Original Article

Evaluating informatics competency of hemodialysis nurses: A longitudinal study

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ABSTRACT

Background & Aim: The complexity of chronic kidney disease care necessitates multidisciplinary coordination, making it susceptible to care fragmentation. Electronic Health Records are strategic tools for integrating this care, but their effectiveness depends on the informatics competency of their users, mainly nurses. This study aimed to determine and compare the level of nurses' self-reported informatics competency before and after the deployment of specialized dialysis software in centers affiliated with Tehran University of Medical Sciences.

Materials & Methods: This longitudinal study was conducted in 2024 using a census sample of 51 nurses across seven hemodialysis centers. The standard Persian version of the Nursing Informatics Competency Assessment Tool was administered before and at least one month after software implementation. Data were analyzed using descriptive statistics, the McNemar Test, and the Paired Samples t-test.

Results: A statistically significant positive shift in nurses' categorical competency status (Sufficient vs. Insufficient) was confirmed by the McNemar test (p=.039). Specifically, 8 nurses shifted from Insufficient to Sufficient status post-implementation. Paired Samples t-tests on the subscales revealed a significant improvement in Information Literacy (mean difference: 5.02; p=.001) and Information Management Skills (mean difference: 3.10; p=.003). However, the change in Computer Literacy scores was not statistically significant (mean difference: 1.67; p=.117).

Conclusion: Direct, sustained, hands-on experience with electronic health records systems improves nurses' informatics competency, particularly in information literacy and information management, even without formal curricular education. This study highlights practice-based learning as an effective and viable strategy for cultivating essential informatics skills in technology-driven clinical environments.

Introduction

Chronic Kidney Disease (CKD) and its progression to End-Stage Renal Disease (ESRD) present a significant global public health challenge (1). At ESRD, the kidneys are no longer able to perform their vital functions (2). The patient's survival depends on the initiation of renal replacement therapies (RRT), which include hemodialysis (HD), peritoneal dialysis, and kidney transplantation (3). Hemodialysis is the most prevalent form of renal replacement therapy (4), requires nursing professionals to work in a highly complex and technical environment, where the quality of care is directly linked to patient outcomes (5). The interdisciplinary nature of ESRD care often leads to "care fragmentation," where crucial patient information becomes scattered across multiple systems and providers, inhibiting the development of integrated and coordinated healthcare models (6). This fragmentation leads to reduced coordination in the provision of healthcare services, the repetition of unnecessary tests and diagnostic procedures, an increase in treatment costs, and a decrease quality of patient care. (7). Therefore, access to comprehensive, continuous health records is essential for optimal patient management (8).

Electronic Health Records (EHRs) and Health Information Technologies (HIT)

are strategic tools designed to mitigate fragmentation by providing a digital, integrated view of a patient's history (9). However, the success of such systems does not lie exclusively with technological progress; instead, it is strongly dependent on human factors, most notably the informatics competency of nurses, who are the primary users of such systems (10, 11).

Nursing Informatics Competencies (NIC) are defined as "an acceptable level of knowledge, skill, and ability to perform specific informatics tasks" (12). These are broadly classified into three core domains: computer literacy, information literacy, and information management skills (13, 14). Attainment of these competencies is an essential prerequisite for nurses to take advantage of EHRs and HITs in providing safe, high-quality, and evidence-based care in today's technology-driven healthcare setting (15-17). However, Studies have shown that many nurses lack the necessary preparation and skills to enter technology-rich environments and effectively use HIT (18). This lack of competence is mainly due to weak nursing education programs in the field of informatics(19, 20). Factors such as a shortage of specialized faculty and the absence of formal training for nurses who graduated before the widespread adoption of digital technologies in healthcare have exacerbated this problem (21). In Iran, nurses who graduated before 2010 received no formal training in this area, and students after 2011 have only taken a single, limited course on the subject. While basic computer skills may be taught in this course, the limited nursing curriculum does not allow for training in the other two areas of Nursing Informatics (NI) (22). Therefore, assessing NI competencies is a crucial first step for developing educational programs tailored to the individual needs of nurses, preparing the workforce, and optimizing the use of EHRs (23, 24).

Tehran University of Medical Sciences (TUMS) has pioneered a strategic organizational transition from paper-based to electronic records in its hemodialysis centers through the implementation of the specialized DiaSys software. DiaSys is a comprehensive operational system designed to gather, store, process, and visualize patient information across the dialysis center, covering essential services from medical records, treatment history, and nursing reports to allergies, laboratories, vascular access, dialysis sessions, hospitalization, visits, inventory management, task management, and scheduling. In adherence to intellectual property rights and with the express permission of the software developers, the information regarding the Diasys software, accessible via the link and QR code provided below (Figure 1) has been adapted from the official website and is presented here with necessary elucidations:

"Diasys" is a comprehensive dialysis information management system designed with an Information Technology (IT) utilization approach. Beyond mere data entry, the system incorporates data analysis modules specifically engineered for clinical application. To provide a more precise analysis of the relationship between this system and Nursing Informatics Competency (NIC), the capabilities of Diasys can be directly mapped onto the three dimensions of NIC as defined by the global TIGER framework. This alignment demonstrates the necessity of each competency level for successful interaction with the system.

1. Diasys and computer literacy (Basic level)

This dimension refers to the fundamental skills required for interaction with any computing system. Despite its specialized design, Diasys is fundamentally a computer program, and its utilization requires basic competencies.

- *User interface interaction:* Nurses must possess the ability to log in to the system, navigate between various menus and sections (e.g., patient files, medical history, dialysis sessions), and utilize graphical elements such as buttons and data entry fields. These skills serve as clear manifestations of computer literacy.

- *Data entry:* Recording initial patient information, vital signs, and nursing notes requires proficiency in using a keyboard and mouse. Without this foundational ability, the documentation process, which constitutes the

cornerstone of working with Electronic Health Records (EHR), is compromised. Consequently, computer literacy is considered an absolute prerequisite and the entry point for utilizing Diasys.

2. Diasys and information literacy (Applied level)

• *Targeted search and retrieval:* A competent nurse does not utilize Diasys solely for data entry but leverages it to retrieve key information, such as previous laboratory results, trends in patient weight changes between dialysis sessions, or vascular access history.

• *Data evaluation and interpretation:* Features such as the "Dialysis Management Dashboard" and "Combined and Analytical Reports" allow nurses to transcend raw data and identify patterns. For instance, a nurse with high information literacy can detect the need to revise a treatment plan by observing an upward trend in a patient's blood pressure over several sessions. This ability extends beyond recording a number and demonstrates data-driven critical thinking.

3. Diasys and information management skills (Advanced level)

This dimension represents the highest level of competency in the clinical environment, referring to the nurse's ability to utilize EHRs seamlessly to manage the entire care process, ensure data quality, and support clinical decision-making. Diasys directly engages these skills:

• *Clinical process management:* Processes such as the "complete registration of a dialysis session" in Diasys constitute complex managerial activities. The nurse must record dialysis machine data, prescribed medications, performed interventions, and patient status in an integrated and standardized manner. This constitutes active information management to guarantee the continuity and safety of care.

• *Standardization and data quality:* The correct use of sections such as "Vascular Access Management" or "Medication Management" with predefined options assists nurses in using standard terminology and enhancing the quality of recorded data. This is vital for subsequent analyses and clinical research.

• *Decision support:* A nurse with advanced information management skills utilizes Diasys as a Clinical Decision Support (CDS) tool. By observing system alerts (e.g., regarding drug interactions) or analyzing reports, the nurse makes more informed decisions, transforming from a passive user into an active and intelligent system operator (25).

The effectiveness of this specialized software is critically dependent on nurses, who are the primary clinical team responsible for executing and documenting patient responses, making their data entry the fundamental input for all subsequent clinical judgment within the system. Therefore, assessing the informatics competency of these primary users is essential for maximizing the system's efficacy. Capitalizing on this unique policy deployment, our study was designed as an observational, single-group, longitudinal assessment. The innovation of this research lies in its focus on evaluating competency changes derived from sustained, practice-based learning within a real-world clinical workflow, rather than assessing the impact of a separate training intervention. The primary objective was to rigorously compare the self-reported informatics competency of hemodialysis nurses at two distinct time points: before and after the sustained use of the DiaSys EHR system. The goal is to provide robust evidence on the magnitude and nature of competency change associated with direct exposure to a specialized EHR, thereby guiding future policy and interventions aimed at enhancing patient safety and quality of care.

Figure 1. QR code of DiaSys
https://idiasys.com/

Methods

This study was designed and executed as an observational, single-group, longitudinal study to evaluate the change in informatics competency of nurses over time and is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. The study protocol received official ethical approval from the Research Ethics Committee of the Faculty of Nursing and Midwifery and the Faculty of Rehabilitation, Tehran University of Medical Sciences (Approval code: IR.TUMS.FNM.REC.1403.010). All participants provided informed written consent, and their data were kept confidential through anonymization and coding.

The study was conducted in 2024 across the seven hemodialysis centers affiliated with TUMS, where the DiaSys system was exclusively implemented. A census method was utilized to include all 51 eligible nurses (N=51) working in these centers, as the system deployment was limited exclusively to these specific units. It is important to note that the research team maintained a strictly observer role; the DiaSys system implementation, including training and orientation, was managed solely by the system developers. To ensure proficiency in utilizing the new electronic health record system (DiaSiS), all nursing staff underwent a dedicated training program conducted via two distinct modalities:

- *Developer-led Training:* Eligible nurses received comprehensive instruction directly from the DiaSiS development team to ensure full familiarity with the software's functionality and user interface.

- *Peer-to-Peer Training:* Nurses unable to attend the formal sessions acquired the necessary operational skills and knowledge through colleagues who had previously completed the developer-led training.

The standard Persian version of the Nursing Informatics Competency Assessment Tool (NICAT) was used for data collection. This self-assessment instrument measures competency across three core subscales: Computer Literacy (10 items), Information Literacy (13 items), and Information Management Skills (7 items), using a 5-point Likert scale. The total possible score ranges from 30 to 150. Based on established criteria, competency levels were classified as: Not Competent (30), Low Competent (31-59), Competent (60-89), High Competent (90-119), and Expert (120-150) (24). The psychometric properties of the NICAT, including the high internal consistency of the Persian version (α=0.95 reported by Jouparinejad et al., 2020), have been affirmed (25).

The NICAT questionnaire was administered at two distinct time points: Time 1, administered immediately before the implementation of the DiaSys system, and Time 2, administered at least one month following initial system deployment and active use of DiaSys. To ensure that the assessment reflected established competency rather than the initial learning curve, a minimum of one month of active system interaction was set as the eligibility criterion for the post-implementation survey. Participants completed the paper-based format independently at both time points.

Data were analyzed using SPSS 25 statistical software. Descriptive statistics, including Mean (M) and Standard Deviation (SD), were used to summarize demographic and competency scores. Analytical tests included the Paired Samples t-test to compare

the mean scores of the three subscales (Computer Literacy, Information Literacy, and Information Management Skills) between the two time points. Furthermore, to assess the statistical significance of the change in categorical competency status, the total scores were dichotomized into 'Insufficient' (<60) and ' Sufficient ' (≥60). This dichotomization is based on the scale's design, where a score of 60 represents the threshold for 'Competent' status. The McNemar Test was applied to analyze the resulting change in frequency distribution. The statistical significance level was set at α=0.05.

Results

The study cohort consisted of 51 nurses. The sample was predominantly composed of female staff nurses (86.3%) holding a Bachelor of Science in Nursing. A key characteristic of the participants was their extensive overall nursing experience, which contrasted with their relatively limited specialized experience within dialysis centers, where a majority (60.8%) had worked for less than five years (Table 1).

The cohort demonstrated substantial technological readiness, with 86.3% reporting prior experience with Hospital Information Systems (HIS) or Electronic Health Records (EHR). Crucially, concerning the specific software under evaluation, the participants reported a mean duration of 'DiaSys' usage of 10.19 months (SD ± 2.93). This relatively narrow standard deviation suggests a homogeneous level of exposure across the sample. Furthermore, a utilization period of approximately ten months indicates that the users had surpassed the initial learning curve and reached a phase of stabilization. Consequently, their feedback reflects informed and sustained interaction with the system, minimizing the potential bias of the "novelty effect" often seen in short-term technology implementations.

Table 1. Demographic and professional characteristics of study participants (N=51)

Characteristic	Description
Gender	Female: 44 (86.3%)
	Male: 7 (13.7%)
Age (years)	Mean ± SD: 38.94 ± 8.78
Overall nursing experience (years)	< 5 years: 6 (11.8%)
	5-10 years: 15 (29.4%)
	11-15 years: 6 (11.8%)
	16-20 years: 12 (23.5%)
	≥21 years: 12 (23.5%)
Dialysis center experience (Years)	< 5 years: 31 (60.8%)
	5-10 years: 11 (21.6%)
	11-15 years: 4 (7.8%)
	16-20 years: 1 (2.0%)
	≥21 years: 4 (7.8%)
Organizational position	Staff Nurses: 44 (86.3%)
	Head Nurses: 7 (13.7%)
Shift work	Morning/Evening shifts: 32 (62.7%)
	Night shifts: 8 (15.7%)
	Rotating: 11 (21.6%)
Education level	Bachelor of Science in Nursing: 48 (94.1%)
	Master of Science in Nursing: 3 (5.9%)
Prior system experience	Previous Experience with HIS or EHR systems: 44 (86.3%)
	Participation in informatics workshops (past year): 3 (5.9%)
Duration of DiaSys use (Months)	Mean ± SD: 10.19 ± 2.93

Analysis of the nurses' self-reported informatics competency levels, based on the NICAT scale (Table 2 & Figure 2), showed a distinct positive shift in the frequency distribution following the implementation and utilization of the DiaSys software.

Before the DiaSys implementation, the nurses' competency was primarily clustered in the "High Competent" (4) (45.1%, n=23) and "Competent" (3) (33.3%, n=17) levels. The "Not Competent" (1) level had zero frequency. A combined majority of 78.4% (n=40) were at the Competent level or higher. Only 17.6% (n=9) perceived themselves as Low Competent (2), and a negligible 3.9% (n=2) considered themselves Expert (5).

Following the DiaSys implementation, there was a clear improvement in self-reported nursing informatics competency. The highest frequency shifted to the "Competent" (3) level, which now accounted for the largest group (45.1%) (n=23). However, the most significant change was the reduction in the lowest competency groups and the growth in the highest. The number of nurses in the Low Competent (2) level decreased dramatically from 17.6% (n=9) to 3.9% (n=2). Conversely, the number of nurses who rated themselves as Expert (5) increased substantially from 3.9% (n=2) to 17.6% (n=9). Importantly, the data suggest a generalized upward movement across the competency spectrum. Specifically,

the sharp decline in the lowest group (2) and the substantial growth in the highest group (5) indicate that the training and practical work with DiaSys provided the necessary impetus for nurses to potentially transition to the next higher self-reported competency level, affecting both initial low-skill and high-skill clusters. The proportion of nurses in the two highest levels (High Competent and Expert) collectively increased from 49.0% before the DiaSys implementation to 50.9% after the DiaSys implementation. This pattern indicates that the implementation of the EHR system effectively increased the nursing informatics competency of participants.

Table 2. Comparative Frequency Distribution of Nursing Informatics Competency Scores before and after the implementation of DiaSys (N=51)

Score Level	Nursing informatics competency pre		Nursing informatics competency post	
	Frequency	**Valid Percent**	**Frequency**	**Valid Percent**
1	0	0	0	0
2	9	17.6	2	3.9
3	17	33.3	23	45.1
4	23	45.1	17	33.3
5	2	3.9	9	17.6
Total	51	100.0	51	100.0

Note: Since the number of missing cases in both phases is zero, the Percent and Valid Percent are identical, and only the Valid Percent is included in the final table.
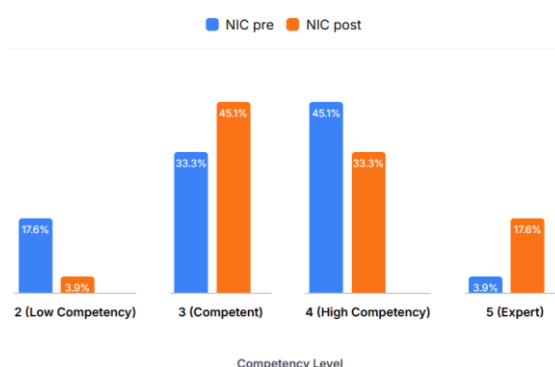

Figure 2. Comparative frequency distribution of Nursing informatics competency scores before and after the implementation of DiaSys (N=51)

To examine the statistical significance of this positive shift in competency status, the McNemar test was employed on the paired data (N=51) after dichotomizing the total scores into 'Sufficient' (Score≥60) and 'Insufficient' (Score<60). This classification means the 'Insufficient ' group includes the lowest two levels of the 5-point scale (levels 1 and 2), while the 'Sufficient' group encompasses levels 3 (Competent) to 5 (Expert). The results (Table 3) indicated a statistically significant change in the competency distribution from before

implementation to after implementation of DiaSys (Exact Sig. (2-tailed) =0.039).

Crosstabulation confirmed a predominantly positive change: 8 nurses transitioned from the 'Insufficient ' status to the 'Sufficient' status, compared to only 1 nurse moving in the opposite direction, thus confirming the effectiveness of the practical experience with the DiaSys software in enhancing nurses' overall informatics competency level.

Table 3. McNemar test results for the change in categorical competency status (sufficient vs. insufficient) before- and after-implementation

NIC Pre	Sufficient	Insufficient
Sufficient	41	1
Insufficient	8	1
Total	49	2

Test statistics[a]	
	NIC Pre & NIC Post
N	51
Exact Sig. (2-tailed)	.039[b]
a. McNemar Test	
b. Binomial distribution used.	

Detailed analysis of the three nursing informatics competency subscales revealed a more nuanced picture of how nurses perceive their own skills in different areas (Table 4).

Computer literacy: The mean self-assessed score increased slightly from 32.29 before the implementation of DiaSys, which is in the "competent" range. It increased slightly to 33.96 after, though this change was not statistically significant (p=0.117). Nurses

placed themselves in the "highly competent" range for this domain after the implementation.

Information literacy: The mean self-assessed score was 32.88 before the implementation, placing nurses in the "competent" range. It showed a statistically significant increase to 37.90 (p=0.001), indicating a statistically significant improvement in self-reported skills. After the implementation, nurses placed themselves in the "highly competent" range for this domain.

Information management: The mean self-assessed score was 20.11 before the implementation, which is in the "competent" range. It increased significantly to 23.21 after (p=0.003), demonstrating a statistically significant rise in the nurses' self-perception of their advanced information management skills. After the implementation, they placed themselves in the "highly competent" range for this domain.

Table 4. Comparison of mean informatics competency scores of hemodialysis nurses before and after DiaSys deployment

Competency subscale	Mean Before deployment (SD)	Mean After deployment (SD)	Mean difference	t-value	p-value	Result
Computer literacy	32.29 (9.45)	33.96 (9.34)	1.67	-1.594	0.117	No significant difference
Information literacy	32.88 (9.16)	37.90 (8.82)	5.02	-3.587	0.001	Significant increase
Information management skills	20.11 (6.32)	23.21 (5.99)	3.10	-3.155	0.003	Significant increase

Discussion

The primary objective of this longitudinal study was to evaluate whether direct and continuous exposure of hemodialysis nurses to a specialized Electronic Health Record (DiaSys), following an initial, non-academic orientation provided by the system designers, could, in the absence of formal academic instruction, lead to an enhancement in their self-reported informatics competency. The findings confirm the research hypothesis, providing robust evidence supporting the effectiveness of Practice-Based Learning (PBL) within the clinical environment. This principle of practice-based learning, where skills are acquired through direct engagement in a real-world setting, is a consistent theme across various studies in healthcare education. For instance, a study in Spain on the training of

healthcare support workers found that "practice-based learning and the dual training mode in core competences are complementary and indispensable elements of the training process."(26). This aligns with our results, which showed that continuous exposure to a specialized electronic health record (EHR) significantly enhanced nurses' information literacy (p=0.001), information management skills (p=0.003). also, competency was categorized into 'Sufficient' (Score≥60) and 'Insufficient' (Score <60). The McNemar test, applied to this paired data (N=51), confirmed a statistically significant shift in competency distribution from pre- to post-implementation (p=0.039). Specifically, the crosstabulation demonstrated a strong positive migration: 8 nurses transitioned from the 'Insufficient' status to the 'Sufficient' status, compared to only 1 nurse moving in the opposite direction. This

significant shift confirms that the observed change towards the 'Sufficient' competency status is highly unlikely to have occurred by chance, indicating the effectiveness of practical experience with the DiaSys software in enhancing nurses' overall informatics competency level. The DiaSys system transcends a mere documentation tool; it has evolved into an active and continuous learning instrument. The only subscale that did not show a significant change was computer literacy (p=0.117).

Detailed analysis of the three subscale scores, conducted using paired t-tests for dependent samples, provides a more nuanced picture of the mechanism driving the overall changes:

One of the most salient outcomes of the current study was a statistically significant enhancement in nurses' perceived information literacy competence (p=0.001). Information literacy, defined as the ability to identify information needs, conduct systematic searches, critically evaluate the quality of evidence, and ethically apply it in evidence-based care (27), is considered a vital prerequisite for providing coordinated care in complex chronic diseases such as renal failure. It appears that the functional nature of the DiaSys system, by necessitating nurses to analyze and interpret complex clinical data (including laboratory trends, vascular access status, and records of previous dialysis sessions), has provided the necessary foundation for the practical reinforcement of this competence. This aligns directly with the study's fundamental objective of countering care fragmentation, as a nurse's capacity to synthesize and analyze fragmented data constitutes the core of care integration.

However, a precise interpretation of this finding faces a fundamental question: Does the significant increase in information literacy scores reflect an improvement across all dimensions of this construct, or does it merely indicate an improvement in "System Usership" and an increase in nurses' self-confidence in utilizing in-system data? Given that self-report tools primarily reflect individuals' subjective perceptions of their abilities, a definitive answer to this question and the differentiation

between general information literacy and system-specific skills requires the utilization of objective measures and the assessment of actual performance in the clinical setting to complement self-reporting instruments.

Information Management Skill is characterized as a high-level, applied competence that extends beyond mere technical interaction with systems. This competence encompasses the ability to utilize EHR for standardized documentation, integrated patient data management, and clinical decision support. Crucially, by enabling nurses to adapt and customize tools to overcome technological barriers and facilitate patient-centered care, this skill transforms the nurse from a passive user into an active and intelligent agent within the healthcare system (28). The results of the current study indicate a statistically significant increase in Perceived Information Management Skills scores (p=0.003). While the findings demonstrate a significant improvement in nurses' self-reported informatics competency, particularly in Information Management skills, these results warrant cautious interpretation. Self-assessment tools primarily measure "perceived competence" rather than "actual proficiency." Cognitive biases, such as the Dunning-Kruger effect, suggest that individuals with lower objective skills may inadvertently overestimate their competence due to a lack of metacognitive awareness regarding the complexity of the task (29). However, within the context of this longitudinal study, the participants' sustained engagement with the DiaSys system over a ten-month period serves as a mitigating factor against this bias. Unlike novice users who might exhibit an "illusion of competence," the significant rise in post-implementation scores likely reflects a transition towards "experience-based self-efficacy." Nevertheless, to definitively distinguish between the enhancement of actual technical skills and merely increased user confidence, future research should complement self-reports with objective, performance-based evaluations.

Computer Literacy Competency: The lack of a significant change in this subscale (p=0.117) is, in fact, an expected and

confirming finding. The baseline mean score in this subscale, prior to system deployment, already indicated that the nurses were operating in the 'high competency' range. Therefore, the lack of change can be interpreted as a Ceiling Effect in the NICAT self-assessment tool within this specific population, meaning the nurses already possessed the foundational skills required for general software operation, and the specialized DiaSys implementation was not aimed at improving these basic competencies but rather provided a platform for applying these skills in a specialized context.

Our findings align with previous studies but introduce a key difference. Jouparinejad et al. (2020) in Iran also showed that a three-day workshop could elevate the competency level of critical care nurses from "competent" to "proficient," with the most significant improvement occurring in the domain of information literacy (22). The present study takes this finding a step further, demonstrating that this competency enhancement is achievable not only through a separate educational workshop but also through the integration of a practical tool into daily work processes. compulsory use during actual clinical workflow (Work-Integrated Learning), rather than a separate workshop or simulated environment. This distinction strongly reinforces the concept that "the EHR system itself is the hidden teacher." Furthermore, the results of this research confirm the findings of Choi's (2021) study, which emphasized the effectiveness of working with a simulated electronic record in learning complex informatics concepts, within a real and high-pressure clinical environment (30). This consistency indicates that practice-based learning and the use of real or simulated tools are effective strategies for enhancing specialized informatics competencies. The "practice-based learning" approach in our study transformed abstract concepts, such as data trend analysis, into concrete, immediate clinical tasks, effectively making the DiaSys software a "cognitive bridge" between informatics principles and patient care. This process creates a continuous, necessity-driven learning cycle that is more effective than one-time theoretical training.

However, the crucial distinction of the current research is that the competency enhancement resulted from compulsory use during actual clinical workflow (Work-Integrated Learning), rather than a separate workshop or simulated environment. This distinction strongly reinforces the concept that "the EHR system itself is the hidden teacher."

Conclusion

Ultimately, the findings of this study indicate that the path to enhancing informatics competency is not a one-way street from training to practice, but a dynamic cycle in which practical tools themselves become the most powerful teachers. The most effective and sustainable way to build informatics competency is to integrate learning into the clinical workflow. This means that investing in a high-quality, user-friendly electronic health record is, in itself, a strategic investment in human resource education and empowerment. A well-designed information system can act as a "silent educator" that continuously challenges nurses to think critically and use data during their work. This highlights the critical importance of user-centered design in health technologies; a system that is intuitive and supports clinical thought processes will naturally enhance the competency of its users.

For the successful implementation of any new technology, a two-phase approach is recommended. The first phase involves a quick assessment and, if necessary, a brief retraining to ensure the presence of fundamental computer skills. The second phase, which should be the main focus, involves practical and contextualized training within the new system, focusing on clinical workflows, problem-solving, and decision-making, rather than merely teaching "how to click buttons."

Limitations of the study

This research employed a census sampling method and was conducted exclusively in hemodialysis centers affiliated with Tehran University of Medical Sciences. Consequently, the findings may not be directly generalizable to other healthcare settings with different conditions, technological infrastructures, or cultural contexts.

Additionally, a primary limitation of this study is the exclusive reliance on a self-reporting instrument to assess nursing informatics competency. This methodological constraint may introduce social desirability bias, as participants often tend to overrate their proficiency. Therefore, relying solely on self-perception is inadequate for effective human resource management and evaluation systems. To ensure accuracy, future assessments should adopt a 360-degree evaluation approach, combining self-reported data with objective measures to overcome the subjective limitations of self-assessment tools.

Future research suggestions

To expand and deepen the findings of the present study and address its limitations, future research can focus on several key areas. Firstly, conducting research in multiple healthcare centers with larger sample sizes is essential to enhance the generalizability of findings to other healthcare environments.

Additionally, comparative studies can assess the informatics competency of nurses in different clinical departments (e.g., hemodialysis versus intensive care) or compare the impact of various Electronic Health Record (EHR) systems on this competency. Furthermore, longitudinal studies are crucial for evaluating the sustainability of increased informatics competency after the implementation of new systems and examining its long-term impact on patient outcomes and quality of care. Finally, future research should directly examine the impact of informatics competency on clinical outcomes (e.g., reduction in errors and enhancement of patient safety) as well as on the quality of data and electronic documentation within EHR systems. Collectively, these suggestions will significantly contribute to enriching knowledge in the field of nursing informatics and providing practical solutions for developing the nursing workforce in the digital age.

Conflict of interest

The authors declare that they have no competing interests. The work presented in this paper was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AI statement

The authors confirm that generative AI, specifically the Gemini model, was used to assist in the paraphrasing, editing, and translation of the manuscript to ensure academic integrity, clarity, and adherence to journal guidelines. The AI's role was strictly limited to refining the language and presentation of the authors' original work and data.

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