Supportive Care in Cancer (2022) 30:8313–8322
https://doi.org/10.1007/s00520-022-07279-w

ORIGINAL ARTICLE

Effects of naturalistic decision-making model-based oncofertility care education for nurses and patients with breast cancer: a cluster randomized controlled trial

Sheng-Miauh Huang[1] · **Ling-Ming Tseng**[2,3] · **Pei-Ju Lien**[2]

Received: 25 February 2022 / Accepted: 5 July 2022 / Published online: 15 July 2022

Abstract

Purpose This study examined the effects of an oncofertility education program on decisional conflict in nurses and patients with breast cancer.

Methods A cluster randomized controlled trial was conducted with 84 nurses of five breast care units. Three units were randomly selected from the five as the nurse experimental group. Nurses at the experimental group accepted the oncofertility education based on the naturalistic decision-making (NDM) model, while those at the control group accepted the other non-oncofertility education. We also collected data from female patients before and after the nurses' educational training, respectively. The decisional conflict was measured using the Chinese version of the decisional conflict scale.

Results Nurses in the experimental group had less decisional conflict after the oncofertility educational intervention than those in the control group. After the intervention, nurses with higher infertility knowledge scores had significantly lower decisional conflict. Single nurses had significantly higher decisional conflict than married nurses. A higher perceived barrier score was significantly associated with a higher decisional conflict score. Among patients with the same fertility intention scores, those in the experimental group had lower decisional conflict scores than those in the control group.

Conclusions Our work demonstrates that NDM-based oncofertility care education is feasible and acceptable to improve nurse and patient decisional conflict. Educational training based on the NDM model decreased the decisional conflict regarding oncofertility care.

Trial registration.

ClinicalTrials.gov Identifier: NCT04600869.

Keywords Education · Decisional conflict · Breast cancer · Nurse · Oncofertility

Abbreviations

FIS	Fertility intention scale
GnRHa	Gonadotropin-releasing hormone agonist
IKQ	Infertility knowledge questionnaire
LMM	Linear mixed model
NDM	Naturalistic decision-making
OBS	Oncofertility barrier scale

✉ Sheng-Miauh Huang
r910862@yahoo.com.tw

Ling-Ming Tseng
lmtseng@vghtpe.gov.tw

Pei-Ju Lien
prlain@vghtpe.gov.tw

1 Department of Nursing, MacKay Medical College, New Taipei, Taiwan

2 Comprehensive Breast Health Center, Department of Surgery, Taipei Veterans General Hospital, Taipei, Taiwan

3 School of Medicine, National Yang Ming Chiao Tung University, Taipei 112, Taiwan

Introduction

Oncofertility guidelines are well developed in several countries [1–3]. Tailored posttreatment pregnancy rates, cost ranges, and financial assistance for the fertility options based on patients' situations were key information regarded as necessary for fertility decision-making by most patients and healthcare providers [4]. The need for an interdisciplinary oncofertility team, communication surrounding educational practice norms, and designated oncofertility navigators was recommended [5]. However, a gap to link supplementary fertility information between nurses and patients still exists.

Decision-making is a crucial daily nursing activity. The naturalistic decision-making (NDM) model might be helpful to guide research on understanding how to better support novice nurses' decision-making for providing nursing care [6, 7]. The NDM model implies that helping nurses protect patient fertility must also consider the decision-making processes of nurses. Nurses' experiences with a broad range of patient interactions in clinical practice influence their intuitive, unconscious processes, which facilitates decision-making. When providing oncofertility care, less experienced nurses might feel decisional conflict due to worry regarding a possible disagreement with the attending physician, delaying the start of cancer therapies, and timing of treatment. Novice nurses required more patient encounters to attain the concepts with certainty [6, 8]. The role of situation awareness in the NDM model is an important key point on the way to becoming an experienced acquaintance [9]. Accordingly, how nurses make decisions about providing oncofertility care should be clarified from their perspectives.

The development of an evidence-based intervention to overcome barriers is recommended to improve information provision [10]. Multifaceted strategies, including the development of professional informational and educational material, a role for oncology nurses in informing patients, and simple referral and counseling, were suggested by professionals working in oncofertility care [5, 10, 11]. Previous studies showed oncofertility education for nurses or oncofertility care were provided by nurses [12, 13]. For example, Zwingerman et al. [12] created the role of an oncofertility nurse navigator within the regional cancer center to improve the knowledge of fertility preservation and services for local physicians and to improve patient access to counseling and services. Quinn et al. [13] designed a web-based reproductive health training program to educate nurses about reproductive issues in cancer healthcare. The intervention for oncology nursing care should increase nurses' knowledge, communication skills, and the frequency of discussions on reproductive health with patients.

The training protocols from Canada [12] and the USA [13] are in line with their national health and medical care systems. A previous study indicated nurses worked within a disease-focused model of care, making it difficult for them to take responsibility for decision-making [14]. This disease-focused model implied programs are not completely suitable for nurses caring for patients with breast cancer in Taiwan because of the different role requirements of care providers and the medical care system. The nurses in Taiwan has struggled to assume the responsibilities that have come to be associated with its professional caring role. While these nurses were wondering whether to provide oncofertility care, patients with breast cancer were also struggling with fertility options. Therefore, based on our care culture and previously published literature, we applied the NDM model to design the education process, including information accumulation, sense-making, and decision-making [15]. We examined (1) the primary effect of NDM-based education on decisional conflict before and after an educational intervention with the nurses and (2) we explored the secondary effects of NDM-based education on decisional conflict before and after chemotherapy in patients with breast cancer. Other predictors of decisional conflict were also explored.

Methods

Research design

This study was an experimental and cluster randomized trial of NDM-modeled oncofertility education for nurses and its effects on patients with breast cancer whose treatment involved chemotherapy. For practical reasons and to minimize cross-contamination, a cluster randomized trial was conducted at one medical center in Taipei. There were five units involved in breast care at the research hospital. Two units were randomly selected from the five as the nurse control group (Fig. 1). The nurses in the other three units were assigned to the nurse experimental group. We evaluated the effects of education in oncofertility care among nurses as they performed their expected clinical duties in patients (Fig. 1). Patient data were collected before and after the nurses' educational training (Supplemental Figure).

Participants

The a priori sample size was calculated using a power analysis based on a previous study of group education on decisional conflict among pregnant women. In that study, the difference and standard deviation between pre- and post- intervention for the control and experimental groups were -0.44 ± 2.07 vs. -31.21 ± 10.39 [16]. Therefore, we assumed the effect size to be 0.3 and the correlation among repeated measures was 0.5. 0.8 was considered an acceptable value for power. The needed sample size was 34 participants per group when the power was set to 0.8, the number of repeated measurements was 2, and the number of groups was 2. Additionally, we considered a non-response rate of 10%, yielding a required sample size of 75.

We conducted face-to-face interviews using a structured questionnaire before and after oncofertility education for the nurses. The timeframes before and after oncofertility training were defined as 1 week before training and 1 week after completing training, respectively. All nurses involved in breast care were recruited into the study. Eighty-four nurses met the inclusion criteria. Two nurses declined to participate in the study at the first contact. Because three nurses traveled abroad and transferred to other units, they were lost to follow-up on the second contact (after oncofertility training). Finally, 79 nurses (96.3%) completed the study (Fig. 1).

Female patients with breast cancer who were younger than 50 years and who were about to start cancer treatment were recruited from one teaching hospital in Taipei, Taiwan. Women with a major illness (e.g., heart failure, kidney failure) or mental disorder before their cancer diagnosis were excluded. Patients who received a breast cancer diagnosis and accepted therapy during the nurses' education program were excluded to avoid cross-contamination bias. Thirty-five patients met the inclusion criteria before the nursing training period (patient control group), and 36 patients met the inclusion criteria after the nursing training period (patient experimental group). Two patients declined to participate in the study at first contact. Eight patients traveled abroad, were not interested in preserving fertility, or had participated in another clinical trial; they were lost to follow-up on the second contact (after nursing oncofertility training). Finally, 61 patients completed the study (Fig. 1).

The oncofertility care education program

We designed the education program according to Klein's NDM model, which explored the reasoning mechanism behind decision-making [15]. It depends on the on-the-job training date in each unit. The education program consisted of the following: (1) information accumulation: explanations of common cancer therapies related to subsequent infertility, psychological and mental change in cancer survivors with infertility, the necessity and method of early determination of fertility intention, and type of fertility preservation. (2) sense-making: situational case sharing, emphasis on the guidance interaction between experienced and novice nurses to understand the patient's situation. (3) Decision-making: how to provide support, how to correspond, and attitudes toward people with strong fertility intention. The role of nurses was defined to assess the fertility needs of patients and offer the appropriate information and referral resources. The fertility pathway was developed in the education program to support and guide the primary care team when making referrals to this service.

One trainer delivered the education program in the nursing wards. The education content in the face-to-face education group was presented using the explanatory education method, along with the use of PowerPoint presentation software (Microsoft Corporation, Redmond, WA). Participants could ask questions and get answers on the spot at any time during the education process. At the end of the first session, the education package (including the education booklet about oncofertility care with these contents: importance, cancer therapies related to subsequent infertility, method of early determination of fertility intention, options of fertility preservation, and referral resources) was prepared by the researcher and given to nurses for reading in the work unit. Each program took approximately 60 min. The education program was conducted on different days. Nurses in the control group accepted the other non-oncofertility (standard) nursing training for the intervention, whereas those in the experimental group accepted the oncofertility training. Based on research ethics and design, a standard education course was held for the control group after completing data collection in the nursing experimental group. We began to recruit patients into the patient experimental group after all nurses completed their educational courses.

Measurements and data collection

For the measurements and data collection in nursing participants, the variables included demographics (age, education, marriage, and children), decisional conflict, infertility knowledge, and barriers regarding oncofertility care. Before oncofertility training, we collected the nurses' demographic, decisional conflict, infertility knowledge, and oncofertility barrier data. Only the decisional conflict, infertility knowledge, and oncofertility barrier data were collected again after training.

For the measurements and data collection in patients with breast cancer, the variables included demographics (age, education, marriage, occupation, and children), disease and treatment characteristics (fertility preservation option and cancer stage), decisional conflict infertility knowledge, and fertility intention. Before the nurses' training, the patients in the control group were recruited to collect the demographics, disease, and treatment characteristics, decisional conflict, infertility knowledge, and fertility intention data. The decisional conflict, infertility knowledge, and fertility intention were collected before and after chemotherapy. Patients in the experimental group were recruited after the nurses underwent oncofertility training.

The decisional conflict was measured using the Chinese version of the decisional conflict scale, which is a self-reported outcome measure [17]. It comprises 14 items covering three domains: informed and values clarity, uncertainty and effective decision, and support. Each item was rated on a five-point Likert scale, ranging from zero to 4. The score was calculated by averaging the sum of individual item scores, then multiplying the product by 25. Hence, the scores range from 0 to 100. A higher score indicates higher decisional conflict. Both nursing and patient participants were asked to fill out the questionnaire.

An Oncofertility Barrier Scale (OBS) was developed to assess nurses' perceptions of comprehensive barriers regarding oncofertility care. The responses to each item were provided using a five-point Likert scale. A higher scale score meant the nurses perceived that it was more difficult to provide oncofertility care. Cronbach's alpha calculated for the OBS (27 items) was 0.91, and the test–retest reliability coefficient was 0.55 [18].

We used the Infertility Knowledge Questionnaire (IKQ) to measure both of nurses' and patients' knowledge of infertility in patients with breast cancer [19]. They answered each question as true, false, or do not know. A do-not-know response was regarded as a wrong answer in the analysis. Total scores for the 11 items ranged from zero to 11. Centimeters were used to show the ratio of correct answers visually. A higher score meant a greater level of knowledge about infertility. Both nursing and patient participants were asked to fill out the questionnaire.

The Fertility Intention Scale (FIS) with 15 items was used to measure patients' fertility intentions. The standardized scale ranged from 1 to 5 points on a five-point Likert scale. Higher scores indicated a greater degree of fertility intention. The reliability and validity of the FIS have been well established [20].

Data analysis

Individual variables were examined by calculating percentages, means, and standard deviations. Differences between the control and experimental groups were analyzed using χ^2 statistics and *t*-tests. Pearson's correlation was used to investigate the relationship between two continuous variables. As substantial individual differences were expected in our data, the linear mixed model (LMM) was applied to assess the fixed and random effects. By incorporating random effects, clustered data could be accommodated by using LMMs. SPSS (Statistical Package for the Social Sciences), version 26.0, (IBM Corp., Somers, New York, USA) was used to perform the statistical analyses. An alpha level of 0.05 was considered statistically significant, with reported *p*-values corresponding to two-sided analyses.

Results

Participant characteristics

Of the 84 eligible nurses, the response rate was 96.3% (79 nurses). The characteristics of the 79 nursing participants are presented in Table 1. There were no significant differences in the demographic variables of participants between experimental and control groups. Overall, more than 93% of the nursing staff had an education level with college at least, and less than one-third of nurses was married. About one-quarter of the nurses had at least one child. The mean age of the nursing study participants was 33.5 years (range, 23–53 years).

Of the 69 eligible patients with breast cancer, the response rate was 88.4% (61 patients). Table 2 summarizes the characteristics of the patients who participated. The mean age (± SD) of the women was 41.5 ± 5.5 years (range: 24–50 years), and 14 women were single. Of the 61 patients, 49 (80.3%) had full-time jobs, and 48 (78.7%) graduated from college. The breast cancer diagnoses were stage I or II for 93.4% of the women. Finally, only 15 women chose to undergo temporary ovarian suppression with

Table 1 Demographic characteristics of the nursing participants

Variable	All (n=79) n (%)		Group Control (n=44) n (%)		Experimental (n=35) n (%)		t/χ^2	p
Education							1.28	.26
Bachelor	74	(93.7)	40	(90.9)	34	(97.1)		
Master	5	(6.3)	4	(9.1)	1	(2.9)		
Marital status							0.06	.50
Single	53	(67.1)	29	(65.9)	24	(68.6)		
Married	26	(32.9)	15	(34.1)	11	(31.4)		
Children							0.01	.57
No	59	(74.7)	33	(75)	26	(74.3)		
Yes	20	(25.3)	11	(25)	9	(25.7)		
Age, years [a]	33.5	±8.7	34.5	±9.0	32.3	±8.3	1.11	.27
Working duration, years [a]	10.1	±8.7	11.3	±9.1	8.3	±7.9	1.54	.13

Data are presented as number (%) unless otherwise indicated

[a]Age and working duration are presented as mean ± standard deviation

Student's *t*-test and chi-squared test statistics (*t* and χ^2, respectively); the significance level was set at $p <$ .05

Table 2 Demographic characteristics of the patients with breast cancer

Variable	Group						t/χ^2	p
	All (n=61) n (%)		Control (n=30) n (%)		Experimental (n=31) n (%)			
Age, years [a]	41.5	±5.5	42.8	±6.3	40.4	±4.4	1.7	.09
Marital status							1.3	.52
Single	14	(23.0)	6	(20)	8	(25.8)		
Married	43	(70.5)	21	(70)	22	(71.0)		
Widowed/divorced	4	(6.6)	3	(10)	1	(3.2)		
Employment status							0.5	.48
No	12	(19.7)	7	(23.3)	5	(16.1)		
Yes	49	(80.3)	23	(76.7)	26	(83.9)		
Education							2.7	.10
Senior high school	13	(21.3)	9	(30)	4	(12.9)		
College at least	48	(78.7)	21	(70)	27	(87.1)		
Children							3.2	.07
No	21	(34.4)	7	(23.3)	14	(45.2)		
Yes	40	(65.6)	23	(76.7)	17	(54.8)		
Cancer Stage							4.1	.04
I & II	57	(93.4)	30	(100)	27	(27)		
III & IV	4	(6.6)	0	(0)	4	(4)		
Fertility preservation							0.01	.93
No	45	(73.8)	22	(73.3)	23	(74.2)		
Yes	16	(26.2)	8	(26.7)	8	(25.8)		

Data are presented as number (%) unless otherwise indicated

[a]Age is presented as mean ± standard deviation

Student's t-test and chi-squared test statistics (t and χ^2, respectively); the significance level was set at $p <$ .05

gonadotropin-releasing hormone agonist treatment (GnRHa) during chemotherapy. One woman accepted egg freezing before cancer treatment and accepted GnRHa treatment during chemotherapy.

Predictors of decisional conflict scores regarding oncofertility care for nurses

Univariate analysis showed that there were no significant differences in the demographic characteristics between control and experimental groups (Table 1). Independent t test showed the nurses in the experimental group had significantly lower mean scores for decisional conflict after the intervention (control vs. experimental group: 61.1 ± 23.6 vs. 56.8 ± 17.9, t = 0.92, p = 0.36 before intervention; 56.1 ± 22.8 vs. 26.5 ± 17.8, t = 6.31, p < 0.01 after intervention; Table 3). Nurses in the experimental group had significantly higher mean scores for IKQ after the intervention (control vs. experimental group: 66.3 ± 15.4 vs. 65.2 ± 18.2, t = 0.30, p = 0.77 before intervention; 66.5 ± 18.5 vs. 85.5 ± 14.2, t = −4.98, p < 0.01 after intervention; Table 3). Nurses in the experimental group had significantly lower mean scores for OBS after the intervention (control vs. experimental group: 77.9 ± 15.6vs. 77.7 ± 15.4, t = 0.03, p = 0.97 before intervention; 78.5 ± 13.9 vs. 65.6 ± 13.6, t = 4.13, p < 0.01 after intervention; Table 3). The result of random effect showed that individual differences in groups (clustered data) could not be ignored (variance estimate = 88.51, SE = 43.57, p = 0.04; Table 4). Furthermore, we chose the final model by considering the goodness of fit of the model and the simplicity of the model. The final LMM model showed that nurses in the experimental group had less decisional conflict after the intervention than before the intervention (β = −14.81, 95% CI: −26.31 to −3.30; Table 4). Single nurses had significantly higher decisional conflict than married nurses (β = 9.02, 95% CI: 1.87 to 16.16; Table 4). A higher OBS score was significantly associated with higher decisional conflict score (β = 0.48, 95% CI: 0.27 to 0.70; Table 4). After the intervention, nurses with higher IKQ scores had significantly lower decisional conflict (β = −0.34, 95% CI: −0.66 to −0.01; Table 4). The result of random effect showed that individual differences in groups (clustered data) could not be ignored (variance estimate = 88.51, SE = 43.57, p = 0.04; Table 4).

Table 3 Univariate analysis by times and groups for nurses and patients with breast cancer

Variable	All mean ±SD		Group: Control mean ±SD		Group: Experimental mean ±SD		*t*	*p*
Nurses	(I=79)		(*n*=44)		(*n*=35)			
Decisional conflict score								
Before intervention	59.2	±21.2	61.1	±23.6	56.8	±17.9	0.92	.36
After intervention	43.0	±25.3	56.1	±22.8	26.5	±17.8	6.31	< .01
IKQ score								
Before intervention	65.8	±16.6	66.3	±15.4	65.2	±18.2	0.30	.77
After intervention	74.9	±19.2	66.5	±18.5	85.5	±14.2	–4.98	< .01
OBS score								
Before intervention	77.8	±15.4	77.9	±15.6	77.7	±15.4	0.03	.97
After intervention	72.8	±15.1	78.5	±13.9	65.6	±13.6	4.13	< .01
Patients	(n=61)		(n=30)		(n=31)			
Decisional conflict score								
Before therapy	30.9	±16.3	29.0	±17.3	32. 8	±15.3	–0.91	.37
After therapy	37.6	±18.2	36.8	±20.0	38.4	±16.5	–0.34	.74
IKQ score								
Before therapy	43.8	±19.0	40.6	±19.7	47.0	±18.2	–1.30	.20
After therapy	48.1	±21.8	49.1	±23.3	47.2	±20.5	0.33	.74
FIS score								
Before therapy	48.2	±8.5	48.1	±9.3	48.4	±7.8	–0.10	.92
After therapy	44.9	±8.6	44.5	±9.5	45.3	±7.8	–0.37	.71

Student's *t*-test statistics; the significance level was set at $p < .05$

Abbreviations: *FIS*, fertility intention scale; *IKQ*, infertility knowledge questionnaire; *OBS*, oncofertility barrier scale

Table 4 Predictors of the decisional conflict scale score for nurses and patients with breast cancer

	β	SE	95% CI Lower	95% CI Upper	*p*
Nurses[d]					
Intercept	11.00	12.70	–14.09	36.10	.39
After intervention (vs. before intervention)	17.11	11.49	–5.68	39.89	.14
Experimental group (vs. control group)	–4.35	4.22	–12.70	3.99	.30
Experimental group × after intervention [a]	–14.81	5.79	–26.31	–3.30	.01
Single group (vs. married group)	9.02	3.58	1.87	16.16	.01
OBS score	0.48	0.11	0.27	0.70	< .01
IKQ score	0.10	0.12	–0.14	0.35	.42
IKQ score× after intervention [b]	–0.34	0.17	–0.66	–0.01	.04
Patients[e]					
Intercept	39.09	10.66	17.99	60.20	< .01
After intervention (vs. before intervention)	–7.61	2.75	–13.10	–2.12	.01
Experimental group (vs. control group)	44.27	16.85	10.89	77.66	.01
Experimental group × after intervention [a]	5.03	3.86	–2.68	12.74	.20
FIS score	–0.05	0.23	–0.51	0.40	.82
FIS score × Experimental group [c]	–0.94	0.36	–1.66	–0.22	.01

Linear mixed model with autoregressive (AR) errors

Abbreviations: *CI*, confidence interval; *FI*S, fertility intention scale; *IKQ*, infertility knowledge questionnaire; *OBS*, oncofertility barrier scale; *SE*, standard error

Reference group: [a]Control group × Before intervention; [b]IKQ score × Before intervention; [c]FIS score × Control group × Interaction; [d]Data of random effect (subject × group) in nurses: Variance estimate is 88.51 (SE=43.57, *p*= .04). [e]Data of random effect (subject × group) in patients: Variance estimate is 167.27 (SE=41.63, *p*< .01)

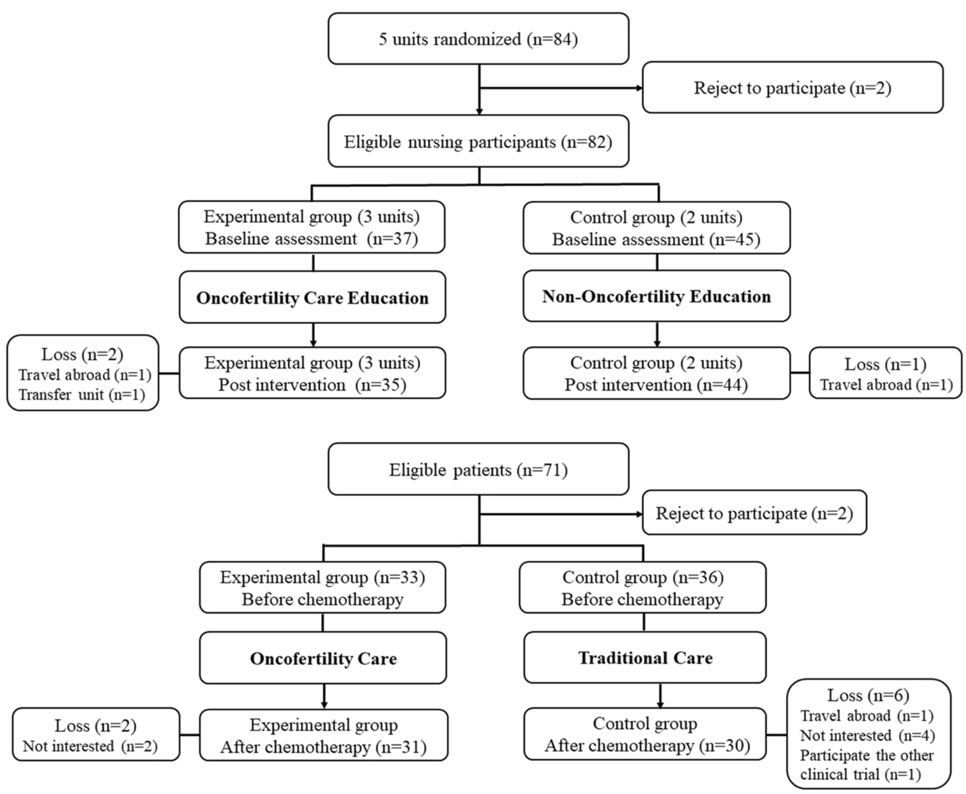

Fig. 1 Flow chart of nursing participants and patients selection

Predictors of decisional conflict scores regarding oncofertility options for patients with breast cancer

Univariate analysis showed that there was a significant difference in the cancer stage between control and experimental groups (Table 2). Age, job status, education, marital status, children/no children, cancer stage, and fertility preservation were not significantly associated with decisional conflict. There was no significant difference in decisional conflict scores between control and experimental groups before or after chemotherapy (control vs. experimental group: 29.0 ± 17.3 vs. 32.8 ± 15.3, $t = -0.91$, $p = 0.37$ before chemotherapy; 36.8 ± 20.0 vs. 38.4 ± 16.5 after chemotherapy, $t = -0.34$, $p = 0.74$; Table 3). Pearson correlation showed that only FIS was significantly correlated with decisional conflict. The result of random effect showed that individual differences in groups (clustered data) could not be ignored (variance estimate = 167.27, SE = 41.63, $p < 0.01$; Table 4). The final LMM model showed patients in the experimental group had lower decisional conflict than those in the control group when the patients had the same FIS scores ($\beta = -0.94$, 95% CI: – 1.66 to – 0.22; Table 4). The result of random effect showed that individual differences in groups (clustered data) could not be ignored (variance estimate = 167.27, SE = 41.63, $p < 0.01$; Table 4).

Discussion

Based on our findings, the nurses involved in breast care in Taiwan had insufficient knowledge of infertility and perceived many oncofertility care barriers before education. The NDM-based oncofertility care education significantly improved the nurses' decisional conflict, infertility knowledge, and lowered barriers to oncofertility care at the end of the intervention. These findings were consistent with those of Nibbelink and Brewer's claim [6], who noted the use of NMD was feasible as a conceptual framework to guide nursing practice and research. Early literature reported that decision-making among nurses demonstrated cautiousness when the patient status was presented with uncertainty [21]. Those decision-making studies focused on the approaches of coherence and correspondence, using a mathematical approach based on logic [22]. Now, the NDM model focuses on experienced decision-makers following a unique process when making decisions in critical time-limited circumstances. The important influence of team members and a pattern-matching process guides decision-making by experienced decision-makers [6, 23]. This concept is consistent with our educational design, which develops an understanding of the patients' status and situational awareness that leads to pattern identification in patient care. We built several strategies, such as referrals, which indicated the decision frequencies of nurses were linked to nurses' experience, appointment level, and location [24]. We only arranged NDM-based educational training once per nurse. Whether increasing the number of training sessions and improving awareness could enhance the effect of NDM-based educational training deserves future research.

Our findings indicated that patients in the experimental group had lower decisional conflict than those in the control group only when those had the same FIS scores. The effect of NDM-based oncofertility care was not very obvious among patients. One possible cause was the spread of COVID-19. In our study, about half of the patients were recruited after January 2020. All hospitals in Taiwan took precautions to reduce unnecessary medical treatments, such as fertility preservation, to prevent COVID-19 infection during the period. Such actions could have reduced the fertility intentions of patients and increased their decisional conflict and thus undermined the effect of NDM-based oncofertility care. In our study, about one-quarter of patients accepted fertility preservation, especially temporary ovarian suppression. Only one patient in the experimental group chose to freeze her eggs before chemotherapy and accepted temporary ovarian suppression during chemotherapy. Our result also showed single nurses had more decisional conflict than married nurses when providing oncofertility care. It may be attribute to lack of experience toward fertility decision among single nurses. The result is consistent to the previous study [25], which indicated health provider's experience might had negative impact on their willingness and ability to raise fertility-related issues with young women with cancer.

There were several limitations to our study. The sample size was estimated using a repeated measures formula with the nurse as the target. The sample size in our study may have been underestimated by ignoring the effect of the cluster design. Patients in the control and experimental groups were recruited at different times, so the effects of time and vital events could not have been neglected. Additionally, the results might not apply to women with other types of cancer and treatment because only women with breast cancer were studied. Our study collected patient data before and after chemotherapy. Whether the improvements in decisional conflict and behaviors could be sustained in the long term should be further explored. We did not follow-up on the actual behavior of becoming pregnant. An evaluation of whether fertility intention and actual pregnancy are consistent merits future longitudinal study.

Conclusions

Our study showed both nurses and patients had decisional conflicts regarding oncofertility care before the intervention, especially in the domain of informed and values clarity. Educational training based on NDM modeling improved the infertility-related knowledge, reduced oncofertility barriers, and decreased the decisional conflict regarding oncofertility care among nurses. The patients with the same fertility intention also reduced the decisional conflict regarding oncofertility. Development of education programs based on NDM modeling for fertility perseveration by nursing bodies could mitigate the decisional conflict and psychological burden that oncology nurses tacitly are expected to undertake to assist patients with fertility-related tasks. To ensure that the initial fertility intentions of women with breast cancer are met after cancer treatment, longitudinal measures including tracking the actual performance outcome of fertility preservation merit future research.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00520-022-07279-w.

Author contribution Sheng-Miauh Huang contributed to the study concept, design writing—review and editing. Ling-Ming Tseng and Pei-Ju Lien were responsible for the acquisition of the data. All authors read and approved the final manuscript.

Funding This study was supported by grants from the Ministry of Science and Technology, Taiwan (fund no. MOST 106–2314-B-715 -004 -MY2) and MacKay Medical College, Taiwan (grant no. MMC-RD-111-1B-P001). The funding source did not influence the study design, procedure, data analysis, or interpretations of the findings. We sincerely thank all the participants in the study.

Availability of data and material The data that support the findings of this study are available from the corresponding author, Sheng-Miauh Huang, upon reasonable request.

Code availability Not applicable.

Declarations

Ethics approval This study was approved by the Institutional Review Board of Taipei Veterans General Hospital in Taiwan (No. 2017–01-011AC).

Consent to participate Informed consent was obtained from all participants included in the study.

Consent for publication A signed informed consent was obtained from each participant. The informed consent is available upon request.

Competing interests The authors declare no competing interests.

References

1. Kim H, Kim SK, Lee JR, Hwang KJ, Suh CS, Kim SH (2017) Fertility preservation for patients with breast cancer: the Korean Society for Fertility Preservation clinical guidelines. Clin Exp Reprod Med 44(4):181–186
2. Oktay K, Harvey BE, Loren AW (2018) Fertility preservation in patients with cancer: ASCO Clinical Practice Guideline Update Summary. J Oncol Pract 14(6):381–385
3. Takai Y (2018) Recent advances in oncofertility care worldwide and in Japan. Reprod Med Biol 17(4):356–368
4. Speller B, Sissons A, Daly C, Facey M, Kennedy E, Metcalfe K, Baxter NN (2019) An evaluation of oncofertility decision support resources among breast cancer patients and health care providers. BMC Health Serv Res 19(1):101
5. Keim-Malpass J, Fitzhugh HS, Smith LP, Smith RP, Erickson J, Douvas MG, Thomas T, Petroni G, Duska L (2018) What is the role of the oncology nurse in fertility preservation counseling and education for young patients? J Cancer Educ 33(6):1301–1305
6. Nibbelink CW, Brewer BB (2018) Decision-making in nursing practice: an integrative literature review. J Clin Nurs 27(5–6):917–928
7. Nibbelink CW, Reed PG (2019) Deriving the practice-primed decision model from a Naturalistic decision-making perspective for acute care nursing research. Appl Nurs Res 46:20–23
8. Kydonaki K, Huby G, Tocher J, Aitken LM (2016) Understanding nurses' decision-making when managing weaning from mechanical ventilation: a study of novice and experienced critical care nurses in Scotland and Greece. J Clin Nurs 25(3–4):434–444
9. Endsley MR (1997) The role of situation awareness in naturalistic decision making. In: Zsambok CE, Klein G (eds) Naturalistic decision making. Lawrence Erlbaum Associates, Hillsdale, NJ, pp 269–283
10. Goossens J, Delbaere I, Van Lancker A, Beeckman D, Verhaeghe S, Van Hecke A (2014) Cancer patients' and professional caregivers' needs, preferences and factors associated with receiving and providing fertility-related information: a mixed-methods systematic review. Int J Nurs Stud 51(2):300–319
11. van den Berg M, Baysal Ö, Nelen WLDM, Braat DDM, Beerendonk CCM, Hermens RPMG (2019) Professionals' barriers in female oncofertility care and strategies for improvement. Hum Reprod 34(6):1074–1082
12. Zwingerman R, Melenchuk K, McMahon E, Liu KE, Siren A, Laferriere N, Greenblatt EM (2020) Expanding urgent oncofertility services for reproductive age women remote from a tertiary level fertility centre by use of telemedicine and an on-site nurse navigator. J Cancer Educ 35(3):515–521
13. Quinn GP, Bowman Curci M, Reich RR, Gwede CK, Meade CD; ENRICH/ECHO Working Group, Vadaparampil ST (2019) Impact of a web-based reproductive health training program: ENRICH (Educating Nurses about Reproductive Issues in Cancer Healthcare) Psychooncology 28 5 1096 1101
14. Rodrigo O, Caïs J, Monforte-Royo C (2017) Professional responsibility and decision-making in the context of a disease-focused model of nursing care: the difficulties experienced by Spanish nurses. Nurs Inq 24(4):https://doi.org/10.1111/nin.12202.
15. Klein G (1993) Twenty questions: suggestions for research in naturalistic decision making. In: Klein GA, Orasanu J, Calderwood R, Zsambok CE (eds) Decision-making in action: models and methods. Ablex Publishing Corporation, Norwood, NJ, pp 389–403
16. Kordi M, Riyazi S, Lotfalizade M, Shakeri MT, Suny HJ (2018) A comparison of face to face and group education on informed choice and decisional conflict of pregnant women about screening tests of fetal abnormalities. J Educ Health Promot 7:6

17. Lam WW, Kwok M, Liao Q, Chan M, Or A, Kwong A, Suen D, Fielding R (2015) Psychometric assessment of the Chinese version of the decisional conflict scale in Chinese women making decision for breast cancer surgery. Health Expect 18(2):210–220
18. Huang SM, Lai JCY, Li CC, Chen PH, Lien PJ, Lien CT (2022) Development and validity testing of an assessment tool for the oncofertility barriers among multidisciplinary healthcare providers of the breast cancer patients. J Nurs Res 30(2):e195
19. Huang SM, Tseng LM, Lai JC, Lien PJ, Chen PH (2019) Infertility-related knowledge in childbearing-age women with breast cancer after chemotherapy. Int J Nurs Pract 25(5):e12765
20. Li CC, Huang SM, Lai JC, Hsiung Y, Chen YH, Lee CF (2018) Development and validation of a fertility intention scale in breast cancer survivors. J Nurs Res 26(3):177–184
21. Hammond KR, Kelly KJ, Schneider RJ, Vancini M (1967) Clinical inference in nursing: revising judgments. Nurs Res 16(1):38–45
22. Hammond KR (1996) How convergence of research paradigms can improve research on diagnostic judgment. Med Decis Making 16(3):281–287
23. Klein G, Calderwood R, Clinton-Cirocco A (2010) Rapid decision making on the fire ground: the original study plus a postscript. J Cogn Eng Decis Mak 4(3):186–209
24. Bucknall TK (2000) Critical care nurses' decision-making activities in the natural clinical setting. J Clin Nurs 9(1):25–35
25. Covelli A, Facey M, Kennedy E, Brezden-Masley C, Gupta AA, Greenblatt E, Baxter NN (2019) Clinicians' perspectives on barriers to discussing infertility and fertility preservation with young women with cancer. JAMA Netw Open 2(11):e1914511