Improving the information technology competency of nurses in critical care units: an interventional study

Somayeh Jouparinejad  
Kerman University of Medical Sciences

Golnaz Foroughameri  
Kerman University of Medical Sciences

Reza Khajouei  
Kerman University of Medical Sciences

Jamileh Farokhzadian  
Kerman University of Medical Sciences  
Corresponding Author  
ORCiD: 0000-0002-9621-3486

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Abstract

Introduction To convert nurses of the critical care units into active users of evidence-based practices, their IT competency should be improved by appropriate planning. This study aimed to evaluate the impact of a training program on nurses' IT competency in critical care units.

Methods In this interventional study, 60 nurses working in critical care units of hospitals were randomly assigned into the control and intervention groups. The three-day workshop on IT skills training was conducted for the intervention group. Data were collected using demographic questionnaire and Nursing Informatics Competency Assessment Tool (NICAT) before and one month after the intervention.

Results In the pretest stage, both groups were at the competent level with regard to the competency level and no significant difference was observed between them in the pretest. However, in the posttest, the IT competency of the intervention group significantly increased compared to the control group. This showed that the intervention group was at the proficient level.

Conclusions Education enhanced the nurses' IT competency in critical care units. So, in order to provide nurses with the latest scientific information and to promote high quality evidence-based practices, related educational programs should be added to continuous educational programs for all clinical nurses.

INTRODUCTION

Since beginning of the third millennium, information technology (IT) has emerged as a major driver of development throughout the world. In the dynamic health environment, IT has dramatically influenced the pattern of health care at all levels.
Application of IT in health care centers has improved patient safety, increased organizational effectiveness, reduced costs, enhanced standards of care [2], resulted in better patient identification, improved patient outcomes, ameliorated information management, and ultimately upgraded the user and patient satisfaction [3-5]. Moreover, results of previous studies showed that IT, such as nursing information system, improved care planning, facilitated access to nursing records, led to better readability of these documents, reduced duplicate documentation, and improved nurses' workflow. As a result of applying IT systems, nurses can spend more time on patient care [6-8]; so, advances in health care are increasingly in need of an IT-dependent nursing workforce to provide new treatments in clinical practices [9]. In line with these developments, nurses must embrace innovation and use their abilities and knowledge to change and develop their old ways of thinking [10]. They are also required to actively participate in designing and deploying IT in health care [9, 11, 12].

On the other hand, nurses need to upgrade their IT competency to use research evidence in making smart clinical decisions and providing higher quality services [13]. So, the need for IT-qualified nurses is felt at a high level more than ever [14]. Critical care nurses' need for IT competency is much higher than those of other nursing groups due to the increased sensitivity of working in critical care units, critical and high-risk situations of patients, and application of sophisticated high-tech equipment [12]. Application of IT is vital in critical care units considering the shortage of specialist nurses as well as use of electronic and remote monitoring systems to prevent hazardous events. Furthermore, IT is of great importance to reduce hospital mortality and improve patient outcomes [15].

In this regard, IT qualification includes familiarity with basic IT concepts, ability to
use computers and manage files, ability to work with Microsoft Office software such as presentation programs and word processors, access to information using the Internet, as well as ability to use email and the World Wide Web [16]. Various studies have confirmed the gap in IT competencies of nurses and nursing students. For example, Edwards and O'Connor conducted a study in the USA and reported existence of a large gap in the basic knowledge of nurses about computer software, email, as well as online and telecommunication skills [17]. In China, Yang et al. reported that the IT competency level of nursing managers was at the moderate level [18]. Ajayi in Nigeria reported that majority of nurses did not have sufficient computer knowledge [19]. In Egypt, Elsayed et al. showed a positive relationship between IT competency score and attitude toward evidence-based practice [11]. Researchers of several studies indicated that nurses obtained much of their information needed for clinical decision-making in evidence-based practice from printed and human sources. In other words, they less frequently search for information in electronic sources. One of the prominent reasons clearly identified in these studies was the lack or insufficiency of IT competency, evidence retrieval and search skills, as well as skills and knowledge in application of database search capabilities [13, 20, 21]. Fung implemented an IT training program to improve nurses' IT performance. According to the results, nurses' IT competency increased after the intervention. Fung stated that nurses must have informatics competency to use patients' electronic health records. With improve in nursing documentation, nurses are more aware of patients' individual care needs and provide higher quality nursing care by extracting information from a more effective electronic health record [22]. However, various studies have shown nurses' weak IT competencies in their results
and suggested training courses in nursing education programs to increase IT competency and improve evidence-based practice in nurses [12, 20, 23-26]. Despite the growing trend of IT in the health care system, few studies have addressed IT competency, especially among critical care nurses. Moreover, given the researchers' experience in the critical care units; they have repeatedly witnessed the challenges caused by making inappropriate care decisions due to the lack of applying the latest scientific findings and weak IT competency of nurses. Therefore, this study aimed to evaluate the impact of a training program on IT competency of nurses working in critical care units.

Materials and Methods

**Study Design and Settings**

This interventional study was conducted using a pretest-posttest design over the intervention and control groups in 2019. The participants included nurses of the critical care units (ICUs, CCUs, and dialysis) selected from three educational hospitals affiliated with Kerman University of Medical Sciences in the southeast of Iran.

**Sample**

The study population included all nurses (N = 330) working in the critical care units at the time of data collection. The sample size was calculated as 60 using the sample size formula. Later, 20 nurses were selected from each three hospitals using the random number table. Finally, these nurses were randomly assigned into the intervention (n = 30) and control groups (n = 30). The inclusion criteria were having a bachelor's degree and higher as well as at least six months of work experience in the critical care units. The exclusion criteria included having one absence during
the course and incomplete questionnaire [12].

**Instruments and Data Collection**

The instrument used in this study consisted of two questionnaires. The first one was about the nurses' demographic information including gender, age, working experience, organizational position, type of shift, level of education, marital status, history of participation in research courses, information literacy skills, information-seeking skills, and computer skills (Table 2).

The second tool was Nursing Informatics Competency Assessment Tool (NICAT), developed by Rahman in the US in 2015 based on the American Nurses Association (ANA) standards (2008), Technology Information Guiding Education Reform (TIGER) recommendations (2009), and Benner's Dreyfus model of skill acquisition (1984). This tool assesses IT competency in three dimensions of: 1- Computer literacy (10 items, items 1 to 10), 2- Informatics literacy (13 items, items 11 to 23), and 3- Information management skills (7 items, items 24 to 30).

The NICAT should be scored on a five-point Likert scale ranging from one to five: not competent (1 score), somewhat competent (2 scores), competent (3 scores), very competent (4 scores), and expert (5 scores). The overall score range of the instrument is 30-150. Higher scores indicate higher IT competency; a total score of 30 shows novice, a score in the range of 31-59 represents advanced beginner, a score in the range of 60-89 indicates competent, a score from 90 to 119 offers proficient, and a score within 120-150 is considered as an expert [27].

Kleib et al. (2018) aimed at assessing the Canadian nurses' informatics competency and confirmed the NICAT validity using internal consistency. They reported a Cronbach's alpha coefficient of 92% for this scale [28].

This scale was also translated and validated in Iran [29]. For cross-cultural
comparison of the translation, the original NICAT was accurately translated into Persian (forward translation). The backward translation of Persian version was done by a proficient English translator. Later, agreement of the translated version with the original version was examined. In order to check the face validity of NICAT, a number of nurses' perception about the items was investigated. Content validity of the Persian version of NICAT was confirmed by two medical informatics specialists and eight faculty members of nursing. Furthermore, 30 nurses participated in the pilot-test of the questionnaire and the Cronbach’s alpha coefficient was used to assess its reliability ($\alpha = 0.95$).

**Outcome measurement**

The NICAT was used to evaluate effects of the educational program on the IT competency. The aim was to assess the effect of an educational course on the critical care nurses' IT competency. The self-reported questionnaires were distributed among nurses of the intervention and control groups in the pretest stage (before workshop) and in the posttest stage (one month after the workshop). It should be noted that all participants completed questionnaires simultaneously and attended the routine or traditional programs in hospitals, except that the intervention group was provided with additional material derived from workshop and the control group attended no educational program during this period. In other words, the two study groups had equivalent conditions for work duties and performance. However, in order to increase internal validity of the study, researchers monitored the study conditions thoroughly to ensure that the intervention and control groups were identical in all aspects, except attending the educational program.

**Intervention procedure**
The workshop was conducted in three eight-hour sessions in three weeks. The intervention group was divided into two groups to increase the members' participation opportunity in the workshop. The educational course was held by one Ph.D. nurse and three experts in medical informatics using lectures, questions and answers, slide presentations, hands-on exercises and online exercises, home work, and educational CDs. Table 1 shows the content presented in this workshop.

Table 1. Topics presented in the workshop

| Session | Topics presented in the workshop |
|---------|----------------------------------|
| Session 1 | Initially, the educational contents of the previous session were reviewed. Search strategies in databases such as PubMed and Scopus were taught. Later, a variety of electronic search capabilities were explained, such as the ways to subscribe and receive free articles, do simple and advanced search, and conduct limited search (based on the publication year, full text, keywords, Mesh, AND, OR, NOT). The participants practiced what they learned simultaneously. In this regard, a title "Intubate Patient Care" was introduced. Participants were asked to search the related articles in PubMed database with related keywords and to provide search results. Finally, participants' questions were answered and they were asked to find results of the related articles based on several keywords and to present them in the third session. |
| Session 2 | This session included application of various technologies such as the Health Information System (HIS) and its various capabilities such as documenting care plan in the medical record, collecting and maintaining patient care data like laboratory data, updating the picture archiving and communication system, and applying the HIS system for patient admission and discharge. Furthermore, participants practiced the contents of prior sessions by retrieving scientific evidences. Finally, nurses were asked to email their articles to the professors. |
| Session 3 | Statistical analysis

The data were analyzed in SPSS 21 using descriptive statistics (frequency, percentage, mean and standard deviation) and inferential statistics (independent samples t-test, paired t-test, chi square, and Fisher's exact test). The Kolmogorov-Smirnov test showed that the data followed a normal distribution. The significance level was considered ≤0.05. |

RESULTS

Demographic and professional information

All participants completed the educational program. The results showed that most of the participants in both groups were female, married, and in age range of 23-33. In terms of work experience in critical care ward, 35.70% of the participants in the
intervention group had 11-15 years of experience; whereas, 36.60% of participants in the control group had less than five years of experience. Based on the chi-square test, no significant difference was found between the intervention and control groups in terms of demographic and professional information (Table 2). Moreover, no significant difference was observed in the mean scores of IT competency between the study groups at the pretest stage (Table 3). Independent samples t-test indicates homogeneity of the participants in the two study groups at the baseline.

Table 2. Comparison of demographic and professional information of nurses in the intervention and control groups

| Variables                                      | Groups     | Intervention | Control | Statistic |
|------------------------------------------------|------------|--------------|---------|-----------|
| Gender                                         | male       | n            | %       | n         | %         |
|                                                |            | 5            | 16.70   | 5         | 16.70     |
|                                                | Female     | 25           | 83.30   | 25        | 83.30     |
| Age groups                                     | 20-40      | 25           | 83.30   | 24        | 80        |
|                                                | >40        | 5            | 16.70   | 6         | 20        |
| Marital status                                 | Single     | 9            | 29.10   | 8         | 26.70     |
|                                                | Married    | 21           | 70.90   | 22        | 73.30     |
| Work experience (year)                         | <5         | 8            | 25.80   | 12        | 40        |
|                                                | 5-10       | 4            | 12.90   | 4         | 13.30     |
|                                                | 11-15      | 12           | 41.90   | 6         | 20        |
|                                                | >21        | 2            | 6.50    | 4         | 13.30     |
| Work experience in critical care unit (year)   | <5         | 7            | 25      | 11        | 36.60     |
| Work position                                  | Head nurse | 0            | 0       | 3         | 10        |
|                                                | Nurse      | 30           | 100     | 27        | 90        |
| Shift work                                     | Fix        | 1            | 3.20    | 2         | 6.70      |
|                                                | Rotation   | 29           | 96.80   | 28        | 93.30     |
| Participate in research courses                | Yes        | 1            | 3.20    | 5         | 16.70     |
|                                                | No         | 29           | 96.80   | 25        | 83.30     |
| Participate in information literacy courses    | Yes        | 2            | 6.90    | 5         | 16.70     |
|                                                | No         | 28           | 93.50   | 25        | 83.30     |
| Participate in literature search and retrieval courses | Yes | 1 | 3.20 | 5 | 16.70 |
|                                                | No         | 29           | 96.80   | 25        | 83.30     |
| Participate in computer skills                 | Yes        | 4            | 12.90   | 5         | 16.70     |
|                                                | No         | 26           | 87.10   | 25        | 83.30     |
| The tendency to use databases                  | low        | 2            | 6.50    | 8         | 26.70     |
|                                                | moderate   | 16           | 54.80   | 12        | 40        |
|                                                | high       | 12           | 38.70   | 10        | 33.30     |

IT competency

In the pretest phase, the mean scores of IT competency were at the “competent” level for all participants, but they were not significantly different between the
intervention (79.78±26.52) and control (82.69±19.29) groups (t=0.45, P=0.65).

However, a significant difference was observed between the intervention
(114.29±20.68) and control (81.76±17.99) groups in terms of the IT competency in
the posttest (t=6.54, p=0.001). This shows that the educational program had a
significant effect on the IT competency level of the intervention group and their IT
competency increased from the “competent” to “proficient” levels. In the
intervention group, the mean scores of all IT competency dimensions improved
significantly in the posttest. The highest mean difference was associated with
informatics literacy (15.26), while the lowest mean difference was associated with
informatics management skills dimension (8.00). These differences show that the
educational program had the highest impact on the informatics literacy dimension
and the lowest impact on the informatics management skills (Table 3).

According to Table 3, the paired t-test showed that IT competency and its
dimensions had no significant difference in the pretest and posttest for the control
group; the scores were at the “competent” level in both stages.

Table 3. Comparison of mean scores of IT competency and its dimensions between
the intervention and control groups at pretest and posttest.

| Statistic  | Groups       | Variables     | Mean difference | Post test M ± SD | Pre test M ± SD | t & p         |
|------------|--------------|---------------|-----------------|-----------------|-----------------|--------------|
| t = 7.71   | Intervention | Informatics   | 78.79±26.52     | 39.70±6.78      | 28.46±10.28     | t = 0.001    |
| p = 0.001  | Control      | Informatics   | 28.46±10.28     | 28.03±8.32      | 28±8.27        | t = 0.194    |
| t = -1.39  | Intervention | Informatics   | 6.05            | 34.43±7.79      | 34.70±8.33      | p = 0.001    |
| p = 0.71   | Control      | Informatics   | 34.70±8.33      | 34.03±8.32      | 33.51±11.45     | t = -0.45    |
| t = 6.93   | Intervention | Informatics   | 15.26           | 48.77±9.46      | 33.51±11.45     | p = 0.001    |
| p = 0.001  | Control      | Informatics   | 33.51±11.45     | 32.03±8.32      | 28±8.27        | t = 0.194    |
| t = -1.39  | Intervention | Informatics   | 8.00            | 19.30±5.40      | 18.80±5.21      | p = 0.001    |
| p = 0.32   | Control      | Informatics   | 19.88±5.21      | 19.03±5.40      | 17.80±6.78      | t = 0.194    |

*Paired t-test

** Independent t-test
DISCUSSION

Principal findings

The results of this study indicated that the educational intervention significantly influenced IT competency and all its dimensions in the intervention group compared to the control group. In the intervention group, the IT competency was promoted from “competent” level to “proficient” level. Consistent with the results of this study, numerous studies confirmed effectiveness of the educational workshop on IT competency of participants [17, 22, 30]. Desjardins et al. studied the impact of IT in an evidence-based curriculum on nurses' IT competency and reported that although the intervention group had IT competency prior to the education, their competency increased significantly in the posttest [31]. In the same vein, studies by Park in South Korea on clinical nursing directors [32], Broff and Thomas in Canada on medical students and practitioners [33], and Chu et al. on students in China [34] showed that the participants' IT competencies increased significantly after attending the educational courses. In Iranian studies, a significant increase was reported in IT competency scores of the faculty members [35] and nurses in intensive care units [12] after attending the educational program compared to the control group. The similarity of the findings is perhaps caused by application of a similar training program and advancement of IT in health care and in everyday life, which has prompted individuals and health care providers to acquire and enhance their IT competency. These developments require the health professionals to equip themselves with IT competencies in formal and informal training outside and within the organization. On the other hand, managers and policymakers in the health care system have emphasized on this issue and strived to provide the necessary
infrastructure to empower their employees. In justifying the results, some researchers stated that since nursing education has evolved in recent years, the nurses' levels of knowledge and IT skills should be improved by providing online education as well as simulation and computerized learning systems with the necessary training courses. Nurses' IT competency in health care is defined as a top priority in nursing education and is essential for the success of nursing students' education [17].

Contrary to results of the present research, several studies reported no significant difference between the intervention and control groups regarding their IT competency scores after the intervention. As they reported, both groups improved their information seeking skills in the posttest [36-38]. The reason for the discrepancy in the results may be due to the difficulties in randomizing and matching groups, participants' previous computer skills, and differences in study design, conditions, and data collection tools.

The results of our study showed that the educational program had the most impact on the dimension of informatics literacy, while its least impact was on the dimension of informatics management skills. Consistent with our study, Bakken et al. [39] reported that the highest score was related to informatics knowledge after the intervention. Fung [22] showed that the lowest score was related to the informatics literacy (that confirms our finding), while the highest score was attributed to the computer literacy (that contradicts our results).

Our results showed that IT competency and all its dimensions remained at the "competent" level in the control group and no significant difference was observed between the pretest and posttest scores. In explaining these results, it can be said that nurses' IT competency is a determinant factor of success in applying clinical
information systems. The current conditions and the hospitals' emphasis on application of IT in different healthcare units required the nurses to seek minimum IT competency.

Esfandani et al. investigated critical care nurses and reported that the scores of information seeking skills were low in the control group and no significant difference was observed in the control group members' scores before and after the intervention [12]. Karimi et al. [40] as well as Raei and Haseli [35] showed that the mean scores of IT skills such as information seeking skills did not have a significant difference before and after the educational course. Moreover, several studies in Iran and other countries reported that nurses' IT competency was at the competent level before attending any intervention [14, 18, 41, 42].

Contrary to our findings, other studies indicated that nurses' IT competency was within the range of no-low level of competency [26, 43, 44]. Some other studies reported the nurses' IT competency at the expert and proficient levels [11, 45, 46]. Probably the high level of IT competency in these participants is existence of a nursing informatics' course in their curriculum and difference in their educational degree. Brettle and Raynor also reported that the mean score of information seeking skills increased in the control group after the education [36]. In Patterson's study over the medical students, the control group scores increased after the intervention, which may be due to differences in the participants' randomization and groups' matching as well as the differences in data collection tools [38].

LIMITATIONS

This study had several limitations. First, this study was conducted only in hospitals affiliated to a University of Medical Sciences with a limited sample size. Second,
application of a self-report questionnaire to assess IT competency could lead the participants to exaggerate about their competency levels and would result in bias results. Third, data collection was conducted one month after the intervention. In order to have more accurate results and compare the findings to determine the long-term impact of training, 3-6 months interval follow-ups are recommended to assess the effect of educational courses on IT competency.

CONCLUSIONS
Results showed that the educational program improved the IT information of nurses working in the critical care units. Therefore, nursing managers are recommended to implement training programs and new methods in hospitals to improve the IT competency of nurses, especially in the field of information management skills. As a result, nurses can represent evidence-based practices as well as higher and more effective quality care more frequently.

ABBREVIATIONS
CCU: Coronary care unit
ICU: Intensive care unit
IT: information technology
NICAT: Nursing Informatics Competency Assessment Tool
ANA: American Nurses Association
TIGER: Technology Information Guiding Education Reform
HIS: Health Information System
CINAL: Cumulative Index to Nursing & Allied Health Literature
SID: Scientific Information Databases
DECLARATIONS

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Availability of data and materials

The data are available upon request to the corresponding author after signing appropriate documents in line with ethical application and the decision of the Ethics Committee.

Authors' contributions

SJ, RK, GF, and JF contributed to conceiving and designing the research. The data were collected, analyzed, and interpreted by JF, SJ, RK and GF. SJ, RK, GF and JF contributed equally to writing and revising the manuscript and approved the final manuscript.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Kerman University of Medical Science with the ethics code of IR.KMU.REC.1397.373. Furthermore, the participants were explained that they could withdraw from the study at all stages. Moreover, they were ensured about confidentiality of information. At the beginning of the study, all nurses consented to participate in the study and signed the written consent forms. In order to ensure the participations' information confidentiality,
special codes were allocated to each questionnaire and the data were analyzed based on these codes. Upon completion of the intervention and collection of the second phase data, participants of the control group were provided with the educational package in the form of a CD and a handbook.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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