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Construction of a risk index system for the prediction of chronic post-surgical pain after video-assisted thoracic surgery for lung resection: A modified Delphi study

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Abstract: In the present study, several research methods were adopted, including literature retrieval, theoretical analysis, and qualitative research, and then the draft of the prognostic factors for the chronic post-surgical pain (CPSP) index system after video-assisted thoracoscopic surgery (VATS) for lung resection was constructed. A Delphi survey was used for the study of 24 experts in the field of pain from three different grade-A tertiary hospitals in Guangzhou, China. In the two rounds of survey, the experts rated these indicators for the importance and feasibility of measurement (round 1, n = 21 participants; round 2, n = 20). Finally, we calculated Kendall's W index as a measure of consensus. A general consensus was reached on predicting CPSP after VATS, consisting of 10 first-level domains and 64 second-level indicators, involving biological, psychological and social perspectives. This study provides a comprehensive draft of risk factors developed and identified by experts to inform research-based evidence on chronic pain. Increased clinical awareness and a full understanding of how to screen and identify people with CPSP problems may lead to earlier recognition of chronic pain and greater facilitation of professional prevention.

***Keywords*:** Delphi method, index system, risk factors, chronic post-surgical pain (CPSP)

Introduction

According to the 2022 cancer statistics report by the American Cancer Society (*1*), lung cancer has the second most new cancer cases, after prostate cancer in men and breast cancer in women. However, approximately 350 people die from lung cancer each day, more than those from prostate and breast cancers combined. Lung cancer has become the leading cause of cancer death. Similarly, as shown by the latest national cancer statistics in China, lung cancer ranks first among all cancers in terms of morbidity and mortality (*2*).

In the early stages of lung cancer, surgical resection is the only effective and widely accepted treatment (*3*). The incidences of developing chronic post-surgical pain (CPSP) from lung resection performed by general thoracotomy or less invasive video-assisted thoracic surgery (VATS) are 30–60% (*4*) and 40–60% (*5*), respectively. Despite advances in technology and medical care, the incidence and severity of CPSP after VATS have been reported to be similar to those of the traditional thoracotomy (*6*). Multiple pain management strategies had been applied during the perioperative period (before, during, and after surgery), but patients may still experience intense pain after VATS (*7*). What is more, acute pain after surgery can turn into chronic pain, and the mechanisms are complex and diverse (*8*). Lower quality of life and higher healthcare costs are accompanied with the extremely high frequencies of CPSP after VATS (*9*).

CPSP is now proposed in the International Classification of Diseases (ICD) 11th Revision (ICD-11), where it is classified as any pain related to the surgical area that persists for 3 months or longer after surgery, and other causes of pain, such as pre-existing pain conditions or infections, or malignancy, must be excluded (*10*). An in-depth understanding of the risk factors for CPSP may reduce morbidity, strengthen postoperative pain management, and ultimately improve patients' quality of life (*11*). Despite a huge number of research reports, there are no final conclusions and clear definitions on the incidence and severity of CPSP as well as on pain-related factors after VATS (*11,12*). The wide variability in risk factors may be due to different and appropriate methods of analysis (*9,13*), as well as the exclusion or short-listing of some potential risk factors, such as anxiety, depression, and social status (*14,15*). In a word, identification of patients at risk for chronic pain remains inadequate and challenging (*13,16*).

Previous research has suggested that an ideal prediction model for chronic pain is a thorough clinical survey that would include preoperative, intraoperative

and postoperative data (*17*). Some researchers have suggested that it is time to establish core risk factors for CPSP, which should encompass demographic, pain, clinical, surgery-related, and psychological domains (*13*). However, not all risk factors for CPSP after VATS have been taken into account, and no such study has been published so far.

The Delphi method is applied in various fields, especially in health care and nursing, to systematically integrate uncertain and incomplete issues from experts with research or practice backgrounds. The goal of this technique is to identify general statements, and consequently to reach a group consensus using previously determined criteria (*18,19*). Generally speaking, the Delphi method contains four key features, namely anonymity, iteration, controlled feedback, and the statistical aggregation of group response (*20*). It is constructed through a series of questionnaires and typically 2–3 iterations among experts in the relevant fields, without face-to-face communication, and then controlled feedback is presented in the form of statistical summary in each round. The modified Delphi technique focuses on collecting items from the literature review, and scoring each item in the questionnaire on a Likert scale, while suggestions are encouraged in each round. After the rounds, the items are modified or added to, and disputes will be reduced. In the end, a core outcome set is established, and measurable outcomes or topics in clinical trials are identified (*21,22*).

The objective of this study is to construct a core risk index system for CPSP after VATS, and to summarize and synthesize the current evidence on risk factors for CPSP through a Delphi survey consulting experts in related fields.

Materials and Methods

Design

Since data about CPSP predictors have been extensively reported and are available, we carried out a modified Delphi survey (Figure 1), which allowed us to construct a first draft of the risk index for CPSP through a literature review. The modified recommendation for the Conducting and REporting of DElphi Studies (CREDES) was used to guide the study (*23*). This study was approved by the Ethics Committee of Guangdong Provincial General's Hospital (KYH202200801).

Literature review and preliminary list of indicators

The literature review, including retrospective and prospective studies, randomized controlled trails, and a systematic review, was performed mainly in PubMed, Web of Science, and CNKI databases. The main search terms used are as follows: "chronic post-surgical pain", "chronic postoperative pain", "chronic pain", "video assisted thoracic surgery", "thoracic surgery", "risk factor", "pain related". A total of 1,428 articles were searched. Of those, 1,335 irrelevant studies were excluded based on the screening of titles or abstracts. The remaining 93 articles were reviewed in full for eligibility, of which 75 were excluded because they were solely related to the prevalence of CPSP or did not report risk factors for CPSP. Eventually, 18 articles highly correlated with the risk factors for CPSP were included.

Two researchers independently reviewed all the included articles to identify the risk factors for CPSP mentioned in these studies. The preliminary list was tested for readability and feasibility by group members. A new conceptual framework, including ten fields (baseline characteristics, psychological and social factors, health status, primary disease-related, genetic and biological factors, surgery-related, anesthesia management-related, postoperative recovery management, postoperative pain management, primary disease progression and treatment) was preliminarily developed, and an initial item pool containing 58 items was obtained.

Recruitment and panel formation

The panel members were medical professionals from three different grade-A tertiary hospitals and researchers of Guangzhou Pain Society in Guangzhou. The inclusion criteria of consultant experts are as follows: *i*) They should have been engaged in pain management-related medical work for not less than 10 years. However, for specialists in the fields of basic research, if they show academic excellence and have published more than two papers as the first author, the working years may be relaxed appropriately. *ii*) Their professional title should be intermediate or above. *iii*) They should have a bachelor's degree or higher. *iv*) They should be professionals in pain management, including surgeons, anesthetists, pain specialists, nurses, rehabilitation specialists, and pain researchers. Since there is no agreement on the optimal panel size, a carefully considered selection of the most symbolic experts, rather than a large sample, may yield valuable results (*21*). Consequently, we decided to form a majority panel of 24 based on a systematic review (*24*).

Questionnaire development and administration

The research tools were developed with reference to a biopsychosocial approach to postoperative pain and calls for research on the combination of risk factors and pain in clinical settings (*17*). The questionnaires for the two survey rounds were administered in 2021, from September 16th to 24thand October 14th to 24th, respectively.

In Round-1, we introduced the subject to the experts by email and obtained their consent in the questionnaire. The questionnaire was composed of three parts: *i*) general information about the experts: age, working

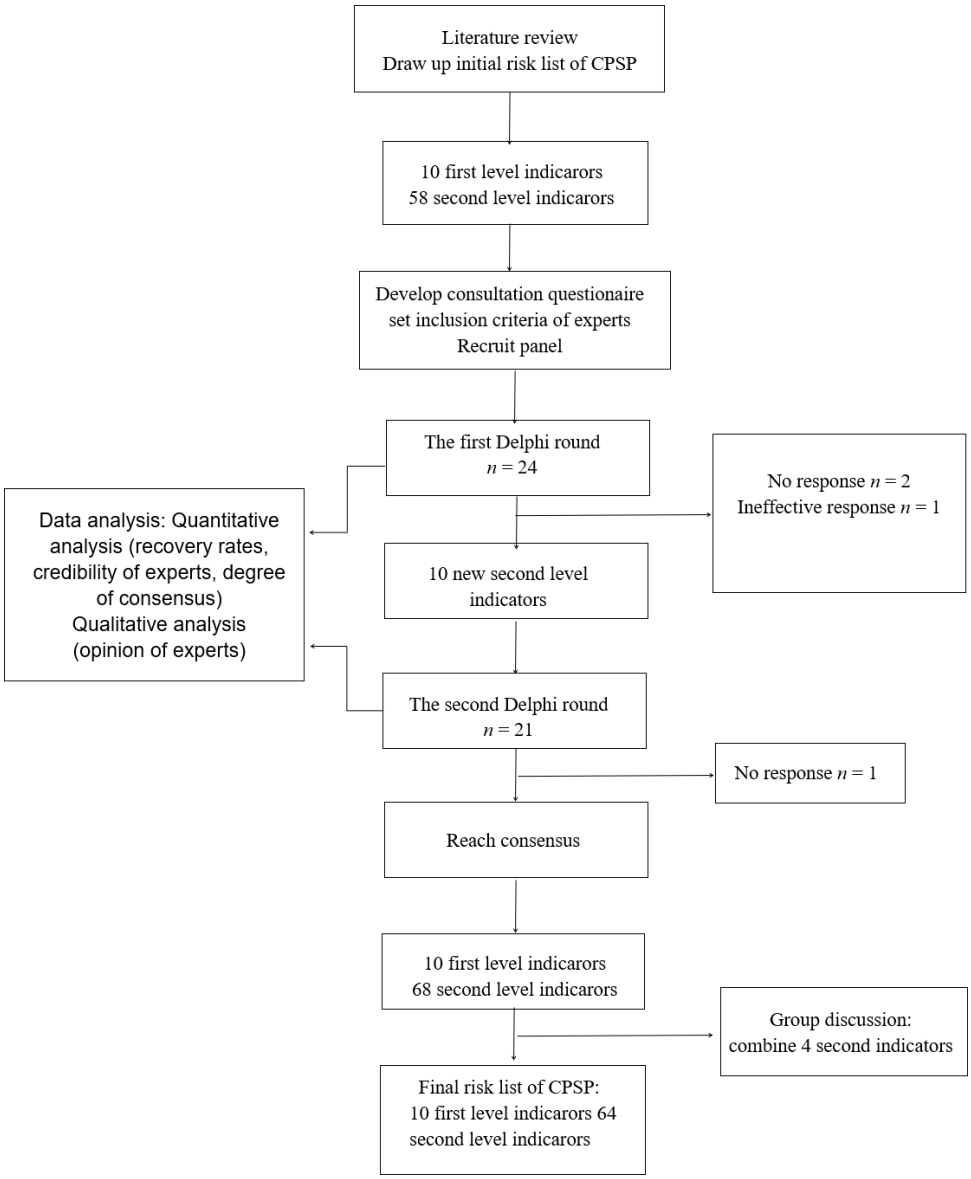

Figure 1. The flowchart of the Delphi process. CPSP, chronic post-surgical pain.

years, educational background, professional title, *etc.*; *ii*) the prediction index system of the CPSP after VATS expert consultation form: the importance and feasibility of the items were evaluated by the way of Likert 5-level scoring method (5 = very important or very good, 4 = important or good, 3 = fair, 2 = unimportant or bad, and 1 = completely unimportant or very bad), and the column for suggestions was provided; *iii*) experts' familiarity with the content of the survey and index judgment. Importance referred to whether these items had a strong correlation with the occurrence of CPSP after VATS. Feasibility referred to whether information could be easily and completely collected from the medical record system. Participants were asked to rank the items based on their theoretical knowledge, evidence from empirical research, clinical experience in pain treatment, and any personal experience. New or missing items were encouraged to be proposed in the first round.

In Round-2, an average score for the importance and feasibility of each item was calculated. The summary results of Round-1 were shared with participants in the form of text prompts. The summary indicated the items that had reached a consensus and those that had not. An improved questionnaire, including the experts' feedback and added items, was sent *via* web-based survey software. At the same time, all the experts had the opportunity to reconsider their evaluations at this turn. After the second round of consultation, our analysis revealed that the results were quite consistent with those of the first round. Therefore, we decided to confirm the prediction index system.

Data analysis

SPSS 26.0 statistical software and online SPSSAU (Statistical Product and Service Software Automatically, a version available on the website) were applied in the data analysis process. After the first round, the

importance and measurability of the indicators were calculated by the form of mean ± standard deviation. The enthusiasm and suggestions of the experts was reflected in the questionnaire return rate and the percentage of suggestions made. Kendall's W and variable coefficients were used to indicate the degree of expert coordination, *i.e.*, whether the experts' scoring results are consistent. The larger the Kendall's W value (value between 0 and 1), the higher the coordination degree of the experts. The significance of the coordination coefficient was analyzed by Chi-square test. The test of significance is a credibility test of the consensus among experts, and $p < 0.05$ was considered statistically significant, indicating the higher the confidence of the results. The variable coefficient presented the coordination degree of the importance and measurability of the items. Generally, an indicator with a variable coefficient < 0.25 is considered a good one. After the second round, we received less dispute about the issue of indicators. According to the importance scoring of each indicator, we analyzed the weighting target using the analytic hierarchy process (AHP). It not only reflects the percentage of a certain factor or indicator, but also emphasizes its relative importance. After discussion in the research group, through analysis and integration, we finally established a risk index system on CPSP after VATS. The test of significance is a credibility test of the consensus among experts, and $p < 0.05$ was considered statistically significant, indicating the higher the confidence of the results.

Results

Sociodemographic and professional characteristics of the expert panel

In the final round, we received a total of 20 valid questionnaires. Fifty-five percent of the participants (11 cases) were male, and forty-five percent (9 cases) were female. They ranged in age from 29 to 65 years old, with a mean age of 45.95 (SD: 8.27) years. Their working years ranged from 6 to 40 years, with an average of 18.5 (SD: 7.67) years. Table 1 presents the sociodemographic and professional characteristics of the Delphi expert panel.

Experts' enthusiasm

In the first round, 24 experts were invited for the questionnaire, and 22 of them responded, with a response rate of 91.67%. Of the 22 collected questionnaires, 1 questionnaire contained so many missing values that it was eliminated, giving a valid questionnaire rate of 95.45% (21/22). In the second round, 21 questionnaires were distributed and 20 of them were returned, with a return rate of 95.23% and a validness rate of 100% (20/20). The suggestion rate (number of experts raising doubts about the items) was 38.10% (8/21) compared to 10.00% (2/20) in the second round (Table 2).

Table 1. Demographic information of the experts

Project	Frequency (*n*)	Proportion (%)
Age (Years)		
< 40	4	20.00
40–50	9	45.00
> 50	7	35.00
Highest degree		
Undergraduate	6	30.00
Master	6	30.00
Doctorate	8	40.00
Work experience (years)		
< 10	2	10.00
10 – 20	12	60.00
> 20	6	30.00
Professional title		
Intermediate level	6	30.00
Senior vice level	7	35.00
Advanced level	7	35.00
Research field		
Thoracic surgeon	3	15.00
Anesthetist	4	20.00
Pain Management specialists	4	20.00
Nurse	4	20.00
Rehabilitation specialist	2	10.00
Basic research specialist in pain	3	15.00

Expert authority coefficient and opinion coordination degree

The judgement coefficient, familiarity coefficient, and authority coefficient were 0.955, 0.793, and 0.966, respectively. When the expert authority coefficient $Cr \geq 0.7$, it demonstrated that the results of the survey were reliable. In the first round of the survey, the Kendall's concordance coefficients for the first- and second-level indicators were 0.397 and 0.366 in importance and 0.288 and 0.255 in measurability, respectively. In the second round, the Kendall's concordance coefficients for the first- and second-level indicators were 0.370 and 0.393 in importance and 0.302 and 0.234 in measurability, respectively. All the Kendall's tests were of statistical significance (all $p < 0.001$) (Table 3).

The first round of Delphi

In the first round, the experts scored the initial draft of the post-VATS CPSP index system containing 58 items in 10 domains. We received 26 suggestions on redefining, adding, merging, and splitting the items. These suggestions were reviewed and the items were integrated in a group discussion, incorporating possible related factors from the literature or expert experience. Ten new items proposed by the experts after modifying were included. Sixteen items were modified, merged or separated. All the retained items and new items entered the second round for the experts to rate. Consequently, a form of 68 items in ten domains was sent to 21 experts for the next round of the survey.

The second round of Delphi

In the second round, no new items were proposed, but the content of the items was further refined. After discussions by our research group, the final form of 64 risk factors in 10 domains was determined (Table 4).

Discussion

After reviewing the literature (*8*) on the basis of our clinical experience, we realized the great diversity of points on the validation, importance, and feasibility of the predisposing risk factors within CPSP, especially after VATS in lung resection (*25*). We retrieved potential and relevant risk factors from systematic review or research, and constructed the initial version of item pool. The modified Delphi method is a rigorous expert consultant, with the assistance of the anonymous panel, rating scale, iteration, and controlled feedback (*21*). The experts were allowed to scale the importance and measurability of the items that have been generated from previous studies, and to propose any items that have an impact on CPSP but have not been mentioned in previous studies. At the same time, we set blanks in the last column of the questionnaire form, where suggestions can be made for adding or deleting any of the items. Through rounds of feedback and statistical analysis, new items could be continuously included, and existing ones could be modified or deleted, to supplement and perfect the item pool, striving to build a comprehensive index system.

The consensus-based set of risk factors provides the first comprehensive understanding of CPSP after VATS. In this study, we applied classical statistical analysis, well known as the Delphi technique. We calculated the means, standard div SD, authority coefficient and Kendall's coefficient of concordance (Kendall's W), which have been widely used and proved effective in previous and similar studies (*26,27*). Hence, we have powerful evidence that this study is scientific, reliable, and trustworthy. Firstly, the valid return rates of both rounds were higher than 90%, indicating that the experts showed great enthusiasm and involvement in each round of consultation. Secondly, the authority coefficient was 0.966, which exceeded the standard value of 0.7, demonstrating that the experts' authority was high and the results were credible. Thirdly, the Kendall's W of the first level in the second round was slightly smaller than that of the first round (0.370 *vs.* 0.397), probably due to their different professional backgrounds and different main focuses, resulting in different views on the attributes of the items. However, the Kendall's W of the second level was higher in Round 2 than in Round 1 (0.393 *vs.* 0.366). Although the Kendall's W did not show the same trend in both rounds, the results were valuable and reliable, showing very good coordination and consistency.

In this study, the experts would qualify each item for attribution and rate the importance and measurability of each item on a scale of 1–5 at each level. The composite index, including biological, psychological and social aspects, is essential to CPSP identification, for the latter is complex and changeable (*28*). At the same time, the biopsychosocial factors were also comprehensive and diverse, so we tried our best to summarize and classify the items. Two experts had doubts about the attribution of the first-level items, but in the second round they reached an agreement on this issue. For the second level of the indicators, some experts — not more than half — held the view that some items did not fit neatly into a particular category. Firstly, there was no standardized classification approach to divide these items/indicators into different dimensions (first-level indicators), and the final categories were largely retrieved from the literature (*12,17,29*) and integrated from our research group's opinions. Secondly, the scope of this item pool was very broad, so the team of experts came from different fields and might have different perspectives. Thirdly, we attempted to make these items easily recognized in a particular way rather than to make them presented.

At the end of the two rounds of consultation,

Table 2. Recovery of the questionnaire and suggestions offered

Questionnaire recovery	First round	Second round
Number of questionnaires distributed	24	21
Number of recycled questionnaires	22	20
Rate of recovery (%)	91.67	95.23
Effective questionnaire	21	20
Effective proportion (%)	95.45	100
Proposed ratio		
Number of experts	8	2
Constituent ratio (%)	38.10	10.00

Table 3. The results of expert opinions' coordination degree

Hierarchical level	The importance				The Measurability			
	Index (*n*)	Kendall's W	x^2	*p*	Index (*n*)	Kendall's W	x^2	*p*
First round								
First-level	10	0.397	74.987	0.000	10	0.288	54.448	0.000
Second-level	58	0.366	438.142	0.000	58	0.255	304.643	0.000
Second round								
First-level	10	0.370	66.599	0.000	10	0.302	54.325	0.000
Second-level	68	0.393	537.245	0.000	68	0.234	314.083	0.000

Table 4. Core risk index system of chronic post-surgical pain after video-assisted thoracic surgery

Index level 1st, 2nd	Importance			Measurability	
	Significance grade	Variable coefficient	Weighting targets	Measurability grade	Variable coefficient
Basic information	3.95 ± 0.69	0.174	0.087	4.90 ± 0.31	0.063
Age	4.40 ± 0.60	0.136	0.119	4.90 ± 0.31	0.063
Gender	4.20 ± 0.70	0.166	0.114	4.90 ± 0.31	0.063
BMI	3.70 ± 0.80	0.217	0.100	4.90 ± 0.31	0.063
Marital status	3.05 ± 1.10	0.360	0.083	4.65 ± 0.59	0.126
Health insurance	2.90 ± 1.12	0.386	0.079	4.70 ± 0.66	0.140
Family member	2.80 ± 1.11	0.395	0.076	4.50 ± 0.76	0.169
Social status	3.30 ± 0.86	0.262	0.089	4.00 ± 1.02	0.256
Educational level	3.30 ± 0.47	0.142	0.089	4.60 ± 0.68	0.148
Psychological and social parameters	4.5 ± 0.51	0.114	0.100	3.95 ± 0.61	0.153
Smoking	3.70 ± 0.86	0.234	0.147	4.65 ± 0.67	0.144
Drinking history	3.60 ± 0.82	0.228	0.143	4.60 ± 0.68	0.148
Sleep distress	4.35 ± 0.67	0.154	0.173	4.40 ± 0.99	0.226
Depression	4.55 ± 0.60	0.133	0.181	4.20 ± 0.83	0.198
Anxiety	4.60 ± 0.60	0.130	0.183	4.20 ± 0.77	0.183
Stress	4.40 ± 0.60	0.136	0.175	3.60 ± 0.88	0.245
Health status and comorbidities	4.65 ± 0.49	0.105	0.103	4.25 ± 0.72	0.169
Operation history	3.95 ± 0.83	0.209	0.113	4.65 ± 0.67	0.144
Hypertension degree	3.15 ± 0.99	0.314	0.090	4.60 ± 0.68	0.148
Diabetes mellitus	3.80 ± 0.95	0.250	0.109	4.60 ± 0.76	0.164
ASA classification	3.60 ± 0.82	0.228	0.103	4.40 ± 0.68	0.155
Emergency operation	3.40 ± 0.88	0.260	0.097	4.60 ± 0.75	0.164
Preoperative pain	4.70 ± 0.73	0.156	0.134	4.65 ± 0.59	0.126
Preoperative sensory assessment	4.35 ± 0.88	0.154	0.127	4.15 ± 0.93	0.225
Respiratory illness	3.55 ± 1.23	0.348	0.102	4.35 ± 0.75	0.171
Primary disease related	4.60 ± 0.68	0.148	0.102	4.65 ± 0.49	0.105
Tumor type and stage	3.75 ± 0.97	0.258	0.187	4.65 ± 0.59	0.126
Tumor progression	4.10 ± 1.02	0.249	0.204	4.45 ± 0.76	0.171
Tumor type	3.35 ± 1.18	0.353	0.167	4.55 ± 0.69	0.151
Preoperative chemotherapy	4.40 ± 0.75	0.171	0.219	4.65 ± 0.76	0.160
Preoperative radiotherapy	4.45 ± 0.76	0.171	0.222	4.75 ± 0.55	0.116
Epigenetic and biological factors	4.00 ± 0.76	0.181	0.889	3.95 ± 0.94	0.239
Genetics	3.20 ± 1.11	0.345	0.284	3.50 ± 1.00	0.286
Inflammatory respond	4.50 ± 0.76	0.169	0.400	4.15 ± 0.81	0.196
Endocrine respond	3.55 ± 1.00	0.281	0.316	4.10 ± 0.79	0.192
Surgery-related	4.80 ± 0.41	0.085	0.106	4.40 ± 0.68	0.155
Surgeon	3.85 ± 0.93	0.242	0.909	4.45 ± 0.89	0.199
Surgical option (VATS / open)	4.65 ± 0.49	0.105	0.109	4.80 ± 0.52	0.109
Operation type	4.15 ± 0.88	0.211	0.097	4.65 ± 0.67	0.144
Operation change	4.40 ± 0.68	0.155	0.103	4.65 ± 0.67	0.144
Surgical site	4.55 ± 0.60	0.133	0.107	4.80 ± 0.41	0.085
VATS type (single-port/three-port)	4.05 ± 0.83	0.204	0.095	4.60 ± 0.75	0.164
Number of chest tube	4.25 ± 0.79	0.185	0.100	4.60 ± 0.68	0.148
Duration of drainage	4.40 ± 0.60	0.136	0.103	4.80 ± 0.52	0.109
Operation time	4.25 ± 0.72	0.169	0.100	4.80 ± 0.52	0.109
Drainage specification	4.10 ± 0.64	0.156	0.096	4.60 ± 0.68	0.148
Anesthesia management-related	4.85 ± 0.37	0.076	0.107	4.75 ± 0.55	0.116
Opioids sum	4.85 ± 0.37	0.076	0.177	4.80 ± 0.41	0.085
NSAIDs sum	4.75 ± 0.44	0.094	0.173	4.80 ± 0.523	0.109
Other kinds of analgesic	4.60 ± 0.50	0.109	0.168	4.75 ± 0.55	0..116
Assisted anesthesia	4.65 ± 0.59	0.126	0.170	4.75 ± 0.44	0.094
Preemptive analgesia	4.65 ± 0.59	0.126	0.169	4.70 ± 0.57	0.122
Intraoperative awareness	3.90 ± 1.12	0.287	0.142	4.00 ± 0.86	0.215
Postoperative recovery management	4.80 ± 0.22	0.045	0.110	4.35 ± 0.67	0.130
Incision healing	4.65 ± 0.59	0.126	0.160	4.70 ± 0.57	0.122
Reconstruction	4.20 ± 0.77	0.183	0.145	4.60 ± 0.68	0.148
Hospital stay	4.05 ± 0.76	0.187	0.140	4.55 ± 0.83	0.181
WBC change	3.65 ± 0.88	0.240	0.126	4.50 ± 0.76	0.169
Drainage of fistula	4.20 ± 0.83	0.198	0.145	4.65 ± 0.59	0.126
Postoperative pleural effusion	3.95 ± 0.89	0.225	0.136	4.45 ± 0.69	0.154
Irritable cough	4.30 ± 0.57	0.133	0.148	4.15 ± 0.88	0.211
Postoperative pain management	4.95 ± 0.22	0.045	0.110	4.60 ± 0.60	0.130
Personal control analgesia (PCA)	4.70 ± 0.57	0.122	0.174	4.60 ± 0.75	0.164
Kinds of analgesic in ward	4.70 ± 0.47	0.100	0.174	4.40 ± 0.94	0.213

Table 4. Core risk index system of chronic post-surgical pain after video-assisted thoracic surgery (continued)

Index level 1st, 2nd	Importance			Measurability	
	Significance grade	Variable coefficient	Weighting targets	Measurability grade	Variable coefficient
Dose of opioids	4.60 ± 0.50	0.109	0.170	4.70 ± 0.47	0.100
Dose of NSAIDs	4.50 ± 0.51	0.114	0.167	4.75 ± 0.44	0.094
Duration of PCA	4.20 ± 0.83	0.198	0.156	4.70 ± 0.66	0.140
Side-effect of analgesic	4.30 ± 0.86	0.201	0.159	4.35 ± 0.75	0.171
Disease progression and treatment	4.05 ± 0.69	0.170	0.090	4.15 ± 0.81	0.196
Tumor recurrence	3.90 ± 1.02	0.262	0.215	4.40 ± 0.75	0.171
Tumor type and stage	3.30 ± 1.08	0.328	0.182	4.45 ± 0.76	0.171
Postoperative chemotherapy	3.80 ± 1.15	0.303	0.209	4.50 ± 0.76	0.169
Postoperative radiotherapy	3.75 ± 1.21	0.322	0.207	4.45 ± 0.83	0.186
Postoperative targeted therapy	3.40 ± 1.10	0.322	0.187	4.45 ± 0.83	0.186

the experts came up with ten new items and several suggestions. One participant believed that how couples get along with each other may affect their medical experience. This item was proposed by a rehabilitation specialist who focused more on involvement and support between couples in the clinical setting. In fact, social support may plays a major role in coping with toxic stimuli, whether physical or mental (*30*). In the second round, another nursing expert noted that this added item was vague and general, and could be covered by the items of marital status and family members. Because this new item was related to the existing ones, we did not include a similar indicator for assessing support from social members. BMI, or body mass index, is the ratio of weight to height, so we decided to remove the item of weight and height. In the category of psychological and social parameters, the dispute centered mainly on which measurement scales were more appropriate for evaluating depression, anxiety, and stress. Previous studies have used the EuroQol 5 Dimensions (EQ5D) questionnaire or the PROMIS questionnaire to assess psychological status (*25,31*). The measurement tool may not be the most appropriate but the simplest and most convenient to use, and this should be made clear in our further research. One expert offered a new perspective on respiratory diseases, including asthma or chronic obstructive pulmonary disease (COPD) and changes in pulmonary function, which would definitely affect the early postoperative respiratory function exercises and slow down the recovery. However, the evidence regarding pain is problematic and needs further investigation. Some experts found that the item of preoperative response to experimentally induced pain was a similar indicator to preoperative sensory assessment and suggested that one of them be retained. Some experts expressed their concerns on chemotherapy, as mentioned in a previous study (*9*), but there are differences in treatment regimens, timing, and side effects, indicating key points for data collection in further research. Despite numerous studies showing that genetic predictors or inflammatory molecules are important evidence (*8,32*), this evidence is not easy to detect and easily routinely tested. It does provide a novel perspective and understanding of genetic testing, inflammatory factors and changes in the internal environment. Larger numbers of studies recommend replacing the conventional thoracic drainage tube with a new ultrafine chest tube (central venous catheter), which has proved to reduce postoperative pain (*33*). The experts proposed that both the duration and the specifications of drainage also play a role in postoperative pain, and are worth emphasizing. The use of parecoxib sodium for preemptive analgesia has become a hot topic with the expectation of reducing the pain score and even reducing opioid consumption (*34*). The experts pointed out that the efficacy of parecoxib for preemptive analgesia may be controversial, but its benefits are still noteworthy. At the same time, they considered that the experience of intraoperative consciousness, though rare, is potentially catastrophic. Patients can recall the misery of surgical pain, which can bring about follow-up psychological problems. Research has been focused on the importance of the prolonged drainage, uniport VATS, and time of operation for CPSP (*12*), but less on the complications of drainage fistulas and pleural effusions. We also adopted the idea that postoperative bad cough might induce serious pain. Multiple analgesic management will bring various side effects, such as postoperative nausea and vomiting, at which time the nurse would withdraw the patient-controlled analgesia, so the pain is not relieved (*7*). Targeted therapy is one of the treatments for malignant diseases, and the experts suggested in the questionnaire that people can suffer from weakened immunity, which would induce pain, but the mechanism remains unclear and still needs attention.

The overall domains have been identified and specific items have been developed after the two rounds of consultation. The risk factor system in this study is relatively comprehensive and multi-dimensional. However, attention must be paid to the wording, splitting or integration of the items, as well as to further guidance and scope of application. In short, while some indicators may be very useful, others may need to be adapted. The list of indicators is in accordance with the guidelines or other recommended perioperative management

strategies for patients undergoing lung surgery, with the best availability and high levels of evidence (*35*). The index system will provide an important resource for clinical practitioners and holds great promise for early identification of patients at a high risk of CPSP after VATS.

In this study, we invited experts from different fields, and summarized the suggestions from different and unique perspectives. In addition, we included prior evidence that is based on systematic and prospective studies of CPSP. Hence, the index system combines the strengths of being empirical and experimental. Delphi evaluations are typically less expensive than more traditional forms of data collection, such as surveys and interviews. Since the heterogeneous results of CPSP highlight the current challenges in identifying risk factors, our study has the potential to represent a valuable contribution and a meaningful guideline, thus pointing the way for further research.

However, our study is limited to regional expert consultants from several Guangzhou grade-A tertiary hospitals, and their opinions do not represent the whole world. But the literature comes from articles published worldwide, which can compensate for this shortcoming. Another limitation is that all the risk factors were grouped into biological, psychological, and social domains throughout the perioperative period. Some risk factors could have fit into other categories, and different categorizations may lead to different interpretations of the items. Additionally, the Delphi process is highly dependent on the expertise of each panelist and their ability to make unbiased and accurate judgments. The results can be difficult to replicate if another group of experts evaluates the same issue.

Conclusions

This index system provides a consensus-based resource for clinicians and researchers seeking help for patients at a high risk of CPSP after VATS. Increased clinical awareness and a full understanding of how to screen and identify people with CPSP problems may lead to earlier recognition of chronic pain and greater facilitation of professional prevention. We developed the first version of the risk index for the detection of patients at high risk of CPSP after VATS for lung resection in a modified Delphi method. The development of the index system was informed by a biopsychosocial approach to postoperative pain and by calls for research on combining risk factors with pain in clinical settings. The item pool, where the items were strictly selected using the Delphi technique, is highly recommended. Researchers are welcome to refer to the list of indicators, especially those with high scores in importance and measurability.

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