BMC Women's Health

RESEARCH

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Effects of a web-based decision aid on breast cancer patients considering a breast reconstruction: a randomized controlled trial

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Abstract

Purpose Due to the variety of surgical methods, breast cancer patients may face dilemmas regarding decision-making. Web-based decision aids (WDAs) are interactive tools that help patients make informed decisions by meeting their needs both inside and outside the hospital, providing real-time decision assistance, and being more practical and convenient. Although the incidence of breast cancer ranks first among female cancers in China, studies focusing specifically on the use of WDAs in breast cancer patients have not been conducted in the country. The objective of this study was to determine the effects of WDAs on breast cancer patients considering a breast reconstruction.

Methods A total of 70 patients with breast cancer were randomized, with 63 completing the whole trial. The control group used paper-based decision aids, which they could use freely in the ward to obtain health information support. The intervention group used web-based decision aids, including decision assessment, decision support, and decision evaluation, which they could use anytime and anywhere on their mobile phones. The study measured decision conflict, preferred decision-making roles, unmet needs, and decision satisfaction at baseline and before and after the intervention.

Results No differences were found in the demographic and clinical features between the two groups. Compared with the control group, the intervention group had lower scores for the dimensions of decision support and decision effectiveness, decision uncertainty, total score of decision conflict and information needs, work and financial needs, access and continuity of care, coping, sharing and emotional needs, and total score of unmet information needs (P all < 0.05). Patients in the intervention group had a higher proportion of active and collaborative roles, higher scores in the information, deliberation, decision, and global satisfaction and confidence dimensions, and a higher total score for decision satisfaction (P all < 0.05).

Conclusion WDAs are a convenient tool for promoting collaborative decision making, satisfying information needs, reducing decision conflict, and improving decision satisfaction. In addition, the development of WDAs avoids the limitations of region and time, and provides sufficient knowledge for patients to improve their medical experience.

Trial registration Registration Number: ChiCTR2400092924 Dated: 26.11.2024.

Keywords Breast cancer, Web based decision aids, Decision conflict, Decision satisfaction

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Introduction

Breast cancer is the most common malignant tumor in women in China and is increasingly diagnosed in younger women [1].The Chinese Center for Disease Control and Prevention predicts that there will be more than 400,000 new cases and more than 100,000 deaths nationwide by 2030 [2]. With the development of treatment concepts and technology, clinical treatment does not always involve extensive and radical resection of tumors. For example, breast reconstruction (BR) helps patients who cannot or do not want to retain breast to build a new breast using appropriate surgical methods. However, the overall reconstruction rate after mastectomy in China is only 10.7% [3]. Although BR surgery improves patients'postoperative quality-of-life, it is associated with risks such as bleeding, infection, and poor healing, with the benefits and potential risks to patients varying according to the procedure. Surgical decision making is a complex process that takes into account disease characteristics, patient values, and personal preferences. Because of insufficient access to information, patients often have difficulty in judging the timing of surgery (immediate BR or delayed BR), reconstruction method (autologous tissue or implant reconstruction), tumor safety (tumor metastasis or tumor recurrence), and economic costs [4] Family and social factors may also influence decision-making progression in the background of the Chinese culture [5].

Decision aids (DAs) are tools that assist in meeting information needs and facilitate the decision-making progress. A study has reported that 51.4% of breast cancer patients regretted their treatment decision-making [6]. Cancer patients often experience decision conflict, caused by repeatedly considering different health risks and the impact of surgery on their families when making treatment decisions [7]. DAs help patients make concrete and valued decisions among different choices by providing evidence-based information about individual health [8]. A recent systematic review showed that DAs effectively improved patients' health knowledge and reduced decision conflicts and regret in the decision-making process of reconstructive surgery [9]. DAs are different from traditional health education by not only providing basic treatment information and nursing knowledge, but also covering knowledge regarding reconstruction, type of surgery, economic cost, expected effect, and postoperative pain and personal preferences [10]. Chinese researchers have developed a DA manual for BR patients which has the ability to improve disease knowledge, promote an individual's engagement, reduce their sense of uncertainty, and clarify their personal preferences [11].

With the advent of the"Internet +"era, m-health has become an important source of health information for patients [12]. Patients can use fragmented time such as waiting periods for examination queues to access disease management, medical consultation and follow-up services anytime and anywhere, in order to realize the sharing and sustainable development of medical resources. At present, the common forms of DAs include manuals, videos, computer learning modules, and web-based decision aids (WDAs) systems [13]. WDAs are interactive tools that provide personal information-based support and online interaction based on patients' values and preferences. They allow patients to access professional information such as disease management, medical consultation, and follow-up anytime and anywhere, using fragmented time to achieve dynamic sharing of medical information that helps patients make informed decisions [14]. Fang et al. showed WDAs are very useful for patients to access multimedia material and online consultations compared with only receiving a pamphlet. A research team then developed a personalized and interactive WDA (Breast reconstruction Decision Aid: BRECONDA), a menu-driven, self-controlled, modular website that provides information about breast cancer surgery and reconstruction options, and includes video interviews and photo libraries for patients and surgeons. This provides value clarification and stress management, which facilitates effective decision-making. The website https://breconda.bcna.org.au/ provides information support and online interaction, with a randomized controlled study showing that it decreases decision conflicts and improves decision satisfaction among women considering BR [15]. Recently, a systematic review showed that WDAs promote the progress of achieving a shared decision-making mode and improve the quality of decision-making in patients with chronic disease [16]. In China, related research has focused mainly on shared decision theory, DAs manuals, problem checklists, and decision-making experience, with less research on WDAs in breast cancer patients. The objective of this study was therefore to determine the effects of WDAs on the breast cancer patients considering BR.

Methods

Study design

The study was a randomized controlled clinical trial with a 1:1 allocation ratio. The participants were assigned randomly to an intervention or control group. Both groups of patients used paper-based DAs before surgery, while the intervention group also used WDAs. Before the formal study, we collected experience feedback from five users, simplified the operation interface, and added step-by-step hints based on the usage time of each module of the applet and user feedback. Finally, we constructed an operation flow chart. The effects of the interventions

during the surgical decision-making process for BR were compared in the two patient groups. The study protocol was registered with the Chinese Clinical Trial Registry (ChiCTR2400092924) and approved by the Ethics Committee of Tianjin Medical University Cancer Institute & Hospital. All the data collected did not contain identifiable information and was stored locked in the first author's office.

Randomization, allocation concealment, and blinding

The randomization process was performed using computer-generated software (Stata 17.0) and a simple randomization method by independent researchers who assigned the patients to either the control or intervention group in a 1:1 ratio. After the allocation sequence was generated, the results were sealed by third-party personnel not involved in the study, into sequentially numbered, opaque envelopes, labelled on the outside with only a unique number with no other grouping information. When the patient completed the baseline assessment and was formally enrolled, the researcher unsealed the envelope in the numbered sequence and assigned the appropriate intervention based on the group assignment. The control group received paper-only DAs, on while, the intervention group was also able to access WDAs through an exclusive account. The two intervention groups were separated into two wards in the same department to avoid communication between the groups. The data analysts were blinded to the grouping information until the statistical analyses were completed.

Participants

The participants were from a tertiary Grade A hospital in Tianjin. Patients who met the following inclusion and exclusion standards were enrolled in the study. Inclusion criteria: (a) Pathological diagnosis of breast cancer, (b) 18 years of age or older, (c) first planned surgery for breast cancer treatment, excluding previous breast surgeries, (d) has a smartphone with either iOS or Android operating systems, (e) agree to participate in the study. Exclusion criterion: patients with mental or cognitive disorders.

The intervention research formula was used to calculate the required sample size in which n1 $=$n2$=2\left[\frac{(\mu_\alpha+\mu_\beta)}{\delta/\sigma}\right]^2$ [17]; n_1 and n_2 in the formula correspond to indicate the sample size to be included in the control group and the intervention group; σ is the estimated values of the standard deviation of the two overall decision dilemma scores; δ is the difference between the means of the decision dilemma scores of the two samples; α and β correspond to their z-values, respectively, and in this study, the probability of type I error is taken as $\alpha = 0.05$, and the probability of type II error is taken as $\beta = 0.20$, i.e., 1-β $=0.80$, and in the two-sided test,$Z_{\alpha/2} = 1.96$, and $Z_\beta = Z_{1-\beta} = 0.84$; according to the relevant literature studies [11], it is calculated that $\sigma = \sqrt{\frac{(n_1-1)S_1^2+(n_2-1)S_2^2}{n_1+n_2-2}} = 7.68$, and $\delta = 6.23$, which was brought into the formula to give $n_1 = n_2 = 24$, considering a 20% loss to follow-up, we recruited at least 30 patients for each group.

Intervention and control conditions

Patients allocated to the control group received health information support through paper-based DAs, including comparison charts of different surgical procedures, a question prompt list, and health education manuals. On the day of admission, members of the research team informed the patients of the information and usage methods that paper-based DAs can provide. On the same basis, the intervention group also were able to use WDAs which included multiple modules such as health information, and decision evaluation, support, and assessment. The health information module provided relevant knowledge on various surgical procedures, including surgical indications, contraindications, complications, costs, and processes. The decision evaluation module provided a preliminary evaluation of which surgical procedure was suitable based on the patient's personal preferences and physical condition, thereby helping them to narrow down their decision-making scope. The decision support module included electronic comparison charts of different surgical procedures, a problem prompt list, and DA cases. The decision assessment module included disease knowledge quizzes, surgical plan scoring, and decision feedback. On the day of admission, the researchers assisted the patients to complete registration and guided them to understand the content and usage of each module. After the patient had completed all the examinations, the researchers assisted them in completing the decision evaluation and helped narrow down the scope of their decision. One day before surgery, the patients completed a disease knowledge test and surgical plan scoring to ensure that they had chosen the surgical method based on a thorough understanding of surgical-related knowledge. Two days after surgery, the patients provided feedback on how satisfied they were with their decision.

Demographic information in both groups of patients was collected on the day of admission (T0), and was used to provide corresponding decision support from admission to surgery. One day before surgery (T1), the decision evaluation was conducted to clarify the patient's personal preferences. After communication between medical staff and the patients, a joint surgical decision was determined. After surgery, the patient's surgical method was

recorded, and the quality of the decision was evaluated one week (T2) and one month (T3) after surgery.

Variables and instruments

The study questionnaires included demographic information (T0 only), decision conflict scale (T1 only), control preference scale and short-form survivor unmet needs survey (T2 only), and decision satisfaction scale (T3 only).

Demographic information

The demographic information collected included age, gender, education, marital status, monthly income, medical expense payment, and religious belief.

Decision conflict scale

The patients' level of decision conflict in the surgical decision-making process was evaluated using the Decision Conflict Scale (DCS) developed by O'Connor et al. [18] and localized by Li Yu [19]. The DCS includes three dimensions: information and values, decision support and effectiveness, decision uncertainty, for a total of 16 items. Each item was rated on a 5-point Likert scale from 0 (strongly agree) to 4 (strongly disagree). The standardized score of the scale was calculated by multiplying the average score of each item by 25. A score < 25.0 indicated no decision conflict, 25.0–37.5 a moderate level of decision conflict, and > 37.5 a high level of decision conflict and decision delay. The Cronbach's alpha of this scale was 0.897.

Control preference scale

The patients' preferred decision-making roles were evaluated using the Control Preference Scale (CPS) designed by Degner [20] and localized by Xu Xiaolin [21]. The CPS consists of one question with six options. The patients' preferred surgical decision-making roles were divided into active, collaborative, passive, or full representation of family members. The test–retest reliability was 0.856.

Short-form survivor unmet needs survey

The content of the patients' needs and the degree of assistance required were evaluated using the Short-Form Survivor Unmet Needs Survey (SF-SUNS) developed by Campbell et al. [22] and localized by Yan Tingting [23]. The SF-SUNS includes four dimensions: information needs, work and financial needs, access and continuity of care, and coping, sharing and emotional needs, each with 3, 8, 6, and 13 items respectively, making a total of 30 items. Each item was rated on a 5-point Likert scale from 0 (no need) to 4 (very high need). The maximum scores for each dimension were 12, 32, 24, and 52 points, respectively, with a maximum total score of 120 points. The higher the score, the more severe the patient's unmet need. The Cronbach's alpha of this scale was 0.890.

Participation satisfaction in the medical decision-making scale

The patients' participation satisfaction in surgical decision-making was evaluated using the Participation Satisfaction in Medical Decision-making Scale (PSMDS) developed by Xu Xiaolin [21]. The PSMDS includes four dimensions: information, deliberation, decision, global satisfaction, and confidence, for a total of 16 items. Each item was rated on a 5-point Likert scale from 1 (not at all) to 5 (very much). The standardized score of each item was then calculated by subtracting 1 from its original score and multiplying it by 25. The score for each dimension was the average score of each item within that dimension, while the total score of the scale was the average score of each dimension, with a maximum score of 100 points. The higher the score, the higher the patient's satisfaction with participating in medical decision-making. The Cronbach's alpha of this scale was 0.899.

Statistical analysis

Categorical variables were expressed as frequencies and percentages and continuous variables as means and standard deviation. Homogeneity of variance tests were performed before comparison of the two groups to determine whether the data conformed to a normal distribution with homogeneous variance. The chi-square test and t-test were used to evaluate the differences in various observation indicators between the intervention and control groups. All the data analyses were conducted using SPSS (version 26.0, IBM Corp) with the level of significance set at $p < 0.05$.

Results

From January to August 2024, a total of 70 patients who met the inclusion and exclusion criteria were recruited and allocated randomly into either the control group ($n = 35$) or intervention group ($n = 35$). During the research period, 4 patients were unable to complete the study due to changes in treatment methods (2 in the control group and 2 in the intervention group), while 3 patients were lost to follow-up (2 in the control group and 1 in the intervention group). Therefore, 31 and 32 patients completed this study in the control group and intervention group, respectively (Fig. 1).

Demographics

All the participants were female, with no differences in age, education, marital status, job status, monthly household income, medical expense payments, or religious

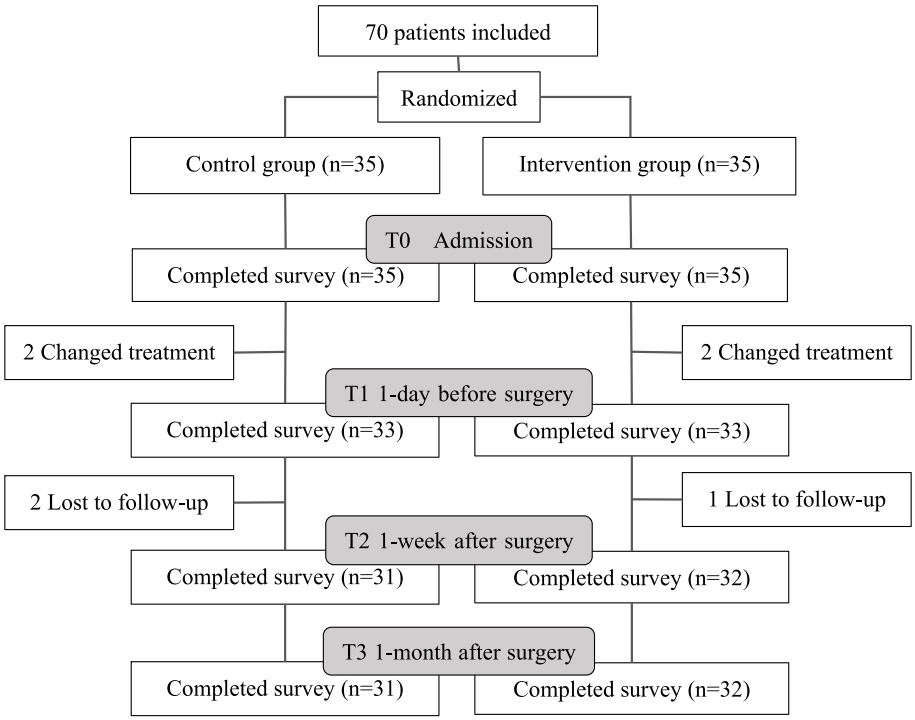

Fig. 1 Flow diagram of the study

beliefs between the control and intervention groups (Table 1).

Decision conflict

Compared with the control group, the intervention group had lower scores in all the dimensions and total scores for decision conflict. There were statistically significant differences between the two groups for the decision support and decision effectiveness dimension, decision uncertainty dimension, and total score ($P < 0.05$, Table 2).

Preferred decision-making roles

There were statistically significant differences between the control group and intervention group for the patients' preferred decision-making roles ($P < 0.05$). The intervention group had a higher proportion of active and collaborative roles, and a lower proportion of passive and full representative family members roles (Table 2).

Unmet information needs

Compared with the control group, the intervention group had lower scores in the information needs, work and financial needs, access and continuity of care, and coping, sharing and emotional needs dimensions, and the total score. The differences between the two groups were statistically significant ($P < 0.05$, Table 2).

Decision Satisfaction

Compared with the control group, the intervention group had higher scores in information, deliberation, decision, and global satisfaction and confidence dimensions, and the total score. The differences between the two groups were statistically significant ($P < 0.05$, Table 2).

Discussion

This study tested the effectiveness of WDAs aids in breast cancer patients considering BR. The results showed that WDAs can significantly alleviate the decisional conflict during the surgical decision-making progress. A recent systematic review also provided consistent evidence that WDAs improved decisional conflict in the reconstruction decision-making process in breast cancer patients [24]. However, Manne et al. [25] showed no differences between a web-based BR DA and pamphlets in patients with early breast cancer. These inconsistent results may be due to the low follow-up completion rate (67.7%) in the intervention group in the Manne et al. study, which may have led to data attrition and affected accurate assessment of the final results. Other studies such as Jacklin et al. [26] reported a virtual patient stimulated clinical decision-making and communication, while in China, Wang et al. [27] showed a WeChat-based DA reduced decisional conflict in liver cancer patients over

Table 1 Distribution of demographic and clinical features

Variables	Total ($N=63$)	Control group ($N=31$)	Intervention group ($N=32$)	t/χ^2	*P* value
Age (years)				1.268[a]	0.210
Mean(SD)	44.7 (9.4)	46.2 (8.9)	43.3 (9.7)		
Range	22–66	32–62	22–66		
Education, *n* (%)				2.279[b]	0.733
Primary and below	3 (4.8)	1 (5.0)	2 (8.1)		
Junior high	15 (23.8)	9 (30.0)	6 (21.6)		
Senior high or vocational	14 (22.2)	6 (17.5)	8 (13.5)		
Undergraduate	27 (42.9)	14 (42.5)	13 (48.7)		
Graduate and above	4 (6.3)	1 (5.0)	3 (8.1)		
Marital status, *n* (%)				0.693[b]	0.935
Married	52 (82.5)	25 (80.0)	27 (89.2)		
Single	2 (3.2)	1 (2.5)	1 (2.7)		
Widowed	4 (6.3)	2 (7.5)	2 (2.7)		
Divorced	5 (7.9)	3 (10.0)	2 (5.4)		
Job status, *n* (%)				3.622[b]	0.258
Employed	27 (42.9)	15 (45.0)	22 (48.7)		
Retired	12 (19.0)	8 (22.5)	4 (18.9)		
Unemployed	1 (1.6)	1 (5.0)	0 (16.2)		
Housewife	13 (20.6)	7 (27.5)	6 (16.2)		
Monthly household income, *n* (%)				3.508[b]	0.494
< 1000	6 (9.5)	2 (10.0)	4 (5.4)		
1000 ~ 3000	15 (23.8)	10 (12.5)	5 (5.4)		
3000 ~ 5000	19 (30.2)	10 (50.0)	9 (59.5)		
5000 ~ 10,000	16 (25.4)	6 (17.5)	10 (24.3)		
> 10,000	7 (11.1)	3 (10.0)	4 (5.4)		
Medical expense payments, *n* (%)				1.648[b]	0.711
Rural cooperation	12 (19.0)	6 (22.5)	6 (29.7)		
Urban residents	41 (65.1)	20 (65.0)	21 (59.5)		
Self-funded	4 (6.3)	3 (7.5)	1 (8.1)		
Other	6 (9.5)	2 (5.0)	4 (2.7)		
Religious beliefs, *n* (%)				0.318[b]	1.000
Yes	3 (4.8)	1 (3.2)	2 (6.3)		
No	60 (95.2)	30 (96.8)	30 (93.8)		

[a] *t* test

[b] Chi-square test

a short period. Decisional conflict is a sense of uncertainty caused by a lack of knowledge regarding treatment options. In the current study, the decision support content of WDAs was developed through semi-structured interviews with patients and family members and expert consultation. Our findings indicate that WDAs have a positive effect on alleviating decisional conflict and can help patients use limited time to weigh the risks and benefits of different surgical methods.

The study also demonstrated that WDAs promotes collaborative decision-making regarding BR. A DA is a tool to implement the shared decision mode. Another study reported that the development of TalkingMats as WDAs to facilitate doctor-patient communication, relieved the stress of decision-making and promoted participation of older patients in decision making [28]. However, Gulati et al. [29] showed that video-based DAs had no positive effect on participation for surgery in patients with obstructive sleep apnea. The reason for these inconsistent results may be the different forms of intervention, with implementation of the WDAs enhancing patients' confidence and providing personalized decision coaching by providing richer decision-making information [30]. In China, the paternalistic decision-making mode

Table 2 Between-group comparisons of participants' decision conflict, decision roles, unmet information needs, and decision satisfaction

Outcome measure	Control group ($N = 31$)	Intervention group ($N = 32$)	t/χ^2	*P* value
T1 (1 day before surgery)				
Decision conflict, mean (SD)				
Information and values	28.23 ± 14.29	25.14 ± 20.89	0.684[a]	0.497
Decision support and decision effectiveness	25.05 ± 11.24	17.23 ± 13.47	2.496[a]	0.015
Decision uncertainty	45.16 ± 15.70	23.83 ± 16.30	5.287[a]	< 0.001
Total score	28.73 ± 10.61	21.00 ± 14.09	2.455[a]	0.017
T2 (1 week after surgery)				
Preferred decision-making roles, *n* (%)			9.314[b]	0.017
Active	9 (29.03)	10 (31.25)		
Collaborative	7 (22.58)	17 (53.13)		
Passive	13 (41.94)	5 (15.63)		
Full representative of family members	2 (6.45)	0 (0.00)		
Unmet information needs, mean (SD)				
Information needs	6.35 ± 2.47	4.66 ± 2.85	2.526[a]	0.014
Work and financial needs	17.39 ± 5.44	13.56 ± 5.76	2.706[a]	0.009
Access and continuity of care	15.26 ± 5.00	10.13 ± 4.98	4.081[a]	< 0.001
Coping, sharing and emotional needs	30.13 ± 10.55	21.34 ± 10.98	3.236[a]	0.002
Total score	69.13 ± 19.21	49.69 ± 20.82	3.848[a]	< 0.001
T3 (1 months after surgery)				
Decision satisfaction, mean (SD)				
Information	74.77 ± 16.09	85.47 ± 17.08	−2.556[a]	0.013
Deliberation	74.74 ± 17.53	86.44 ± 16.93	−2.694[a]	0.009
Decision	69.9 ± 13.21	90.63 ± 13.52	−6.151[a]	< 0.001
Global satisfaction and confidence	77.26 ± 14.42	87.66 ± 18.62	−2.472[a]	0.016
Total score	75.45 ± 15.58	86.78 ± 17.32	−2.727[a]	0.008

[a] *t* test

[b] Chi-square test

is dominant, with patients obeying doctor's advice completely throughout the medical decision process [31]. As a good communication medium, WDAs not only make efficient use of health resources and optimize the decision-making process, but also encourage patients to participate positively in decision-making, thereby promoting high-quality interaction between nurses and patients that results in shared decision-making.

A patient's understanding of different surgical knowledge is the premise for them making choices in line with their personal values. Our study showed that WDAs help patients efficiently understand surgery-related information. Varelas et al. [32] also demonstrated that a virtual DA led to higher post-consultation knowledge. The reason for these similar results may be that WDAs as an online tool can clearly provide the introduction, indication, contraindication, prognosis, and cost of different surgical methods that meet the diverse needs of patients. Meeting the information needs of patients has become one of the indicators to improve the quality of care, with relevant policies having been introduced in China to implement cancer informatization actions and promote the sharing of information resources [33]. Patients can benefit from the WDAs as they provide a real-time consultation service, answer disease knowledge queries, assess surgical risk, promote decisions, and assist in disease management and associated functions [34]. Therefore, WDAs provide a convenient way to obtain information for shared decision-making, which helps patients obtain better information and improves their perception of risk, thereby enabling them to make informed choices.

Patient satisfaction is one of the important indicators for evaluating medical quality. The current study demonstrated that WDAs effectively improved decision satisfaction in patients requiring breast cancer surgery, a finding similar to that of a systematic review [24]. At present, breast cancer patients have been hesitant about online information and have diverse and complex opinions [35]. Faced with different types of BR surgery, patients

considering BR often experience uncertainty, insecurity, and confusion, and may feel regret and guilt when the surgical effect did not meet their expectations. WDAs use the four-terminal intelligent interaction mode of patients, nurses, doctors, and the platform to determine the standardization procedure, personalized content, and human–computer interaction during the decision-making process. This can help patients make reasonable decisions in line with their preferences and improve their satisfaction with the decision.

WDAs face many challenges in practical application. For example, patients may have insufficient medical knowledge to fully understand the information that limits the role of decision-making [10]. Some healthcare professionals are therefore skeptical of WDAs and are reluctant to use them, fearing that they will interfere with professional judgment or increase burden [36]. Therefore, integrating WDAs into the clinical workflow is not an easy task, and requires systematic training of healthcare professionals to understand the advantages of the tools and how to use them in order to increase both their willingness to use them and their self-confidence. At the same time, using publicity and educational activities it is possible to improve patients' knowledge and understanding of the tools. In addition, when considering the high rate of postoperative loss in breast cancer patients which may lead to missing longitudinal data and difficulty determining the impact on long-term quality of survival, the intervention in this study only addressed the need for decision-making in the surgical phase and did not analyze the long-term impact of WDAs on postoperative patients. Moreover, the intervention in this study only focused on the decision needs of breast cancer patients during the surgical phase. Future research is therefore needed to develop online decision-making tools, which monitor the dynamic state over the entire oncologic treatment progress.

Limitations

Even though WDAs are a useful intervention for improving decision quality, the current study had several limitations. Because of ethical principles, the Hawthorne effect could not be ruled out as the participants were aware of their group assignment. Secondly, some patients withdrew from the study midway due to changes in treatment methods, which may have impacted the accuracy of the results. Lastly, the limited sample size and the singular origin of this research may constrain the applicability of the findings to a broader population. To address this, multiple tumor centers have been engaged, and in the future, the sample size will be further expanded to conduct multicenter clinical trials.

Conclusion

This study demonstrated that WDAs optimize the shared decision-making process and promote information sharing. A WDA is a convenient tool for promoting collaborative decision making, satisfying information needs, reducing decision conflicts, and improving decision satisfaction. In addition, the development of WDAs overcomes limitations of region and time, and provides sufficient knowledge for patients to improve their medical experience. With the advent of the era of digital intelligence, future research will be able to design virtual decision-making simulation scenarios based on personalized characteristics in order to achieve the intelligence, dynamic and precision of the shared decision-making process, and effectively improve the health outcomes of patients.

Acknowledgements

We would like to thank all participants for their contributions to this study. At the same time, We would like to thank the doctors and nurses in our department for their help and support during the study.

Authors' contributions

Authors' contributions: Yan Wang is responsible for the entire design and writing of the main paper. Qingyue Zhang is responsible for data collection and writing of the main paper. Chang Cheng is responsible for data collection and writing of the methods. Xiaoyuan Wang and Jian Yin is responsible for revising a paper and data collection. Wanmin Qiang guides the design and writing of papers.

Funding

This work was funded by Tianjin Key Medical Discipline (Specialty) Construction Project (TJYXZDXK-011 A) and Research project of Chinese Nursing Association (ZHKYQ202205).

Data availability

The data that support the findings of this study were not openly available due to reasons of sensitivity. If reasonably requested, it could be obtained from the corresponding author.

Declarations

Ethics approval and consent to participate

This study adhered to the Declaration of Helsinki and was approved by the Ethics Committee of Tianjin Medical University Cancer Institute and Hospital (bc2023101) and registered with the China Clinical Trials Center on Nov 26 th, 2024 (ChiCTR2400092924). All participants voluntarily participated and signed informed consent forms.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 10 February 2025 Accepted: 24 April 2025
Published online: 07 May 2025

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