



## Assessing Health Level Seven Standards in Hospital Information Systems: Utilization of the EHR Functional Model

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### Abstract

**Introduction:** HL7 standards of EHR functional model provide a standardized framework which help evaluate, design, and improve hospital information systems. This study examines hospital information systems in terms of their compliance with HL7 standards in the EHR functional model at teaching hospitals affiliated with Shiraz University of Medical Sciences

**Methods:** This is an applied descriptive cross-sectional study conducted among 11 hospital information system officials affiliated with Shiraz University of Medical Sciences. A questionnaire based on HL7 standards of EHR functional model was used for data collection and validated by information technology experts. Data were collected through interviews and direct observation. Data analysis was performed using SPSS 16, including a one-sample T-test to compare the sample and population means.

**Results:** The results of the study revealed a significant disparity between the average values of the community and the security domain within the examined sample ( $P < 0.001$ ). Additionally, notable distinctions were observed between the community average and the means of health records management and information ( $P = 0.03$ ), terminology services and standard terminology ( $P < 0.001$ ), and workflow ( $P = 0.03$ ).

**Conclusion:** Evaluating Healthcare Information Systems (HIS) performance is crucial for meeting the needs of the healthcare organizations. The HL7-EHR functional model provides a comprehensive framework for assessing HIS functionality and integration. Evaluation based on this framework enhances the patient's care and safety through efficient hospital information system implementation in Iran.

**Keywords:** Assessment, HIS, HL7 standard, Functional model

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### Introduction

Healthcare is an important social and economic component of modern societies, with the acceptance and impressive use of health information systems being significant to its success (1). Health Information Systems (HIS) are critical tools that enable healthcare providers to capture, store, manage, and transmit the patient's health information electronically (2, 3). HIS plays an essential role in modern healthcare delivery systems, improving the quality of patient care, enhancing communication between healthcare providers, and streamlining administrative tasks. Implementation and utilization of these systems make better clinical processes and healthcare quality, reduce healthcare costs, and increase the healthcare providers' and patients' satisfaction (4,

5). In general, the Health Information System is a comprehensive framework comprising individuals, data, activities, and material resources that facilitate organized clinical functions. These components are interconnected; they enable the processing and seamless flow of data, either through manual or automated means, within the organization in alignment with its objectives. To ensure the quality of information within the HIS, it is crucial to develop reliable assessment tools (6). Providing high-quality, efficient, and patient-centered care (7) is the goal of a hospital information system with integrated support of the administrative and management tasks that are necessary for support such care (8). Well-designed HIS systems have reduced the cost of quality care and the access time to patient records (9). Health information

systems are essential in healthcare delivery, and their effective evaluation is necessary to achieve high-quality patient care (1, 10).

Evaluating HIS through standardized frameworks and tools is critical in ensuring efficient and effective healthcare delivery (6). New technology often used continually EHRS functions, but the EHRS functional framework is almost stable. Implementation and functional framework are apart from each other; it is one of EHRS principles (11). The Health Level Seven International (HL7) Electronic Health Record System Functional Model (EHR-S FM) is a widely used framework that facilitates the development and evaluation of HIS (11, 12).

The model contains 7 major sections: Overarching Criteria, Care Provision, Care Provision Support, Population Health Support, Administration Support, Record Infrastructure, and Trust Infrastructure. As indicated by their names, these sections have functional requirements that use: (1) all systems (e.g., archive and restore, authentication, authorization, access control), (2) the direct care of a specific patient (e.g., history, problem list, medication management, orders, results), (3) support of the care provision (e.g., creating and managing order sets), (4) support of the prevention and control of disease among a group of people, (5) management of administrative and financial operations, resources, workflow, and communication, (6) record management (e.g., origination, attestation, amendment, access/use, translation, transmittal, receipt, archive, de-identification) and record lifespan (e.g., audit, encryption), and (7) EHR system infrastructure (e.g., security, privacy, and confidentiality, data integrity, and interoperability) (12).

In a systematic literature review by Noë et al. (6) the standards, processes, and tools used to evaluate the quality of HIS were identified. The study found that standardized evaluation frameworks and tools were necessary for assessing HIS quality effectively. Implementing standardized and interoperable HIS plays a significant role in enhancing usability and improving data management (11, 12). Meehan et al. (12) demonstrated how conformance criteria in the HL7 EHR-system functional model can improve EHR system usability by providing standardized specifications for system components. Similarly, Meng et al. (11) analyzed the HL7 EHR-S FM and

its potential applications in China, highlighting the need for interoperability between different HIS components to ensure efficient information exchange.

Moreover, understanding the functionality of HIS is essential for identifying areas of improvement and optimization of the use of these systems (9). A survey of quality directors at Turkish hospitals by Saluvan and Ozonoff (9) assessed the functionality of HIS and identified several areas for improvement, including system integration and user training. For instance, Esfahani et al. (13) proposed an evaluation model for implementing HIS in public hospitals using multi-criteria decision-making approaches. This model enabled a comprehensive evaluation of HIS capabilities and identified areas for improvement to enhance the system usability and data management. In conclusion, the EHR-S FM provides a standardized framework that can help evaluate, design, and improve HIS in various healthcare settings. Its application can potentially enhance healthcare delivery, patient outcomes, and data management (13, 14). Given the Ministry of Health objectives to develop hospital information systems standards and the importance of hospital information systems in moving towards electronic health records and prioritizing information structures in EHR development based on the current standards, this study examines hospital information systems in terms of their compliance with HL7 standards in the EHR functional model at teaching hospitals affiliated with Shiraz University of Medical Sciences.

## Materials and Methods

This is an applied descriptive cross-sectional study. The research community consisted of 11 hospital information system officials of educational centers affiliated with Shiraz University of Medical Sciences (Moharrei, Khalili, Chamran, Namazi, Ebnesina, Poostchi, Rajayee, Zeinabie, Alzahra, and Hafez). The data collection tool was a questionnaire that was prepared, arranged, and translated based on the HL7 standards of EHR functional model (14). The main function of the questionnaire includes: 1) security, 2) health record information and management, 3) registry and directory services, 4) standard terminologies or terminology services, 5) integration, 6) business rules management, and 7) workflow

management, each of which includes several subcategories. A 5-degree fuzzy scale was used for measurement. The validity and reliability of the tool were confirmed by information technology experts. A validation form was prepared for the questionnaire, considering three aspects of transparency, appropriateness, and importance for each question. Validation forms were distributed among eight experienced individuals. Also, for reliability, the test-retest method was used. In this way, a subgroup was selected consisting of eight individuals from the study population. These individuals were asked to complete the questionnaire on two separate occasions, with a ten-day interval. The obtained results showed a correlation coefficient of 86%, indicating a high level of consistency and confirming the reliability of the questionnaire. The data collection method consists of a researcher-made questionnaire completed by hospital IT officials and direct observation. Data analysis was performed using the SPSS 16 statistical software, and a one-sample T-test was used to compare the sample mean with the population mean.

**Results**

In this study, the research community consisted of 11 hospital IT officials of educational centers affiliated with Shiraz University of Medical Sciences. They completed a questionnaire based on HL7 standards of the EHR functional model. The results of the single-variable t-test on the compliance level of functional model components of EHR in hospital information systems are shown in Table 1. The comparison between the average scores of the variables and the community average revealed that there was a significant difference between the community average

and the security mean in the examined sample ( $P<0.001$ ). Furthermore, there were significant differences between the community average and the means of health records management and information ( $P=0.03$ ), terminology services and standard terminology ( $P<0.001$ ), and workflow ( $P=0.03$ ).

**Discussion**

Hospital Information Systems (HIS) have become indispensable components of contemporary healthcare systems, facilitating healthcare organizations in enhancing efficiency, safety, and patient care. Evaluating the performance of HIS is vital to ensure that they effectively meet the needs of healthcare organizations and are aligned with their missions. Several models have been proposed for evaluating the effectiveness of HIS, one of which is the HL7-EHR functional model (1). Carvalho et al. (1) and Abedian et al. (15) proposed that a comprehensive evaluation could be conducted using the EHR functional model for hospital information systems in Iran. This study aimed to assess the extent of compliance of Hospital Information Systems with the EHR functional model. The findings indicated a significant difference between the community average and the mean score for security in the examined sample ( $P<0.001$ ). Additionally, there were significant differences between the community average and the mean scores for health records management and information ( $P=0.03$ ), terminology services and standard terminology ( $P<0.001$ ), and workflow ( $P=0.03$ ).

Carvalho et al. (1) emphasize that the collection, storage, and analysis of health data in healthcare services have been efficient in the past

**Table 1:** The results of the single-variable T-test on the compliance level of functional model components of EHR in hospital information systems

| Variable                                       | N  | Mean   | Std. Deviation | Std. Error Mean | Test Value=3 |    |                 |                 |   |
|--|----|--------|----------------|-----------------|--------------|----|-----------------|-----------------|---|
|  |    |        |                |                 | t            | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference |
| Security                                       | 11 | 4.0537 | 0.61282        | 0.18477         | 5.703        | 10 | 0.000           | 1.05372         | 0.6420                                    |
| Health Record information and management       | 11 | 3.7306 | 0.92831        | 0.27990         | 2.610        | 10 | 0.026           | 0.73064         | 0.1070                                    |
| Registry and directory services                | 11 | 3.2655 | 1.27928        | 0.38572         | 0.688        | 10 | 0.507           | 0.26545         | -0.5940                                   |
| Standard terminologies or terminology services | 9  | 4.1250 | 0.33657        | 0.11219         | 10.028       | 8  | 0.000           | 1.12500         | 0.8663                                    |
| Integration                                    | 8  | 3.5139 | 1.46678        | 0.51859         | 0.991        | 7  | 0.355           | 0.51389         | -0.7124                                   |
| Business rules management                      | 10 | 3.4909 | 0.97767        | 0.30917         | 1.588        | 9  | 0.147           | 0.49091         | -0.2085                                   |
| Workflow management                            | 9  | 3.8632 | 0.98267        | 0.32756         | 2.635        | 8  | 0.030           | 0.86325         | 0.1079                                    |

and their importance continues to grow with the increasing volume of health data collected daily. In hospital management systems, effective data management and exchange play a crucial role, while the current study revealed the lowest average in the field of registry and directory services.

The present study showed that there was a significant difference between the community average and the mean of health records management and information. In this regard, Chatterjee et al. (16) highlight the significance of adhering to international standards to enhance data transfer and management. Additionally, Carvalho et al. (1) propose a maturity model for hospital information systems which enables the authorities to evaluate the compliance levels in terms of management performance and patient record-keeping, based on the EHR functional model.

Additionally, according to the study results, it is necessary to assess the level of adherence to the performance management of work rules within the hospital management system EHR functional model. In line with the findings of our study, Esfahani et al. (13) suggest that employing multi-criteria decision-making (MCDM) approaches can aid in constructing an evaluation model for implementing a hospital information system. Such an approach can effectively gauge the efficacy of the EHR functional model in overseeing work rules. Security issues within organizations often arise due to the lack of integration between security discussions and business goals (1). They propose an evaluation model that utilizes multi-criteria decision-making approaches to assess the implementation of hospital information systems in public hospitals. This model can also be employed to evaluate the level of security compliance based on the EHR functional model.

The use of standardized terms not only facilitates a comprehensive understanding of the patient's condition but also plays a crucial role in information exchange. The present study showed that there was a significant difference between the community average and the mean of terminology services and standard terminology. In this regard, Abedian et al. (15) propose a functional assessment model for hospital information systems in Iran, which can be employed to evaluate adherence to standard terms and term services based on the EHR functional model. Also, Chatterjee et

al. (16) introduced the use of HL7 FHIR with SNOMED-CT to achieve semantic and structural interoperability in personal health data. This study offers valuable insights to the development of compliance standards for hospital information systems based on the EHR functional model, particularly about data security. The findings of this study can inform decision-makers and stakeholders involved in the implementation of HIS. Assessing the compliance rate of the workflow management and EHR functional model within a hospital management system is crucial to ensure the smooth and efficient execution of all processes. To evaluate the level of compliance with workflow management, the evaluation model proposed by Esfahani et al. (13) can be utilized.

### Conclusion

In conclusion, the evaluation of Healthcare Information Systems (HIS) performance is crucial to ensure that they effectively meet the needs of the healthcare organizations and support their missions. The HL7-EHR functional model offers a comprehensive framework for assessing HIS functionality and integration within healthcare systems. Several evaluation models have been proposed based on this model, providing valuable insights to decision-makers and stakeholders involved in HIS implementation. Ultimately, these evaluations contribute to improving patient care and safety. The implementation of an efficient hospital information system is a significant step towards the full adoption of electronic health records in Iran. With the current development and maturity of the electronic prescription system in Iran, an efficient hospital information system becomes even more essential in facilitating the acquisition of electronic health records.

### Ethics Declaration

This study was approved by the Shiraz University of Medical Sciences Ethics Committee (ID: IR.SUMS.REC.1399.939). All methods were carried out following relevant guidelines and regulations under ethics approval and consent to participate.

**Conflict of Interest:** None declared.

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