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Development of a Multidimensional Assessment Form for Risk Factors of Postoperative Lower Limb Lymphedema in Gynecological Malignancies: A Delphi-Based Study

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Abstract: *The Delphi method was used to construct a multi-dimensional risk factor assessment table for postoperative lower extremity lymphedema after gynecological malignant tumor surgery, providing a reference basis for clinical medical staff to identify high-risk groups for lower extremity lymphedema after gynecological malignant tumor surgery. Through literature review and discussions among the research group members, the risk factors for lower extremity lymphedema after gynecological malignant tumor surgery were initially determined. Eight experts from eight provinces and cities across the country were selected for three rounds of Delphi expert inquiries. The obtained data were summarized and analyzed, and finally, a risk factor assessment table for lower extremity lymphedema after gynecological malignant tumor surgery was formed. The positive coefficients of the three rounds of expert inquiries were 95%, 100%, and 95% respectively; the authoritative coefficients were 0.92, 0.92, and 0.93 respectively; the Kendall's coefficient of agreement among experts was 0.497, 0.415, and 0.447 (all P<0.001). The final formed risk factor assessment table for lower extremity lymphedema after gynecological malignant tumor surgery includes 5 primary indicators and 23 secondary indicators. The multi-dimensional risk factor assessment table for lower extremity lymphedema after gynecological malignant tumor surgery constructed based on the Delphi method is relatively scientific and reasonable, and can provide a reference basis for the prevention and assessment of lower extremity lymphedema after gynecological malignant tumor surgery.*

Keywords: *gynecological malignant tumors; postoperative lower limb lymphedema; Delphi method; risk factors*

1. Introduction

The latest data released by the National Cancer Center [1] shows that approximately 290,000 new cases of gynecological malignant tumors were diagnosed in China, accounting for 15% to 20% of all female malignant tumor patients. Cervical cancer, endometrial cancer, and ovarian cancer ranked fifth, eighth, and ninth, respectively; approximately 100,000 deaths were reported, with cervical cancer and ovarian cancer ranking sixth and ninth, respectively, posing a serious threat to women's health. Lower limb lymphedema is one of the common complications following surgery for gynecological malignant tumors, with an overall incidence rate of 25%[2]. The primary cause is damage to lymphatic vessels or lymph nodes during surgery, leading to impaired lymphatic fluid drainage and accumulation in interstitial spaces, resulting in lower limb lymphedema. The high-incidence phase for lower limb lymphedema occurs 3–6 months post-surgery, with clinical manifestations including lower limb pain, heaviness, weakness, and a tight sensation [3]. This condition involves progressive, disabling pathological changes that develop over a prolonged period. Currently, there are no effective treatment options for lower limb lymphedema, and once it occurs, it is difficult to cure. It significantly impacts patients' limb mobility, daily activities, mental health, and economic well-being, leading to a marked decline in quality of life [4-5]. Therefore, identifying risk factors for postoperative lower limb lymphedema and implementing targeted interventions through multidisciplinary collaboration are key to preventing postoperative lower limb lymphedema. This study aims to establish a multidimensional risk factor assessment table for postoperative lower limb lymphedema in gynecological malignancies based on the Delphi expert consultation method, thereby providing a basis for identifying high-risk

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populations and implementing effective preventive measures.

2. Data and Methods

2.1 Selection of Experts

Expert panel selection criteria: ① Bachelor's degree or higher; ② Intermediate-level professional title or higher; ③ At least 10 years of work experience in the field; ④ Engaged in clinical medicine/clinical nursing/nursing education/nursing management/rehabilitation medicine related to gynecological malignant tumors. ⑤ Informed and willing to participate in this study, with prior knowledge of the research field. A total of 18 experts were ultimately selected.

2.2 Preliminary Identification of Risk Factors

Based on literature reports, the research team identified the following terms as keywords and free-text keywords: "gynecologic malignant tumors, cervical cancer, ovarian cancer, lower limb lymphedema, risk factors and so on, " as keywords and free-text terms to search China National Knowledge Infrastructure, Wanfang, VIP, China Biomedical Literature Service System and PubMed, Web of Science, Embase, Cochrane, gynecologic malignant tumor surgery was developed, including 5 primary indicators and 25 secondary indicators.

2.3 Development of the Expert Questionnaire

The questionnaire consists of four sections: ① Introduction: Provides an overview of the background and objectives of this study. ②Expert Profile Survey: a. General information about the expert, including age, education level and so on; b. The expert's basis for evaluating the research content; c. The expert's familiarity with the research content. ③Indicator Content and Importance. Experts rate the importance of each item and provide a blank space for suggesting revisions.

2.4 Expert Questionnaire Process

After the first round of questionnaires is returned, they are promptly statistically analyzed. Based on expert opinions and item screening criteria, discussions and revisions are conducted to form the second and third rounds of expert consultation questionnaires.

2.5 Evaluation Indicator Screening Criteria

The indicator screening criteria for this study are an average importance score of ≥3.5 and/or a coefficient of variation ≤0.25 [6].

2.6 Statistical Methods

Data were entered using Excel and analyzed using SPSS 26.0 software. Continuous variables following a normal distribution were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage(%).

3 Results

3.1 Expert Profile

This study employed purposive sampling, enrolling 18 experts in the Delphi expert consultation. (Table1)

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Table1 Participant demographics

Project	Grouping	Number of people (persons)	Composition ratio (%)
Age (years)	30~40	2	11.11
	41~50	9	50.00
	>50	7	38.89
Years of work experience (years)	10~20	5	27.78
	21~30	6	33.33
	>30	7	38.89
Educational background	Bachelor's degree	10	55.56
	Master's degree	7	38.89
	Doctorate degree	1	5.56
Professional title	Intermediate level	3	16.67
	Associate senior level	7	38.89
	Senior level	8	44.44
Field of work	Clinical nursing	8	44.44
	Clinical medicine	5	27.78
	Nursing management	2	11.11
	Nursing education	2	11.11
	Rehabilitation medicine	1	5.56

3.2 Expert Participation

In the first round, 20 expert questionnaires yield a response rate of 95.0%. Among these, 8 experts (42.1%) provided constructive feedback; In the second round, 19 expert questionnaires result a response rate of 100%. In the third round, 19 expert questionnaires result in a response rate of 95%.

3.3 Expert Authority Level

The authority level of experts is represented by the authority coefficient (Cr), which is the arithmetic mean of the basis for judgment (Ca) and the degree of familiarity (Cs).The authority coefficients of experts after the three rounds of expert inquiries in this study were 0.92, 0.92, and 0.93 respectively. This indicates that the experts in the inquiries have high authority. (Table2)

Table 2 Results of the degree of authority of the experts

Rounds	Number of people	Ca	Cs	Cr
First round	19	0.96	0.87	0.92
Second round	19	0.96	0.88	0.92
Third round	18	0.98	0.89	0.93

3.4 Degree of Expert Opinion Coordination

The Kendall correlation coefficients for the three rounds of expert consultations were 0.497, 0.415, and 0.447, respectively. (Table3)

Table 3 The Coordination Degree and Significance Test of Expert Opinions.

Rounds	Kendall's W	χ^2	P
First round	0.497	226.767	<0.001
Second round	0.415	173.558	<0.001
Third round	0.447	177.081	<0.001

3.5 Results of Expert Consultation

After the first round of expert consultation, five primary indicators were retained. Among the 25 secondary indicators,12did not simultaneously meet the criteria of an importance score average ≥3.5 points and/or a coefficient of variation (CV) ≤0.25. The indicators for educational level, hypertension, diabetes, and lymph node metastasis were removed, while the importance scores for postoperative chemotherapy surgical procedure importance score, surgical duration importance score, intraoperative

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bleeding importance score, importance score for postoperative drainage tube retention time, importance score for preoperative neutrophil-lymphocyte ratio, preoperative platelet-to-lymphocyte ratio importance score, preoperative systemic immune inflammation index importance score" Although the mean values of the 8 indicators are <3.5points and CV >0.25, they are temporarily retained after reviewing the literature and discussing with the research team. Following the first round of expert consultations, the experts suggested adding or removing the following items: “Whether lymph node metastasis is present” under “Disease-related factors” can be removed; under “Treatment-related factors,” add “Whether medical compression stockings were worn postoperatively,” “Whether the postoperative drainage tube became infected,” and “Whether infection occurred postoperatively.” After considering the opinions of all experts, the research team discussed and adopted the above suggestions, forming the second round of expert consultation forms. After the second round of expert consultation, the Kendall coefficient decreased compared to the first round, and upon comparison, it was found that the coefficient of variation for laboratory indicators remained somewhat high. Some experts suggested discussing whether there is a relationship between laboratory indicators and the occurrence of lower limb lymphedema postoperatively, indicating significant controversy among experts regarding laboratory indicators. Therefore, a third round of expert consultation was conducted, with controversial factors noted in the consultation form and supporting references inserted. At last, this table was ≤0.25, and the Kendall coefficient also increased, indicating improved consensus among experts. (Table 4)

Table 4 Concentration of expert opinions on risk factor assessment form for lower extremity lymphedema after gynecological cancer surgery (third round)

Indicator	average score	SD	CV
1 Individual factors	4.44	0.78	0.18
1.1 Age	4.00	0.69	0.17
1.2 Preoperative body mass index	4.44	0.62	0.14
2 Disease-related factors	4.83	0.38	0.08
2.1 FIGO staging	4.78	0.43	0.09
3 Treatment-related factors	4.78	0.43	0.09
3.1 Postoperative radiotherapy	5.00	0.00	0.00
3.2 Number of postoperative radiotherapy sessions	4.67	0.49	0.10
3.3 Cumulative postoperative radiotherapy dose	4.61	0.50	0.11
3.4 Postoperative chemotherapy	3.61	0.78	0.22
3.5 Lymph node dissection	5.00	0.00	0.00
3.6 Number of lymph nodes removed	4.67	0.49	0.10
3.7 Surgical approach	4.00	0.97	0.24
3.8 Surgical duration	3.89	0.90	0.23
3.9 Intraoperative bleeding	3.67	0.84	0.23
3.10 Postoperative drainage tube retention time	3.61	0.78	0.22
3.11 Postoperative use of medical compression stockings	4.39	0.78	0.18
3.12 Postoperative infection	4.39	0.70	0.16
4 Laboratory indicators	3.94	0.94	0.24
4.1 Preoperative neutrophil-to-lymphocyte ratio	3.50	0.86	0.24
4.2 Preoperative platelet-to-lymphocyte ratio	3.50	0.86	0.24
4.3 Preoperative systemic immune inflammation index	3.78	0.81	0.21
5 Activity factors	4.44	0.62	0.14
5.1 Prolonged sitting postoperatively	4.67	0.49	0.10
5.2 Prolonged standing postoperatively	4.67	0.49	0.10
5.3 Weekly exercise frequency postoperatively	4.44	0.51	0.12
5.4 Duration of each exercise session postoperatively	4.50	0.51	0.11
5.5 Intensity of daily exercise postoperatively	4.56	0.62	0.14

4. Discussion

4.1 Scientific validity of the research method and reliability of the results

The evaluation form used in this study was developed through three rounds of expert consultations, based on literature reviews and discussions among the research team, resulting in relatively reliable conclusions. The effective response rates for the three rounds of expert consultations were 95.0%, 100%, and 95%, respectively, fully reflecting the high level of attention and active participation of the experts in this study; the expert authority coefficients were 0.92, 0.92, and 0.93, respectively; The Kendall coefficient for the third round of consultations was 0.447, indicating that after three rounds of

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adjustments and revisions, the experts' opinions on the criteria became more consistent. In summary, the multidimensional risk factor assessment table was established through three rounds of Delphi expert consultations has good representativeness, with relatively concentrated opinions.

4.2 Analysis of risk factors for lower limb lymphedema after surgery for gynecological malignancies

4.2.1 Individual Factors

As age increases, the elastic fibers in lymphatic vessels decrease, leading to reduced lymphatic vessel elasticity and impaired lymphatic fluid transport capacity. Under surgical stimulation, post-operative lymphatic repair and compensation become more difficult, resulting in lymphatic fluid easily accumulating in interstitial spaces [7-8]. The higher the body mass index, the slower the lymphatic fluid return. This is because excessive fat tissue can mechanically compress lower limb lymphatic vessels, narrowing the vessel lumen and obstructing normal lymphatic fluid return [9].

4.2.2 Disease and Treatment-Related Factors

The later the FIGO stage, the higher the rate of lymph node metastasis. During cytoreductive surgery, surgeons will attempt to remove as many affected lymph nodes as possible, which can cause significant damage to the lymphatic system [10]. Postoperative radiotherapy, especially with increased treatment sessions and doses, can lead to obstruction, narrowing, and local tissue fibrosis of pelvic capillaries and lymphatic vessels, causing damage to lymphatic vessels and impairing lymphatic drainage, thereby increasing the risk of lower limb lymphedema [11-12]. Chemotherapy drugs have cytotoxic effects and can directly damage lymphatic endothelial cells. Once damaged, lymphatic endothelial cells impair the normal function of lymphatic vessels, reducing their ability to absorb and transport lymphatic fluid, leading to lymphatic fluid accumulation in interstitial spaces and subsequently causing lower limb lymphedema [13]. Experts estimate that the risk of lower limb lymphedema in cervical cancer patients who undergo pelvic lymph node dissection during surgery followed by postoperative radiotherapy is approximately three times higher than in those who do not receive postoperative radiotherapy [14].

Jiang Xinge et al. [15] pointed out that open surgery is more likely to cause lower limb lymphedema compared to laparoscopy, as laparoscopy is a minimally invasive procedure that causes less trauma to the patient. It can accelerate lymphatic fluid absorption through a retroperitoneal open approach, thereby reducing the incidence of lower limb lymphedema. Research has shown [15] that the longer the surgical duration, the higher the risk of developing lower limb lymphedema postoperatively. This is because patients with advanced-stage gynecological malignant tumors often require cytoreductive surgery, and in some cases, lymph node dissection, which can cause significant damage to the lymphatic system; Damage to lymphatic vessels impairs lymphatic fluid return, leading to the accumulation of large amounts of lymphatic fluid in the interstitial spaces of the lower limbs. Vascular damage can result in impaired venous return, causing increased capillary pressure and more fluid leakage, thereby exacerbating the burden on lymphatic circulation. Excessive bleeding during surgery can trigger an inflammatory response in the body. The release of inflammatory mediators increases vascular permeability, causing more fluid and proteins to leak into the interstitial spaces, further exacerbating local swelling [16].

Postoperative drainage tubes can promptly remove exudate and blood from the body, but prolonged placement may compress local tissues, causing greater damage and impairing lymphatic drainage [7,15]. The pressure applied by compression stockings increases interstitial pressure, preventing fluid accumulation in interstitial spaces and promoting the entry of excess fluid into lymphatic vessels for circulation, thereby reducing the risk of lower limb lymphedema [17]. Postoperative infection can reduce local resistance, leading to accelerated circulation of macrophages and lymphocytes, which exacerbates lymphatic vessel obstruction [18].

4.2.3 Laboratory Indicators

Lymphocytes and neutrophils are important indicators for assessing the body's inflammatory response. In patients with lymphedema, the destruction of normal cellular structures leads to impaired immune transport function. Additionally, the edematous skin itself contains abundant cytokines, and chronic inflammation and infection further exacerbate the damage to the lymphatic system [19]. Research has shown [20] that preoperative NLP, PLR, and SII are positively correlated with the occurrence of lower limb lymphedema in cervical cancer patients postoperatively. These may be associated with inflammatory states, The exacerbation of inflammatory states may be related to factors

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such as impaired immunity , and these factors may all lead to damage to lymphatic system function.

4.2.4 Activity Factors

Prolonged sitting can slow down venous blood return in the lower limbs, increase venous pressure, and impair lymphatic fluid return, leading to lymphatic fluid accumulation and the development of lymphedema. If patients remain standing for extended periods postoperatively, it can increase the load on the lower limbs, impair lymphatic fluid return, and elevate the risk of developing lower limb lymphedema. Liu Gaoming et al. [21] noted that postoperative exercise with a frequency of more than five times per week can stimulate muscle contraction, thereby fully leveraging the compensatory lymphatic drainage function of the “muscle pump.” Therefore, it is necessary to assess the patient's postoperative exercise status.

4.3 The Significance of Developing a Multidimensional Risk Factor Assessment Table for Lower Limb Lymphoedema Following Surgery for Gynaecological Malignant Tumours

The multidimensional risk factor assessment tool for postoperative lower limb lymphedema in gynecological malignancy patients developed in this study includes individual factors, disease-related factors, treatment-related factors, laboratory indicators, and activity factors. Compared with previous studies, this tool is more comprehensive, aiding clinical healthcare professionals in effectively identifying high-risk factors and high-risk populations for postoperative lower limb lymphedema, thereby helping patients improve their quality of life. Additionally, through precise assessment, early intervention can be implemented, medical resources can be allocated reasonably, and the need for prolonged and complex treatment processes can be avoided, thereby reducing the economic burden on patients.

5. Summary

In summary, this study constructed a multidimensional risk factor table for postoperative lower limb lymphedema in patients with gynecological malignant tumors through three rounds of systematic Delphi expert consultations. The table has good reliability and provides certain guidance for clinical practice. However, this study also has certain limitations. There are few experts from specialized fields such as rehabilitation, with most participants coming from clinical medicine and nursing fields, which may lead to biased results. Future research will involve assigning values to this risk assessment table, collecting clinical data, conducting follow-ups and evaluations, and establishing a risk prediction model based on machine learning algorithms to validate its feasibility.

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