The Use of Health Information Technology by Nurses in Healthcare

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Abstract

Background: Health Information Technology (HIT) has the potential for improving the quality, safety, and efficiency of healthcare and nurses are the largest group of HIT users.
Objectives: Therefore, the present study mainly aimed to investigate the use of HIT by nurses in healthcare.
Methods: This cross-sectional and descriptive-analytical study was conducted in four educational and treatment centers of Zanjan University of Medical Sciences in 2019. A researcher-made questionnaire was used for data collection, the validity and reliability of which were confirmed by experts' approval and Cronbach's test (0.84). Eventually, the data were analyzed by R and Rstudio statistical Software, and Chi-square test was used to examine the relationship between the variables.
*Results***:** The most commonly used HITs among nurses were the hospital information system (100%), picture archiving and communication system (83.2%), as well as tele-nursing (76%) and mobile-health (64.9%). However, none of the nurses used a radio frequency identification system (0%) in nursing care.
Conclusion: The findings of this study revealed that although the application of HITs presents potential benefits in improving healthcare quality, their features are not used completely in nursing care.

Keywords: health information technology, hospital information system, mobile-health, picture archiving and communication system, radio-frequency identification, tele-nursing

Introduction

Health information technology (HIT) is defined as "the application of information processing involving both computer hardware and software that deal with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making [1]. The most important and useful HITs in healthcare are Hospital Information System (HIS), Picture Archiving and Communication System (PACS), Tele-Nursing, Mobile-Health (M-health), and Radio-Frequency Identification (RFID).

HIS can be defined as massive, integrated systems that support the comprehensive information requirements of the hospital, including patients, as well as clinical, ancillary, and financial management [2]. A digital radiology department has two parts, namely, the Radiology Information System (RIS) and Picture Archiving and Communication System (PACS). RIS is a subsystem of the HIS that includes patients' demographic and financial information. Moreover, PACS includes capturing, archiving, transmitting, retrieving, displaying, and processing the radiology images and information [3]. Additionally, Tele-nursing is the use of "technology to deliver nursing care and conduct nursing practice by distance". Nurses who were engaged in tele-nursing practices continued assessing, planning, intervening, and evaluating the outcomes of the nursing care, but they did not

do so using technologies such as the Internet, computers, telephones, digital assessment tools, and tele-monitoring equipment [4]. Mobile-health is a general term for the use of mobile phones and other wireless technologies in medical care [5]. Although there can be an overlap between Tele-nursing and M-health, the two are not interchangeable. The main difference is that M-Health is delivered exclusively via mobile devices while Tele-nursing can be delivered on mobile platforms. In addition, it refers to the delivery of remote care via electronic information and telecommunication technologies. Similarly, the RFID is a technology that uses radio waves to transfer data from an electronic tag called "RFID tag attached to an object" through a reader for identifying and tracking the object. Further, the RFID is valuable for quickly retrieving patient information and monitoring patient locations in the hospital [6].

The utilization of HITs for improving patient safety and quality of care has become a high priority area for the governments and healthcare organizations. Although the adoption of HITs has advanced in Iran over the past decade, considerable challenges remain in their development, adoption, and effective use in healthcare. The widespread adoption of HITs brings many potential benefits to healthcare. Simultaneously, problems with HITs can disrupt the delivery of healthcare and increase the medical errors that can affect the patient's safety and quality of care [7,8]. Despite these problems, replacing the traditional and paper-based system by the electronic-based system is essential in the healthcare setting. Further, the use of HITs can improve the quality of hospital resource management by reducing problems and extra costs. HITs have a positive effect on the quality of patient care and decision-making skills that improve the efficiency of healthcare services [9].

Nurses are the largest group of HIT users and spend a great deal of time for communicating with them at work. Future technological innovation is going to keep transforming healthcare. Therefore, nurses need to know about HIT features and their capabilities for improving healthcare quality. Some benefits and advantages of HITs in nursing care are improving communication that leads to healthcare improvement, providing better education, improving treatment, and better

keeping the records [10]. HITs also improve the quality of nursing documentation while reducing medication and administration errors [11]. The healthcare recognizes the critical goal for adopting and effectively using HITs. Considering strong institutional powers and policies pushing the use of these technologies to better support service delivery, HITs offers many opportunities for healthcare transformation. Although HIT is implemented in healthcare, limited adoption and use of HIT features remain a challenge. Accordingly, this study sought to investigate the nurses' use of HIS, RFID, PACS, Tele-nursing, and M-health technologies and their features in nursing care.

Methods
This descriptive-analytical study was performed in four educational and treatment centers of Zanjan University of Medical Sciences (ZUMS) in 2019. Nurses working at hospital wards were the statistical society of this study and 223 nurses with at least two years of work experience were selected as the sample based on the following formula [12].

$$n = \frac{z_{a/2^2}.N.P.Q}{e^2(N-1) + Z_{a/2^2}.P.Q} = 223$$

$Z_{a/2} = 1.96$
N=the number of society
P=0.5 the probability of success in the Bernoulli function
Q=0.5 the probability of failure in the Bernoulli function
e=the value of estimated error
n=the numbers of the sample.

A 5-point Likert-type scale questionnaire was designed for data gathering based on nurses' duties in educational and treatment centers [13]. This questionnaire had six parts and 50 questions. Each part was assigned to one HIT and its applications in healthcare. The parts of the questionnaire included demographic information, HIS, PACS, Tele-nursing, mobile-health, and RFID. The validity of the questionnaire was confirmed using the comments of three nursing and two medical informatics expert who worked at ZUMS. To examine the reliability of the questionnaire, it was provided to 15 nurses and revised based on their answers. Some questions were edited and the main applications of HITs in

nursing care were considered in the questionnaire. Then, it was provided to 20 nurses, and the amount of Cronbach's alpha was calculated (0.84) and its reliability was confirmed as well. This study was approved by the Ethics Committee of ZUMS and ethical issues were observed in the processes of collecting, analyzing and reporting the findings. Ethical issues included the confidentiality of respondents' information, the compliance of honesty and scientific trust, and anonymity of the respondents in the questionnaire. A list of the study population and their information was collected after obtaining the required permissions and approving the proposal in the Research Committee of ZUMS. Then, the questionnaires were provided to study the community by referring to their workplace and

the completed questionnaires were collected after two weeks. Eventually, the obtained data analyzed by R and Rstudio statistical Software, followed by using the Chi-square test to evaluate the relationship between variables like education degree, hospital wards, and HIT usage.

Results
Of 223 questionnaires distributed among nurses, 208 cases were returned to the researcher. The majority of participants were women (88.9%) and the mean age of the participants and the mean hospital work experience was 9.6±6.6 and 33.5±7.2 years, respectively. Further, most participants were nurses who worked at Mousavi Hospital (38%) and surgery wards (40.4%), the details of which are provided in Table 1.

Table 1: Results of Demographic Information of Participants

Center	Total	Sex		Degree		Age	work experience	Hospital Wards			
	N (%)	Men N (%)	Women N (%)	Bachelor N (%)	Master N (%)	$\bar{X}\pm SD$	$\bar{X}\pm SD$	Internal N (%)	Intensive N (%)	Surgical N (%)	Emergency N (%)
Mousavi	78(38)	13(16.5)	66(83.5)	70(88.6)	9(11.4)	38.8±6.9	14.4±6.7	6(7.6)	22(27.8)	43(54.4)	8(10.1)
Valiasr	59(29)	5(8.5)	54(91.5)	59(100)	0(0)	32.8±8.7	8.6±8.3	14(23.7)	4(6.8)	23(39)	18(30.5)
Beheshti	14(6)	2(14.3)	12(58.7)	14(100)	0(0)	30.3±4.7	7±4.2	10(71.4)	0(0)	0(0)	4(28.6)
Alghadir	56(27)	3(5.4)	53(94.6)	55(98.2)	1(1.8)	32±8.8	8.5±7.3	20(35.7)	18(32.1)	18(32.1)	0(0)
Sum	208(100)	23(11.1)	185(88.9)	198(95.2)	10(4.8)	33.5±7.2	9.6±6.6	50(24)	44(21.2)	84(40.4)	30(14.4)

Note. N: Number; LOS: Length of stay; X̄: Mean; SD: Standard deviation. **Internal wards included internal, oncology, infectious, and psychiatry wards. Intensive wards encompassed ICU, CCU, PICU, and NICU. In addition, surgery wards included men, gynecology, orthopedics, urology, general surgery, kidney transplantation, neurosurgery, and cardiac surgery wards. Finally, emergency wards encompassed trauma, midwifery Emergency, and child emergencies**

The most-used technologies among nurses were HIS (100%) and PACS (83.2%) although the Tele-nursing (76%) and M-health (64.9%) were

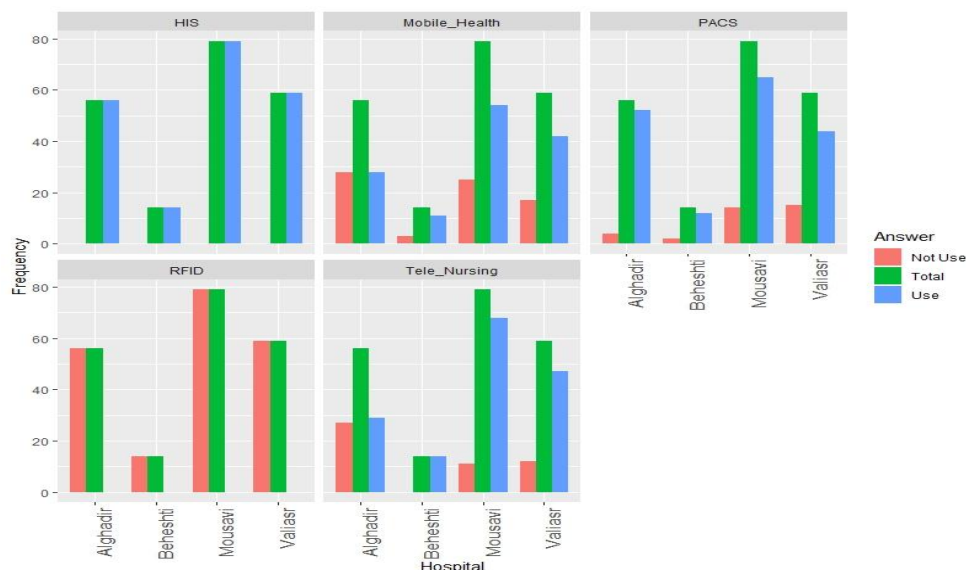rarely used in nursing care and none of the nurses used RFID (Chart 1).

Chart 1. HIT usage in the hospitals

The findings of the Chi-square test demonstrated that surgical and intensive care wards used HIS (p<0.001), PACS (p<0.09), and Tele-nursing (p<0.03) more than the others and there were no significant statistical differences between M-health (p=0.3) and RFID (p=0) and hospital wards. Nurses with a Bachelor's degree further used HIS compared to the other technologies (p<0.001) and there were no significant differences between PACS (p<0.1), Tele-nursing

(p=0.1), M-health (p=0.9), and RFID (p=0) and education degrees.

The nurse stated that accessing and registering drug orders and sending them to the pharmacy by the doctor's order had the most usage of HIS features (with a mean of 4.3). Furthermore, they sometimes used HIS features to access and register nursing interventions and reports like the findings of vital signs (with a mean of 2.7), related data are presented in Table 2.

Table 2: Participants' Answers on the Use of HIS Features in Nursing Care

HIS Features	The Mean of DU	Always (5) N (%)	Mostly (4) N (%)	Sometimes (3) N (%)	Rarely (2) N (%)	Never (1) N (%)
Organizing and scheduling the appointments	3.2	58(27.9)	47(22.6)	27(13)	33(15.9)	43(20.7)
Accessing to the demographic and financial information of the patients	2.9	48(23.1)	48(23.1)	18(8.7)	21(10.1)	73(35.1)
Accessing to the medical and clinical history of a patient	3.6	88(42.3)	47(22.6)	16(7.7)	26(12.5)	31(14.9)
Managing the clinical care effectively and using information to make decisions about the treatment	3.7	77(37)	61(29.3)	25(12)	15(7.2)	30(14.4)
Accessing and registering physicians' prescriptions	2.8	59(28.4)	23(11.1)	15(7.2)	29(13.9)	82(39.4)
Accessing and registering diagnostic orders for performing paraclinical tests and sending them to the lab on the physician's orders	4.1	131(63)	32(15.4)	10(4.8)	12(5.8)	23(11.1)
Accessing and registering non-pharmacological treatment orders (e.g., physiotherapy, radiotherapy, and the like) on the physician's orders	4	136(65.4)	15(7.2)	19(9.1)	4(1.9)	34(16.3)

Accessing and registering medication orders and send them to the pharmacy on physician's orders	4.3	153(73.6)	14(6.7)	11(5.3)	12(5.8)	18(8.7)
Accessing and registering medical advice on the physician's orders	4	128(61.5)	25(12)	15(7.2)	17(8.2)	23(11.1)
Accessing and registering surgical treatments on the physician's orders	3.5	106(51)	21(10.1)	8(3.8)	18(8.7)	55(26.4)
Accessing and registering nursing interventions and reports such as vital signs	2.7	63(30.3)	15(7.2)	15(7.2)	26(12.5)	89(42.8)
Evaluating a patient's treatment plan (e.g., medication history, laboratory results, and the like)	3.2	67(32.2)	41(19.7)	17(8.2)	29(13.9)	54(26)
Accessing to scientific resources, educational materials, and treatment protocols	3.2	71(34.1)	30(14.4)	33(15.9)	22(10.6)	52(25)
Accessing to requested reports for evaluating the patient's treatment plan	2.9	55(26.4)	23(11.1)	29(13.9)	40(19.2)	61(29.3)
Other	0	0	0	0	0	0

Note. HIS: Hospital information system; N: Number; $\bar{X}$: Mean; DU: The degree of usage.

Based on the data in Table 3, access to the findings of radiology pictures and scans (M=3.6) was the most used PACS features in nursing care and request medical advice on radiology image and radiograph was used rarely in nursing care (mean 2.6).

Table 3: Participants' Answers on the Use of PACS Features in Nursing Care

Picture Archiving and Communication System Features	The Mean of DU	Always (5) N (%)	Mostly (4) N (%)	Sometimes (3) N (%)	Rarely (2) N (%)	Never (1) N (%)
Accessing to radiology imaging commands	3.4	98(56.6)	40(23.1)	13(7.5)	4(2.3)	18(10.4)
Request medical advice on radiology images and radiographs	2.6	56(32.4)	25(14.5)	25(14.5)	9(5.2)	58(33.5)
Storing medical images electronically for submission to other hospitals	2.9	71(41)	28(16.2)	27(15.6)	18(10.4)	29(16.8)
Accessing to radiology graphs and scan results	3.6	64.7(112)	19(11)	32(18.5)	2(1.2)	8(4.6)
Accessing to radiology imaging reports	3.2	96(55.5)	24(13.9)	14(8.1)	5(2.9)	34(19.7)
Accessing to patients' radiology digital image archives	3.3	94(54.3)	29(16.8)	23(13.3)	11(6.4)	16(9.2)
Transferring clinical information and patient images between the hospital's wards	3.1	76(43.9)	19(11)	51(29.5)	17(9.8)	10(5.8)
Other	0	0	0	0	0	0

Note. N: Number; $\bar{X}$: Mean; DU: The degree of usage

Based on the findings of Table 4, consulting with a physician or other specialists remotely with the phone, cellphone, or the Internet for nursing interventions was the most used Tele-nursing feature (M=2) while writing nursing reports in a patient's electronic records distantly was rarely used by nurses in healthcare (M=1.2). The findings (Table 5) further revealed that planning patient care based on goals and priorities by using the apps is the most common used M-health

feature (mean 2.1) whereas connecting to HIS for writing nursing records by M-health features was rarely used by nurses in healthcare (M=1.3).

Table 4: Participant s' Answers on the Use of Tele-nursing Features in Nursing Care

Tele-nursing Features	The Mean of DU	Always (5) N (%)	Mostly (4) N (%)	Sometimes (3) N (%)	Rarely (2) N (%)	Never (1) N (%)
Accessing to lab tests or radiology imaging command orders remotely (e.g., by phone, mobile phone, or the internet)	1.9	11(7)	22(13.9)	46(29.1)	35(22.2)	44(27.8)
Receiving medical consultation from a physician or other specialist for nursing interventions (e.g., by phone, mobile phone, or the internet)	2	0(0)	33(20.9)	54(34.2)	45(28.5)	26(16.5)
Writing nursing reports in patient electronic records remotely (e.g., by the internet)	1.2	0(0)	4(2.5)	27(17.1)	23(14.6)	104(65.8)
Performing nursing interventions e.g. teaching how to use the medication over the phone, cell phone or the internet	1.6	0(0)	15(9.5)	34(21.5)	62(39.2)	47(29.7)
Consulting, training, or sharing information with other colleagues through video conferencing or social networking	1.5	0(0)	13(8.2)	42(26.6)	31(19.6)	72(45.6)
Controlling the patient's level of consciousness and controlling environmental stimuli or post-discharge home care (e.g., by phone, mobile phone, or the internet)	1.3	0(0)	7(4.4)	38(24.1)	21(13.3)	92(58.2)
Other	0	0	0	0	0	0

Note. N: Number; $\bar{X}$: Mean; DU: The degree of usage.

Table 5: Participant s' Answers on the Use of Mobile Health Features in Nursing Care

Mobile–health Features	The Mean of DU	Always (5) N (%)	Mostly (4) N (%)	Sometimes (3) N (%)	Rarely (2) N (%)	Never (1) N (%)
Accessing to patient medical records	1.7	5(3.7)	26 19.3)	43(31.9)	30(22.2)	31(23)
Sending pictures, laboratory results, or medical information to the physician and requesting medical advice	1.5	10(7.4)	9(6.7)	36(26.7)	42(31.1)	38(28.1)
Using scheduling or scheduling appointments, surgeries, lab tests or radiography imaging	1.6	9(6.7)	9(6.7)	50(37)	29(21.5)	38(28.1)
Accessing to online educational content or the one stored on the cell phone	1.6	5(3.7)	25(18.5)	31(23)	47(34.8)	27(20)
Using apps for training patients or other medical staff to improve the healthcare quality	1.7	10(7.4)	22(16.3)	49(36.3)	24(17.8)	30(22.2)
Planning patient care based on goals and priorities using the apps	2.1	29(21.5)	32(23.7)	30(22.2)	22(16.3)	22(16.3)

Following up nursing care interventions at home or post-treatment recommendations after discharging from the hospital	1.6	7(5.2)	33(24.4)	14(10.4)	42(31.1)	39(28.9)
Taking notes or providing training contents from daily healthcare processes (e.g., films and photo) and sharing them with others	1.9	21(15.6)	36(26.7)	24(17.8)	24(17.8)	30(22.2)
Connecting to HIS for writing nursing reports in patients' records by the cell phone	1.3	5(3.7)	9(6.7)	20 14.8)	43(31.9)	58(43)
Sending medical advice to the patient before, during, or after the treatment on physician's order	1.5	7(5.2)	11(8.1)	34(25.2)	43(31.9)	40(29.6)
Informing the patient about the date and time of surgery or other treatment plans	1.6	9(6.7)	18(13.3	43(31.9)	24(17.8)	41(30.4)
Other	0	0	0	0	0	0

Note. N: Number; X̄: Mean; DU: The degree of usage.

None of the nurses used RFID technology in their healthcare. Based on the findings, nurses who had a bachelor's degree and worked in the surgery ward demonstrated the highest use of technologies. Moreover, HIS and PACS were the most used technologies compared to the other technologies in nursing care (Charts 2 and 3).
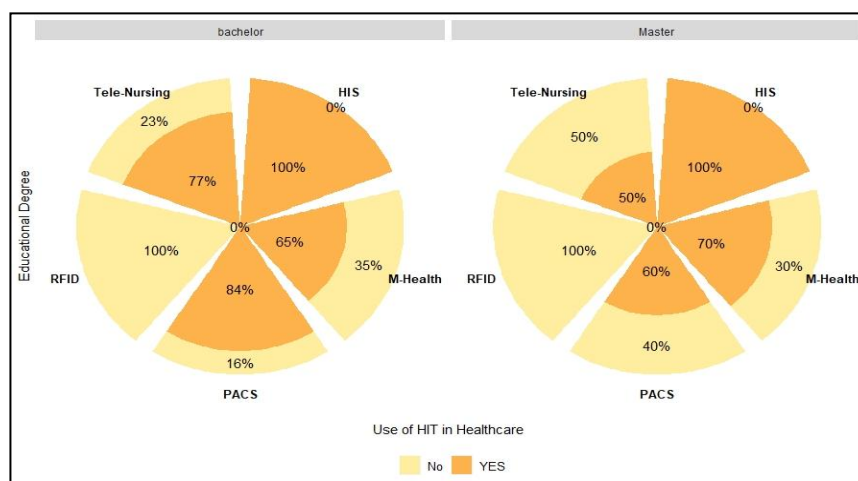

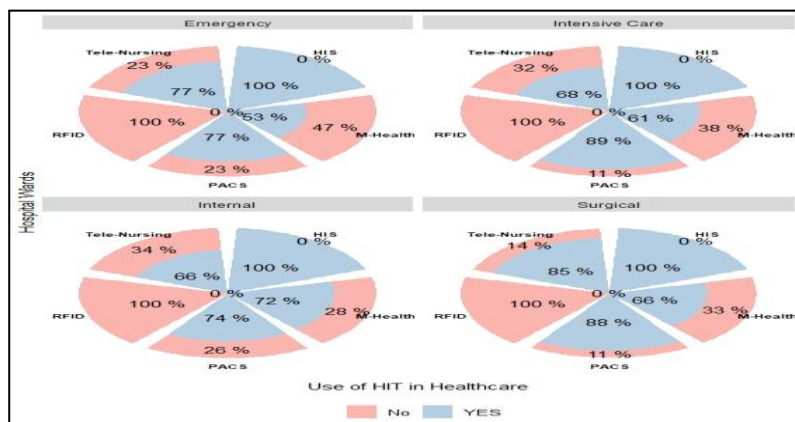*Chart 2: The usage of HIT based on education degree*

Chart 3: The usage of HIT based on the hospital ward

Discussion

Overall, using HIT enhances patients' safety by preventing medical errors, assessment errors, and the surveillance system with a rapid response while it reduces the risk of harm created after the fact [14]. Recent studies have discussed the fewer use of HIT by nurses in healthcare as the most important issue. For example, many studies focused on the adoption and use of HIT among nurses and physicians. Additionally, nurses may have concerns about the use of HIT in healthcare that may have negative effects on patient care and treatment sequences [1].

The findings of this study showed that all hospitals of Zanjan University of Medical Sciences have HIS as the most widely used technology (100%) in nursing care. Although it was extensively used, some of its features were rarely used in healthcare. The result of the study by Ahmadi indicated that the level of HIS features, which fit to work, was between 0.91 and 3.33 out of 5 [15].

Of the total evaluated hospitals in another study by Ghazi Saeedi, 68.3% of the study population stated the HIS performance capability for registering the laboratory tests was more than 60. As regards registering the medication orders, 59.6% of the samples reported that it was over 60% while 5.9% of them represented that it was less than 30% [16], which is consistent with the findings of this study.

Out of 902 hospitals using HIS for outpatient management in Germany [17], 12.4, 6.3, 0.3, and 0.2% of the cases were allocated to human resource management, the laboratory, medical documentation, and the discharge summary (a clinical patient record), respectively, some of which (e.g., request system, patient management, along with healthcare documentation and planning) were consistent with the findings of this study. In general, Nursing Information Systems as the subsystem of the HIS, fulfill the general needs in some areas such as patient care (28%), ward management processes (19.2%), communication processes (43.3%), as well as education and research processes (22%), which is in line with the results of [18]. "Accepting and transferring patients between the wards" and "requesting a blood test" were the most usable features of HIS in Farabi Hospital, which corroborates with the findings of [19].

In addition, PACS was the second most used technology among nurses. The highest use of PACS in nursing care was related to accessing the results of radiology pictures and scans (M = 3.6) while the least PACS use belonged to requesting medical advice on radiology images and radiographs (M = 2.6). Based on the findings of a study in Australia, nurses with access to PACS could independently and easily access images, did extremely more frequently when required, and perceived that this had the potential to positively affect patient safety. Those without PACS usually viewed images more traditionally as part of a ward round. Further, the introduction of PACS to ICU settings promoted changes in nursing work practices by enabling nurses to act more autonomously with the potential for enhancing patient care [20].

Most Tele-nursing studies have focused on the use of phone or cell-phone by nurses for counseling or following up patients remotely, which indicates the importance of using this technology in nursing care [21]. The findings of this study showed that consulting with a physician or other specialists distantly with a phone, cell-phone, or the internet for nursing interventions was the mostly used Tele-nursing feature (M=2) whereas writing nursing reports in patient's electronic record remotely was rarely used by nurses in healthcare (M=1.2). Tele-nursing is used for the care and control of chronic diseases such as cardiovascular diseases, chronic obstructive pulmonary diseases, diabetes type 2, and other chronic diseases like cancer and mental illness [22]. Various evidence exists for the use of phone care to guide healthcare. Based on the findings of a study in the United States, telecare to help postpartum patients was proved to be an easy, safe, low-cost and effective intervention that improved the health outcomes of mothers and children and reduced spending on healthcare [23]. In Malaysia, telephone calls to support breastfeeding were shown to be an effective resource, which increased exclusive breastfeeding rates in the first month postpartum [24].

Based on the reports of another study in the USA, 96% of nursing students used mobile technology in clinical tasks [25]. According to these studies, the use of mobile technology, especially the smartphone, is increasing among medical and nurses, which is consistent with the findings of the present study [26]. The highest use of M-health by nurses was to plan for patient care based on goals and priorities by using mobile apps, taking notes, or providing educational content from daily nursing care (e.g., films and photos) and sharing them with others. However, registering nursing records in patients' electronic records by connecting to HIS was used rarely among nurses. The findings of this study revealed that although M-health in healthcare presents potential benefits for improving healthcare service delivery, their features are not completely used in nursing care. The result of the study conducted among nurses showed that 69.5% (573/825) of respondents believed that nurses' use of personal mobile phones while working had a negative effect on patient care [27].

None of the 208 participants in this study utilized RFID technology. Major barriers to RFID adoption in healthcare include prohibitive costs, technological limitations, and privacy concerns. Although RFID offers advantages to healthcare practitioners for enhancing clinical practice, better designed RFID systems are needed to increase the acceptance and proper use of RFID in healthcare [28].

M-Health (64.9%) like Tele-nursing (76%) was used less than HIS (100%) or PACS (83.2%) among nurses for providing healthcare. According to some review studies [8, 9, 11] and the result of this study, there can be four types of barriers to use HIT among nurses in healthcare, including organizational, usability, inadequate technology support or access barriers, and the lack of need or motivation. Organizational barriers include the lack of integration and institutional supports and legal issues. For example, nurses cannot use HIT to access patient data if institutions do not have integrated information systems that allow for real-time access to hospital databases. Moreover, usability barriers encompass usability issues such as system status visibility, user control and freedom, consistency and standards, error prevention, flexibility and minimalist design, as well as help and documentation and privacy. Additionally, inadequate technology support and access barriers include technology support unavailability, expired warranty, and unavailable features or applications. In addition, the lack of need or motivation encompasses applications or features perceived as unnecessary and highly general for practice, information integrated into a profession, dissatisfaction with previous experience, preference for manual method, the function performed by other personnel, and function performed by using other hardware or methods.

Overall, the findings of this study demonstrated that although the application of information technology in healthcare presents potential benefits regarding improving healthcare service delivery, their features are not completely employed in nursing care. Health Information Technology (HIT) continues to be widely integrated into health care systems. Further, nurses play a significant role in the delivery of

health care services, which has been enabled and supported by technology. Based on study findings, organizational policies, technology support or its features and user's motivation can influence nurses' intention to use HIT in nursing care. Furthermore, the findings highlight the importance of the issue for nurse and health system managers, and educators to foster an organizational culture that supports the use of HIT in nurses' day-to-day practice by offering adequate education and training, including user champions to support HIT implementation, having an adequate representation of nurses during the design phase of the HIT and being receptive to their feedback, and finally, having sufficient technological support in practice.

Limitations
This study had some limitations. There was a noticeable gender bias in this study. More precisely, 88.9% of the participants were females. In addition, the data sample was only collected from Zanjan, Iran. Thus, generalizing the findings to all parts of Iran is not advisable. Finally, the lack of cooperation among some nurses due to heavy workload and the lack of time was the other limitations of this research.

Acknowledgments

Conflict of interest
The authors declare that they have no competing interests.

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