Original Article

Effect of Nursing Informatics' Training Program on Nurses' Proficiency in Remote Follow-Up for Liver Transplant Recipients

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ABSTRACT

Background: Nursing informatics is expanding and developing with health information technology and becoming an essential component of all nursing practice areas particularly in monitoring of the organ transplanted recipients. **Aim:** To evaluate the effect of nursing informatics' training program on nurses' proficiency in remote follow-up for liver-transplant recipients. **Research design:** Quasi-experimental pretest-posttest design. **Sitting:** The present study was carried out at the Liver Transplantation follow-up Unit, National Liver Institute, Menoufia Governorate, Egypt. **Sample:** Convenient sample of all available nurses (50) divided random into intervention and control groups. **Tools:** Two tools were used; assessment questionnaire and Nursing Informatics Competency Assessment Tool (NICAT)**. Results:** All the 50 nurses completed the instructional program, but there was no clear differentiation between the interventional and control participants at the pretest phase in terms of the Nursing informatics competence and its elements (p = 0.54). However, in the post-test phase, the interventional nurses' Nursing informatics competence and its elements considerably improved with a big effect size in comparison to the control nurses (p=0.001), this distinction demonstrated the intervention nurses' competence in the post-test phase. The informatics literacy component had the biggest mean difference in the interventional group, whereas the informatics management skills element had the least overall mean difference. **Conclusions**: The intervention program obviously enhanced nursing informatics competence in all its dimension values, which suggested that it was helpful in raising the nursing informatics competence of nurses working in liver transplant unit. **Recommendations:** This program should be essentially applied in all health sectors for enhancing nurses' nursing informatics proficiency.

Keywords: Liver Transplanted Recipients; Nursing Informatics; Nurses' Proficiency; Remote Follow-Up; Training Program

Introduction:

Liver transplantation is considered the unique treatment decision for patients with liver failure and for some of those with liver cancer whose condition can't be managed by the existing treatment modalities *(Smith E., 2021)*.

Caring for a patient receiving a liver transplant is complicated, and typical post-

operative nursing interventions must take into account both the avoidance of infection and the assessment of graft rejection indicators *(Younis et.al, 2018)*. To minimize complications in the early post-transplantation duration; prevention, anticipating, and earlier intervention all are needed and to maximize short- and long-term grafting outcomes, nurses caring for liver transplanted recipients have to possess particular knowledge and skills *(Baker et.al, 2019 & Liou et.al, 2018)*. Assessing and managing liver recipients' complications requires particular skills, proficiencies and competencies in nursing care *(Rohan et.al, 2020)*.

Healthcare has been significantly impacted by health-related information technology (HIT) since the turn of the 3rd century. Nursing professionals have contributed to the idea, design, and deployment of HIT since it plays a significant role in nursing practice *(Espino et.al, 2018)*. Because of the increase of the expertise needed in this area alongside the growth of information technology innovations in healthcare, the nursing informatics (NI) specialty has developed. To handle and share data, information, and experience in nursing practice, NI is a specialty that combines nursing science, computer technology, and information sector *(McGonigle&Mastrian , 2021).*

According to several surveys, NI advocates evidence-based practice (EBP) and incorporates best practices into patient's treatment to improve patient's safety, raise healthcare quality, and lower healthcare expenses while also having a favorable impact on nursing practice *(Saba & McCormick,*

2019). The interaction between patients and nurses is enhanced by NI, which promotes sharing of information. It supports patients, nurses, and other members of the healthcare team in making wise decisions and achieving positive results *(Atiqueet.al, 2020)*.

Considering the well-established benefits of HIT, numerous investigations have found that its use in clinical contexts can have unwanted and unanticipated adverse effects, including poor patient's outcomes and hazards to patient's safety *(Boothet.al, 2021)*. Burnout in clinicians, stress from HIT, unhappiness with HIT, a propensity to cut back on medical working time, as well as terminating a job or existing practice, are additional detrimental effects *(Honeyet.al, 2020)*. Besides, investigators underlined that poor nurse NI competence was linked to HIT's detrimental effects on care delivery as simple clinical abilities and advanced application-based understanding are also included in the NI competence *(Collinset.al, 2022)*.

Based on the American Nurses Association (ANA), four stages of nursing practice; beginner nursing, experienced nursing, informatics nursing specialist, and informatics innovator that prescribe specific nursing informatics practices *(Mantaset.al, 2020)*. Besides, The Technology Informatics Guiding Education Reform (TIGER) Project made suggestions in 2019 for post-operative nurses' NI proficiency and incorporation of NI into nursing education as well as for the growth of nursing staff in all positions, including post-operative liver transplant nurse, nursing

manager, and nurse educators *(Frith& Hoy, 2021)*. The suggestions are divided into three groups; information literacy, managing of informatics, and digital literacy. Without NI competence, HIT in medical contexts will be useless, having the mentioned adverse effects. NI was taken into account as a prerequisite for EBP. Higher levels of NI competence would improve a nurse's preparation for EBP *(Deckroet.al, 2021& Hillet.al, 2019)*.

Due to how crucial their work is, nurses who work in liver transplant facilities require substantially more NI proficiency than other nursing specialties, as advanced high-tech devices are required for patients in post-transplant surgery situations, and skilled professionals must constantly watch them *(Ohet.al, 2017)*. In these settings greater than in other facilities, patient's outcomes and safety are crucial. The gap between the necessary NI competencies for nursing in various workplace settings and post-operative circumstances has been identified by the literature research, at the same time, the preceding researches' findings indicated that further interventional programs are required to boost NI competence and better satisfaction is the key competencies of the nursing field *(Seoet.al, 2019)*.

Liver-transplanted recipients receiving subpar treatment are affected by insufficient nurses' NI competence, which also puts additional strain on nurses who are supposed to demonstrate better patient outcomes through using HIT *(Kleibet.al, 2021)*. As a result, nurses' NI proficiency in providing patient care must be enhanced by

ongoing learning and without educational initiatives; nurses are unable to efficiently implement HIT in practice *(Kaihlanenet.al, 2021)*.

Additionally, recently graduating nursing staff in healthcare institutions claimed that their teachers had a limited knowledge of NI and that the abilities they had learned in these classes did not translate effectively to the fieldwork *(Kwaket.al, 2019)*. According to experts, the NI competence that student nurses are obliged to learn is not taught at nursing programs consistently. Nursing curriculum reform and the creation of novel educational programs are necessary for the incorporation of NI competencies into nursing education *(Nagelet.al, 2017)*.

Operational definitions:

Nursing Informatics is theoretically defined as the ability of nursing staff to gather, keep, access, analyze, and utilize information in nursing care is referred to as NI competencies *(Collinset.al, 2022)*.

Nurse's proficiency The American Nurses Association (ANA) defines proficiency as an expected level of performance that integrates knowledge, skills, abilities, and judgments. It encompasses; patient care, medical/clinical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and system-based practice *(Benner P., 2019)*.

Remote patient's follow-up is the ability to monitor certain aspects of a patient's health from their own home through applying tele-health

option. Remote patient monitoring lets health care providers manage both acute and chronic conditions. Besides, it allows cutting down on patients' travel costs, waiting time and infection risk *(Valentaet.al, 2018)*.

Significance of the study:

At various points along the nursing continuum, nurses are required to be a nursing informatics competent in order to deliver patient-centered and substantial proof healthcare. Therefore, it is crucial and required for the efficient use of health information technology that educational programs are used to increase the nurses' health informatics proficiency *(Smith, 2021)*.

Moreover, the professional development of nursing necessitates implementing nursing interventional programs and courses on HIT in practice that in turn will help nurses perform better, which will lower the likelihood of patient's complications after liver transplantation*(Fung KYM, 2019)* additionally, Investigators' observations indicated that nurses' knowledge and application of those criteria were weak and needed to be improved *(Choi, 2022)*. Whereas few studies used a training program to promote nurses' NI competence indicated that the nurses' NI competence rose because of the educational intervention; however, the research does not though fully discuss how liver transplant nurses might increase their NI competence *(Belchez, 2019)*.

Aim of the study

This study aimed at evaluating the effect of nursing informatics' training program on nurses' proficiency in remote follow-up for liver-transplant recipients.

Research Hypothesis

H1: Implementing nursing informatics' training program will improve nurses' proficiency in remote follow-up for liver-transplant recipients.

Research design:

A quasi-experimental pretest-posttest methodology was used in this research, comprising an intervention and control groups.

Study setting:

The current research was conducted at the Liver Transplantation Follow-up Unit, National Liver Institute, Menoufia Governorate, Egypt.

Sample size calculation
Subject or Sample:

Convenient sample of all available nurses (50) with at least six months of experience working in liver transplant units divided random into intervention and control groups (n=25) for each group and this number was based on previous studies and the sample size equation, the sample size was determined. Considering that $\alpha= 0.05$, testing power was 80%, and the effect size was significant (Cohen d = 0.7), 22 individuals for each group were recruited (44 nurses are required for the whole sample and researchers increased it up to 50).

Inclusion criteria

Nurses with a bachelor's degree, at least six months of experience working in liver transplant units, and no clinical shifts booked on the training days were required for enrollment.

Exclusion criteria

Being unavailable from one session and having an inadequate survey were the exclusion criteria. According to the inclusion criteria, none of the nurses were disqualified.

Tools and data collection procedure:

Two assessment questionnaires were made up for data collection in this research:

Tool 1: The first assessment questionnaire was developed by researchers based on extensive reviewing of the related literature and previous studies. It included 11 items to assess the participants' personal and professional characteristics, 3items asked about gender, marital status & age while, the next 3items about work; experience, position and shifting rotation. Finally, five items on participation background at studies in the form of; attendance at research training, information literacy training, literature search & retrieval training skills, and computer skills training and the tendency to use database

Tool 2: *The Nursing Informatics Competency Assessment Tool (NICAT)*, which adapted from *(Rahman A., 2015)* to assess the educational and training initiatives for nursing informatics competence among nurses through measuring their psychomotor abilities in using

computer technologies to detect, locate, assess, and effectively use patient's available information for the application of data supporting follow-up through using information management skills. NICAT was created in the United States in 2015 using the ANA criteria from 2008, the TIGER guidelines from 2009, and Benner's Dreyfus paradigm of skills acquisition in 1984. This instrument has the ability to examine, assess and hire the academic qualifications of each nurse through its 30 questions, which categorized on three-dimensional components as follows:

Part 1: Successful nurse requires the psychomotor abilities to use computer technologies as well as a basic understanding of how hardware and software work (10 elements, from 1 to 10).

Part 2: The ability of nurses to detect, locate, assess, and effectively use information for remote follow-up of liver-transplanted recipients is known as informatics literacy (13 elements, from 11 to 23).

Part 3: The application of the data supporting follow-up judgment, documenting, data integrity, privacy, and safety is accomplished through information management skills (7 elements, from 24 to 30). The usefulness of information systems in enhancing patient's safety, efficiency, and outcomes is demonstrated by information management skills.

Scoring system:

Adjusting Likert scale system with a range of one to five, the NICAT is graded as follows:

- Not competent (1 point), moderately competent (2 points), competent (3 points), proficient (4 points), and expert (5 points)

- The tool's total range of scores is ranged between 30-150 with higher scores indicating more proficiency.

- A nurse who receives a total scoring of 30 is regarded to be a beginner;

- A nurse who receives a rating upwards of 31 and 59 is an advanced beginner;

- A nurse who receives a rating somewhere around 60 and 89 is competent;

- A nurse who receives a rating between 90 and 119 is proficient; and

- A nurse who receives a scoring between 120 and 150 is regarded to be a NI specialist.

With the assistance of an information technology professional, the investigators of the current study assessed the content's legitimacy. Internal consistency was then used to verify the reliability. For all variables and all dimensions, the Cronbach's alpha coefficient was 0.846, showing adequate internal consistency (*Abd El Monem A., 2019*).

Ethical consideration: The Ethical Committee of Menoufia University's Faculty of Nursing authorized this study (Approval No. 896). From the mid of August to the end of November

2022, the current study served as an instructional intervention program to enhance the NI competence of nurses in liver transplant units. After describing the purpose of the investigation, all participants provided a written agreement to participate in the study, and they were guaranteed that all gathered data would be kept strictly secret and used solely for the purpose of the study. Participation in the study was not obligatory and anonymous, according to the researchers. Participants were also advised that refusing to participate in the study would not have any impact on their care or their health.

Validity of tools:

A jury of five academic medical surgical nursing staff and two healthcare informatics' experts attested to the accuracy of the adapted version of NICAT's material. By incorporating direct quotes from specialists, in-person conversations, and feedback, content legitimacy was increased.

Reliability of tools:

The reliability co-efficient regarding the first tool revealed (0.87). The investigators repeated the reliability co-efficient regarding the second tool, the Cronbach's alpha of the tool was showed (0.80) while for the nurse's proficiency the reliability co-efficient was equal to (0.847), which was adapted from (*Rahman A., 2015*). Hence, the study tools indicate good reliability for conducting the research study.

Additionally, 20 nurses took part in the questionnaire's pilot survey, and its reliability was

evaluated using the Cronbach's alpha coefficient (α = 0.95).

Pilot study

Five nurses who participated in a pilot study (10%) were subsequently incorporated in the sampling because the study tools had not been changed. The goal of the pilot trial was to assess the instruments' usability and intelligibility, as well as to estimate how long it would take every nurse to fill in the demographic assessment questionnaire and the observational survey.

Data collection Procedure: In a three-day program, the interventional nurses received a training course in NI competency. Instruments and data before (pre-test) and one month after the interventional program (post-test) data were gathered using a demographic questionnaire and an adaptation of the Nursing Informatics Competency Assessment Tool (NICAT).

- At first, the investigator used different shift workplaces as the study locations and gave surveys to participants in the intervention and control groups during the pre-test (before the training) and post-test phases (one month after the training).

- Additionally, the researcher instructed nurses on how to complete the survey questions. The investigator allocated enough duration to survey questions and coordinated training times with participants in the intervention group, in order to get the highest response rate, also interacted with the respondents and set a delivery deadline for the questionnaire responses, then recalled the interventions group's obligation to show up at the training at the appointed hour.

- In addition to routine or conventional training courses in health facilities, it is important to acknowledge that all of the attendees filled out survey questions throughout paid work hours.

- However, only the intervention participants received supporting documents from the training session, while the control participants were not given access to this educational program. In other terms, the settings for employment obligations and participation at other educational programs in health facilities were equal for the two research groups.

- Furthermore, to boost the survey's internal validity, the investigator closely monitored the experiment circumstances to make sure that the interventional and control participants were equal in every way, with the exception of participating in the educational program.

Intervention procedure

- Three-hour training per day, three-day training was held in four weeks in the informatics center at the remote follow-up unit of the National Liver Institute, which has enough computers and internet connectivity. All training was held over a six-day period for each intervention group nurse with the same format and subject matter.

- The investigator conducted a literature review to identify the requisite NI competencies for liver transplant nurses and their educational requirements in NI competence in order to create and develop the training material *(Abd El Monem A., 2019, Belchez, 2021, Choi, 2022, Fung KYM, 2019, Edwards & O'Connor, 2018, Hillet.al, 2019 &Seoet.al, 2019).*

- To come to an agreement on objectives, substance, and teaching methodologies, the researcher reviewed the selected subjects. The literature identified three crucial NI competency areas: data management abilities relevant to nursing care, computer literacy, and informatics literacy. These locations complied with ANA criteria from 2008 and TIGER suggestions (2009). The author conducted the selection of key NI competencies using the TIGER NI competencies as a guideline. A uniform and consistent set of competencies for nurses can improve their ability to use it.

- The investigator also interviewed a multidisciplinary team that included three healthcare informatics experts, two nursing university staff members, a medical training expert, three educational administrators, and two liver transplant nurses. In addition, the coworkers discussed their thoughts on teaching-learning practices and educational options for healthcare informatics in study settings, in addition to the knowledge and skills

clinical nurses should possess about nursing informatics in current practice. Focus group discussions were used to produce the themes in this phase, and the workgroup then evaluated them for acceptability, feasibility, applicability, and relevance to the nursing process. Every piece of developed content underwent extensive revision and evaluation.

- Then the investigator prepared the workshop's curriculum after deciding on the NI competences. Five academic staff and two healthcare informatics' experts gave their approval for the instructional content validity. Little changes were implemented because of their recommendations.

- Lastly, the generated contents were instructed using the following methods by a PhD nurse and three healthcare informatics specialists; lectures, demonstration, questions and answers, slides presentation, hands-on training, group discussion and work, web-based activity (with explanations of literature survey using concepts recommended by nursing staff), class work, video film, and educational CDs. Training courses on principles and application were included in the course each day and were illustrated in table (A) that provides a list of the workshop's themes.

Table A: Primary subjects covered in the training program

The first week session	Covered knowledge and proficiency with computers in the following areas: • Showing how to look for just-in-time training resources, rules, and processes • Microsoft Windows, data transformation, accessibility to data, and data protection • Maintaining the security of computer systems to safeguard data, equipment, credentials, and detect viruses. • Slideshows and important comments (hyperlinks, transitions, slides master, designs), presenting various file formats and major remarks on sophisticated word processing features, organizing references • Looking for regulations, processes, and data, as well as presenting databases, search engines, Google, and essential remarks (translation- images- books- directory-scholar...), as well as displaying Web tutorials and presenting training just-in-time resources on the internet. • Employing software tools for Tele-health and communications, such as Skype, Google forms, Adobe Connect, and emails
The second week session	• Presenting and orienting a wide range of information sources, such as printed materials and digital files • Showing online libraries for medicine and nursing, including Current Nursing and Allied Health Literature (CINAHL), Scopus, Pub Med, and Research gate • Utilizing search techniques in datasets like Research gate Pub Med and Scopus. • Showing off many digital search features, such as how to enroll and obtain free articles. • Employing searching operators like AND, OR, NOT, and others, performing basic and sophisticated searches, and executing restricted searches based on the publishing time, full transcript, keywords, and Medical Subject Headings (MeSH). • Performing practical training, taking "Intubated Patient Care" as an example, finding relevant articles using related

	keywords in databases like Pub Med and Research gate and Scopus • Forwarding search suggestions to lecturers via email in order to get their comments
The third week session	• Providing examples and useful tasks related to the subjects covered in the second episode's lesson. • Evaluating IT projects like HIS and its features, including its ability to capture and monitor patient care statistics such lab results, the imaging and communication protocol, patients' admittance, and discharging. • Using HIT for better care efficiency and patient-nursing interactions and detecting bottlenecks in human-computer interaction to improve healthcare outcomes. • Incorporating the utilization of informatics tools, including the Nursing Interventions Classification (NIC) and Nursing Outcomes Classification (NOC), for the construction of successful care strategies • Addressing issues with data retrieval and privacy, levels of security and the accessibility of health data • Talking about obstacles to accurate documentation, evaluating techniques for enhancing documentation quickly and effectively, and giving shocking examples

Statistical analysis

Employing descriptive data (frequencies, percentages, means, and standard deviations) and inferential statistics, the data were examined in SPSS 21. (Independent samples t-test, paired t-test, chi square test, and the analysis of covariance). The dataset was normally distributed, as the Kolmogorov-Smirnov test revealed. The significance threshold was set at ≤ 0.05.

Results

Table (1) clarified that the interventional program was accomplished by all nurses, and they all submitted the full survey (response rate = 100%). According to the current study findings, the majority of participants in the intervention and control groups were women (92% & 88%, respectively), participants in their 30s to 40s (52% and 48%, respectively), and married (86% and 60%). In contrast to the 60% of nurses in the control group who had between 5 and 10 years of professional experience, 40% of intervention group nurses had fewer than five years of job experience.

Furthermore, majority of nurses in the control and intervention cohorts lacked training in both researching and computer skills (88% & 96%, respectively), information literacy (84% & 92%, respectively), academic searching and retrieval (80% & 92%, respectively). The majority of nurses (40% & 36%, respectively) leaned to use websites moderately. The chi-square test revealed no significant differences in the demographics and occupational data in between intervention and control cohorts according to Table 1.

Moreover, there were no discernible statistical differences in the research groups' average NI competence scores at the pretest phase according to Table 2. The independent samples t-test revealed initial homogeneity between subjects in the two research groups. Besides, the same table illustrated a strong posttest statistical significance (p=0.001) regarding all domains of NI competence among subjects of both groups, also an apparent statistical significance was observedregarding NI

competency posttest total scores in comparison between interventional and control groups as p value was (0.001).

Evaluation of the interventional group's improvements in NI competence According to Table 2, the interventional group's overall NI competence rating on the pretest was at the "competent" grade. With t = 6.60, p = 0.001, Cohen d = 1.22, the paired t-test demonstrated that the overall NI competence rating in the interventional group grew statistically significantly and reached the "proficient" grade in the post-test (a significant high effect size). Within post-test, all grades for the NI competence-based measurements risen statistically significantly as computer literacy scoring rate was t = 6.05, p = 0.001, Cohen d = 1.08 while; informatics literacy rating was t = 5.82, p = 0.001and informatics management skills rating was t = 6.79, p = 0.001with Cohen d = 1.06 which is a rather noticeable effect size.

These huge discrepancies demonstrate that the training program had a very large impact size and raised the interventional group's overall NI competence and its components ratings from "competent" to "proficient" grades. The informatics literate component had the largest mean difference (mean difference = 14.15), whereas the informatics management skills component had the least overall mean difference (mean difference = 7.00). The training program had the greatest influence on the informatics literacy component and the least effect on the informatics professional skills, according to the mean differences.

Contrast of the controls' improvements in NI competence

No discernible change in NI competence and its aspects was found in the control participants' pretesting and post-testing scores, which were both at the "competent" grade (t = -1.28, p = 0.14).

Analysis of the interventional and controls' improvements in NI competence Table 2 compared the two samples' levels of NI competence pre and post-test. Independent sample t-test results from the pretest stage identified no statistically significant differences between the interventional group (77.68 ± 25.41) and controls (81.58 ±18.18) in terms of NI competences (t = -0.34, P = 0.54). In addition, the evaluation of the interventional and controls demonstrated that both samples' NI competence and its demotions ratings were at the "competent" grade. In the post-testing stage, there was a statistically significant variation in the overall scoring of the NI competence between the interventional (113.18 ± 19.57) and controls (79.65 ± 16.88) with t = 5.43, p = 0.001, Cohen d = 1.46 (Having a huge effect size).

Additionally, the existent study results demonstrated a statistically significant post-testing enhancement in grades of the overall NI competence-based dimensions for interventional group when compared to the controls. Where

computer literacy scored t = 5.04, p = 0.001 with Cohen d = 1.61 indicating a quite significant effect size while, informatics literacy scored t = 5.33, p = 0.001 with Cohen d = 1.40 indicating a rather larger effect size, and informatics management skills scores were t = 3.44, p = 0.001.

What is more, a covariance analysis test was utilized in Table 3 to limit the effect of the pretesting on the nurses' NI competence. Regarding the pre-testing effects, the findings showed a statistically significant distinction in the overall post-testing scores of NI competence and its aspects between the control and interventional samples. These outcomes concur with those in Table 2 as well.

Moreover, figure 1showed pre-test and post-test distribution of studied groups scores regarding elements of NI competence. Which revealed that the post-test informatics' literacy score for intervention group has been improved from (32.4) in pre-test to (47.6) and the post-test informatics' competency total score has been elevated from (77.68) in pre-test up to (113.18) while, the control group's post-test informatics competency total score has been decreased from (81.58) in pre-test to (79.65).

Table 1: A comparative analysis of the nurses' occupational and demographic data as from interventional and control groups

Domains	Parameters	Controls N=25		Interventional group (N=25)		χ2	P
		N	%	N	%		
Gender	Female	22	88	23	92	0.014	0.93
	Male	3	12	2	8		
Age groups	> 40	6	24	5	20	1.99	0.257
	30–40	7	48	13	52		
	< 30	12	28	7	28		
Marital status	Married	10	60	19	86	1.04	0.47
	Single	15	40	6	24		
Work experience (year)	>10	4	16	8	32	3.81	0.36
	5–10	15	60	7	28		
	< 5	6	24	10	40		
Work position	Nurse	21	84	18	72	2.88	0.4
	Head nurse	4	16	7	28		
Shift rotation	Rotation	24	96	23	92	0.299	0.48
	Fixed	1	4	2	8		
Attendance at research training	No	22	88	24	96	2.95	0.066
	Yes	3	12	1	4		
Attendance at information literacy training	No	21	84	23	92	1.77	0.18
	Yes	4	16	2	8		
Attendance at literature search & retrieval training	No	20	80	23	92	2.18	0.06
	Yes	5	20	2	8		
Attendance at computer skills training unit	No	22	88	24	96	0.22	0.51
	Yes	3	12	1	4		
The tendency to use databases	High	8	32	12	48	3.74	0.07
	Moderate	10	40	9	36		
	Low	7	28	4	16		

Table 2: Association between the interventional and control participants regarding pretest and posttest NI competence scores

| Variables	Groups	Post test M ± SD	Pretest M ± SD	Size effect (Cohen d)	Mean difference	Statistic t^a & pvalue
Computer literacy	Control	27.02 ± 7.21	27 ± 7.16	0.04	0.02	$t = 0.26$ $p = 0.60$
	Intervention	38.69 ± 5.67	27.35 ± 9.17	1.08	10.13	$t = 6.05$ **$p = 0.001$**
	P	**$p = 0.001$**	$p = 0.74$			
	Effect size (Cohen d)	1.61	0.03			
	Statistic t^a	$t = 5.04$	$t = 0.183$			
Informatics literacy	Control	33.32 ± 6.68	33.69 ± 7.22	0.02	− 0.16	$t = − 1.28$ $P = 0.29$
	Intervention	47.66 ± 8.35	32.40 ± 10.34	1.22	14.15	$t = 5.82$ **$p = 0.001$**
	P	**$p = 0.001$**	$p = 0.56$			
	Effect size (Cohen d)	1.40	0.09			
	Statistic *t*b	$t = 5.33$	t = − 8.31			
Informatics management skills	Control	18.29 ± 4.39	18.77 ± 4.10	0.11	− 0.47	$t =1$ $p = 0.21$
	Intervention	24.79 ± 4.61	16.79 ± 5.67	1.06	7.00	$t = 6.79$ **$p = 0.001$**
	P	**$p = 0.001$**	$p = 0.16$			
	Effect size (Cohen d)	1.02	0.29			
	Statistic *t*b	$t = 3.44$	$t = − 1.16$			
Informatics competency total	Control	79.65 ± 16.88	81.58 ± 18.18	0.033	− 0.82	$t = − 1.28$ $p = 0.14$
	Intervention	113.18 ± 19.57	77.68 ± 25.41	1.22	34.4	$t = 6.60$ **$p = 0.001$**
	P	**$p = 0.001$**	$p = 0.54$			
	Effect size (Cohen d)	1.46	0.13			
	Statistic *t*ᵃ	$t = 5.43$	$t = − 0.34$			

a =Paired *t*-test, b =Independent *t*-test

Table 3: Covariance (ANCOVA) analysis for pre-test results of the two samples of interventional and controls regarding their participation background at studies

Variables	Domain	F	Mean square	df	*p-value*
Informatics management skills	Corrected model	49.45	601.7	2	**< 0.001**
	Group	41.10	614.61	1	**< 0.001**
	Pretest	54.80	805.03	1	**< 0.001**
	Intercept	39.00	446.4	1	**< 0.001**
	Error	12.78	57		
Informatics literacy	Corrected model	28.15	1007.47	2	**< 0.001**
	Group	43.36	1813.7	1	**< 0.001**
	Pretest	17.35	1417.32	1	**< 0.001**
	Intercept	40.06	1104.42	1	**< 0.001**
	Error		42.58	57	
Computer literacy	Corrected model	66.06	1871.70	2	**< 0.001**
	Group	64.38	1830.81	1	**< 0.001**
	Pretest	63.71	1812.66	1	**< 0.001**
	Intercept	59.38	1442.28	1	**< 0.001**
	Error		24.60	57	
Informatics competency total	Corrected model	31.60	9,507.1	2	**< 0.001**
	Group	44.86	12,804.31	1	**< 0.001**
	Pre-test	23.51	7506.48	1	**< 0.001**
	Intercept	31.06	9,348.45	1	**< 0.001**
	Error		137.5	57	

Figure 1: Pre-test versus post-test percentage distribution of studied groups scores regarding elements of NI competence
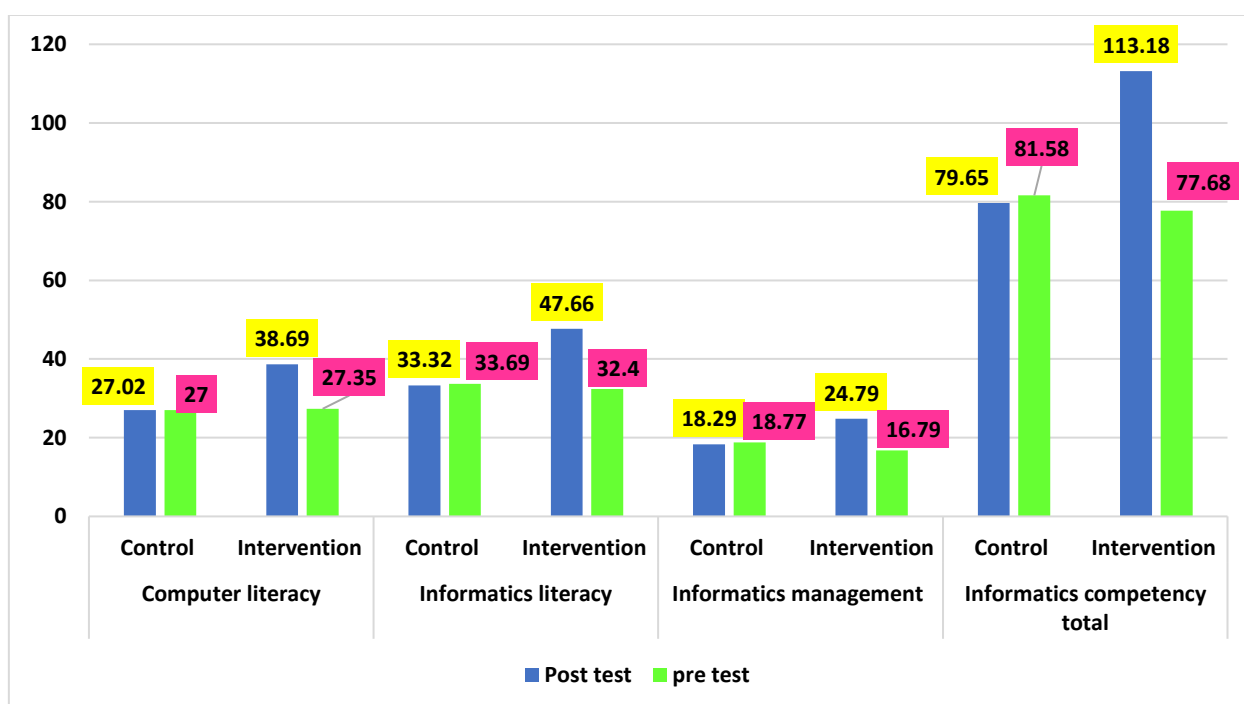
Discussion

This study assessed the impact of an interventional educational program on liver transplant follow-up unit nurses' NI competence. The outcomes showed a large impact factor and a significant improvement in NI competence across all of its parameters in the interventional sample compared to the control sample. The interventional sample's NI competence increased from "competent" in the pre-testing to "proficient" after the training program.

The results of numerous research conducted in various nations indicated, "Nurses' NI competence was at the competitive level prior to participating in any educational interventional program" *(Abd El Monem, 2019; Elsayed et.al, 2019 & Yang et.al, 2019)*. The NI competence of nurses though was poor according to previous research *(Hwang & Park, 2021; Campbell & McDowell, 2020 &Espino et.al, 2019)*. The nurses' NI competence was observed in some other researches to be at the expert and proficient grades *(Nwosu et.al, 2018; Hunter et.al, 2019 & Fetter, 2019).*

Numerous research conducted in various nations "assessed the effects of the training programs on the respondents' NI competence and indicated an enhancement" *(Gonen et.al, 2018 &Rajalahti et.al, 2022)*. Additionally, Power presentation, open meetings, and Babelium were three technology instruments employed by *Pereira et al. (2019)* in Spain "to enhance nursing students' NI competence and to evaluate the efficacy of the curriculum; investigators used self-, peer-, and instructor evaluations. At the conclusion of the program, they stated, "the learners' NI competence had enhanced, and more than half of the educators had experienced a growth in their creative abilities. There was a respectable correlation between one's own and others' evaluations".

In a different study, academics created "a hybrid course" to help student nurses become competent in informatics. The informatics proficiency of student nurses was significantly raised by this effort. The majority of students thought the course's utilization of blended learning as instructional strategies was effective" *Raei&Haseli, (2018)*. At the same time, *(Rajalahti et al., 2022 &Esfandani, 2019)* discovered, "Nursing staff that finished an educational program and staff nurses had increased NI competence. After the initiative, nurses were more competent and self-assured when using the electronic health record (EHR), making better clinical judgments, and caring for patients. Additionally, the professional nurses used nursing process theories and had a greater understanding of EBP".

Other research also noted, "A substantial improvement in NI competence among academic staff and ICU nursing staff" *(Brettle&Raynor, 2019)* compared to the control group after completing the teaching session. Similar outcomes might be attributable to the use of a comparable training curriculum and the growth of HIT in clinical settings and daily life, which has encouraged people and nurses to learn and improve their NI proficiency.

Additionally, modern nurses are referred to as digital immigrants and are technological amateurs. They must therefore get familiar with and implement a variety of new technological practices. If digital immigrants are serious about connecting with digital natives, they must adjust. Consequently, formal, and informal training both inside and outside the organization must prepare nurses with NI competencies. On the contrary, hospital administrators and politicians have focused on this issue and worked to establish the essential framework for staff nurse's empowerment *(Choi & De Martinis, 2020)*.

Furthermore, a study that looked at how training affected NI competence contradicts the current study results, as after the interventional program, the authors noted "no appreciable difference in the nurses' NI competence between the interventional and control samples. They claimed that both samples' post-testing information-seeking abilities had increased" *Karimi et. al, (2019)*. According to their findings, "the informatics literate component had the biggest mean difference in the interventional group and the informatics organizational skills component had the least overall mean difference". According to previous research *Aviv et. al, (2017)*, "the grade of nurses' NI competence fostered in the interventional sample and educational interventional sample had the biggest effect on the component of informatics literate at the post-testing phase".

In contrast, in a different study that evaluated "how a program affected nurses with NI

competence, informatics literate was linked to the least mean difference while information management was linked to the greatest mean difference" *Fetter, (2020)*.

According to the present study findings, the controls' NI competence and all of its aspects stayed at the "competent" grade, and there was no discernible variation between the pretesting and post testing results. It could be claimed that the successful implementation of clinical information systems depends on nursing' NI proficiency. The nurses were compelled to pursue NI competence because of the current situation and the hospital's concentration on applying HIT in various clinical situations.

Numerous studies by *(Raei&Haseli, 2018; Karimi et al., 2019 and Brettle&Raynor, 2021)* supported the existent study results as they demonstrated, "There was no discernible change between the control sample's NI competence levels prior to and after the educational program". In addition, *Esfandani et al. (2017)* looked at the data searching abilities of nurses and found, "There was little improvement in the control group's grades between before and after the training program". On the other hand, a study also revealed, "The control group's post intervention information skills grade improved" *Kirkwood & Price, (2019)*.

The disparities in communities, sample selection procedures, educational backgrounds, diagnostics, therapeutic and instrumental learning environments, respondents' prior skills, respondents' grades of nursing education readiness, research methodology and educational content,

research instruments and conditions may be to blame for the discrepancy between the outcomes of the aforementioned studies and those of the current research. For instance, the TIGER Initiative's suggestions were crucial for the creation of the current research program's data gathering platform and educational materials.

Limitations

There were some shortcomings in this research that must be rectified:

- The training duration could be extended for further issues and covering of NI competence during the program, as this study had a restricted amount of training duration. Many course options will make it possible for more nurses to sign up for such research, improving the outcomes' generalizability and strength.

- Next, since attendees tended to overestimate their stages of NI basic competence, examination of NI basic competence may have been impacted by the social desire bias inherent in the self-assessment and self-report technique used in this research. As a result, the data may not accurately reveal the level of NI basic competence of nursing staff.

- Thirdly, in order to identify the true NI competence, further researches can be done employing hybrid techniques of competence-based assessment, such as Kirkpatrick's four-level modeling and the 360-degree technique. Combining various methodologies that are appropriate for evaluating competence strengthens the assessment of NI competence. Kirkpatrick's modeling helped the theory to gain acceptance and maintain its position as the predominant model of competency assessment.

- Additionally, nurses are more driven to progress effectively within the organization because of their comparing 360-degree evaluation findings, which can help them better grasp their competencies. Additionally, this assessment will assist the nurse manager in effectively understanding and planning for the training and development requirements of nurses.

- Finally, yet importantly, data collection took place a month after the operation. It is advised to conduct follow-ups every three to six months to ensure more reliable data, comparing the findings to ascertain the training's long-term effects, and evaluate the effectiveness of educational NI programs on nurses' competence.

Conclusions

The NI competence of liver transplant unit nurses and its aspects might be greatly enhanced by this initiative. The nursing staffs, as well as the national and global healthcare systems, have recently acknowledged the necessity to maintain NI competency development. It emphasizes the significance of proactive strategies to advance NI nursing skills across the board. Additionally, the

preceding research's findings indicated that further interventional programs are required to boost NI competence and better satisfaction is the key competencies of the nursing field

Recommendations:

The findings of the current research indicated that in order to enhance nurses' NI competency, especially in the field of information management skills, professional nurses, decision-makers, healthcare assistants, and governments of healthcare situations should:

- Developing training programs with the assistance of informatics' experts for nurses and other health workers can take inspiration from the training procedure employed in this program.

- Since nursing programs are in the ideal condition to foster NI competence in future nurses, it is crucial to improve collaboration and engagement between universities and healthcare settings for preparing future nurses to manage HIT and practical requirements efficiently by incorporating NI competence into nursing curriculum and employing integrated courses to enhance nursing students' NI competence.

- It is also advised to conduct more in-depth studies to examine NI competence in healthcare and assess the efficacy of various strategies and approaches to improve NI competence among nurses.

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