Research Article

Nurses' Technological Competency as Caring for Persons with End-Stage Renal Disease Receiving Hemodialysis in China and Related Factors

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Abstract

***Objective**: This study examines the nurses' practice of technological competency as caring persons with end-stage renal disease (ESRD) receiving hemodialysis and the relationship between nurses' practice of technological competency as caring and related factors. The study was based on Locsin's Theory of Technological Competency as Caring in Nursing (TCCN). **Methods**: A descriptive correlational cross-sectional design is used in this study to investigate hemodialysis nurses in Guizhou, China. WeChat and Questionnaire Star were used to collect data. The tools used in the study included the Practice of Technological Competency as Caring in Nursing Instrument (P-TCCNI), the Influence of Technology Questionnaire (ITQ), and a demographic data questionnaire. The content validity index (CVI) of P-TCCNI and ITQ was 1.00 and 0.94, respectively. The Cronbach's alpha coefficient of P-TCCNI and ITQ was 0.8 for both, respectively. The data was collected in the tertiary hospitals in Guizhou province from October to December 2024. Altogether, 180 nurses were recruited for the study. Data was analyzed using SPSS 26 software. **Results**: The results showed that the total score of nurses' practice of technological competency as caring in nursing was high (M = 89.42, SD = 14.92). A significant relationship was found between nurses' practice of technological competency as caring in nursing and the influence of technology factor (r = 0.21, p = .003). There was no significant relationship between nurses' practice of technological competency as caring for persons with ESRD receiving hemodialysis and nurses' demographic factors (age, education level, total years of work experience, hemodialysis-specific work experience, specialized education and training, and workload). **Conclusion**: This study underscores the importance of influence of technology on nurses' technological competency as caring for persons with ERSD receiving hemodialysis. Hospital institutions are encouraged to enhance nurses' attitudes toward technologies in healthcare to increase the nurses' technological competency in human caring.*

Keywords: nurses; technological competency; caring; end-stage renal; hemodialysis

Significance of the Problem

A serious type of chronic kidney disease (CKD) that affects people all over the world is end-stage renal disease (ESRD). Despite improvements in dialysis care, patients with end-stage renal disease (ESRD) have significant death rates; even with prompt hemodialysis, 20-50% of patients die within 24 months.[1] Patients with ESRD require hemodialysis (HD), a process that purifies the blood with a dialyzer reprocessing machine; however, this treatment requires constant patient monitoring to be effective. This procedure not only guarantees the standard of treatment throughout each session but also aids in reducing non-physiological occurrences, thus protecting patients and medical staff.[2]

In hemodialysis facilities, nurses are essential to the patient's care. They have a major impact on patient outcomes by skilfully combining technical expertise with kind and patient-centered care. Dialysis nurse-patient relationships are marked by extended, close-knit exchanges that promote empathy and trust. Since interpersonal care is essential to the long-term health of patients receiving hemodialysis, the dialysis nurses' skill set goes beyond technical competency.[3] Technical knowledge alone, however, is not enough to achieve technological competency in nursing care, as enhancing knowledge, attitudes, and skills is part of a continuous process.[4] Technological competency as caring is significant in nursing. Locsin[5] described technological competency as caring is the ability of nurses to effectively use healthcare technology while maintaining a caring and holistic approach to patients.

The literature indicates that nurses' practice of technological competency as caring in nursing has been examined in studies conducted in Bangladesh[6], Japan[7], and China8. A study conducted in Bangladesh found that nurses' practice of technological competency as caring in nursing was significantly associated with self-awareness (r = 0.42, p < 0.01), but showed no significant associations with age, level of nursing education, length of work experience, or continuing education and training.6 Another study in Japan found that nurses with ten or more years of clinical experience demonstrated significantly higher levels of technological competency as caring in nursing compared to those with less than ten years of experience.[7]

In addition, a study in China identified professional values as a significant predictor of nurses' practice of technological competency as caring in nursing (β = 0.41, p = 0.00), whereas age, work experience, education level, and the influence of technology were not significant predictors.[8] The influence of technology reflects nurses' attitudes toward technology.[9] However, previous studies were conducted among nurses working in intensive care units.[6-8] There is limited understanding of nurses' technological competency as caring for persons with end-stage renal disease (ESRD) in hemodialysis units and the factors associated with it. To provide valuable insights for enhancing nursing practice in this specialized field, this study aims to investigate nurses' technological competency as caring for persons with ESRD receiving hemodialysis. Demographic factors and the influence of the technology factor were selected for examination in this study

Research Questions

1. What is the nurses' practice of technological competency as caring for persons with ESRD receiving hemodialysis in China?

2. Are there relationships between the nurses' practice of technological competency as caring for persons with ESRD receiving hemodialysis and related factors such as demographic factors (age, education level, total years of work experience, hemodialysis-specific work experience, specialized education and training, and workload), and the influence of technology factor?

Objectives

1. To examine the nurses' practice of technological competency as caring for persons with ESRD receiving hemodialysis in China.

2. To examine the relationships between the nurses' practice of technological competency as caring for persons with ESRD receiving hemodialysis and related factors such as demographic factors (age, education level, total years of work experience, hemodialysis-specific work experience, specialized education and training, and workload), and the influence of technology factor.

Research Design

A descriptive correlational cross-sectional design is the research design of this study. The study was conducted at the Hemodialysis Department of Tertiary hospitals of Guizhou Province of China.

Research hypothesis

There is a significant relationship between the practice of technological competency and related factors such as demographic factors (age, education level, total years of work experience, hemodialysis-specific work experience, specialized education and training, and workload) and the influence of technology factor

Conceptual framework

Locsin's Theory of Technological Competency as Caring in Nursing (TCCN)[5], which stresses the use of technology in nursing care, serves as the foundation for the present study. Instead of treating patients as objects to be controlled, TCCN views technology as a tool to acknowledge them as people who actively participate in the care process. This theory rests on five assumptions: 1) Persons are caring by virtue of their humanness; 2) The ideal of wholeness is a perspective of unity; 3) knowing people is a multidimensional process; 4) Technologies of health and nursing are elements for caring; and 5) Nursing as a discipline and a professional practice.[9] The framework also highlights several factors from the literature review that may affect hemodialysis unit nurses' technological ability and caring. These factors include 1) demographics and 2) the influence of technology. Demographic factors consist of age, education level, total years of work experience, hemodialysis-specific work experience, specialized education and training on renal failure and using hemodialysis machines, and workload. The influence of the technology factor refers to nurses' views and attitudes about the benefits and barriers of technology that can influence nurses' caring.

Methods

Population and sample

Population were nurses who work in hemodialysis units in the tertiary hospitals of Guizhou Province, China.

Inclusion criteria of the sample:

1) registered nurses with responsibilities for bedside nursing, and

2) work in the hemodialysis unit.

A power analysis was performed to ascertain the sample size using a standard power of 0.80 and a generally recognized significance threshold (α) of 0.05.[10] However, a more cautious impact size of 0.25 was selected for this analysis, considering the contextual variations in study sites and demographics. Even when

assumptions on the strength of the relationships under study are less positive, this choice guarantees that the sample size is sufficient. This effect size, along with the specified statistical criteria, led to an estimated sample size of 123 people. Given that online surveys typically have a low response rate (about 35%)[11] the sample was expanded to 65% of 123 which is 80. Therefore, the target online sample of the study was 203 people. To choose participants from different hemodialysis departments, convenience sampling was used, making the target population easily accessible. However, the final number of participants was 180 nurses. The response rate of online survey in the study is 88.66%.

Ethical consideration

The Prince of Songkhla University, Social and Behavioral Sciences Institutional Review Board (PSU IRB 2023 - St - Nur 051 with approved date from October 22, 2024 to October 22, 2026 and Guizhou Medical University's Affiliated Hospital granted ethical approval for the study. Participation was voluntary, and participants gave their informed consent. The confidentiality of all information was maintained, and coded IDs were used to safeguard the participants' identities.

Data collection instrument

In this study, the data were collected using self-report questionnaires, which included three tools: (1) Demographic Questionnaire (DDQ), (2) Practice of Technological Competency as Caring in Nursing Instrument (P-TCCNI)[7], and (3) Influence of Technology Questionnaire (ITQ).[8] The Practice of Technological Competency as Caring in Nursing Instrument (P-TCCNI) comprises 22 items designed to assess the nurses' practice of technological competency as caring, yielding an overall score ranging from 22 to 110. These items are classified into five sub-scales aligned with the underlying principles of the TCCN theory. The P-TCCNI is a 5-point Likert scale questionnaire (ranging from 1 = never practice to 5 = always practice). Score level of P-TCCNI is divided into three levels: low (22-51.33), moderate (51.34-80.66), and high (80.67-110).[7] The ITQ was designed to assess the nurses' views and attitudes on the influence of technology on nursing care according to the nurses' beliefs. It comprises negative (12 items) and positive (9 items) subscales. The ITQ elicits participants' responses on a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=no idea, 4=agree, 5=strongly agree). After reversing the negative items, a higher score indicates a higher level of influence of technology.[8] The P-TCCNI and ITQ were translated into Chinese and validated in the Chinese hospital context in the previous study.[7] The item-level validity (I-CVI) of PTCI and ITQ was 1.00 and 0.94, respectively.[7] A pilot study was conducted to test reliability among twenty hemodialysis nurses in a tertialy hospital in Guizhou Province, China. Cronbach's alpha coefficient was .80 for both tools.

Data collection was conducted from October 2024 to December 2024, through both the WeChat platform and Questionnaire Star. The WeChat platform is a social application widely used by Chinese people. Questionnaire Star is an application used by researchers to create and distribute the questionaires. Once, the head nurses of hemodialysis units distributed the research information and link questionnaires to participants via WeChat. After reading the consent statement, if the nurses agreed to participate, they were asked to click "Agree" to set the link to the questionnaires. The online survey took approximately 30 minutes to complete, and participants were able to complete it at their convenience

Data analysis

SPSS Version 26 was used to analyze the data. The demographic data and the nurses' practice of technological competency as caring for persons with ESRD receiving hemodialysis were analyzed by descriptive statistics, including frequency, percentage, mean (M), range, and standard deviation (SD). The

relationship between the nurses' practice of technological competency as caring for persons with ESRD receiving hemodialysis and selected factors (demographic factors and the influence of technology factor) was examined using Pearson's and Spearman's correlations. The significance level for statistical tests was set at 0.05. The assumptions of normality, homoscedasticity, and linearity were tested.

Results

Demographic data.

A total of 180 nurse participants participated in this study. The demographic data (Table 1) show that their mean age is 33.88 years (SD = 5.15), with the majority (61.7%) falling into the 31-40 age range, 85% of them are female. Only 3.3% of participants identify as Buddhist, while 96.7% are not religiously affiliated. Most participants (86.7%) are married, whereas 10% are single and 3.3% are divorced. Most participants (85%) hold a bachelor's degree, 10.6% having a diploma, and 4.4% having a master's degree. The average total work experience is 11.17 years (SD = 5.69), with the majority (41.7%) having 6-10 years, followed by 11–15 years (30%), and above 16 years (16.1%). A workforce with significant professional experience is suggested by the fact that just 12.2% of employees have less than five years of work experience. However, regarding hemodialysis unit experience, the average is 6.36 years (SD = 4.41), with 32.8% having 6 to 10 years and 53.5% having less than 5 years. Ninety-one percent of nurses have gotten special training, compared to just 8.9% who have not. Regarding workload, 23.3% of participants reported not experiencing work overload, whereas 76.7% reported experiencing it.

Table 1 Demographic Data of the Nurse Participants (N = 180)

Characteristics	Frequency	Percentage
Age years (M = 33.88, SD = 5.15, Min = 24, Max = 50)		
21-30	50	27.8
31-40	111	61.7
41-50	19	10.6
Gender		
Male	27	15.0
Female	153	85.0
Religion		
No religion	174	96.7
Buddhist	6	3.3
Marital Status		
Single	18	10
Married	156	86.7
Divorced	6	3.3
Education level		
Diploma	19	10.6
Bachelor	153	85
Masters	8	4.4
Total years of work experience in hospital (M = 11.17, SD = 5.69, Min = 2, Max = 30)		
Less than 5 years	22	12.2
6 to 10 years	75	41.7
11 to 15 years	54	30.0
16 years and above	29	16.1

Table 1 Demographic Data of the Nurse Participants (N = 180) (continue)

Characteristics	Frequency	Percentage
Hemodialysis-specific work experience (M = 6.36, SD = 4.41, Min = 1, Max = 22)		
Less than 5 years	96	53.5
6 to 10 years	59	32.8
11 to 15 years	16	8.9
16 years and above	9	5.0
Specialized education & training		
Yes	164	91.1
No	16	8.9
Workload		
Yes	138	76.7
No	42	23.3

Note. M = Mean; SD = Standard deviation; Min = Minimum; Max = Maximum

Nurses' Practice of Technological Competency as Caring for Persons with ESRD Receiving Hemodialysis.

The mean total P-TCCN score is 89.42 (SD = 14.92) at a high level, ranging from 42 to 110. Scores on the subscale "Persons are caring by virtue of their humanness" ranged from 6 to 20, with a mean of 15.45 (SD = 2.91). The subscale "The ideal of wholeness is a perspective of unity" had a higher mean score (16.56; SD = 2.77). The statement "Knowing persons is a multidimensional process" received the highest mean score (20.86; SD = 3.47). A mean score of 16.33 (SD = 3.11) was obtained for the subscale "Technologies of health and nursing are elements for caring". Finally, the mean score for "Nursing as a discipline and professional practice" was 20.22 (SD = 3.87) (Table 2).

Table 2 Nurses' Practice of Technological Competency as Caring for Persons with ERSD Receiving Hemodialysis (N = 180)

Subscales of P-TCCN[a]	Minimum to maximum scores	Range	Obtained Scores M	SD	Level
1. Persons are caring by virtue of their humanness.	4-20	6-20	15.45	2.91	
2. The ideal of wholeness is a perspective of unity.	4-20	8-20	16.56	2.77	
3. Knowing persons is a multidimensional process.	5-25	11-25	20.86	3.47	
4. Technologies of health and nursing are elements for caring.	4-20	7-20	16.33	3.11	
5. Nursing as a discipline and professional practice.	5-25	10-25	20.22	3.87	
Total	22-110	42-110	89.42	14.92	High

M = Mean, SD = Standard Deviation

[a]Practice of Technological Competency as Caring in Nursing

Relationship between Nurses' Practice of Technological Competency as Caring for Persons with ESRD Receiving Hemodialysis and Related Factors

The results in Table 3 demonstrate how several characteristics relate to the nurse' practice of technological competency as caring for persons with ESRD receiving hemodialysis. The influence of

technology (IT) and P-TCCN significantly correlated (r = .21, p = .003). Other variables that did not show statistically significant associations with P-TCCN were age (r = 11, p = .13), education level (r = .05, p = .50), total years of work experience (r = 0.14, p = .05), hemodialysis-specific work experience (r = -.045, p = .553), specialized education and training (r = -.004, p =.962), and work overload (r = .18, p = .812).

Table 3 Relationship between Nurses' Practice of Technological Competency as Caring for Persons with ESRD Receiving Hemodialysis and Selected Factors (N = 180)

Related Factors	P-TCCN[a]	
	r	*p*
Age	0.11	0.13
Education level	0.05	0.50
Total years of work experience	0.14	0.05
Hemodialysis-specific work experience	-.045	0.553
Specialized education & training	-.004	0.962
Work overload	-0.45	0.276
Influence of technology (IT)	0.21	0.003**

**. p < 0.01 (2-tailed). *. p < 0.05 (2-tailed).

[a]Practice of Technological Competency as Caring in Nursing

Discussion

The discussion is based on the two research questions.

Nurses' Practice of Technological Competency as Caring for Persons with ESRD Receiving Hemodialysis.

The results indicate that Chinese nurse participants demonstrated a high level of practice in technological competency as caring in nursing (P-TCCN) for persons with end-stage renal disease (ESRD) undergoing hemodialysis (M = 89.42, SD = 14.92). In hemodialysis therapy, a high level of P-TCCN is essential, as technology plays a critical role in monitoring, diagnosing, and treating patients with ESRD.[12] This finding is consistent with a previous study conducted in China, which reported a high level of nurses' caring practices for critically ill patients in technologically intensive environments, as measured by the P-TCCN instrument (M = 87.30, SD = 13.73).[8] Participants' high PTCCN ratings reflect the importance of technical training in hemodialysis nursing, as evidenced by 91% of participants in this study having specialized education and training, especially in the healthcare technology of hemodialysis. Nurses with higher levels of technological proficiency are better able to deliver person-centered care while effectively utilizing digital technologies, such as electronic health records and hemodialysis machines.[13] In contrast, studies suggest that nurses with limited technological competency may encounter difficulties in integrating technology with compassionate care, which can negatively affect patient outcomes and satisfaction.[14] Locsin also noted that although healthcare has been transformed by technological advancements that improve patient outcomes, accuracy, and efficiency, nurses may still face challenges in adopting new technologies while maintaining a compassionate approach to patient care.[12]

Relationship between Nurses' Practice of Technological Competency as Caring for Persons with ESRD Receiving Hemodialysis and Related Factors

The results of this study show that the P-TCCN was significantly correlated with the influence of technology factor. The substantial relationship is consistent with previous research that indicates nurses who view technology as helpful are more likely to successfully incorporate it into their work, which enhances their proficiency in technological care.[15] However, this finding is inconsistent with a study in intensive care units in China, which reported no significant relationship between the P-TCCN and the influence of technology.[8] This inconsistency may be explained by differences in clinical settings. In hemodialysis units, nurses have ongoing and repeated interactions with patients, allowing attitudes toward technology to more strongly influence technological competency as caring. In contrast, in intensive care units, the routine and intensive use of advanced technology may normalize its role, thereby reducing its perceived influence on caring practices.

In this study, P-TCCN was not significantly ass8ociated with demographic factors, including age, education level, total years of work experience, hemodialysis-specific experience, specialized education and training, or work overload. This finding is consistent with previous studies conducted in Bangladesh[6] and China.[8] These results suggest that while professional and demographic characteristics may influence technical skills in nursing, they are not the sole determinants of technological competency as caring. Although excessive workload may negatively affect nurses' capacity to deliver high-quality care[16], the lack of a significant relationship between work overload and P-TCCN indicates that nurses may continue to integrate technological competency as caring into their practice despite heavy workloads.

Conclusion

The results of this study provide significant insight into the technological competency of nurses in the context of hemodialysis care in China. The findings indicate that nurses demonstrated a high level of technological competency as caring when providing care to persons with ESRD undergoing hemodialysis. Correlation analysis revealed that the practice of technological competency as caring was significantly and positively associated with the influence of technology. However, nurses' technological competency as caring was not significantly correlated with other demographic factors, including age, educational level, total years of work experience, hemodialysis-specific work experience, specialized education and training, or workload

Limitation

Because the study focused on nurses working in haemodialysis settings, its findings might not be as applicable to other nursing specializations or healthcare settings with distinct technology requirements. Since the data were collected at a single point in time, it was not possible to evaluate changes in nurses' technological competency and caregiving practices over time.

Recommendations and implications

1. This study highlighted the influence of nurses' attitudes toward technology on their technological competency as caring. Therefore, to enhance technological competency as caring among nurses in healthcare settings, positive attitudes toward technology should be promoted.

2. Future research should explore the predictive factors that influence nurses' technological competency as caring for persons with end-stage renal disease (ESRD) undergoing hemodialysis.

Participation in article writing

Both authors contributed to writing and revising the manuscript.

Conflict of Interest

None

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References

1. Hashmi MF, Benjamin O, Lappin SL. End-Stage Renal Disease. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 Mar 8]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK499861/
2. Alcalde-Bezhold G, Alcúzar-Arroyo R, Angoso-de-Guzmán M, et al. Hemodialysis Centers Guide 2020. Nefrol Engl Ed. 2021; 41: 1-77. https://doi.org/10.1016/S2013-2514(22)00042-6
3. Jeong E. Impact on health outcomes of hemodialysis patients based on the experience level of registered nurses in the hemodialysis department: a cross-sectional analysis. Front Health Serv. 2023; 3: 1154989. DOI: 10.3389/frhs.2023.1154989
4. Krel C, Vrbnjak D, Bevc S, et al. Technological competency as caring in nursing: A description, analysis and evaluation of the theory. Slov J Public Health. 2022; 61(2): 115-23. DOI: 10.2478/sjph-2022-0016
5. Locsin RC. The co-existence of technology and caring in the Theory of Technological Competency as Caring in Nursing. J Med Investig JMI. 2017; 64(1.2): 160–4. DOI: 10.2152/jmi.64.160
6. Biswas SR, Kongsuwan W, & Matchim Y. Technological competency as caring in nursing as per ceived by ICU nurses in Bangladesh and its related factors. Songklanagarind J Nursing. 2016; 36(1): 1-20
7. Kato K, Miyagawa M, Yasuhara Y, Osaka K, Kataoka M, Ito H, & Kongsuwan W. Recognition and status of practicing technological competency as caring in nursing by nurses in ICU. Int J Nurs Clin Pract. 2017. 4: 264 https://doi.org/10.15344/2394-4978/2017/264
8. Li Y, Kongsuwan W. Predictors of nurses' caring practice for critically ill patients in critical technological environments: A cross-sectional survey study. Belitung Nurs J. 2021 Dec 6; 7(6): 476-84. doi: 10.33546/bnj.1794
9. Sabzevari S, Tayebeh M., Bagherian B, et al. Critical care nurses' attitudes about influences of technology on nursing care. Br J Med Med Res. 2015; 9(8): 1–10. DOI: 10.9734/BJMR/2015/18400
10. Polit DF, & Beck CT. Quantitative research design. Nursing research: Generating and assessing evidence for nursing practice (9th ed., pp. 217–218). Lippincott Williams & Wilkins. 2012.
11. Cook C, Heath F, & Thompson RL. A meta-analysis of response rates in web- or internet-based surveys.Educ Psychol Meas. 2000; 60(6): 821–836. https://doi.org/10.1177/00131640021970934
12. Locsin RC. The co-existence of technology and caring in the theory of technological competency as caring in nursing. J Med Invest. 2017; 64(1.2): 160–4. DOI: 10.2152/jmi.64.160

13. Cheryl F, Kathryn F. Harnessing technology to promote patient-centered care. Nurs Manag Spring house. 2015; 46(1): 14–5. DOI: 10.1097/01.NUMA.0000459044.24554.af
14. Ali S, Kleib M, Paul P, Petrovskaya O, et al. Compassionate nursing care and the use of digital health technologies: A scoping review. Int J Nurs Stud. 2022 Mar; 127: 104161. DOI: 10.1016/j.ijnurstu.2021.104161
15. Bagherian B, Sabzevari S, Mirzaei T, et al. Effects of technology on nursing care and caring attributes of a sample of Iranian critical care nurses. Intensive Crit Care Nurs. 2017 Apr; 39: 18–27. DOI: 10.1016/j.iccn.2016.08.011
16. Zhang N, Xu D, Li J, Xu Z. Effects of role overload, work engagement and perceived organisational support on nurses' job performance during the COVID-19 pandemic. J Nurs Manag. 2022; 30(4): 901–12. DOI: 10.1111/jonm.13598