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A Survey on Intensive Care Units Information System in Hospitals affiliated with Shahid Beheshti University of Medical Sciences

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Abstract

Introduction: The information system of the intensive care unit has been designed and established in order to manage patients' data and quickly retrieve patients' information in this unit. This research was carried out to study the information system of the ICU and reporting capabilities in the hospitals affiliated with Shahid Beheshti University of Medical Sciences (SBMU).

Methods: In this descriptive cross-sectional study, the study population included ICU information systems in seven hospitals that had the system in place. Data gathering tools were a questionnaire and a checklist. The content validity was performed to ensure the validity of the checklist and questionnaire (based on the relevant literature and seeking experts' opinion). The test-retest method was used to determine the questionnaire reliability (r = 0.89). Data were analyzed using descriptive statistics.

Results: Data collection in the ICU information system in all hospitals understudy is done both in the form of paper forms and electronically (semi-automatically). Regarding reporting capability, different types of reports, including patients' demographic information reports, admission reports, discharge reports, transfers, diagnoses, mortality, and management reports, none of the studied hospitals, the automatic reporting capability scores (GCS), reporting patient safety indicators through alerts and reminders, reporting the cost of medications, reporting disease severity, including Sequential Organ Failure Assessment (SOFA), and Acute Physiology and Chronic Health Evaluation (APACHE), were not observed.

Conclusion: Implementing comprehensive and integrated ICU information systems can be an effective step towards organizing patient information and improving the quality of service provided to them. Therefore, the deployment of an ICU information system is necessary to improve care delivery in ICUs.

Introduction

The intensive care unit (ICU) is one of the specialized units of the hospital, which has been established to provide continuous care to medically unstable and critically ill patients who are (1). In this section, where patients are cared for by a multi-specialized team (2), making high-risk decisions (3), continuing care and timely and comprehensive documentation, a large amount of information about the services provided to patients, are significant challenges for intensive care professionals (4).

specialists in the ICU need facilities, such as ease of obtaining data from various sources, quick access to accurate and comprehensive patient data, expediting the patient's condition to improve the quality of care, automating the care process to increase efficiency, and provide timely information; therefore, these cannot be accomplished with large paper files. However, it is necessary to use information systems in the ICU (5).

The Intensive Care Information System (ICIS) is an integrated clinical documentation and decision support system

that manages the complexity of information generated in the ICU. It collects, stores, classifies, and displays data about each patient in this department (6,7).

This system supports therapeutic processes at the patient's bedside, whose primary function is to calculate, store and display various patient data (8). Also, these systems include other benefits such as storing and processing clinical data and converting them into appropriate formats for making decisions, monitoring patient vital signs, offering suggestions to intensive care professionals about improving the quality of patient care, organizing, and reporting needed to make the right treatment decisions (12-9).

The ICIS system reduces mortality and the length of stay of the patient and thus improves the effectiveness of the patient by improving the access of specialists to the patient's medical history and full integration of patient data in the ICU (13,14).

On the other hand, the information system of the ICU is related to hospital information systems (HIS), and through the connection of information with the HIS system, it can automatically record the patient's demographic data. This system is also related to laboratory information systems, radiology information systems, and pharmacy information systems (16, 15).

The results of a study by Hains et al. on ICU information system showed that this system facilitates access to information and makes communication and work processes more efficient (17).

Plenderleith, in his studies, while examining the benefits of the ICU system, concluded that using this system in the ICU, facilitates communication with other information systems in the hospital, including the laboratory, radiology, and other departments, and increases the accuracy of the patient file data (18).

In Iran, a study was conducted on how to record nursing reports through the information system of the cardiac patient's ICU to optimize the electronic hospital information system. The results of this study showed that if this system is used, the accuracy, speed, and quality of record nursing reports and improve the provision of medical services to heart patients will increase and ultimately lead to increased satisfaction of the treatment team and patients (19).

The use of an integrated information system in the ICU is essential to better manage the large volume of data in this department and improve the quality of patient care. Awareness of the status of the information system in this section provides valuable information for developing these systems to the officials of medical centers and manufacturers of these systems. Since no study had been conducted on the status of the information system of ICU patients in the country, or at least it was not available, in this study, the status of the information system of the ICU in the hospitals of Shahid Behehti University of Medical Sciences was investigated.

Methods

The present study was a descriptive cross-sectional study conducted in the hospitals affiliated with SBMU to investigate the status of the information system of the ICU and focus on data collection resources and reporting capabilities. The study population consisted of the ICU information system of seven educational-medical hospitals affiliated with SBMU. Due to the emphasis of the studied hospitals on the confidentiality of information about them, the names of the hospitals have been refused. Questionnaires and checklists were based on studies and were developed focusing on data collection resources and reporting capabilities of systems. The validity of the checklist and questionnaire was assessed by determining the validity of the content, which was based on studies and opinions of experts related to the research topic. To determine the reliability of the questionnaire, the retest method with correlation coefficient ($r = 0.89$) was used. The extracted data were analyzed by using descriptive statistics.

Results

Findings showed that most users of the ICU information system are physicians, nurses, ICU secretaries, laboratory staff, radiologists, and pharmacists in almost all centers under study, data collection was done in the form of both paper forms and electronically (semi-mechanized). Also, in the ICU information system database of the studied hospitals, the patient demographic information element, diagnostic information, and treatment information were recorded, and various processes of this system regarding drug dose calculation, patient nutritional calculations (injectable or oral), input, and output fluid calculations and calculation of hospital statistics were done.

Table 1 shows the data collection sources of the intensive care unit information system in all surveyed hospitals, from hospital information systems, patient clinical monitoring system, ventilators, intravenous injection pumps, laboratory information systems or Laboratory Information System (LIS) , Radiology Information System (RIS), Pharmaceutical Information System (PIS), Picture Archiving and Communication System (PACS) are provided and the Computerized Physician Order Entry (CPOE), the Clinical Decision Support System (CDSS), is not used as a source for data collection in any of the HISs.

Regarding the types of reports provided by the information system of the ICU of the hospitals under study, Table 2 shows that in none of the studied hospitals, the ability to automatically report scores, Glasgow Coma Scale (GCS), reporting patient immunity indicators by providing alerts, reminders, drug cost reports, disease severity reports, including Sequential Organ Failure Assessment (SOFA), and Acute Physiology and Chronic Health Evaluation (APACHE), were not observed.

Table 1. Frequency distribution of ICU data collection resources in hospitals affiliated with SBMU

Row	Data collection resources	Frequency	Percentage
1	Doctors' medical history notes, nursing reports, and other documents	7	100
2	Hospital Information System	7	100
3	Patient clinical monitoring system	7	100
4	Ventilators	7	100
5	Intravenous injection pumps	7	100
6	Blood gas analyzers	7	100
7	Laboratory information system	7	100
8	Radiology information system and communication system and image archive	7	100
9	Electrocardiogram	5	71.4
10	Electroencephalogram	3	42.8
11	Hospital electronic medical records	7	100
12	Pharmacy information system	7	100
13	Computer physician order registration system	0	0
14	Clinical decision support system	0	0

Table 2. Frequency distribution of various reports in the ICU information system in the hospitals affiliated with SBMU

Row	Type of reports	Frequency	Percentage
1	Patient demographic information reports	7	100
2	Reports on admission, discharge and transfer / length of stay / types of hospital services	7	100
3	Diagnosis / Mortality / Infection Prevalence Reports	7	100
4	Reporting physiological variables	7	100
5	Report patient immunity indicators by providing warnings and reminders	0	0
6	Disease Summary Reports (Latest Patient Test Results, Vital Signs, Respiratory, Fluids)	7	100
7	Automatic reporting of multi-organ dysfunction grading scores, assessment of acute and chronic health physiology, clinical pulmonary infection grading, Glasgow Coma Scale score	0	0
8	Reports by ward, person, disease or a combination of these	7	100
9	Drug cost reports	0	0
10	Resource efficiency report	7	100
11	Reporting Ventilator Data / Ventilator-Related Pneumonia	7	100
12	Reports of disease severity models, mortality prediction models	0	0
13	Routine calculation reports such as total fluid balance	7	100
14	Drug prescribing reports by weight	7	100
15	Report and display trends graphically and by the chart	7	100
16	Qualitative and comparative reporting for quality auditors, government and regulatory institutes	7	100
17	Statistical and managerial reports to meet the needs of research, quality, and management departments	7	100
18	Monitoring reporting to optimize hospital reimbursements	4	57/1
19	Standardized mortality reports and quality scales to compare ICU	7	100
20	Statistical reporting to national intensive care units	7	100
21	Automatic reporting of clinical audits	4	57.1

Discussion

The existence of information system in ICU and the use of authorized users in recording patient data reduce the effectiveness of data management by reducing medication error and correct documentation, increases readability, comprehensiveness, and accuracy of data, and facilitate data recovery and the development of data quality of patient care (20). In this study, the results showed that most users of this system are physicians, nurses, ward secretaries, laboratory staff, radiologists, and pharmacies, which due to the significant role of care of these users; effective health care planning is achieved in order to increase the quality of patient care.

In the database of an ICU information system, great emphasis has been placed on completing the patient demographic information elements, diagnostic and treatment information (16) that based on the findings of this study, these information elements are recorded in the information system of the ICU of all hospitals. Furthermore, their completion in ICU information systems is considered necessary, which has led to the creation of a rich database of information for patients in this ward. This ultimately leads to the retrieval of comprehensive information about each patient, so the type of care and treatment of each patient is selected according to the recorded information about that patient.

In an ICU information system, the minimum processes to be performed by the system include drug dose calculation, patient nutritional calculations, fluid input, and output calculations, and automatic calculations of GCS, APACHE, MODs, CPIS, and calculation of hospital statistics (21,22). However, according to the findings of this study, among the mentioned processes, only drug dose calculations, patient nutritional calculations and input and output fluids and hospital statistics were performed by the information system of the ICU in the studied hospitals.

This is while essential processing operations, including calculating the Multiple Organ Dysfunction Score (MODS), APACHE, Clinical Pulmonary Infection Score (CPIS), and Glasgow Coma Scale Score (GCS) was not performed in the information system of the hospitals under study and was calculated manually, which could lead to a care error for patients and reduce the desired level of patient care.

According to studies conducted in an ICU information system, data collection should be done through the information connection of this system with the HIS and its subsystems, PACS, CPOE and CDSS are used (23). However, in this study, the findings showed that in the hospitals under study, data collection is provided only through the information connection of the hospital information system and its subsystems, including laboratory, radiology, pharmacy, and other departments, and none of the hospitals under study uses CPOE and CDSS and this is if the existence of CPOE and CDSS systems reduces errors in medical prescription registration and prescribing the right medication for patients due to the use of warnings and reminders in clinical decision support systems and support for correct decision making timely.

In addition, supporting clinical decisions for patients helps determine financial resources and evaluate the efficiency of the intensive care unit, and improve the distribution of care and treatment facilities, as well as prevent medical errors by providing appropriate advice (23).

These results are in line with the results of other studies in the field of review of other HIS subsystems such as pharmacy information system (24), anatomical pathology information system (25), and hematology information system (26) and data collection in these systems such as ICU information system is semi-mechanized.

In an ICU information system, the reports obtained from this system must include at least various types of reports, including patient demographic information reports, admission reports, discharge reports, transfers, diagnoses, mortality, and GCS, reporting patient immunity indicators by providing warnings and reminders, report drug costs, report disease severity models such as SOFA or APACHE (27, 28, 29). However, in this study, the findings indicate that the ICU information systems of the research centers only provided routine reports, but the GCS, the reporting of patient immunity indicators by providing alerts and reminders, drug cost reporting was not provided by these systems due to the lack of a system for storing financial data in the ICU, reporting of disease severity models, SOFA or APACHE.

The existence of these reports has numerous benefits, including measuring the severity of the disease and a criterion for comparing and determining the risk of mortality of patients in the days after hospitalization in the ICU and in addition, evaluating the treatments used for patients, justifying in-hospital difference mortality in different medical centers and determining the quality of intensive care (28,29), which can be used to obtain valuable reports on the provision of care to patients in the ICU to provide useful and constructive reports for health care providers, managers, health planners, and health policymakers.

Conclusion

This study revealed that data collection sources in the ICU information system are semi-mechanized, and the ability to connect between its modules is not established. Also, the ICU information system is not equipped with CPOE and CDSS systems, which reduce errors in registering medical prescriptions and prescribing the correct medication to patients. Regarding reporting capability, the ICU information systems of the research centers provided only routine reports.

Therefore, it is suggested that designers and analysts design and implement the ICU information system according to users' needs to improve the quality of patients' clinical data records and provide effective care to patients in this ward.

Declarations

Conflicts of Interests
The authors declare that they have no competing interests.

Ethical statement
In this study, no intervention was performed on patients and this research was carried out to study the information system of the ICU and reporting capabilities. The researcher assured participants that information from the study would remain confidential.

Authors' contributions
Concept and study design: FA, RR, HM; analysis and interpretation: FA, RR, HM, BA; Writing the article: BA; critical revision of the article: FA, RR, HM; final approval of the article: FA, RR, HM.

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