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Application of the Betty Neuman Systems Model in Nursing Care of a Breast Cancer Patient: A Case Study

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ABSTRACT

Background: Nursing theories provide structured frameworks that guide practice and enhance care quality. The Betty Neuman Systems Model, widely utilized in the care of patients with chronic diseases, adopts a holistic approach by addressing various dimensions of a patient's health. Therefore, this study aims to apply the model in the nursing care of a patient with breast cancer.

Methods: This case study, conducted in Iran in 2021, involved a 47-year-old breast cancer patient selected through purposive sampling. Data were collected via interviews, medical records, and physical examinations. Using the Betty Neuman Systems Model, the interactions among five key variables—physiological, psychological sociocultural, developmental, and spiritual—were assessed, and intra-, inter-, and extra-personal stressors, along with the patient's reactions, were identified. This, in turn, informed the formulation of nursing diagnoses and the development of a comprehensive care plan, which included goals, targeted interventions across three levels of prevention, and outcomes.

Results: Analysis of the five variables and stressors resulted in 13 nursing diagnoses, including 8 actual and 5 risk diagnoses. The model's evaluation of the nursing care plan indicated positive outcomes for the patient.

Conclusion: This study demonstrated the practical application of the Betty Neuman Systems Model in developing a personalized nursing care plan for a breast cancer patient. The findings highlight the model utility in addressing patients' holistic needs and provide practical insights for oncology nursing practice.

Keywords: Betty Neuman Systems Model, Nursing Care, Breast Neoplasms, Holistic Nursing, Nursing Theory

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Introduction

Among various types of cancer, breast cancer stands out as the second most prevalent cancer worldwide. According to the 2022 report from the International Agency for Research on Cancer, breast cancer accounted for about 2.2 million new cases globally, with approximately 15,500 cases diagnosed in Iran alone (Ferlay et al., 2024). It is a complex disease affected by various factors, including demographic (such as age, gender, or race), hormonal (early menarche or late menopause), genetic (family history), breast-related (higher breast density), and lifestyle (higher BMI, being overweight or obese, exposure to tobacco smoke, or high consumption of fatty foods) factors (Ho et al., 2020; Momenimovahed & Salehiniya, 2019; Youn & Han, 2020).

The onset of breast cancer can profoundly affect an individual's physical, psychological, social, and other dimensions of health, creating significant stress for both the patient and their family (Cohee et al., 2021). Given the high incidence and prevalence of the disease, the substantial costs associated with diagnosis and treatment, the limited resources of healthcare systems, and the absence of a national screening system or early detection protocol, providing comprehensive nursing care to patients at all levels is crucial (Abachizadeh et al., 2018; Shamshirian et al., 2020). However, several gaps exist in the nursing care of breast cancer patients. Studies have highlighted insufficient attention to supportive care needs, inadequate education about treatment and recovery, and a lack of integration of patient-centered care into standard practices (Fallowfield et al., 2021; Smith et al., 2022). Furthermore, research studies have shown that in many oncology departments, nurses prioritize treatment over holistic care, despite cancer patients frequently seeking support for their psychological, social, communicative, and emotional needs in addition to their physical concerns (Neves Júnior et al., 2024; Sousa et al., 2022)

Jansen et al. emphasized that breast cancer patients face various physical, psychological, social, emotional, and cognitive stressors that significantly affect their quality of life (Jansen et al., 2023). Addressing these gaps requires holistic care tailored to diverse needs of patients, grounded in appropriate nursing theories. Theories that adopt a systemic perspective, addressing the client's physical, psychological, familial, and environmental dimensions, can offer valuable frameworks for practice, such as the Betty Neuman Systems Model. This model is based on intra-, inter-, and extra-personal stressors, along with lines of defense. It conceptualizes the client as a dynamic system comprising physiological, psychological, developmental, socio-cultural, and spiritual variables, all striving for stability amidst various stressors. Health, according to this theory, is a balance across all dimensions of the individual (Vanaki & Rafiei, 2020).

While holistic nursing care informed by theories like the Betty Neuman Systems Model is strongly advocated in the literature, its application in clinical settings is limited. One of the key strengths of this model is its relevance to chronic patients, as they endure prolonged illness that impacts every aspect of their lives (Vanaki & Rafiei, 2020). By addressing multiple dimensions of an individual—such as personal, familial, and social factors—the Betty Neuman Systems Model evaluates all possible stressors that a patient with a chronic condition like cancer may encounter (Akhlaghi et al., 2020). Consequently, its implementation by nurses in the care of breast cancer patients can improve the delivery of holistic care. To effectively apply nursing models like the above-mentioned one in practice, they must first be clarified through case studies (Vanaki & Rafiei, 2020). These studies provide an in-depth analysis of various elements of the model in real-world settings, paving the way for larger clinical trials and even its direct integration into clinical practice. However, there is a significant lack of case studies exploring the application of nursing models, including the Betty Neuman Systems Model, in the clinical management of breast cancer patients. Thus, this

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study aims to address this gap by illustrating the use of the Betty Neuman Systems Model, a systemic nursing theory, in the care of a breast cancer patient with complex and multifaceted needs.

Methods

This case study explores the application of the Betty Neuman Systems Model in caring for a breast cancer patient. Due to the lack of prior studies on the use of this model in breast cancer patient care, employing this research method to analyze different components of the model within a real clinical setting offers a valid, cost-effective, and efficient approach (Vanaki & Rafiei, 2020). Therefore, this study utilized this method.

For this purpose, a breast cancer patient hospitalized in an oncology ward in Ramsar, Iran, in 2021 was selected through purposive sampling. The diagnosis was confirmed through diagnostic tests and physician's evaluations. A nursing care plan was developed and implemented using the Betty Neuman Systems Model, offering a structured framework for delivering holistic and individualized care (Alligood, 2021). To achieve this objective, the following steps were taken:

I. *Assessment:* A detailed assessment of the patient was conducted, with data collected through interviews, medical records, and physical examination.

II. *Identification of Stressors:* Based on the assessment, stressors affecting the patient's health—categorized as intra-, inter-, and extra-personal—were identified across physiological, psychological, sociocultural, developmental, and spiritual variables.

III. *Nursing Diagnosis:* Using the collected and analyzed data, nursing diagnoses were formulated to address the patient's unique needs and areas requiring intervention.

IV. *Setting Goals and Interventions:* Nursing goals were established, and targeted interventions were designed to address prevention across primary, secondary, and tertiary levels.

V. *Implementation:* The nursing care plan was put into action.

VI. *Evaluation:* The patient's responses to the interventions were monitored, and the effectiveness of the care plan was continuously assessed.

Results

Assessment

1.1. Case history

The patient, a 47-year-old woman, has been married for 28 years and has two daughters: one aged 26, working as a nurse, and the other aged 19, preparing for the university entrance exam. She is a housewife with an associate degree and resides in a house in a rural area with her spouse, two daughters, and her mother-in-law. The patient identifies as Muslim and considers herself religious. Her spouse, aged 54, is self-employed. The family's economic status is average, with coverage provided by the Social Security Insurance, one of Iran's national insurance systems. The patient first noticed a mass in her right breast in November 2019 after taking a bath, which caused fear and anxiety. Despite these emotions, she did not inform anyone. Two weeks later, during breast screening week, she decided to seek medical attention and visited the local health center for a checkup. The midwife at the center observed the mass and advised her to undergo an ultrasound for further investigation. The ultrasound confirmed the presence of a hard mass with an irregular border. To establish a definitive diagnosis, a biopsy was taken. The results confirmed the diagnosis of breast cancer. According to the patient's statements, upon hearing the diagnosis, she experienced intense sadness and impatience, and cried a lot. However, throughout the treatment process, she had full support from her family. Following the definitive diagnosis, the patient's treatment process began. Initially, after examinations by the general surgeon, she underwent partial mastectomy and right axillary lymphadenectomy at a private hospital on December 1st, 2019. After surgery and subsequent evaluations, she was prescribed eight

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chemotherapy sessions and thirty-five radiotherapy sessions. Two weeks after the surgery, her chemotherapy sessions began. However, due to lack of suitable venous access, a port was placed below the left clavicle, which required to be washed monthly to prevent clotting and infection. The patient also reported a history of curettage in 1995, vitiligo for the past five years, and receiving one unit of packed red blood cells following a drop in hemoglobin levels after the first chemotherapy session. According to the patient's medical record, she received Adriamycin and cyclophosphamide during the first four chemotherapy sessions, Taxol in the fifth, Docetaxel for the last two. She was also prescribed Dexamethasone to be taken 30 minutes prior to each chemotherapy session, Filgrastim ampoule 72 hours following each chemotherapy session, and Diphereline ampoule every 28 days. Moreover, to prevent nausea, she took Amesis tablets 30 minutes before each chemotherapy session. Depending on the severity of her symptoms, she would also take two 80 mg doses at other times on the days following the chemotherapy sessions. Currently, the patient is receiving Diphereline ampoule intramuscularly every three months, Tamoxifen tablet twice a day and Calcium D tablet daily. It is worth noting that the patient did not report any history of breast cancer in her family, although her mother has high blood pressure, and her father, sister, and brother have heart disease.

1.2. Case physical examination

During the head and neck examination, alopecia was detected in the temples. The patient also reported reduced vision, requiring glasses for certain tasks. By skin examination, scars were evident in the right breast, right axillary, and in the area related to the port. Furthermore, brown and white spots indicative of vitiligo were observed throughout the patient's body, except for the face. Continuing to the breast examination, no discharge or signs of infection were noted. Moreover, stiffness was noted in the scar area, indicating radiotherapy-induced fibrosis, consistent with diagnostic results. In the gastrointestinal examination, the patient reported increased appetite and weight gain of approximately 7 kg over the past six months. Abdominal examination with a stethoscope revealed decreased bowel sounds, and the patient reported experiencing constipation for several days. The oral and dental examination revealed three decayed teeth, and the patient used dentures in the upper jaw. Finally, during the musculoskeletal examination, the patient reported sustaining an injury to her right wrist last week, following a sprain to her leg and a subsequent fall on her right hand, resulting in slight movement limitation. The patient's vital signs were also checked during examination, which are as follows: BP: 105/70 mmHg, PR: 76/min, RR: 17/min, and T: 37.2°C.

Identification of stressors

Following the thorough assessment of the patient, intra-, inter-, and extra-personal stressors, along with the patient's reactions, were identified and classified within the physiological, psychological, socio-cultural, developmental, and spiritual variables (**Table 1**).

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Table 1. Patient's specific stressors and corresponding reactions across the five variables

Stressors	Reactions
Physiological variable	
Intra-personal	- Constipation - Fatty liver - Weight gain - Receiving new medication - Cancer diagnosis - Vitiligo - Wrist pain - Uterine fibroids - Sleep pattern disorder - Alopecia in the temples - Hyperopia
Inter-personal	- Monthly washing of the port by a nurse
Extra-personal	- None
Psychological variable	
Intra-personal	- Mental image disorder (associated with post-treatment obesity) - Concerns about appearance (vitiligo) - Concerns about the independent performance of activities - Anxiety about alopecia in the temples - Anxiety about the recent mass - Emotional distress during the disease course - Fear of disease recurrence and experiencing past challenges
Inter-personal	- Anxiety about the younger daughter's entrance exam - Anxiety about her sister's health (recently diagnosed with COVID-19)
Extra-personal	- Financial burden of the treatment - Concerns about constructing a new house
Socio-cultural variable	
Intra-personal	- None
Inter-personal	- Expectation of household responsibilities from the spouse
Extra-personal	- Avoidance of wearing favorite clothes at parties due to appearance
Developmental variable	
Intra-personal	- Decline in independence when performing heavy tasks
Inter-personal	- Maternal role disruption - Disruption in managing household affairs
Extra-personal	- None
Spiritual variable	
Intra-personal	- Concerns about inability to fast - Concerns about inability to fully focus on prayers during treatment
Inter-personal	- None
Extra-personal	- Concerns about inability to participate in religious gatherings

Nursing care plan

Thirteen nursing diagnoses were formulated based on the assessment of the five variables and identified stressors, adhering to NANDA International's Nursing Diagnoses (Ackley et al., 2021). Among these, 8 were actual diagnoses, and 5 were risk diagnoses. Subsequently, goals were established, interventions were designed, and the nursing care plan was implemented. This care plan included specific goals, targeted interventions across the levels of prevention, and outcomes (**Table 2**).

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Table 2. The established nursing care plan using the Betty Neuman Systems Model

Behavior	Nursing diagnosis	Goals	Level of prevention	Targeted intervention(s)	Outcome(s)
Physiological variable					
The patient reported not having a bowel movement in the past three days.	Constipation related to inactivity and weight gain.	To alleviate the symptoms of constipation and facilitate a bowel movement within the next 24 hours.	Secondary	1. Providing education on the benefits of consuming high-fiber food, such as nuts, whole grains, prune, etc. 2. Assessing bowel sounds. 3. Encouraging adherence to a routine of regular physical exercises and walking. 4. Providing education on the benefits of consuming warm liquids following meals.	- The patient followed the recommended diet. - The patient walked for 0.5 to 1 hour daily (She mentioned that every evening, she and her friend would walk for at least half an hour from their home to the bakery to purchase bread).
The patient reported staying up late and waking up early.	Disturbed sleep pattern related to medications.	To attain a consistent sleep pattern, aiming for the patient to sleep for at least 6 to 7 hours each night within the next 2 to 3 days.	Secondary	1. Minimizing the environmental stimuli, such as light and sound. 2. Instructing the patient to use the bed solely for sleep-related activities. 3. Encouraging the patient to take a warm shower before going to sleep. 4. Advising against consuming caffeinated drinks before going to sleep. 5. Modifying medication administration times to avoid disrupting sleep patterns.	- The patient experienced improved rest and achieved sufficient sleep duration at nights.
The patient reported that her clothes became tighter and she gained 7 kg in weight since the beginning of the treatment.	Imbalanced nutrition (using more than body requirements) related to chemotherapy.	To balance the patient's weight, aiming for her to lose half a kilogram a week.	Secondary	1. Providing education on modifying nutritional habits, such as focusing solely on eating during meals, eating slowly and thoroughly chewing food, reducing or eliminating consumption of low-nutrient food, like chips and biscuits, and using smaller plates to control portion sizes. 2. Instructing the patient to read food labels so as to assess their nutritional value and calorie. 3. Implementing weight control measures.	- The patient walked for 0.5 to 1 hour daily. - The patient reduced her consumption of rice and fatty food.

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Behavior	Nursing diagnosis	Goals	Level of prevention	Targeted intervention(s)	Outcome(s)
When the patient moved her right wrist, she reported pain, and her facial expression showed signs of discomfort.	Pain related to the nature of disease.	To decrease the patient's pain level from 7 to 4 within the next 36 to 48 hours.	Secondary	1. Immobilizing the injured limb with a splint. 2. Elevating the injured limb. 3. Applying ice compress. 4. Distracting the patient.	- The patient reported a reduction in pain level from 7 to 4 on the Visual Analogue Scale.
The patient reported that every month the oncology nurse washes her port.	Risk of infection related to insufficient knowledge about port care.	To reduce the risk of infection by educating the patient to identify 2 to 3 signs of infection.	First	1. Emphasizing the need to wash hands thoroughly before washing the port and to consider sterile techniques during the procedure. 2. Providing education on recognizing signs of infection, such as redness, swelling, warmth, and fever, and encouraging her to report any observed symptoms promptly. 3. Regularly monitoring the vital signs. 4. Collaborating with the physician to schedule blood tests and cultures.	- The patient was able to name 2 symptoms of infection.
-	Risk of liver dysfunction related to grade 2 to 3 fatty liver.	To reduce the risk of liver dysfunction by educating the patient to identify 2 to 3 solutions to deal with weight gain and reduce the effects.	First	Promoting lifestyle modifications, such as advising on dietary balance, supporting the reduction of fatty foods intake, facilitating weight management strategies, and advocating for regular physical activity and exercise.	- The patient was able to name 3 solutions to deal with weight gain and reduce the effects.
Psychological variable					
The patient reported discomfort with her appearance due to vitiligo, obesity, weight gain, alopecia in the temples, and the appearance of her breast after the surgery.	Body image disturbance related to vitiligo, obesity, alopecia, and breast incision.	- Creating a positive attitude and improving her mental image, so that she implements two weight loss strategies during her next meal. - creating a positive attitude and improving her mental	Secondary and tertiary	*General interventions:* 1. Promoting emotional expression. 2. Active listening to her concerns. 3. Identifying and reinforcing her strengths and positive attributes. *Interventions for obesity:* 1. Providing education on modifying nutritional habits, such as focusing solely	- It appeared that additional time was required to evaluate the psychological issue and assess the effectiveness of the interventions.

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Behavior	Nursing diagnosis	Goals	Level of prevention	Targeted intervention(s)	Outcome(s)
		image, so that she goes in front of the mirror, and acknowledges and affirms the positive aspects of her appearance.		on eating during meals, eating slowly and thoroughly chewing food, reducing or eliminating consumption of low-nutrient food, like chips and biscuits, and using smaller plates to control portion sizes. 2. Encouraging adherence to a routine of regular physical exercises and walking. *Interventions for vitiligo:* 1. Encouraging positive self-image and self-care practices. 2. Encouraging to communicate with other people with similar conditions. *Interventions for alopecia:* 1. Ensuring the regrowth of hair. 2. Instructing the patient to wear a wig, a scarf or headband until hair regrows. *Interventions for breast incision:* 1. Encouraging to observe and touch the incision. 2. Encouraging to communicate with other people with similar conditions. 3. Recommending to use prosthesis.	
Observing the confused and anxious face of the patient while answering the questions.	Anxiety related to her sister's disease, constructing a house, and her younger daughter's entrance exam.	To reduce the patient's anxiety level by educating her to identify 2 anxiety management strategies.	Secondary	1. Providing education on relaxation and deep breathing exercises. 2. Active listening to her concerns. 3. Encouraging the patient to do her favorite activities.	-
The patient reported concerns about the possibility of something being detected again in the ultrasound,	Fear of disease recurrence.	To reduce the patient's fear level within the next 2 to 3 days, aiming for her to express confidence in her	Secondary	1. Cultivating optimistic and reassuring thoughts (e.g., "i believe everything will proceed positively and happily."). 2. Instructing the patient to discuss the	- The patient was able to name 2 solutions to cope with the fear.

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Table 2. The established nursing care plan using the Betty Neuman Systems Model

Behavior	Nursing diagnosis	Goals	Level of prevention	Targeted intervention(s)	Outcome(s)
expressing the fear of disease recurrence and experiencing past challenges.		health and use strategies to deal with stress.		concerns with family members for support and reassurance. 3. Instructing the patient to write down her fears. 4. Redirecting thoughts and engaging in enjoyable activities as coping strategies.	
The patient reported feelings of helplessness and powerlessness due to limitations in lifting heavy objects, leading to a sense of dependence on others.	Emotional distress related to disability following a mastectomy.	To alleviate the patient's emotional distress and sadness, fostering a mindset where she feels comfortable seeking assistance from others when handling heavy tasks.	Tertiary	1. Establishing clear and effective communication with the patient. 2. Providing support and encouragement for positive behaviors and actions. 3. Ensuring the patient is not left alone. 4. Engaging with family members to assist in household chores and activities, promoting shared responsibility and support. 5. Encouraging engagement in enjoyable activities.	- Following the discussion session, the client sought assistance from others to manage heavy tasks.
Socio-cultural variable					
The patient reported that due to the appearance of her skin (vitiligo), she cannot wear her favorite clothes in social gatherings.	Risk of social isolation related to the appearance of her skin (vitiligo)	To increase satisfaction with community participation to mitigate feelings of isolation.	First	Providing support to maintain basic social skills and minimize social isolation: ✓ Offering therapy-support groups. ✓ Focusing on identifying and reinforcing the patient's strengths and positive attributes. ✓ Implementing self-confidence-building techniques, such as using affirming statements. ✓ Promoting family-oriented support activities. ✓ Wearing covering clothes.	- The patient was able to name 3 ways to deal with the social isolation.

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Behavior	Nursing diagnosis	Goals	Level of prevention	Targeted intervention(s)	Outcome(s)
Developmental variable					
The patient reported that there have been lifestyle changes since the disease, and when discussing these changes, she expressed sadness.	Risk of self-concept disturbance related to the changes of lifestyle and roles	To create a positive view in the patient.	First	1. Promoting emotional expression. 2. Providing accurate information and correcting misconceptions to ensure clarity. 3. Minimizing attention to limitations and emphasizing the identification and enhancement of positive attributes. 4. Assisting in the exploration of strategies to enhance independence and sustain roles within the patient's capabilities. 5. Engaging with family members to assist in household chores and activities, promoting shared responsibility and support. 6. Encouraging participation in group activities and discussions with individuals facing similar challenges.	- It appeared that additional time was required to evaluate the developmental issues and assess the effectiveness of the interventions.
Spiritual variable					
The patient reported concerns about inability to fast and to fully focus on prayers during the treatment course. The patient reported concerns about inability to participate in religious gatherings, due to the COVID-19 pandemic.	Risk of spiritual tension related to the treatment course and COVID-19 pandemic.	To achieve a desirable level of spiritual attitude, resulting in observable changes in the patient's behavior within 24 to 48 hours.	First	1. Listening to the patient's words and respecting her beliefs. 2. Encouraging to pray. 3. If needed, use or coordinate with a spiritual person to talk to her.	- It appeared that additional time was required to evaluate the spiritual issues and assess the effectiveness of the interventions.

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Discussion

This study explores the application of the Betty Neuman Systems Model in caring for a breast cancer patient. The findings demonstrated the practical application of the Betty Neuman Systems Model in developing a personalized nursing care plan for a breast cancer patient. The findings highlight the model's utility in addressing patients' holistic needs and provide practical insights for oncology nursing practice. This aligns with previous studies exploring the application of this model in patients with various clinical conditions.

For instance, Kabusi and Yazdi, in a study involving a patient undergoing Whipple surgery, demonstrated that employing this model in nursing practice aids in identifying diverse intra-, inter-, and extra-personal stressors experienced by the patient (Kabusi & Yazdi, 2024). Similarly, Savsar et al., in a study on a patient with electrical burns, found that the model reinforces the flexible line of defense to enhance individual coping and helps identify deficiencies in the normal and resistance lines of defense. The study also highlighted the model utility as a theoretical framework for nurses caring for burn patients, where systemic impacts are prevalent (Savsar et al., 2022). In another study focused on a patient undergoing a kidney transplant, Goodarzi et al. showed that the model effectively supports nursing care and facilitates the diagnosis of intra-, inter-, and extra-personal stressors (Goodarzi et al., 2021). In the field of cancer care, some studies were identified. For example, Oshvandi et al. evaluated the implementation of a nursing process based on the Betty Neuman Systems Model in a patient with colorectal cancer. They concluded that this approach improves understanding of care needs and supports the delivery of efficient, evidence-based nursing care (Oshvandi et al., 2024).

In general, it can be stated that the Betty Neuman Systems Model offers nurses a valuable framework for delivering holistic care, particularly for patients with breast cancer. However, Cheraghi and Javaheri revealed that the application of this model within the Iranian nursing system is very poor. They also showed that nurses working in hospitals predominantly focus on providing care at the secondary prevention level—care and treatment—and their activities are limited in other settings providing holistic care and prevention levels (Cheraghi & Javaheri, 2020). This may stem from the relatively recent introduction of holistic care concepts in Iranian nursing education, resulting in its limited integration and recognition within the nursing practice. Furthermore, it seems that there are numerous barriers hindering the effective implementation of nursing theories. Addressing these topics solely through postgraduate studies might not adequately prepare nursing students and graduates to overcome the barriers and apply theoretical frameworks effectively in practice. Hence, it is recommended to promote reflective clinical practice among students and faculty members, cultivate a culture of lifelong learning, enhance the utilization of nursing theories, engage clinical nursing professors in nursing education, align teaching with clinical demands, revise curricula, update faculty and nurses' knowledge, equip clinical skill centers in educational institutions and hospitals, and foster greater interaction between professors and nurses in clinical settings. These proactive educational measures can in turn help bridge the theoretical-practical gap and facilitate the effective application of nursing theories (Sadat Hosseini et al., 2020).

Conclusion

The Betty Neuman Systems Model proved to be an effective and practical framework for addressing the nursing needs of the breast cancer patient in this study, particularly in managing the impact of various stressors. The study highlights the model utility in structuring holistic nursing care plans and highlights its potential application in similar clinical contexts. However, as the findings are derived from a single patient case, they are inherently limited and cannot be generalized to other patients or populations. Future research should explore the Betty Neuman Systems Model application across various clinical settings and cancer types to

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assess its adaptability. Larger, longitudinal studies could strengthen evidence of its utility. Tailored interventions addressing specific stressors and integrating technologies like telehealth may enhance its effectiveness. Additionally, nurse training programs could support consistent and efficient implementation in practice.

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Conflict of Interest

The authors declare that they have no competing interests.

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Ethical considerations

The researchers adhered to all ethical principles for medical research involving human subjects, including confidentiality, voluntary participation, etc., throughout all stages. After outlining the research objective and methods, the patient was asked to read and sign the informed consent form.

Code of ethics

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Author's contributions

AF and AR conceptualized the study, developed the research idea, formulated objectives, and designed the study framework. All authors (AF, HR, AR) contributed to data interpretation and manuscript revision. HR and AR planned the research methods, data collection, and analysis. HR oversaw the research process and contributed to manuscript revision. AR wrote the first draft and managed project coordination. All authors read and approved the final manuscript.

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