

# Information Processing in Nursing Information Systems: An Evaluation Study from a Developing Country

## Abstract

**Background:** In recent years, information technology has been introduced in the nursing departments of many hospitals to support their daily tasks. Nurses are the largest end user group in Hospital Information Systems (HISs). This study was designed to evaluate data processing in the Nursing Information Systems (NISs) utilized in many university hospitals in Iran. **Methods and Materials:** This was a cross-sectional study. The population comprised all nurse managers and NIS users of the five training hospitals in Khorramabad city ( $N = 71$ ). The nursing subset of HIS-Monitor questionnaire was used to collect the data. Data were analyzed by the descriptive-analytical method and the inductive content analysis. **Results:** The results indicated that the nurses participating in the study did not take a desirable advantage of paper (2.02) and computerized (2.34) information processing tools to perform nursing tasks. Moreover, the less work experience nurses have, the further they utilize computer tools for processing patient discharge information. The “readability of patient information” and “repetitive and time-consuming documentation” were stated as the most important expectations and problems regarding the HIS by the participating nurses, respectively. **Conclusions:** The nurses participating in the present study used to utilize paper and computerized information processing tools together to perform nursing practices. Therefore, it is recommended that the nursing process redesign coincides with NIS implementation in the health care centers.

**Keywords:** Information processing, Hospital information system, Nursing information system, Evaluation, Iran

## Introduction

The use of health information systems (HIS) has spread to modern health care organizations,<sup>[1,2]</sup> with many health care organizations utilizing information technologies to provide quality services to their patients.<sup>[1]</sup> Nursing care is one of the most important health care services.<sup>[3]</sup> The central coordinating role of nurses in the patient care team has made them to be recognized as one of the most important groups of patient record registrar<sup>[4]</sup> and the main users of HIS.<sup>[5]</sup> Low quality of nursing documentation represents deficiencies in care programs.<sup>[6]</sup>

Hence, in recent years, information technology in the nursing departments of many hospitals has been introduced to support their daily tasks.<sup>[7]</sup> These duties are quite diverse and the main tasks include planning, execution, and documenting nursing care based on care process. Other tasks performed by nurses comprise

entering orders, dispensing and monitoring medication usage, managing the ward, documenting, and communicating with other specialists.<sup>[8]</sup>

Computer-based Nursing Information System (NIS) is part of HIS that deals with nursing aspects and is used to better support nurses in their daily tasks.<sup>[9]</sup> The introduction and development of this system affects the overall processing of information in hospitals.<sup>[6]</sup> NISs help nurses to provide better care to patients and the possibility of assessment and exchange of clinical information with other health care providers. Thus, the proper functioning of NIS improves clinical data integrity and satisfies user needs.<sup>[10]</sup> This system results in easier access to health care information, readability of nursing documents, avoidance of repetition in the documenting process, better support of workflow, and greater respect for the legal rules and principles.<sup>[6]</sup>

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The emergence of new information technologies has made some changes in the nursing documentation, the most important of which is the shift from traditional paper-based records to electronic documentation system in a number of health care centers. Information technology solutions have freed health care providers from specific and important problems of paper documentation and have improved the quality of nursing documentation.<sup>[4,11,12]</sup>

Any changes in the HIS should be evaluated on a regular basis.<sup>[13]</sup> Assessment of information and communication technology systems in health care organizations is essential to determine their side effects. In addition, evaluation of these systems can provide the necessary information to improve knowledge, create better health information systems in the future, and guarantee the existence of efficient information systems.<sup>[14]</sup> As nurses constitute the largest end user group of HISs, evaluation of HISs should begin with the assessment of nursing subsystems. However, despite the increasing number of NISs, their evaluation has not been often done thoroughly and sufficiently.<sup>[9,15]</sup> In addition, no comprehensive theoretical and practical tools, methods, and guides exist for this type of evaluation.<sup>[16]</sup>

The studies conducted in this regard have mostly emphasized on specific evaluation criteria such as the impact on nursing documentation,<sup>[15,17,18]</sup> the time required to perform the nursing duties,<sup>[19]</sup> information quality requirements of users,<sup>[18,20]</sup> and challenges to and facilitators of the nurses' uses of the NIS.<sup>[9,21]</sup>

Furthermore, in Iran, few studies have been done to address issues such as the state of NIS in Iran,<sup>[22]</sup> the structural needs of nursing data classification in the computer system,<sup>[23]</sup> and nurses' experiences of the impact of NIS on the efficiency of nursing service,<sup>[24]</sup> whereas none of them studied the changes in the nursing information processing after the introduction of computer-based NIS. Nevertheless, achieving a full picture of NISs requires taking into account the different evaluation criteria, which encompass all nursing activities.<sup>[6]</sup> Therefore, this study aimed to evaluate the processing of data in the NISs utilized in many university hospitals in Iran from nurses' viewpoint.

## Materials and Methods

A cross-sectional study method was used in this study carried out in the training hospitals of Lorestan University of Medical Sciences in 2016. The HISs used in these hospitals, developed by five HIS software vendors, are applied in many university hospitals with thousands of active clinical users in Iran. Based upon the census sampling method, the study population comprised all nurse managers (including matrons, supervisors, and head nurses) and NIS users of the all five training hospitals in Khorramabad city ( $N = 71$ ).

The questionnaire utilized in this study was based upon the reliable and valid HIS-Monitor questionnaire developed

by Ammenwerth *et al.*<sup>[6,15]</sup> The HIS-Monitor comprises 107 specific questions and 12 general questions, focusing on how a HIS efficiently supports clinical and administrative tasks. It offers a quantitative score of HIS quality from the viewpoints of the professional groups. The questionnaire not only considers information technology aspects but also puts emphasis on the information processing tools used in various situations.<sup>[15]</sup> Thus, it serves as a useful tool for assessing HISs at the centers where computerized and paper systems are employed in parallel.

The adapted version of self-administrated HIS-Monitor questionnaire comprised personal characteristics (work ward, work experience, age, gender, education, and organizational position) as well as 41 specific and general questions, focusing on the quality of information processing in nursing. These questions were divided into the six major specific sections, including 7 questions on nursing admission, 18 questions regarding access to available patient-related information, 6 questions on creation and updation of a nursing care plan, 2 questions on nursing care, 6 questions on the documentation of nursing care, and 2 questions on patient discharge.<sup>[6]</sup> At the end of the questionnaire, there were 2 open-ended questions regarding the fulfilled expectations and problems of nurses about the nursing documentation and tasks. To assess nurses' views about the quality of information processing, a 4-point scale of Likert from very bad (very low) to very good (very high) was applied. The mean values were calculated by attributing the code "1" for the most negative answer to the code "4" for the most positive answer, thus higher values indicate a "better" quality of information processing.

The reliability and validity of this tool have been approved by the previous researchers.<sup>[6,15]</sup> To confirm the validity of the translation into the Persian language, WHO forward/backward translation protocol was used. The English version was first translated into Persian by a qualified translator. Next, the Persian version was examined for any inconsistencies by a panel of experts. Then, the instrument was translated back to English by an independent translator, whose mother tongue was English and had no knowledge of the questionnaire. The backward translated version was forwarded to a board of experts to identify any poorly translated items or expressions and the necessary modifications were made. The validity of the content of this tool to be used in Iran was approved by 5 faculty members of the nursing department. In addition, the average internal reliability of the questionnaire was high,  $\alpha = 0.89$ .

The data analysis was performed using the computerized Statistical Software Package for Social Science (SPSS) version 17 developed by the Institute of Business Management (IBM). To investigate the association between the use of paper and computer information processing tools by the nurses to perform their tasks,

a paired *t*-test was used. Moreover, the relationships between personal characteristics of nurses and the use of the data processing tools (computer and paper) applied to carry out the nursing responsibilities in the training hospitals were assessed by using multivariate analysis of variance (MANOVA).

The open-ended questions were analyzed using inductive content analysis and MAXQDA 12 qualitative analysis software. In the first stage of analysis, the nurses' responses to those questions were read several times to ensure that the analyst had a clear grasp of the overall content. Then, the contents were reduced by changing the nurses' basic statements into simple statements. The statements with similar meanings (semantic similarities) were clustered together and recorded in the frequency table. It should be noted that grouping of the statements was done independently by two researchers, whereas a third researcher was consulted if a consensus was not reached.

### Ethical considerations

Before starting the interview, written consent for filling evaluation questionnaires was obtained from all participants.

### Results

The studied hospitals had 753 active beds and 706 nurses. The NIS was implemented at all the hospitals concurrent with the establishment of the HIS, and all the nursing stations were equipped with computers and covered by a Local Area Network (LAN). The paper-based nursing documentation system in the hospitals included forms of physician order, nursing reports, nursing considerations at the time of patient's admission, patient's training, and vital signs measurement, vital signs chart, and absorption and excretion of fluids.

Questionnaires were completed and returned by 50 nurses (70.4% response rate). The findings of this study showed that 76% of the respondents were females and the rest were males, most of the respondents (94%) had a bachelor's degree. Approximately, 68% of the respondents were under 40 years of age, and most of them (52%) had a work experience of less than 12 years.

The findings of the present study [Table 1] showed that all the respondents (100%) used both paper and computer information processing tools together to perform their nursing duties. Based on the scores assigned to the answers, the total mean scores of these tools revealed that the nurses participating in the study did not favorably take the advantages of using paper (2.02) and computer-based (2.34) information processing tools to perform their nursing tasks; moreover, the information processing with any of the investigated tools was not satisfactory. The nurses' least and most uses of computer tools to perform their tasks were related to nursing admission 1.57(0.49) and documentation of nursing care 2.63(0.73). However, paper tool showed the most and least uses for the access to available patient-related information (2.11) and nursing care (1.89), respectively.

As shown in Table 1, significantly positive relationships were observed between the uses of paper and computer tools in the tasks of creation and update of nursing care plan ( $P = 0.006$ ,  $r = 0.38$ ), nursing care ( $P = 0.013$ ,  $r = 0.34$ ), documentation of nursing care ( $P = 0.021$ ,  $r = 0.33$ ), and patient discharge ( $P = 0.026$ ,  $r = 0.31$ ). However, no significant relationship was found between these two tools (paper and computer) in the task taking of nursing admission and access to available patient-related information ( $P > 0.05$ ). The results of the current study [Table 2] revealed that all the participating groups further used the computer tool to perform their nursing tasks.

The results of the MANOVA [Table 3] showed that there was no significant relationship between gender, organizational position, and age with the information processing tool used for all studied nursing tasks ( $P > 0.05$ ). Further, work experience only had an effect on the information processing tools (computer and paper) used for the task of patient discharge (3). Furthermore, the work experience groups of nurses participating in the study had significant differences at least in one of the tools used to carry out the nursing task of patient discharge ( $P = 0.04$ ).

By separately comparing each tool in terms of work experience, it was seen that there was a significant difference between the two groups based on the computer

**Table 1: Assessment of the support of the nurses' tasks by the information processing tools in the study hospitals**

Tasks of nursing	Information processing tool (Mean (SD))		Correlation coefficient
	Paper-based	Computer-based	
Nursing admission	2.01 (0.69)	1.57 (0.49)	0.19
Access to available patient-related information	2.11 (0.64)	2.46 (0.64)	0.11
Creation and update of a nursing care plan	2.01 (0.65)	2.46 (0.72)	0.38*
Nursing care	1.89 (0.86)	2.52 (0.99)	0.34*
Documentation or nursing care	2.10 (0.76)	2.63 (0.73)	0.33*
Patient discharge	1.99 (0.85)	2.42 (0.93)	0.31*
Total	2.02 (0.74)	2.34 (0.75)	

\* $P \leq 0/05$  was considered as the significant level

**Table 2: Participants' views about the processing tools used for nursing tasks according to personal characteristics**

Participants' information	Information processing tool (Mean (SD))	
	Paper	Computer
Gender		
Female	2.05 (0.57)	2.42 (0.62)
Male	2.09 (0.63)	2.52 (0.30)
Age		
≤40	2.02 (0.54)	2.39 (0.52)
>40	2.13 (0.67)	2.57 (0.62)
Work experience (years)		
≤12	2 (0.53)	2.5 (0.49)
<12	2.12 (0.63)	2.39 (0.63)

**Table 3: MANOVA of the variables of information processing tools used in the nursing task of patient discharge for the two groups of work experience**

Test name	Value	Hypothesis df	Error df	Significant
Pillai's Trace	0.12	3.33	2	0.04*
Wilks' Lambda	0.88	3.33	2	0.04*
Hotelling's Trace	0.14	3.33	2	0.04*
Roy's Largest Root	0.14	3.33	2	0.04*

tool used for the discharge duty ( $P = 0.01$ ), but not based on the paper processing information tool ( $P = 0.46$ ). Therefore, because of the higher average score of the nurses with less than or equal to 12 years of work experience in the use of computer tools for the information processing of patient discharge (2.73 (0.85)) compared to the corresponding group of more than 12 years of work experience (2.08 (0.90)), it can be concluded that the nurses with less work experience took a further advantage of computer tools for processing patient discharge information.

The met expectations and the most important problems of the nurses in the HIS were grouped in 3 and 4 categories using a content analysis method, respectively [Table 4]. The content analysis of the responses to the open-ended questionnaire indicated that the readability of patient information was raised as the expectations met in the NIS by the most nurses ( $N = 43$ ). In addition, the majority of the nurses ( $N = 48$ ) pointed out the repetitive and time-consuming documentation as the HIS problem.

## Discussion

The nurses participating in the present study used to use paper and computer information processing tools together to perform nursing duties, although they did not desirably take advantages of any of the mentioned tools. The results of other studies conducted in Iran have also shown that the NISs are not in a good condition and do not comply with

the duties and areas of nursing work,<sup>[22,24]</sup> though based on the studies performed in other countries, the quality of information processing significantly improved after the introduction of computer-based information systems.<sup>[6,25,26]</sup> The reason for this paradox can be the continuation of using dual processing tools in Iranian hospitals after learning and trusting the information systems, which leads to an enhancement of the nurses' workloads and inappropriate application of NIS.

No significant relationships were found between gender, age, and organizational position and the information processing tool employed for all nursing tasks, however, the nurses with less work experience would take more benefit of computer tools for processing the information of patient discharge. Similarly, in their study, Kahouyi and Babamohamadi reached the conclusion that older nurses with less computer skills would be more likely to spend more time on the use of information technology.<sup>[24]</sup> The findings of the study by Mann also showed that those nurses and midwives who had good experiences of clinical information systems would be more willing to use this system.<sup>[27]</sup>

Repetitive and time-consuming documentation as well as the limited coverage of nursing tasks were of the most important problems mentioned in the information systems used in the hospitals under study. Research studies have pointed to different findings in this regard. Some have stated the use of NIS saves time, accelerates nursing tasks, and provides more time for patient care,<sup>[24,28,29]</sup> and others have known it to impose more time for documentation and less time for patient care.<sup>[6,9,20,25]</sup> Therefore, it seems that if the NIS does not comply with the clinical care and nursing tasks, the documentation time will increase. In addition, a further time-saving will be possible by designing the information systems in a manner that provides facilities such as a coverage for all the nursing tasks, full description of nursing care, and a possibility of recording nursing data at the patient bedside. In the research conducted in this area, some other problems have been mentioned including the existing design flaws in the system content, hardware shortages, system down times, inadequate training of users, concerns about security, increase in nurses' workloads, low number of portable computers, repetition in recording information, and poor communication with other HIS subsystems.<sup>[6,20,24,30]</sup> Improved readability of documents was of the most important expectations of the nurses fulfilled by the NIS in this study, which was in agreement with the other relevant studies indicating improvement of the documentation quality as one of the key benefits of the system.<sup>[9,17,24,25]</sup>

One limitation of the study is related to the difference between the hospitals in the time period that the HIS has been in operation, that is likely to affect the nurses' viewpoint. Another notable limitation is the

**Table 4: Nurses' fulfilled expectations and problems in the fields of documentation and nursing tasks in the HIS (N=71)**

Which one of your expectations has the HIS fulfilled in the fields of documentation and nursing tasks?			What problems does the HIS have in the fields of documentation and nursing tasks?		
Category	Number*	Typical example of a response	Category	Number	Typical example of a response
Readability of patient information	43	"Electronic nursing documentation has caused me to be able to easily read all my colleagues' handwritings and the nursing reports to be readable to all the authorized people."	Repetitive and time-consuming documentation	48	"Parallel uses of computer and manual systems have caused a repetitive documentation in the patient records and system, thus more time is needed for documentation and less time remains for patient care."
Improvement of the quality of nursing documentation	39	"The HIS has caused the information relevant to patient care to be fully standardized and accurately and continuously recorded, as well as the incomplete documentation of care data provided for patients to be prevented."	Limited coverage of nursing duties	35	"The information system designed does not fully comply with the nurses' tasks and fields of profession in the hospital and only some of the nurses' occupational tasks can be performed through the system."
			Incomplete access to the required information	23	"All the information needed for patient care such as the doctor's orders does not exist in the HIS and the patient's paper records must be checked as well to achieve all the required information."
Improvement of interdepartmental communications	26	"The use of this system has improved communications with other clinical departments and units, such as laboratory, radiology, and operating room. It can also transfer the information easier and faster to the applicants."	Not having access to the required data at the patient's bedside	7	"The system has not been able to provide direct access to patient data at his/her bedside, because documentation must be done at the nursing stations and laptops or other mobile technologies are not used for documenting and accessing the patient data at the his/her bedside."

\*The number of nurses who responded the related statement in the open questions

small number of respondents (71), limiting the ability to generalize the findings of the present study.

## Conclusion

Based on the results obtained, it is suggested that the nursing process redesign coincides with the NIS introduction in health care centers. If nurses are involved in the design and development of the system from the early stages to be able to transfer their expectations and needs to the system development team, they will find positive attitudes towards the new system and show less resistance to it.

Furthermore, it is recommended that the statistics and information technology office of ministry of health and medical education, HIS supplier companies, analysts, developers of NISs, and nursing profession communities work together to improve NISs and overcome the challenges. Consequently, the technology implementation in the field of nursing services will not fail and less workload will be imposed on nurses in contrast to the paper-based systems. In this case, the use of health information technology will foster and support nurses in providing health care and improving its quality.

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## Conflicts of interest

There are no conflicts of interest.

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