Factors Influencing the Acceptance of Information Communication Technology among Hospital Nurses in a Tertiary Hospital

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Abstract

Background: This study aimed to identify the acceptance of information communication technology (ICT) and its influencing factors among hospital nurses.
Methods: A total of 201 nurses from a tertiary hospital in Seoul, who provided written consent, participated in the study. Data were collected through a self-reported questionnaire comprising 24 items. The analysis included descriptive statistics, independent samples t-test, one-way analysis of variance, correlation analysis, and multiple linear regression analysis.
Results: The average score for the acceptance of ICT was 3.98±0.61 on a 5 point scale. Significant factors influencing acceptance of ICT included education (β=0.119, P=0.011), perceived usefulness (β=0.445, P<0.001), subjective norm (β=0.246, P<0.001), and self-efficacy (β=0.117, P=0.041).
Conclusions: To enhance nurses' acceptance of ICT, it is crucial to clearly communicate the usefulness of ICT and implement specific strategy to boost nurses' self-efficacy or confidence. Additionally, creating an environment that fosters mutual positive influences among nurses is essential.

Keywords: Information technology, Behavior, Social norm, Self efficacy, Nurses

INTRODUCTION

The Fourth Industrial Revolution has heralded significant advancements in the artificial intelligence (AI)-based healthcare industry, notably in medical robot technology. Examples include Watson, an AI program developed by IBM, and Dr. Answer, a precision medicine service from Korea which aids in diagnostics [1], as well as the da Vinci surgical system. Additionally, AI-driven nursing robots such as Nurse Molly are becoming increasingly prevalent [2].

The integration of science and technology in nursing raises several questions and concerns. Debates persist regarding the potential for robots to replace human nurses, the implications for job security, and the impact on patient relationships [3]. Concerns also exist about whether such technologies align with holistic nursing practices, possibly diminishing the quality of care and presenting ethical dilemmas [4]. Further, legal issues concerning the scope of work permitted to nursing robots and

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accountability in case of malfunctions are under discussion [5].

A 2021 survey on the work performance of nurses working shifts revealed that direct nursing activities constitute 45% of nursing work, while indirect activities make up 55% [6]. It is suggested that robotic systems could alleviate the burden of indirect and non-value-added nursing activities, potentially increasing time for direct patient care [3]. The introduction of information communication technology (ICT) into healthcare settings is likely to alter the nature and methodology of nursing work. In the domestic nursing field, the integration of AI nursing robots remains in its nascent stages. Nonetheless, their application is steadily increasing, particularly in the transport systems within hospitals. These robots are being utilized to autonomously transport items, provide patients with gowns or linens, and manage various other transport tasks [3,5].

There is a consequent need for the development of nursing information competencies and the adaptation of nursing training programs [7]. Previous studies have indicated varying levels of acceptance of these technologies among healthcare professionals, with nurses generally exhibiting lower positive perceptions compared to nursing students and the general public [8].

The acceptance of new technology can be explained using the Technology Acceptance Model [9]. Researchers have been testing and presenting models by adding various variables related to acceptance behavior. The variables included in the model are perceived usefulness, perceived ease of use, subjective norm, self-efficacy, and personal innovativeness [9]. The intention to accept new technologies is influenced by several factors: the belief that using the technology will enhance job performance, the perception that the technology is easy to use and requires minimal effort, the influence of how peers or significant others perceive the use of the technology, confidence in one's ability to successfully utilize the technology, and the enjoyment of experimenting with new technologies. It is suggested that enhancing innovativeness among nurses is crucial for facilitating the adoption of new technologies.

This study aims to identify the factors influencing hospital nurses' acceptance of ICT. Understanding these factors will assist in preparing nurses for the successful integration of these technologies into their practice.

METHODS

Research design
This study is a cross-sectional descriptive research design to

identify the factors influencing the acceptance of ICT among nurses at a tertiary general hospital.

Participants
This study included nurses employed at a tertiary general hospital who voluntarily consented to participate. The sample size was determined using G*Power 3.1.9 software, aiming for a multiple regression analysis (effect size=0.15, power=0.95, α=0.05), and 15 predictors, resulting in a required sample size of 199 participants. Considering an anticipated attrition rate of 10%, questionnaires were distributed to 222 nurses. After excluding 21 questionnaires due to non-response or incomplete answers, data from 201 respondents (response rate: 90.5%) were included in the final analysis.

Measures

Acceptance of information communication technology
The acceptance of ICT refers to the willingness to use or adopt ICT in nursing practice [9]. To assess the acceptance of ICT, tool developed by Heo and Jung [10] was used with permission from the developer. The questionnaire comprises two items. Responses are based on a 5-point scale: 1="strongly disagree" to 5="strongly agree." The total scores ranged from 2 to 10.

The higher the score, the greater the willingness to use or introduce ICT in nursing work. In Heo and Jung [10] study, Cronbach's α of the tool was 0.95, and in the present study, Cronbach's α was 0.93.

Perceived usefulness
Perceived usefulness refers to the extent to which one believes that using ICT in nursing practice can enhance their job performance and work capabilities [9]. The questionnaire comprises three items. Responses are based on a 5-point scale: 1="strongly disagree" to 5="strongly agree." The total scores ranged from 3 to 15. The higher the score, the greater the perceived usefulness of ICT in assisting with nursing work. The reliability coefficients reported in Heo and Jung [10] study with Cronbach's α=0.93. Cronbach's α in the current study was 0.89.

Perceived ease of use
Perceived ease of use refers to the extent to which one believes that using ICT in nursing practice is not difficult and can be used without much effort [9]. The questionnaire comprises three items. Responses are based on a 5-point scale: 1="strongly

disagree" to 5="strongly agree." The total scores ranged from 2 to 15. The higher the score, the greater the perceived ease of use of ICT in nursing work. In Heo and Jung [10] study, Cronbach's α of the tool was 0.92, and in the present study, Cronbach's α was 0.88.

Subjective norm

Subjective norm refers to how an individual's reference group or significant others perceive the use of ICT in nursing practice [9]. The questionnaire comprises three items. Responses are based on a 5-point scale: 1="strongly disagree" to 5="strongly agree." The total scores ranged from 2 to 10. The higher the score, the higher the awareness of the views of reference groups or important people when the subject wants to use or introduce ICT in nursing work. The reliability coefficients reported in Heo and Jung [10] study with Cronbach's α=0.89. Cronbach's α in the current study was 0.73, indicating satisfactory internal consistency.

Self-efficacy

Self-efficacy refers to the belief in one's own capability and skills to use ICT in nursing practice effectively [9]. The questionnaire comprises two items. Responses are based on a 5-point scale: 1="strongly disagree" to 5="strongly agree." The total scores ranged from 2 to 10. The higher the score, the greater the confidence of subject in using ICT. In Heo and Jung [10] study, Cronbach's α of the tool was 0.90, and in the present study, Cronbach's α was 0.94.

Individual innovativeness

Individual innovativeness refers to the willingness and ability of individuals to actively adopt or embrace changes, such as the integration of ICT into nursing practice [9]. The questionnaire comprises three items. Responses are based on a 5-point scale: 1="strongly disagree" to 5="strongly agree." The total scores ranged from 3 to 15. The higher the score, the greater the subjects' voluntary willingness to use or plan to use ICT in nursing work. The reliability coefficients reported in Heo and Jung [10] study with Cronbach's α=0.90. Cronbach's α in the current study was 0.092.

General characteristics

General characteristics consisted of eight items: six demographic questions covering sex, age, Education, working department, position, clinical career, one items on the experience of ICT in daily life, and one item on experience using ICT applied in the hospital environment.

Data analysis

The collected data were analyzed using the SPSS Statistics for Windows, Version 28.0 program. The general characteristics of the subjects were analyzed by frequency, percentage, mean and standard deviation. Independent t-test and one-way ANOVA were conducted to determine differences in acceptance of ICT according to general characteristics. Post hoc tests were analyzed using the Scheffé test. Multiple linear regression analysis was performed to identify factors influencing the acceptance of ICT.

Data collection and ethical considerations

The data collection for this study was conducted from February 23, 2022, to March 11, 2022. Following approval from the Institutional Review Board (IRB) of Asan Medical Center (IRB No. 2022-0058), the researcher explained the study's objectives to the hospital's nursing department and obtained permission to distribute the questionnaire. It was clearly communicated that responses would remain confidential, no personal identifiers would be disclosed, and the information would be used solely for research purposes. Participants were asked to provide their handwritten signatures on consent forms to voluntarily participate, after which they completed the survey. A token of appreciation was given to participants who completed the questionnaire.

RESULTS

General characteristics

Table 1 shows the general characteristics of the study participants included in this study. Of the participants, 198 (98.5%) were female. The average age was 33.14±8.27 years, and the average of clinical career was 9.56±7.93 years. A majority were staff nurses, accounting for 176 (87.6%). The average use of ICT in daily life was rated 3.30±1.05 out of 5. Among the participants, 90 (44.8%) had experience using ICT in a hospital setting.

Acceptance of information communication technology and factors

The participants' acceptance of ICT averaged 3.98±0.61 out of 5. The average perceived usefulness was 3.97±0.56, perceived ease

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Table 1. General characteristics of participants (n=201)

Characteristic	Category	Number (%)	Mean±SD
Sex	Male	3 (1.5)	
	Female	198 (98.5)	
Age (yr)	≤29	87 (43.3)	33.14±8.27
	30–39	61 (30.3)	
	≥40	53 (26.4)	
Education	≤Bachelor	168 (83.6)	
	≥Master	33 (16.4)	
Department	Ward	53 (26.4)	
	ICU	36 (17.9)	
	OPD	51 (25.4)	
	OR	49 (24.4)	
	Others	12 (6.0)	
Position	Staff nurse	176 (87.6)	
	Non-staff nurse[a]	25 (12.4)	
Clinical career (yr)	<5	85 (42.3)	9.56±7.93
	5–9	31 (15.4)	
	10–14	32 (15.9)	
	≥15	53 (26.4)	
Experience of ICT in daily life	Strongly agree	18 (9.0)	3.30±1.05
	Agree	83 (41.3)	
	Neutral	54 (26.9)	
	Disagree	33 (16.4)	
	Strongly disagree	13 (6.5)	
Experience using ICT in a hospital setting	Yes	90 (44.8)	
	No	111 (55.2)	

The sum of the percentages does not equal 100% because of rounding.
ICT, information communication technology; ICU, intensive care unit; OPD, outpatient department; OR, operating room; SD, standard deviation.
[a]Including advanced practice nurse, unit manager.

of use was 3.53±0.74, subjective norm was 3.90±0.58, self-efficacy was 3.71±0.65, and personal innovativeness was 2.88±0.85 (Table 2).

Acceptance of information communication technology by general characteristics

Comparing the acceptance of ICT according to the general characteristics of the participants are as follows (Table 3). Participants with a master's degree or higher showed higher acceptance compared to those with a bachelor's degree or lower (t=−2.811, P=0.005).

Relationship between acceptance of information communication technology and factors

In the analysis of the correlation between the acceptance of ICT and other variables, all factors showed a significant positive correlation (Table 4).

Table 2. Acceptance of ICT and factors (n=201)

Variable	Mean±SD
Acceptance of ICT	3.98±0.61
Perceived usefulness	3.97±0.56
Perceived ease of use	3.53±0.74
Subjective norm	3.90±0.58
Self-efficacy	3.71±0.65
Individual innovativeness	2.88±0.85

ICT, information communication technology; SD, standard deviation.

Influencing factor of acceptance of information communication technology

To determine the influence of general characteristics, experience of ICT in daily life, education, perceived usefulness, perceived ease of use, subjective norm, self-efficacy, and personal innovativeness on the acceptance of ICT, a multiple linear regression analysis was conducted (Table 5). The Durbin-Watson

is 1.837, and the variance inflation index ranged from 1.032 to 2.093, which is well below the threshold of 10, indicating no issues with multicollinearity. The regression model was found to be fit (F=37.267, $P<0.001$). The model explained 59.2%. Significant factors included education (β=0.119, $P=0.011$), per-ceived usefulness (β=0.445, $P<0.001$), subjective norm (β=0.246, $P<0.001$), and self-efficacy (β=0.117, $P=0.041$). All of which significantly influenced the acceptance of ICT.

DISCUSSION

This study investigated the acceptance of ICT among nurses at a tertiary hospital. By identifying factors that influence this ac-ceptance, the study aimed to propose methods for introducing and applying ICT in clinical setting.

This study showed participants reported an acceptance of ICT of 3.98 out of 5. Comparative studies indicate lower scores, ranging from 3.30 to 3.59, among nursery and special education teachers using technologies such as mobile payments and ed-ucational robots [11-13]. Nurses demonstrated slightly higher acceptance rates compared to these groups. The higher scores among nurses may be attributed to their exposure to advanced technologies, as their workplace had implemented AI-based diagnostic tools and operated a big data center in participants' institution. Additionally, frequent coverage of topics such as the Internet of Things and Digital Health in continuing education sessions and academic conferences likely influenced their ac-ceptance levels.

In this study, 44% of participants reported the experience using ICT in hospital settings, a figure significantly higher than

Table 3. Acceptance of ICT by general characteristics

Variable	Category	Acceptance of ICT	
		Mean±SD	t or F (*P*)
Age (yr)	≤29	3.88±0.55	1.729 (0.180)
	30–39	4.05±0.65	
	≥40	4.02±0.62	
Education	≤Bachelor	3.92±0.59	−2.811 (0.005)
	≥Master	4.24±0.62	
Department	Ward	3.98±0.55	1.825 (0.126)
	ICU	3.97±0.44	
	OPD	3.91±0.66	
	OR	3.92±0.69	
	Others	4.41±0.51	
Clinical career (yr)	<5	3.85±0.53	2.111 (0.100)
	5–9	4.06±0.51	
	10–14	4.10±0.75	
	≥15	4.05±0.64	
Experience using ICT in the hospital setting	Yes	3.97±0.58	0.056 (0.956)

ICT, information communication technology; ICU, intensive care unit; OPD, outpatient department; OR, operating room; SD, standard deviation.

Table 4. Relationship between acceptance of ICT and factors

Variable	Perceived usefulness	Perceived ease of use	Subjective norm	Self-efficacy	Individual innovativeness
			r (*P*)		
Acceptance of ICT	0.707 (<0.001)	0.499 (<0.001)	0.640 (<0.001)	0.467 (<0.001)	0.324 (<0.001)

ICT, information communication technology.

Table 5. Influencing factors of acceptance of ICT (n=201)

Variable	B	SE	β	t	*P*-value	VIF
(constant)	0.276	0.225	–	1.229	0.220	–
Experience of ICT in everyday life	0.054	0.028	0.093	1.939	0.054	1.130
Experience of ICT in the hospital (=yes)	−0.081	0.056	−0.067	−1.453	0.148	1.032
Education (≥master)	0.195	0.075	0.119	2.581	0.011	1.040
Perceived usefulness	0.483	0.067	0.445	7.244	<0.001	1.847
Perceived ease of use	0.069	0.047	0.083	1.472	0.143	1.563
Subjective norms	0.256	0.068	0.246	3.757	<0.001	2.093
Self-efficacy	0.109	0.053	0.117	2.058	0.041	1.581
Individual innovativeness	−0.012	0.039	−0.016	−0.299	0.765	1.470
F (*P*)=37.267 (<0.001), R^2=0.608, adjusted R^2=0.592, Durbin-Watson=1.837						

ICT, information communication technology; SE, standard error; VIF, variance inflation index.

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that reported in studies involving nursery and special education teachers, where only 14.2% [10] and 17.0% [8], respectively reported such experience. The higher rate among nurses may be attributed to the advanced technological environment at participants' institution. This institution has pioneered several innovations, including the development of Dr. Answer 1.0, a domestic AI-based precision medicine service, and operates the first virtual reality (VR) training center in the domestic medical industry [14]. Additionally, the institution implements Body Interact, a computer-based virtual patient treatment and nursing education program, along with VR education for emergency situation response, which likely influenced the nurses' higher ICT engagement [10,14]. Although this study did not demonstrate a statistically significant difference in acceptance of ICT based on ICT usage experience, the variable was included in the regression analysis based on the researcher's observation that exposure to new ICT increased acceptance rates. However, it was not identified as an influencing factor for acceptance of ICT. Therefore, a multicenter study with an increased sample size is recommended for further study.

In this study, 77.1% of participants reported positive experiences using ICT in their daily lives. However, several respondents requested specific examples of information and communication technology and inquired about the applicability of their experiences, indicating a need for more detailed explanations within the questionnaire.

In this study, participants reported a high perceived usefulness of ICT, with an average score of 3.97 out of 5, which was identified as a significant factor influencing ICT acceptance. These findings align with results from several previous studies [10-14]. To enhance ICT acceptance among nurses, it is crucial to underscore the convenience and efficiency of ICT in facilitating nursing tasks, thereby emphasizing its usefulness, for example, alarm system to prevent medication error and patient identification [15].

In this study, the perceived ease of use of ICT was rated at 3.53 out of 5, closely aligning with the scores ranging from 3.48 to 3.75 found in previous studies [10,12,13]. However, unlike previous research, perceived ease of use did not significantly influence ICT acceptance in this study. This appears to stem from the belief that the utilization of ICT in nursing practice is influenced more by institutional obligations and policies rather than being a choice based on perceived ease of use. Thus strategies should be developed to reinforce nurses' beliefs that adopting ICT in their work can enhance the prestige of both nurses and

their organizations within society, and to trust that ICT will provide reliable information and useful outcomes for the objectives of nursing work [16].

Subjective norms of participants were identified as a significant influence on acceptance of ICT, with a score of 3.9 out of 5. This score is notably higher compared to the 2.84 reported in a previous study [11], indicating a substantial shift in the social pressures and expectations perceived by nurses regarding the use of ICT. The higher subjective norms among nurses compared to other professions appear to be attributed to the unique characteristics of nursing duties.

In this study, self-efficacy was measured at 3.71 out of 5 and was identified as a significant factor influencing the acceptance of ICT. Previous study has established self-efficacy as an important determinant in the study of individual behavior towards technology [17] and has also been shown to affect nurses' job satisfaction [18]. Therefore, to enhance nurses' acceptance of ICT, it is essential to explore strategies that boost their confidence in their skills and abilities to effectively use ICT in their nursing practice.

In this study, personal innovativeness scored 2.88 out of 5, which is lower than the 3.15 to 3.46 points reported for other professions. Personal innovativeness is defined as an individual's tendency to adopt innovations more quickly than other members of their social system [19]. Unlike other professions, nurses tend to adopt technology based on its usage by surrounding peer groups rather than being early adopters themselves [15,16]. To enhance nurses' acceptance of ICT, it is crucial to develop strategies that foster personal innovativeness, enabling nurses to embrace technology independently [15,16,19]. Additionally, creating networks of technologically adept nurses could foster a mutually reinforcing environment, positively influencing broader adoption within the profession. The application of ICT to enhance the efficiency of nursing tasks should be centered on nurses themselves, who are the primary performers of nursing duties. It is necessary to prepare networks to support this endeavor.

The limitations of the study include the focus on nurses from a single institution, which may affect the generalizability of the results. Additionally, the participants' understanding of ICT may vary, necessitating caution when generalizing the findings. However, the study is significant in that it explores the acceptance and influencing factors of ICT in nursing field.

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AUTHOR CONTRIBUTIONS

Dr. Jeong Yun PARK had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: AYL and JYP. Data curation: AYL. Formal analysis: AYL and JYP. Investigation: AYL. Methodology: AYL and JYP. Writing–original draft: AYL. Writing–review & editing: AYL and JYP.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

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DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

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