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Research on the Current Status and Influencing Factors of Oral Health of Breast Cancer Patients during Chemotherapy

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Abstract: Objective: To explore the current status of oral health of breast cancer patients during chemotherapy and to analyze its influencing factors. Methods: From July 2024 ~ February 2025, 409 breast cancer patients who received chemotherapy routinely in three tertiary hospitals were selected as the survey subjects. At the same time, laboratory indicators such as hemoglobin, leukocytes, neutrophils, and C-reactive protein, as well as unstimulated salivary flow rate and salivary PH value, were collected, and multiple linear regression analysis was used to screen the influencing factors of oral health. Results: The oral health status score of breast cancer patients during chemotherapy was (5.12±2.86), and multiple linear regression analysis showed that age, oral disease history, oral PH value, unstimulated salivary flow rate, combined immunotherapy, vomiting during chemotherapy, white blood cell count, lymphocyte count, oral health literacy, and oral self-care efficacy were all influencing factors of oral health status during chemotherapy in breast cancer patients (all $P<0.05$). Conclusion: The oral health status of breast cancer patients during chemotherapy is moderately low, and it is related to a variety of factors, so medical staff should pay attention to their oral health problems and formulate targeted oral care plans to improve the oral health of patients.

Keywords: Breast Cancer; Chemotherapy; Oral Health Conditions; Influencing Factors.

1. Introduction

Breast cancer is the most common malignant tumor among women in the world [1], and chemotherapy is one of the important means of treating breast cancer. Studies have shown that the incidence of chemotherapy-related oral complications is estimated to be 31%~93% [2], and breast cancer patients often face symptoms such as oral mucositis, oral infection, periodontitis, and xerostomia during chemotherapy, which seriously interferes with the treatment effect. Studies have shown that poor oral health may exacerbate the progression of breast cancer through systemic inflammatory responses and even increase the risk of recurrence or metastasis [3,4]. Problems such as oral infections and periodontitis can lead to the release of inflammatory factors that not only affect the local oral environment, but also affect the growth and metastasis of breast cancer cells through blood circulation. A study by West China Stomatological Hospital of Sichuan University [5] showed that the persistence of periodontitis promotes the metastasis of early breast cancer to the cervical lymph nodes. Oral complications during chemotherapy cause oral pain and discomfort in patients, affect eating, lead to malnutrition, and in severe cases, interrupt chemotherapy, affecting the overall treatment effect. Therefore, the oral health of breast cancer patients cannot be ignored, especially during breast cancer treatment, maintaining oral health is crucial to prevent cancer recurrence or metastasis, improve the efficacy of chemotherapy, and improve the quality of life of patients

2. Objects and Methods

2.1. Object

Breast cancer patients who received chemotherapy in three tertiary hospitals in Tangshan City, Hebei Province from July 2024 ~ February 2025 were selected by convenient sampling method. Inclusion criteria: (1) Patients diagnosed with breast cancer by pathological morphology examination and participating in chemotherapy with reference to the Guidelines and Specifications for the Diagnosis and Treatment of Breast Cancer of the Chinese Anti-Cancer Association (2024 Edition); (2) Be over 18 years old; (3) Patients without reading and writing impairment and able to complete the questionnaire independently; (4) Patients who are willing to participate in this study and sign the informed consent form. Exclusion criteria: (1) Previous severe mental illness; (2) Combined with severe heart, brain, kidney and other organ dysfunction or in the acute onset of the disease. (3) Combined with other tumors; (4) Oral health problems such as oral ulcers and gingivitis before treatment. This study has been approved by the Ethics Committee (2024252). All survey subjects gave informed consent and voluntarily participated in this study.

2.2. Sample Size

According to the requirements of variable analysis, the sample size is at least 5~10 times that of the variable [6]. There were 41 variables in this study, and considering a 20% loss to follow-up rate, the sample size should be at least 257 cases. A total of 420 questionnaires were distributed in this study, and a total of 409 valid questionnaires were actually collected, with an effective recovery rate of 97%.

2.3. Survey Tools

Based on literature review, clinical practice experience and group discussion, we designed a questionnaire on the oral health status of breast cancer patients, including age, BMI, education level, diabetes history, hypertension,

hyperlipidemia, oral disease history, daily water intake after chemotherapy, oral self-cleaning habits, oral PH value, unstimulated salivary flow rate, whether immunotherapy, endocrine therapy, number of chemotherapy, whether vomiting occurred during chemotherapy, and whether shirtanes were included in the chemotherapy regimen. Laboratory indicators such as capecitabine, white blood cell count, and neutrophil count were sequentially performed after chemotherapy. The scale used the Chinese version of the Concise Oral Health Examination Form [7](BOHSE), the Oral Self-Care Efficacy Scale (SESS), and the Oral Health Literacy Scale [8](HeLD-14), and the unstimulated saliva flow rate of the patients was collected using a disposable saliva collector, and the oral PH value of the patients was collected by oral PH test strips.

2.4. Statistical Methods

Data were analyzed using SPSS 27.0 software. Measurement data conforming to normal distribution were expressed as x ± s, and count data were expressed as frequency and constituent ratio. Statistical methods included independent sample t-test, one-way analysis of variance, Spearman correlation analysis, and multiple linear regression. A P value < 0.05 or < 0.01 was considered statistically significant.

3. Results

3.1. Oral Health Status of Breast Cancer Patients During Chemotherapy

The BOHSE score of breast cancer patients during chemotherapy was (5.12 ± 2.86) points, which was at a medium to low level. However, it was lower than the oral health status of liver cancer patients (7.64 ± 2.67) points investigated by Tao Yue et al. [9]. The possible reason might be that liver cancer patients had more severe smoking and drinking habits compared with breast cancer patients, and liver cancer patients were accompanied by liver function damage and malnutrition, which might make them more prone to oral mucosa and periodontal problems. In this study, the highest score of oral health of breast cancer patients was 13 points, and the lowest was 0 points (the higher the score, the worse the oral health status).

3.2. Analysis of Influencing Factors of Oral Health Status Based on General Patient Information and Related Disease Information

Table 1. Univariate analysis of oral health status of breast cancer patients during chemotherapy

Factor	number[n(%)]	Oral health status score(x±s)	t or F	*P* value
age			26.445	0.000
18~	80	3.65±2.26		
46~	158	4.73±2.73		
≥60	171	6.17±2.86		
Education			16.094	0.000
Primary school and below	85	6.45±2.73		
Junior high school	151	5.28±2.85		
high school or technical secondary school	95	5.00±2.84		
College degree or above	78	3.51±2.25		
BMI			0.164	0.849
<18.5	17	5.24±2.73		
18.5-23.9	138	5.01±2.82		
>23.9	254	5.17±2.90		
diabetes			-3.574	0.000
No	348	4.91±2.73		
Yes	61	6.23±3.30		
hypertension			-2.288	0.023
No	311	4.94±2.86		
yes	98	5.69±2.76		
High blood lipids			0.725	0.469
No	385	5.15±2.87		
Yes	24	4.71±2.82		
History of oral disease			-8.742	0.000
No	286	4.37±2.62		
Yes	123	6.85±2.66		
Denture			-3.185	0.002
No	310	4.87±2.73		
Yes	99	5.91±3.11		
Oral PH value			8.645	0.000
<6.5	183	6.37±2.74		
≥6.5	226	4.11±2.54		
Saliva flow rate			35.976	0.000
<0.1ml/min	85	6.81±3.32		
0.1-0.2ml/min	187	5.62±2.11		
0.21-0.3ml/min	81	3.49±2.20		
>0.3ml/min	56	3.23±3.00		
Daily water intake after chemotherapy			22.327	0.000
<1000ml	216	5.96±2.85		
1000-2000ml	141	4.28±2.45		
>2000ml	52	3.88±2.92		

Table 1 (Continued table)

Factor	number[n(%)]	Oral health status score(x±s)	t or F	*P* value
Clinical staging			6.929	0.000
I	75	4.13±2.71		
II	247	5.07±2.82		
III	61	5.98±2.90		
IV	26	6.42±2.59		
Molecular typing			10.978	0.000
Luminal A	124	4.27±2.71		
Luminal B	72	4.79±2.72		
HER2	140	5.30±2.91		
TNBC	73	6.55±2.60		
Ki-67			-1.753	0.08
Low expression	221	4.89±2.99		
High expression	188	5.39±2.69		
Combination immunotherapy			-4.600	0.000
No	390	4.98±2.79		
Yes	19	8.00±2.96		
Combined endocrine therapy			-1.711	0.101
No	390	5.08±2.87		
Yes	19	5.89±1.97		
Number of chemotherapy sessions			-6.082	0.000
<4	207	4.30±2.78		
≥4	202	5.96±2.71		
Chemotherapy regimens include paclitaxel			-0.387	0.699
No	84	5.01±2.73		
Yes	325	5.15±2.90		
After chemotherapy, capecitabine was sequentially administered			-3.624	0.000
No	389	5.01±2.83		
Yes	20	7.35±2.60		
vomit			-6.252	0.000
No	274	4.53±2.66		
Yes	135	6.33±2.90		
White blood cell count			-6.239	0.000
$<4\times10^9$/L	128	6.46±3.10		
$\geq4\times10^9$/L	281	4.51±2.53		
Serum albumin			2.132	0.036
<40g/L	60	5.98±3.50		
≥40g/L	349	4.97±2.72		
Use mouthwash prophylactically			2.719	0.008
No	328	5.33±2.75		
Yes	81	4.28±3.17		

The univariate analysis of the oral health status of breast cancer patients during chemotherapy based on general patient information and related disease information is detailed in Table 1. The oral health status of breast cancer patients during chemotherapy showed statistically significant differences in age, educational level, history of diabetes, history of hypertension, history of oral diseases, presence or absence of dentures, oral pH value, unstimulated salivary flow rate, water intake on the second day after chemotherapy, clinical stage, molecular typing, whether combined with immunotherapy, number of chemotherapy sessions, sequential capecitabine after chemotherapy, occurrence of vomiting during chemotherapy, white blood cell count, and serum albumin count ($P < 0.05$).

3.3. Correlation between Some Relevant Laboratory Indicators, Oral Health Literacy, Oral Health Self-Efficacy and Oral Health Status of Breast Cancer Patients during Chemotherapy

The correlation between relevant laboratory indicators and oral health status during chemotherapy in breast cancer patients is shown in Table 2. The results showed that hemoglobin count, neutrophil count, platelet count, lymphocyte count were negatively correlated with oral health status scores.

The correlation between oral health literacy, oral self-care efficacy and oral health status of breast cancer patients during chemotherapy is detailed in Table 3. The results showed that the mean values of the HeLD-14 scale and SESS scale were negatively correlated with the BOHSE score.

Table 2. Correlation between some relevant laboratory indexes and oral health status scores in breast cancer chemotherapy patients

Project	r	*P value*
haemoglobin	-0.269	<0.01
Neutrophils	-0.283	<0.01
platelet	-0.225	<0.01
lymphocyte	-0.341	<0.01
Alanine aminotransferase	0.041	0.425
Aspartate aminotransferase	0.112	<0.05
Serum creatinine	0.014	0.747
C-reactive protein	0.119	<0.05

Table 3. Correlation of oral health literacy, oral health-related self-efficacy, and BOHSE scores in breast cancer chemotherapy patients

project	HeLD-14							SESS			
	concern	Under-stand	In the tank	Financial burden	Medical treatment	communicate	apply	Regular oral visits	Brush your teeth properly	Balanced diet	BOHSE total score
concern	1										
understand	.751**	1									
In the tank	.713**	.689**	1								
Financial burden	.723**	.747**	.765**	1							
Medical treatment	.809**	.797**	.775**	.778**	1						
communicate	.773**	.754**	.723**	.768**	.851**	1					
apply	.740**	.706**	.663**	.733**	.748**	.860**	1				
Regular oral visits	.761**	.650**	.645**	.672**	.689**	.645**	.590**	1			
Brush your teeth properly	.741**	.678**	.629**	.675**	.693**	.687**	.637**	.781**	1		
Balanced diet	.623**	.557**	.488**	.547**	.537**	.562**	.531**	.659**	.756**	1	
BOHSE total score	-.547**	-.514**	-.528**	-.528**	-.524**	-.484**	-.445**	-.567**	-.600**	-.462**	1

*P<0.05, **P<0.01

3.4. Multiple Linear Regression Analysis of Oral Health Status During Chemotherapy in Breast Cancer Patients

Table 4. Multiple linear regression analysis of oral health status of breast cancer patients during chemotherapy

	Non-standardized coefficients			Standardization coefficient	T value	*P* value	Collinearity diagnosis	
	B value	Standard error		β value			VIF	Tolerance
constant	9.606	1.203			7.985	<0.001		
Age	0.031	0.010		0.122	3.129	0.002	1.643	0.609
History of oral disease	0.759	0.226		0.122	3.353	0.001	1.414	0.707
Oral PH value	-0.689	0.202		-0.120	-3.419	0.001	1.319	0.758
Saliva flow rate	-0.660	0.105		-0.217	-6.272	<0.001	1.284	0.779
Chemotherapy combined with immunotherapy	1.042	0.466		0.077	2.239	0.026	1.261	0.793
vomit	0.657	0.205		0.108	3.211	0.001	1.217	0.822
White blood cell count<4×10^9/L	0.685	0.240		0.111	2.856	0.005	1.623	0.616
Lymphocyte count	-0.560	0.177		-0.113	-3.156	0.002	1.379	0.725
Oral health literacy	-0.039	0.013		-0.161	-2.925	0.004	3.238	0.309
Oral self-care efficacy	-0.053	0.013		-0.208	-4.069	<0.001	2.800	0.357
R^2					0.648			
Adjusted R^2					0.620			
F /P					23.206/0.000			
D-W					1.705			

The results of multiple linear analysis (Table 4) show that the tolerance of the model is 0.309 to 0.822, and the variance inflation factor is 1.217 to 3.238, indicating that there is no multicollinearity among the independent variables. F = 23.206, P = 0.000, indicating that the regression equation is valid. Among them, the independent variables with a P value less than 0.05 from the t-test of each independent variable were included in the multiple stepwise regression model: age, history of oral disease, oral pH value, unstimulated salivary flow rate, whether combined with immunotherapy, whether vomiting occurred during chemotherapy, white blood cells < 4×10^9/L after chemotherapy, lymphocyte count, oral health literacy, and oral health-related self-efficacy. According to the absolute value of the standardized partial regression coefficient (β), the influence of the independent variables on the dependent variable from large to small is as follows:

salivary flow rate, oral self-care efficacy, oral health literacy, history of oral disease, age, oral pH value, lymphocyte count, white blood cells < 4×10^9/L after chemotherapy, whether vomiting occurred during chemotherapy, and whether combined with immunotherapy. The adjusted R^2 = 0.620, indicating that the 10 variables jointly explain 62% of the total variation in oral health status during chemotherapy in breast cancer patients. The final regression equation is: oral health status = 9.606 - 0.906 × salivary flow rate - 0.053 × self-care efficacy - 0.039 × oral health literacy + 0.759 × history of oral disease + 0.031 × age - 0.689 × oral pH value - 0.560 × lymphocyte count + 0.685 × white blood cells < 4×10^9/L after chemotherapy + 0.657 × whether vomiting occurred during chemotherapy + 1.042 × whether combined with immunotherapy.

4. Discussion

4.1. The Oral Health Status of Breast Cancer Patients During Chemotherapy is at a Moderately Low Level

The results show that the oral health status of breast cancer patients during chemotherapy is (5.12 ± 2.86) points, which is at a moderately low level. The scores of the three items of buccal, floor of mouth and upper jaw mucosa, saliva secretion and tissue influence. Therefore, during chemotherapy for breast cancer patients, attention should be paid to their oral health, especially for the protection of oral mucosa and the maintenance of salivary gland function, and early intervention measures should be taken to reduce chemotherapy-related oral complications and improve the quality of life and treatment compliance of patients.

4.2. Age

This study found that age is an important factor influencing the oral health of breast cancer patients during chemotherapy. The older the patients are, the worse their oral health condition tends to be. This may be related to factors such as the decline in oral barrier function, poor periodontal health, weakened immune function, tooth loss, and decreased estrogen levels in the body after menopause, which all contribute to oral dryness [10]. Additionally, elderly patients often lack adequate knowledge of oral health and proper implementation of health behaviors, which results in them less frequently adopting effective oral self-care measures in their daily lives. Chemotherapy drugs not only cause dryness, pain, and ulcers in the oral mucosa of patients, but also lead to gum atrophy and gum bleeding, making the oral environment even more vulnerable.

4.3. History of Oral Diseases and Oral pH Value

Breast cancer patients with a history of oral diseases had poorer oral health during chemotherapy. This is consistent with the conclusions of relevant studies [11, 12]. This might be due to the imbalance of oral microecology caused by previous oral diseases, and under the immunosuppressive effect of chemotherapy, patients are more prone to oral complications [11]. Therefore, conducting a comprehensive oral assessment and treatment for patients before chemotherapy, and improving the original oral disease conditions, may help reduce the risk of oral health deterioration during chemotherapy. The research results show that breast cancer patients with an oral pH value < 6.5 have poorer oral health. Chemotherapy may lead to reduced saliva secretion and oral flora imbalance, causing oral acidification and making the mouth more prone to infection or mucosal damage. Therefore, during chemotherapy, encouraging patients to drink appropriately, using weakly alkaline mouthwash, and reducing high-sugar diet can help maintain the stability of oral pH value and reduce the risk of oral complications.

4.4. No Stimulated Saliva Flow Rate

This study found that patients with lower salivary flow rates who were not stimulated had worse oral health. Saliva not only helps lubricate the mouth, buffer the acidic environment, and maintain microbial balance, but also has antibacterial, anti-inflammatory, and wound healing functions [13]. Studies have shown that decreased estrogen levels in postmenopausal women can lead to salivary gland atrophy and decreased saliva secretion [14], which can worsen dry mouth symptoms. According to the salivary flow rate standard, unstimulated salivary flow rate <0.1 ml/min is considered an indicator of xerostomia, and dry mouth symptoms can be felt < 0.2 ml/min [15]. Foreign [16] surveys on the oral health of cancer patients pointed out that among various cancer patients, breast cancer patients have the highest incidence of insufficient saliva secretion, and dry mouth has become one of the important factors affecting their quality of life.

4.5. Chemotherapy Combined with Immunotherapy

The results of this study showed that breast cancer patients receiving chemotherapy combined with immunotherapy had worse oral health than chemotherapy alone. Immunotherapy is an important means of cancer treatment in recent years, oral mucosa is one of the common target organs for immune-related adverse reactions, and common oral adverse reactions in clinical practice include oral mucositis, oral ulcers, taste disorders and dry mouth. Studies have shown that PD-1/PD-L1 inhibitors and CTLA-4 inhibitors may cause oral immune-mediated inflammatory responses [17], thereby damaging oral mucosal tissues and aggravating oral discomfort symptoms.

4.6. Vomiting During Chemotherapy

The results of this study showed that patients who experienced vomiting during chemotherapy had significantly worse oral health. Feng Wen et al. [12] pointed out that vomiting is a risk factor for chemotherapy-associated oral mucositis in patients with hematological malignancies. Vomiting can cause stomach acid to reflux into the mouth, causing irritation and damage to the oral mucosa, weakening its barrier function, affecting oral hygiene, and lowering saliva pH, thereby increasing the risk of oral infections. Therefore, for patients who are prone to vomiting during chemotherapy, antiemetic measures should be actively taken and patients should be instructed to rinse their mouths after vomiting.

4.7. Decrease in White Blood Cell Count and Lymphocyte Count After Chemotherapy

The results of this study showed that patients with lower white blood cell counts and lower lymphocyte counts after chemotherapy had worse oral health. A decrease in white blood cell levels means that the body's immune function is

reduced, and patients are more likely to develop oral infections. In addition, lymphocytes, as a core component of the body's immune system, can effectively regulate the local immune response and maintain the health of the oral mucosa, and lymphocytopenia will weaken the oral immune defense against microorganisms. Foreign studies have found [18,19] that leukopenia or lymphocyte reduction after treatment in cancer patients is one of the risk factors for oral health problems. Clinical nurses should identify immunocompromised patients early for oral health interventions.

4.8. Oral Health Literacy and Oral Self-Care Efficacy

The results of this study show that patients with higher oral health literacy and oral self-care efficacy have better oral health conditions. Patients with higher oral health literacy can better understand and implement oral care measures, such as correct tooth brushing, preventive use of mouthwashes, and regular oral examinations, thereby reducing the occurrence of oral health problems. Patients with higher oral self-care efficacy can adopt more proactive coping strategies when facing oral discomfort caused by chemotherapy, such as strengthening oral hygiene and promptly reporting to the doctor. A study by Yang Xuemei on the oral health status of patients with mental disorders showed that patients with higher oral health literacy have stronger oral health understanding and knowledge application abilities, and can better identify oral health problems.

5. Conclusion

This study suggests that early screening, comprehensive intervention and health education should be strengthened in clinical practice to improve patients' oral health, improve their quality of life, and reduce the risk of breast cancer metastasis or recurrence.

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