12873-018-0188-z.
8. Despins LA, Wakefield BJ. The Role of the Electronic Medical Record in the Intensive Care Unit Nurse's Detection of Patient Deterioration: A Qualitative Study. *Comput Inform Nurs*. 2018;36(6):284-92. doi: 10.1097/CIN.0000000000000431.
9. Garavand A. Survey of possibility deployment of electronic medical record in Shiraz teaching hospitals. *Journal of Health and Biomedical Informatics*. 2015;2(1):33-41.
10. Efatmaneshnik M, Shoval S, Qiao L. A standard description of the terms module and modularity for systems engineering. *IEEE Transactions on Engineering Management*. 2018;67(2):365-75.
11. Virtua Med Student [Internet]. Organize an ICU note america. c2019. [Available from: http://www.virtualmedstudent.com/links/medicalstudent_resources/icu_note.html
12. Farzandipour M, Nabovati E, Zaeimi GH, Khajouei R. Usability Evaluation of Three Admission and Medical Records Subsystems Integrated into Nationwide Hospital Information Systems: Heuristic Evaluation. *Acta Inform Med*. 2018;26(2):133-8. doi: 10.5455/aim.2018.26.133-138.
13. Baker T, Schell CO, Lugazia E, Blixt J, Mulungu M, Castegren M, et al. Vital Signs Directed Therapy: Improving Care in an Intensive Care Unit in a Low-Income Country. *PLoS One*. 2015;10(12):e0144801. doi: 10.1371/journal.pone.0144801.
14. Buchanan EM, Crain SE, Cunningham AL, Johnson HR, Stash H, Papadatou-Pastou M, et

al. Getting started creating data dictionaries: How to create a shareable data set. *Advances in Methods and Practices in Psychological Science*. 2021;4(1):2515245920928007. doi: 10.1177/2515245920928007.
15. Bishop P, Hines A, Collins T. The current state of scenario development: an overview of techniques. *Foresight*. 2007;9. doi: 10.1108/14636680710727516.
16. Vollmar HC, Ostermann T, Redaelli M. Using the scenario method in the context of health and health care--a scoping review. *BMC Med Res Methodol*. 2015;15:89. doi: 10.1186/s12874-015-0083-1.
17. Lund AM. Measuring usability with the use questionnaire. *Usability interface*. 2001;8(2):3-6.
18. Fallahnejad E, Niknam F, Nobar RN, Zand F, Sharifian R. Development of minimum data set for electronic documentation of progress note in the general intensive care unit. *Frontiers in Health Informatics*. 2020;9(1):37. doi: 10.30699/fhi.v9i1.226.
19. Gao M, Kortum P, Oswald F, editors. Psychometric evaluation of the use (usefulness, satisfaction, and ease of use) questionnaire for reliability and validity. *Proceedings of the human factors and ergonomics society annual meeting*. 2018;62:1414-8. doi: 10.1177/1541931218621322.
20. Macefield R. How to specify the participant group size for usability studies: a practitioner's guide. *Journal of Usability Studies*. 2009;5(1):34-45.
21. Hercigonja-Szekeres M, Somek M, Cukljek S, Ilic B, editors. Documenting the Health Care Processes in the Intensive Care Unit. *Studies in Health Technology and Informatics*. 2014;205:1232.
22. Sadoughi F, Shahi M, Ahmadi M, Davaridolatabadi N. The Comparison of the Minimum Data Set for Elderly Health in Selected Countries. *Acta Inform Med*. 2015;23(6):393-7. doi: 10.5455/aim.2015.23.393-397.
23. ANZICS [Internet]. APD Data Dictionary for Software Programmers ANZICS CORE - adult patient database. c2020. Available from: https://www.anzics.com.au/
24. Ahmadi M, Mirbagheri E. Designing Data Elements and Minimum Data Set (MDS) for Creating the Registry of Patients with Gestational Diabetes Mellitus. *J Med Life*. 2019;12(2):160-7. doi: 10.25122/jml-2019-0011.
25. Moeil Tabaghdehi K, Ghazisaeedi M, Shahmoradi L, Karami H, Bashiri A. Designing a minimum data set for major thalassemia patients: towards electronic personal health record. *Journal of Community Health Research*. 2018;7(1):24-31.
26. Jahanbakhsh M, Safari F, Babaei Z, Jafari M, Heydarian G, Bahrami F, et al. Redesign of the Admission and Discharge Summery Sheet Based on Information Need Assessment in the Educational Hospitals in Isfahan. *Journal of Modern Medical Information Sciences*. 2016;2(2):10-8.
27. Mwakyusa S, Wamae A, Wasunna A, Were F, Esamai F, Ogutu B, et al. Implementation of a structured paediatric admission record for district hospitals in Kenya--results of a pilot study. *BMC Int Health Hum Rights*. 2006;6:9. doi: 10.1186/1472-698X-6-9.
28. Goodyear HM, Lloyd BW. Can admission notes be improved by using preprinted assessment sheets? *Qual Health Care*. 1995;4(3):190-3. doi: 10.1136/qshc.4.3.190.
29. Irtiza-Ali A, Houghton CM, Raghuram A, O'Driscoll BR. Medical admissions can be made easier, quicker and better by the use of a pre-printed Medical Admission Proforma. *Clin Med (Lond)*. 2001;1(4):327. doi: 10.7861/clinmedicine.1-4-327.
30. Khammarnia M, Sharifian R, Zand F, Keshtkaran A, Barati O. Designing Computerized Provider Order Entry Software in Iran: The Nurses' and Physicians' Viewpoints. *Comput Inform Nurs*. 2016;34(9):413-20. doi: 10.1097/CIN.0000000000000250.
31. Dargahi H, Ghazi Saeedi M, Safdari R, Hamedan M. A survey of clinical information system process in general hospitals of Tehran University of Medical Sciences. *Payavard Salamat*. 2010;4(2):31-43.
32. Kusriyanti D, Matuwi B. Readiness Analysis of Electronic Medical Record Implementation at Dinda Tangerang Hospital Using Correlational Method. *European Journal of Business and Management Research*. 2021;6(4):19-25. doi: 10.24018/ejbmr.2021.6.4.915.
33. Garavand A. Survey of possibility deployment of electronic medical record in Shiraz teaching hospitals. *Journal of Health and Biomedical Informatics*. 2015;2(1):33-41.
34. Safdari R, Ghazisaeidi M, Pezeshki A, Mahmoodzadeh B, Nikmaram A. The Introduction of Electronic Medical Records for Chronic Kidney Disease as a Reliable Method for the Diagnosis of the Disease. *Journal of Advances in Medical and Biomedical Research*. 2016;24(104):112-20.

35. Shahmoradi L, KhoramiMoghadam R, Ghazisaeedi M, Gholamzadeh M. Implementation of Electronic Health Record as a Clinical Information Tool to Improve Gastric Cancer Care. *Applied Health Information Technology*. 2020;1(1):19-29. doi: 10.18502/ahit.v1i1.5255.
36. Sadoughi F, Khoshkam M, Farahi SR. Usability evaluation of hospital information systems in hospitals affiliated with Mashhad University of Medical Sciences, Iran. *Health Information Management*. 2012;9(3):310-7.
37. Alanzi T, Istepanian R, Philip N. Design and Usability Evaluation of Social Mobile Diabetes Management System in the Gulf Region. *JMIR Res Protoc*. 2016;5(3):e93. doi: 10.2196/resprot.4348.
38. Agharezaei Z, Khajouei R, Ahmadian L, Agharezaei L. Usability evaluation of a laboratory information system. *Director General*. 2013;10(2):1-12.
39. Colleti Junior J, Andrade AB, Carvalho WB. Evaluation of the use of electronic medical record systems in Brazilian intensive care units. *Rev Bras Ter Intensiva*. 2018;30(3):338-46. doi: 10.5935/0103-507X.20180057.
40. Lin HL, Wu DC, Cheng SM, Chen CJ, Wang MC, Cheng CA. Association between Electronic Medical Records and Healthcare Quality. *Medicine (Baltimore)*. 2020;99(31):e21182. doi: 10.1097/MD.0000000000021182.