Research Article

Development of an instrument to measure technological caring in nursing

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Abstract   Twenty-seven statements make up the Technological Caring Instrument (TCI) which was developed to measure technological caring in nursing. In order to establish a database and its reliability and validity, responses were generated from 193 professional nurses who participated in the study. The results indicate that the TCI has a high internal consistency, construct validity, and sufficient split-half reliability. Cronbach's alpha was 0.8129 with split-half alpha of 0.666 for 14 items in Part 1 and 0.828 for 13 items in Part 2. Significant differences were found between factors (F = 97.0199, *P* = 0.0000). Factor analysis identified eight items with the first factor revealing nine cluster statements with values of 0.51–0.84. The second factor had two cluster statements with 0.75 and 0.74 values. The independent sample *t*-test results demonstrated the influence of education, area of expertise, and years of experience on the technological caring of registered professional nurses. The utilization and continued investigation of TCI are suggested.

Key words   caring, instrument development, nursing, technology.

INTRODUCTION

Professional nursing practice occurs in various settings. The categorization of settings into two distinct areas is very well established: critical care (where patients are ministered to because of physiological demands and the high degree of intensive medical intervention and attention), and non-critical care (where the intensity of physiological and medical care requirements of patients are secondary to meticulous nursing care). The former setting is technically demanding, so much so that technologically proficient care is imperative, but it is also the place where practitioners of nursing may be perceived to be less caring. The practice of nursing in non-critical areas, although less technologically demanding, yields professional nurses who are perceived as generally practicing caring in nursing. From this perspective of caring, practicing nursing in critical care areas may

be described as the illustration of technological caring.

Technological caring is defined as the technical achievement of caring in critical care settings (Ray, 1987). It epitomizes the use of technology in nursing. As an expression of this framework, the generation of an appropriate database using reliable and valid instruments (like the Technological Caring Instrument (TCI)) facilitates the advancement of a renewed understanding of the value of technological competence/proficiency in nursing practice.

The concept of caring has been studied and described in various ways. Mayeroff (1971) described ingredients of caring behaviors to illuminate the experience of the caring phenomenon: knowing, alternating rhythms, patience, honesty, trust, humility, hope, and courage. Roach (1987) described five attributes of caring that emphasize the understanding that it is not only whether or not to care, but ultimately how caring can best be accomplished. These attributes are compassion, competence, confidence, conscience, and commitment. Including competence as an attribute raises our consciousness to the challenge of appreciating technological competence as an expression of caring in nursing. Competence is described as the expression

of having the knowledge, skill, energy, motivation, judgment, and experience necessary to respond appropriately to one's professional responsibilities (Roach, 1987). Ray's (1987) investigation of the influence of technology in caring among critical care nurses disclosed the concept of technological caring, succinctly described as 'the experience of caring in the critical care unit [that] comes as a process of growth [where] technical achievement is one of the meanings' (p. 168).

Nursing has been categorized into two major types of healthcare functions: technologically demanding, and supportive/expressive practices (Fenton, 1987). The former emphasizes technical or task-orientated functions, while the latter requires person- or care-orientated expressions constituting most of the independent functions. Various definitions of nursing emphasized the supportive/expressive functions of nursing. Although a universal definition of nursing does not yet exist, the expression of various supportive and expressive functions and perspectives of nursing are distinctly defined, affirming a practice discipline with influential roles to attain or maintain quality health care. Paterson and Zderad's (1976) 'humanistic nursing' launched a movement to define nursing as not only a 'supportive/expressive' function, but also a process of care in which the whole person is realized as an interacting human being, and 'the between' is acknowledged as the situation where the practice of nursing is lived. While Mayeroff's (1971) definition of caring as a mode of helping the other grow and while Leininger's (1975) caring as the essence of nursing instigated the phenomenal study of caring in nursing, various ways of expressing caring in nursing have since emerged. Some of these influential ways include: caring as the human mode of being (Roach, 1987) in which 'the moment' is nursing transpiring; caring as the moral ideal of nursing (Watson, 1985) in which the 'caring moment' is lived as nursing; and nursing as caring (Boykin & Schoenhofer, 1993), in which the 'caring between' is nursing. Caring has been recognized as a concept that is not unique to nursing but rather unique in nursing.

As Neighbours and Eldred (1993) pointed out, 'there is an increasing body of evidence, which indicates that nurses must be able to perform complex procedures and skills when providing nursing care. The rapid development of technology and its increased utility in health care have contributed to this phenomenon' (p. 96). Clearly, both technology and caring are integral to the valuable contribution of nursing in health care. Because caring is unique in nursing and technological competence is

an expression of that caring, the extent of technological caring as an expression of nursing can be recognized more fully by utilizing an instrument to measure technological caring. Currently, caring in nursing achieves a distinct place in the delivery of nursing, while technological proficiency is assumed to have a lesser position because of its emphasis on non-disease. The development and testing of the reliability and validity of the TCI, the coexistence of technology and caring through competence in nursing can facilitate the recognition of technological competency and technological caring as expressions of caring in nursing.

RESEARCHER'S PERSPECTIVE

Throughout their years of education and practice, professional nurses, students, and other healthcare providers have always considered and questioned the role of nurses in health care. The researcher's particular interest in this issue focused on remarks heard frequently from nurses such as 'there is no time left to care'. A predominant theme in these conversations has been the nurses' preoccupation with their inability to care for patients when various duties and responsibilities take priority over their 'nursing time'. These priorities over 'care' include, but are not limited to, the documentation and proficiency of using equipment (e.g., respirators, ventilators, and cardiac monitors). Nurses' responses to their work realities succinctly explain what nursing activities are equated to be: simply those activities that involve being physically present while personally interacting with patients in ways such as hand-holding or listening.

When nurses reach the end of their work shifts having been unable to perform these supportive/ expressive activities, a sense of uselessness pervades because they feel they have failed their patients. This situation questions whether or not caring exists when nurses must provide technological 'care' instead of more personal care, such as 'holding the patient's hands' or simply being physically present. The primacy of technological adeptness as an expression of caring in nursing requires visionary reconciliation as a concept of nursing.

While a perceived differentiation between care and caring exists, it is the intention of the researcher to clarify 'caring' and 'care'. Caring is not simply the mean physical activity of the nurse and the nursed, nor is it an emotion. Caring encompasses care. It is the expression of the cognitive process of care and the realization of the intention of care. In this context, technological caring is not technological care. The former is the technical achievement of caring, with

technological care assuming a cognitive position in its expression.

REVIEW OF LITERATURE

In their germinal study, Boykin and Schoenhofer (l990) analyzed extant theories of caring in nursing. Ontological, anthropological and ontical issues about caring in nursing were analyzed and synthesized, focusing on the theoretical and practical values of caring in nursing. While caring has been described as a mode of 'helping the other grow' (Mayeroff, 1971), the 'human mode of being' (Roach, 1987) and 'a moral ideal of nursing' (Watson, l985), it is the person in authentic presence within a nursing situation who communicates caring (Paterson & Zderad, 1988). The ontology of caring stresses the importance of authenticity, specifying caring in nursing as 'a mutual human process where the nurse responds to calls for nursing, nurturing persons as they live their hopes, dreams, and aspirations as caring persons thus enhancing personhood, a process of living grounded in caring' (S. Schoenhofer, pers. comm., 1994). The anthropological aspect of caring centered on the question, 'What is a caring person?'. Roach (1987) described the entailments of caring: having the capabilities to care, the appropriate use of these capacities, the eagerness and authenticity to answer the call of the other, doing or manifesting the ability to care, and performing the care competently. The ethical process towards competency begins when the nurse reaches a comfortable level of technical expertise to make the right decisions about the uses and applications of technology. When this comfortable level of technical competence is reached, the nurse can concentrate more fully on the needs of the patient and family (Roach, 1987). Ray (1987) found the process of value shifts in ethical and moral decision-making to be part of the maturation process in understanding the meaning of caring. These operating processes include the dominant values of the critical care nurse who believes in technology and treatment, and how the uses of technology are interpreted.

Currently, there is no instrument that measures technological caring in nursing. The development of the TCI proposes to advance inquiries into technological caring as an expression of nursing and to further the data support for the emerging understanding of technological proficiency/competency as an expression of caring in nursing. The instrument will reinforce its value as a means to know persons who live their caring values and grow in caring. As technology and caring are often perceived as dichotomous concepts which do not occur simultaneously, the researcher desires to illuminate these concepts as not at all estranged but rather coexisting within the expression of nursing.

METHODS

Developing and scoring the instrument

Data derived from the technological caring instrument (TCI) facilitate the recognition of technological caring in nursing. The TCI scale was developed to measure technological caring among licensed professional nurses who practice in various settings. Of particular interest is its anticipated ability to determine technological caring among nurses who practice in critical care areas. Because the TCI was formulated using themes of technological caring (Ray, 1987) among other expectations, it is expected to verify that these themes are indeed expressions of technological caring.

Each statement of the instrument was developed to reflect the nature of caring based on Ray's (1987) theoretical perspective of technological caring among critical care nurses. There were 27 statements that reflected technological caring. In constructing the TCI, all statements were expressed affirmatively to facilitate evaluation and analysis of data. The approach to analysis relied on the extent of agreement and disagreement by respondents toward statements in the TCI: the higher the participants agreed to the statements of the TCI, the stronger their expression of technological caring. Table 1 provides the item statements, number of respondents to the statements, means, standard deviations, t-values, F-ratios, and level of significance.

As a visual analogue scale with 87-cm spaces between end choices of 'strongly disagree' and 'strongly agree', there is an absence of forced choices which encourages respondents to freely indicate their options (Gift, 1989; Baggs, 1994). Responses of participants were quantified by measuring the distance from the left-most extreme (strongly disagree) to the intersection of the 'X' mark. These distances were entered in the computer and treated as interval scale numbers. When all the information from the retrieved copies of the questionnaire was recorded, various statistical treatments were conducted in order to determine the reliability and validity of the TCI.

Data administration and collection

Instrument development from a methodological research design was used in this study. Approvals from Human Subjects Institutional Boards were obtained and copies of the TCI were subsequently distributed.

Table 1. The technological caring instrument

Item	Item statement (variable)	No. respondents	Mean	SD	t-values	F-ratio	P
1.	When nurse's needs are met mastering the machinery, the nurse can meet other's need.	190	55.132	24.21	2.52	1.55	038*
2.	Burn-out comes when one is overwhelmed with the equipment	192	24.67	25.25	0.64	1.24	0.295
3.	It all comes down to knowing the patient and being confident in one's own knowledge. We think of more than the physical.	189	66.79	14.47	1.39	1.02	0.922
4.	Technical achievement is one of the meanings of being a nurse.	192	49.797	25.86	0.61	1.00	0.991
5.	Caring is technology. It means that we have to interpret the meaning of the monitors, the numbers, the tubes, and the lines and act on that interpretation with right judgment.	191	41.487	29.77	0.92	1.03	0.892
6.	Caring is technical competence.	189	30.83	27.13	0.4	1.17	0.446
7.	When a nurse is comfortable with technology, he/she can concentrate on the patient and the family.	191	58.84	21.25	2.36	1.34	0.168
8.	It all has to mean something—the combination of technology and touch.	189	63.074	20.04	−0.38	1.36	0.145
9.	Caring is touch, holding hands, 'pat' or touch a shoulder; just touching a person.	189	56.905	23.50	2.03	1.25	0.284
10.	Caring is attachment—emotional investment.	187	48.096	27.42	1.04	1.00	0.982
11.	Caring is bonding. Look beyond the technical and pick up the inner feelings in contact with you. As I know a patient, he or she knows me.	190	54.905	25.20	1.4	1.09	0.687
12.	Caring is meeting the inner person's fear.	188	60.13	21.14	0.96	1.06	0.770
13.	Caring is making the person feel safe.	189	67.857	12.98	0.63	1.13	0.570
14.	Caring is compassion—being there physically and emotionally.	192	70.09	11.24	1.19	2.46	0.000***
15.	You have to have a sense of humor.	188	65.399	18.07	1.13	1.08	0.710
16.	Caring is talking to persons, and his/her family.	191	69.948	13.22	1.05	1.63	0.020*
17.	Caring is comfort—relieving pain; persons see you as having the power to relieve pain.	191	64.581	17.44	1.30	1.04	0.836
18.	Caring is keeping the family informed and updated.	191	71.010	11.34	0.16	2.13	0.000***
19.	Caring is collegiality with other nurses and physicians.	190	67.247	16.50	0.85	1.13	0.553
20.	Caring is support from each other.	192	71.089	13.01	−0.60	1.13	0.565
21.	Caring is establishing rapport so you can talk to a patient or a family member.	192	72.449	11.72	0.07	1.24	0.310
22.	Caring is understanding how the patient feels.	192	71.573	13.19	0.74	1.03	0.875
23.	Caring is the trust among patients, families, nurses and physicians.	192	70.620	14.22	0.21	1.02	0.931
24.	Caring is making the right decisions.	186	60.543	23.92	0.81	1.05	0.811
25.	Caring is valuing—aggressive technical care or permission to die a peaceful death.	186	68.661	15.68	0.41	1.70	0.012*
26.	Caring is choice for patients and families.	190	66.574	18.38	−0.15	1.18	0.440
27.	Caring is economics—death so patients are off expense account.	176	19.881	24.61	−0.52	1.02	0.923

*, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

The sample was composed of 193 licensed professional nurses from critical and non-critical care settings in three selected hospitals in southeast Florida.

Two of these hospitals are non-profit, private institutions of 350–450-bed capacity, while the other is a 300-bed for-profit, private institution that is a member of a healthcare company. These three institutions were selected for accessibility, willingness to participate in nursing research, and their relationship to the host institution as clinical teaching sites. All contact persons facilitated the approval of the study through their respective Institutional Review Boards. Each submitted a list of licensed professional nurses and facilitated the distribution of the questionnaires. In two hospitals, the TCI questionnaires were included with the participants' paychecks, while in the other institution, a volunteer was instructed to place a copy in each employee's unit-assigned mailbox.

The TCI questionnaire packet contained a cover letter, demographic data sheet, the process consent form, the TCI, and a self-addressed business reply mail envelope. The cover letter explained the voluntary nature of the study and the assurance of confidentiality, while the process consent form elucidated the extent of participation. The self-addressed, business reply envelope was provided to facilitate retrieval of the documents. Six hundred three copies were distributed to all the nurses listed, with 3 weeks to provide the information and return. No specific dates for returning the copies were given, but a relative time period was prominently indicated in the process consent form. This allowed the participants to complete the forms as best they could in their own time. Follow-up telephone calls were made to respective institutional contact persons regarding questionnaire retrieval. With the success rate of questionnaires by mail between 30 and 40%, a 32% ($n = 193$) return rate was considered acceptable.

All professional nursing personnel in respective specialty areas were represented in the sample in order to approximate the general population of nursing staff. While five respondents failed to indicate their educational levels, the majority of the participants possessed associate degrees (74 = 38.3%), 17 (8.8%) had diplomas in nursing, and 59 (30.6%) had baccalaureate degrees. Because graduate education in nursing requires a bachelor's degree in nursing, the categories of 'earned credits toward MSN' (13 = 6.7%) and 'MSN' (7 = 3.6%) were combined, consequently representing 79 (40.9%) respondents with a baccalaureate degree in nursing. This combined score was used for the BSN category.

Each participant was asked to indicate their present area of expertise and the duration of experiences in this area. This was subsequently reclassified into two categories: critical care area (medicine/surgery intensive care, coronary care, telemetry, neonatal intensive care, and emergency room with a total of 79 respondents), and non-critical care area (medicine/surgery floor, psychiatric area, operating room and clinics, out-patient department and administration) with a total of 60 respondents. Twenty-three (11.9%) respondents failed to indicate their area of expertise. Duration of ex-perience in their area of expertise revealed 55 (28.5%) respondents with 6–10 years of experience, and 46 (23.8%) with 11–15 years of experience, 31 (16.1%) with 1–5 years of experience and 25 (13.0%) with 16–20 years of experience.

Construct validity and internal consistency

The TCI was evaluated for meaning and content accuracy by Marilyn Ray, who coined the phrase 'technological caring' in her earlier studies, one of which was published in 1987. She provided significant and substantive contributions, particularly in the sequencing and chronology of statements. Face validity was established by giving the TCI to two critical care nurses from another institution out of state. All items were found to be relevant and well presented; no additional items were suggested.

A frequency distribution of nurses' responses was created. As a criterion to indicate technological caring, all items with a mean score of 50% or greater indicate agreement that the statements in the TCI reveal technological caring. Of the 27 statements, 15 obtained mean scores of 43.5 cm spaces (50% of 87 cm) and higher, signifying that the respondents of the TCI considered each statement sensitive to their understanding of technological caring. Table 2 presents the item statements, loading in factor, percentage of variations, and eigenvalues.

Factor analysis and independent sample Student's t-test were used to estimate construct validity. Using the Statistical Program for the Social Sciences (SPSS), factor analysis was performed first, using principal factoring with iteration followed by orthogonal (Varimax) rotation which determines the number of factors to be extracted from the original correlation matrix, lessening investigator bias. An initial exploratory component analysis determined that eight factors had eigenvalues greater than one, which met the established criterion. The first two factors had eigenvalues greater than two with the rest of the factors explaining 67.3% of the cumulative percentage. Based on these results, a second factor analysis

Table 2. The technological caring instrument

Item #	Item statement	Loadings	% of variations	Eigenvalues
1.	When nurse's needs are met from mastering the machinery, the nurse can meet other's needs.	6.70781	24.8	7.08783
2.	Burn-out comes when one is overwhelmed with the equipment.	2.298	8.5	2.85798
3.	It all comes down to knowing the patient and being confident in one's own knowledge. We think of more than the physical.	1.35144	5.0	1.89292
4.	Technical achievement is one of the meanings of being a nurse.	1.19183	4.4	1.58056
5.	Caring is technology. It means that we have to interpret the meaning of the monitors, the numbers, the tubes, and the lines and act on that interpretation with right judgment.	0.90033	3.3	1.36559
6.	Caring is technical competence.	0.72273	2.7	1.20172
7.	When a nurse is comfortable with the technology, he/she can concentrate on the patient and family.	0.67801	2.5	1.11617
8.	It all has to mean something—the combination of technology and touch.	0.64229	2.4	1.05720

Table 3. Factor analysis. Rotated factor loading with the Varimax method

Item #	Item statement	Loading in factor	Rank	Factor coefficient
Factor 1				
21.	Caring is establishing rapport so you can talk to the patient or let a family member talk.	0.83750	1	0.92
18.	Caring is keeping the family informed and updated.	0.73039	4	0.68
22.	Caring is the trust among patients, families, nurses physicians.	0.69688	5	0.64
20.	Caring is support from each other.	0.67810	3	0.71
19.	Caring is collegiality with other nurses and physicians.	0.67582	9	0.18
26.	Caring is choice for patients and families.	0.64559	6	0.57
25.	Caring is valuing aggressive technical care or permission to die a peaceful death.	0.64166	7	0.52
22.	Caring is understanding how the patient feels.	0.60459	2	0.73
16.	Caring is talking to persons and his/her family.	0.51075	8	0.52
Factor 2				
10.	Caring is attachment—emotional investment.	0.74755	2	0.599
11.	Caring is bonding. Look beyond the technical and pick-up the inner feelings in contact with you. As I know a patient, he or she knows me.	0.73993	1	0.66

Loadings < 0.50 are omitted.

was carried out that specified four factors with factor loadings greater than one. Table 3 shows the loading in factors, rank, and factor coefficients for each item. The Varimax method of rotation converged in 13 iterations was used to maximize the correlation of items with factors (DeVellis, 1991). The aforementioned results mean that the TCI was able to cluster the statements into factors that reflect technological caring. These factors allowed the measurement of technological caring of the participants.

Second, a contrasted group approach was used and an independent sample Student's t-test was conducted. This test indicated statistically significant differences in technological caring considering variations between factors ($F = 97.0199$, $P = 0.0000$). Significant differences among the respondents' educational attainments, years of experience, places of employment, and areas of experience ($F = 2.824$, $P = 0.041$) were revealed, indicating educational attainment as the most ($F = 4.953$, $P = 0.028$).

Using Cronbach's alpha, an internal consistency coefficient of 0.812 was obtained for the total instrument. At the same time, inter-item correlations for the total instrument ranged from 0.77 to 0.92. Using the split-half coefficient, the correlation between the two halves of the instrument was 0.46. The equal length Spearman-Brown split-half coefficient was 0.63 with alpha coefficients of 0.67 for Part 1 and 0.83 for Part 2. The unequal length Spearman-Brown split-half coefficient was 0.63.

Reliability

Analysis of the scale for reliability followed the following steps: (i) determination of sample size and the method of handling missing values; (ii) retention of items based on predetermined criteria; (iii) analysis of unclassified items; and (iv) final decision to retain or delete each dimension.

Missing data presented special problems in constructing composite scores for reliability analysis. Because no single procedure is available that best handles this problem, three methods were developed and tested. A comparison was made on the effect of each scale dimension against the alpha coefficients to ascertain whether the results were method-dependent. In each case, the effect of the sample size was also considered. The decision to delete all cases with missing values was appropriated as the other option. When this was done, the information obtained had minimal effect on the alpha coefficient. A sample size of 193 without substitution of item means was chosen for the final analysis. This represented a compromise between the decrease in sample size and an acceptable number of missing values. Only 39 participants in the sample had missing values.

DISCUSSION

This study was an effort to establish reliability and validity for the TCI. Despite its high reliability, determining reliability estimates is still important whenever the instrument is used for different samples. In developing the TCI to measure technological caring, the researcher derived statements from descriptions provided by critical care nurses as studied by Ray (1987), expressed as themes of technological caring. From these themes, 27 statements were formulated to comprise the TCI. After Ray conducted content accuracy and consistency evaluations (March 1993, at Florida Atlantic University College of Nursing), revisions were done and the TCI was finalized for instrument testing. Face validity and initial testing supported construct validity, internal consistency, and split-half reliability. Construct validity was supported through the contrasted group approach suggesting that a reasonably representative collection of items was included in the TCI.

The value of using the themes of technological caring to develop the TCI is its qualitative worthiness since these are derived from perceptions of practicing professional critical care nurses. Their agreements with the TCI statements reflect acceptance of the concept of technological caring. Two associated findings were established in this investigation: first, the support for the TCI as possessing statements that reflect technological caring, and second, the statistical support for the validity and reliability of the TCI. These findings support the TCI as an instrument worthy of further investigation.

Implications for future research

The development of the TCI facilitates clarification of technological caring in nursing. Data derived from the instrument facilitate the promotion of the model of technological caring as an expression of nursing. This model exposes the harmonious existence of technology and caring in nursing (Locsin, 1995). In addition to the quantitative data gathered by the TCI, the utilization of themes of technological caring that comprise the TCI augments the value of and relationship between qualitative and quantitative research. This methodological investigation facilitates the expression of the unanimity that exists between quantitative and qualitative research, and the legitimacy of the process in the development of nursing knowledge. It also shows how quantitative research can build on qualitative research in nursing. The use of the TCI as a tool to measure technological caring enhances the realization of technologically competent nurses as caring nursing professionals whose response to calls for technological competency is the ultimate expression of nursing in critical care settings.

Furthermore, additional testing of this instrument will determine its ability to generate a database to further clarify and establish technological caring as an expression of caring in critical care nursing practice. Although the present study consisted of a fairly homogeneous group of professional nurses from the same region, differences in educational qualifications were skewed more toward Associate degrees. Enhanced multiple sampling distributions considering educational attainments may further contribute to the establishment of the TCI as a valid instrument for measuring technological caring in nursing. Augmenting the questionnaire-by-mail response rate to 40% or 50% can increase the total number of

respondents. Inexpensive strategies to increase this retrieval rate must be instituted, such as a follow-up letter to each participant or follow-up correspondence with the contact person of the institution.

Further support for construct validity can be obtained through convergent and discriminant validity testing to assess correlations across measures, in different areas of practice such as licensed professional nurses in hospice care or intensive care, and different participant groups, such as student nurses. In addition, subsequent comparisons of years of experience, educational attainment, and ethnicity may be necessary in order to further the construct validity and reliability of the TCI. Such studies are fundamental to the development of an instrument that will ultimately be utilized to generate data to support the model of technological caring as nursing.

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