Development and psychometric validity of the Perioperative Anxiety Scale-7 (PAS-7)

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Abstract

Background

Preoperative anxiety is a common psychological reaction in perioperative patients. The absence of a valid measurement tool of it hinders the evaluation of interventions to treat preoperative anxiety in China. This study aims to develop the Perioperative Anxiety Scale-7 (PAS-7) and to test its reliability, validity and cut-off value.

Methods

A total of 280 patients over 16 years old who were undergoing elective surgery were recruited to complete the PAS-7 and the Generalized Anxiety Disorder-7 scale (GAD-7) one day before surgery.

Results

The PAS-7 included 7 items, which were divided into two dimensions: mental anxiety and somatic anxiety. These two dimensions could explain 74.294% of the population variance. The internal consistency of each dimension ranged from 0.761–0.933. The confirmatory factor analysis showed that the model fit of the scale was good ($\chi^2= 34.798$, df = 13, $\chi^2$/df = 2.677, CFI = 0.949, GFI = 0.924, RMSEA = 0.115). The correlations between the GAD-7 and each dimension and the total score of the scale were significant. A cut-off score of 8, maximizing the Youden Index, yielded a sensitivity of 75% and a specificity of 84.6% (95% CI: 0.88–0.97).

Conclusions

The PAS-7 had good reliability and validity and could be used as an effective tool to evaluate preoperative anxiety.

1. Background

Preoperative anxiety is a common psychological reaction among perioperative patients (Kiecolt-Glaser et al.,1998); the incidence of this reaction is high both domestically, at approximately 50% (Yang et al., 2016; Luo et al., 2017), and abroad, at 40%~80% (Renouf et al., 2014; Aust et al., 2016).

The high incidence of preoperative anxiety has been suggested to be associated with many adverse effects for patients, including the following: increased postoperative pain and postoperative analgesic requirements (Ali et al., 2014; Raichle et al., 2015); increased heart rate, blood pressure and epinephrine levels (Wolf et al., 2003; Orbach-Zinger et al., 2012); increased postoperative nausea, vomiting and delirium (Kain et al., 2004; Hak et al., 2014); and increased recovery times and hospital stays (Rn and
Ruey-Hsia, 2010; Dekker et al., 2016). Thus, given the high frequency and adverse outcomes of preoperative anxiety, a statistically valid assessment and a timely intervention for preoperative anxiety have been important issues for anesthetists and psychologists (Vetter et al., 2013).

Currently, preoperative anxiety measurement tools exist in two categories: universal anxiety scales and specific anxiety scales (Le et al., 2017). Universal anxiety scales include the State-Trait Anxiety Inventory (STAI) (Spielberger et al., 1970, 1983; Zheng et al., 1993), the Self-Rating Anxiety Scale (SAS) (Zung, 1971; Zhang, 2005), and the Hamilton Anxiety Scale (HAMA) (Hamilton, 1959; Wang et al., 2011). These anxiety scales are widely suitable for both patients and healthy respondents; however, their limitations include low sensitivity and less assessment of preoperative anxiety. The most common specific anxiety scales are the Generalized Anxiety Disorder-7 scale (GAD-7) (Zigmond and Snaith, 1983; Hicks and Jenkins, 1988) and the Amsterdam Preoperative Anxiety and Information Scale (APAIS) (Moerman et al., 1996; Wu et al., 2016). The GAD-7 is applied easily and widely, but it has certain restrictions on the applicable population. For example, it is necessary to exclude patients with physical symptoms, and its discriminant validity is not high among elderly patients. The APAIS is specifically used to evaluate surgical patients and has been proven to be effective in preoperative anxiety assessment in China (Jia et al., 2015). However, due to being developed in another country, certain cultural differences, and a lack of items related to physical anxiety, its use in China also has certain limitations.

The absence of a valid measurement tool that could be easily applied in preoperative settings hinders the evaluation of interventions to treat preoperative anxiety among patients in China. The purpose of this study was to develop an effective scale, namely, the Perioperative Anxiety Scale-7 (PAS-7), for the assessment of mental and somatic symptoms of preoperative anxiety.

2. Methods

2.1. Participants

A total of 280 participants who underwent an elective operation under general anesthesia from March 1st 2019 to May 31st 2019 were recruited from a comprehensive hospital in Shanghai. The inclusion criteria were as follows: (1) older than 16 years old; (2) undergoing elective operation under general anesthesia; (3) Chinese native speakers; (4) no history of psychiatric drug use; (5) completed the scale independently or with the doctor's help. The participants were excluded if (1) they had poor medical conditions or (2) they could not correctly understand the meaning of the scale. A total of 280 questionnaires were sent to the participants on the day before their operation, and 256 questionnaires were completed. The information on the questionnaires mainly included the hospital number, gender, age, educational background, American Society of Anesthesiologists (ASA) grade, etc. Specifically, 109 men and 147 women completed the survey, and their ages ranged from 16 years old to 91 years old ($M = 55.1$, $SD = 14.3$). Twenty-eight participants completed primary school or below (10.94%), 75 completed junior high school (29.30%), 78 completed special secondary or senior high school (30.47%) and 75 had a college degree or above (29.30%). According to the ASA grade, 107 were grade I (41.80%), 138 were grade II
(53.91%), 20 were grade III (3.91%) and 1 was grade IV (0.39%). Informed consent was obtained from all individual participants included in the study.

2.2. Measures

2.2.1. Generalized Anxiety Disorder-7 (GAD-7)

The GAD-7 is a simple and convenient self-reported anxiety scale with favorable reliability and validity (Hinz, 2016) that is widely used in scientific research and clinical practice. The GAD-7 has a total of seven items. Higher scores indicate more severe anxiety symptoms. Some Chinese researchers believe that the cut-off score for the GAD-7 in China should be adjusted to 6 points, rather than the cut-off of 10 points recommended by the developers of the scale (Spitzer et al., 2006; Kroenke et al., 2007; Qu and Sheng, 2015; Zeng et al., 2013).

2.2.2. Perioperative Anxiety Scale-7 (PAS-7)

For the PAS-7, preoperative anxiety was defined as mental and somatic anxiety among adult patients who underwent elective operation under general anesthesia. The original items of the PAS-7 were from three sources: (1) relevant references of the existing preoperative anxiety scales, such as the APAIS, GAD-7, STAI, SAS and HAMA; (2) items from an open questionnaire survey, combined with investigation and interviews to collect the information; and (3) new items from theory structures. In the process of developing the PAS-7, a team of psychiatrists, anesthesiologists, surgeons and other related clinical experts conducted analyses and evaluations of the structure of the scale to identify inappropriate or duplicate items and to improve the scale.

To investigate the applicability of the original items of the PAS-7, a preliminary investigation was conducted with 80 patients from a hospital in Shanghai who underwent elective operation under general anesthesia. According to the panel discussion of the preliminary investigation, 14 items were eventually identified to be included in the first draft of the PAS-7. Responses are rated on a 5-point Likert scale and range from 0 (not at all) to 4 (very obvious). A higher score represents more severe preoperative anxiety. The items are shown below.

1. I'm worried about the effect of operation.
2. I'm worried about accidents during the operation.
3. I'm worried about my life getting worse after the operation.
4. I'm worried about pain caused by the operation.
5. Thinking about the operation makes me more nervous and worried than usual.
6. Thinking about the operation makes me easily distracted.
7. Thinking about the operation makes my hands tremble.
8. Thinking about the operation makes me lose my appetite or makes my stomach uncomfortable.
9. Thinking about the operation makes me use the toilet more often.
10. Thinking about the operation makes my face become hot and blushed and my hands and feet sweat.

11. I feel fear about the operation from time to time.

12. I'm worried about the aftereffects of anesthesia repeatedly (such as intelligence, and memory impairment).

13. Thinking about the surgery makes my heartbeat increasing.

14. Thinking about the surgery makes my breathing difficult.

2.3. Statistical analyses

SPSS 22.0 and AMOS 22.0 were used to analyze the data as follows. (1) A correlation analysis and exploratory factor analysis were conducted by using principal component analysis to extract the common factors and to obtain the initial load matrix; then, VARIMAX was used to obtain the ultimate factor load matrix. The value of KMO and Bartlett's test were used to determine the appropriateness of the factor analysis and to perform the scree test; the number of factors was then determined on the basis of the above results. (2) The confirmatory factor analysis was conducted using the internal consistency coefficient, construct validity and criterion validity to test the reliability and validity of the PAS-7. (3) The Receiver-Operating Characteristic (ROC) curve was used to validate the PAS-7 against GAD-7, to compare the sensitivity and specificity of PAS-7 under different cut-off scores, and to determine the cut-off and predictive values of the PAS-7 in certain groups.

3. Results

3.1. Item analysis

The participants were sorted by the total score. Participants with the highest 27% of scores were defined as the high group, and those with the lowest 27% of scores were defined as the low group. The t-test revealed that there were significant differences between the two groups on all items (p < 0.001) (Table 1).

3.2. Exploratory factor analysis

Exploratory factor analysis was carried out. Bartlett’s test showed that the KMO = 0.910, p < 0.001; thus, the scale was suitable for exploratory factor analysis. Through principal components analysis, the authors extracted the common factors and then deleted items if any of the following criteria were met: (1) the factor loadings are close in two or more common factors; (2) only one item is under a factor; (3) the maximum factor loading is less than 0.5 on the common factor; and (4) classification is inappropriate items. Finally, using these criteria combined with the experts’ opinions, seven items were deleted, including items 3, 6, 8, 9, 11, 12 and 13. Exploratory factor analysis with VARIMAX was carried out on the remaining 7 items. The study found two factors that explained 74.294% of the variance: F1-mental anxiety (items 1, 4, 2, 5) refers to excessive preoperatively worry and stress about the surgery and its effects, accidents and pain; F2-somatic anxiety (items 7, 14, 10) refers to the muscle, respiratory and sensory symptoms caused by preoperative anxiety (Table 2).
3.3. Confirmatory factor analysis

AMOS 22.0 was used for confirmatory factor analysis, and the path diagram is shown in Fig. 1. The model fitting of the scale was ideal. In detail, the fit indices were $\chi^2 = 34.798$, $df = 13$, $\chi^2/df = 2.677$, showing that the model had a good fit. CFI was $0.949 > 0.9$, GFI was $0.924 > 0.9$, and IFI was $0.950 > 0.9$. All fit indices were acceptable. RMSEA was also acceptable at 0.115, which is nearly 0.1.

3.4. Reliability analysis

Cronbach’s $\alpha$s were calculated to measure the internal consistency of the scale. The coefficient of each dimension was between $0.761–0.933$, showing that the scale had good internal consistency and reliability.

3.5. Validity analysis

3.5.1. Construct validity

The correlation coefficients between the total score and the two factors were 0.942 and 0.847, and that between F1 and F2 was 0.619. All the factors of the scale were not only correlated but also independent.

3.5.2. Criterion validity

We determined the correlation of the PAS-7 by regarding GAD-7 as the criterion. The correlation coefficients between the GAD-7 and F1, F2, and total score of the PAS-7 were 0.711, 0.719 and 0.789 ($p < 0.01$), indicating that the PAS-7 had good criterion validity.

3.6. The ROC curve

The GAD-7 score was used as a standard. We used 6 scores as the dividing point and divided participants into high- and low-anxiety groups. When the Youden index was at the maximum, a cut-off score of 8 was obtained, with a sensitivity of 75% and a specificity of 84.6%. The area under the ROC curve (AUC) was 0.89 for the PAS-7 (95%, CI: 0.88 ~ 0.97) (Fig. 2).

4. Discussion

This research mainly focused on developing a preoperative anxiety scale that can be widely used during preoperative evaluations in general hospitals in China (Table 3). Based on theory and research from previous scholars, the final scale includes 7 items and is suitable for patients over 16 years old. Confirmatory factor analysis results revealed that preoperative anxiety was divided into 2 dimensions: mental anxiety and somatic anxiety. Specifically, the mental anxiety factor had 4 items, and the somatic anxiety factor had 3. The internal consistency coefficients between the two factors ranged from 0.761-0.933, showing that the PAS-7 had good internal consistency and reliability. The significant correlation between the two dimensions and their total score indicated that the PAS-7 has good construct validity.
Our research adopted the GAD-7 as the criterion to evaluate the validity. We also regarded the GAD-7 as the “gold standard” for using ROC curves to determine the cut-off values, and we found that when the cut-off was 8, the PAS-7 had the largest value of screening, with a sensitivity of 75% and a specificity of 84.6%. In previous studies, the HAMA, STAI, and MINI-International Neuropsychiatric Interview (Lecrubier et al., 1997; Si et al., 2009) were used as the standards to obtain cut-off values. However, there are too many items in these scales, which might impose a heavy burden on perioperative patients who suffer somatic pain. Rating scales are more time-consuming for non-clinical psychological staff in general hospitals. Considering that assessments among general anesthesia patients should be short and convenient and that the general hospital lacks professionally trained evaluators, self-reported scales are the most suitable. Therefore, we adopted the GAD-7 as the criterion. Even so, the possible bias of this choice cannot be ignored. There is no consensus regarding the cut-off point for the Chinese version of the GAD-7. Although we used the cut-off value of 6 points that was recommended by Chinese researchers, those researchers assessed patients in the Department of Psychology of general hospitals, which was different from the subjects we recruited (Qu and Sheng, 2015; Zeng et al., 2013). This option might impact the currently determined cut-off value of the PAS-7. Follow-up studies could include other criteria to draw ROC curves and compare the differences to determine the best cut-off value.

Compared with other perioperative anxiety scales, the items in this study basically started from the core symptoms of anxiety disorders and innovatively introduced the "somatic anxiety" factor, which made the aspects of anxiety assessment more complete. In patients with physical diseases, the somatic reaction to anxiety is often confused with their other physical symptoms or is easy to ignore, which makes treatment even more difficult. The differentiation of somatic anxiety increased the recognition of patients with preoperative anxiety, which can better prompt doctors to make corresponding treatment plans to improve the psychological feelings and prognosis of such patients (Xia et al., 2014).

Although this study established an ideal psychometric tool of perioperative anxiety, it also had some limitations. First, all participants were patients who had surgery under anesthesia from the same general hospital, which might have led to selection bias, thus limiting the generalizability of our findings. Future studies should increase the sample size and increase the diversity of samples, such as patients under local anesthesia, patients undergoing ambulatory surgery and patients using outpatient anesthesia (Zheng, 1998). Additionally, a previous study reported that patients with preoperative anxiety were concerned with psychological characteristics and demographic variables (Dong and Pan, 2000; Zhou et al., 2003). Our study did not collect much information in this category and thus did not deeply explore the relation between gender, education level or other related factors. Increasing the amount of information collected from patients during clinical assessment should be considered in the future.

5. Conclusion

In conclusion, this study established the Perioperative Anxiety Scale-7 and proved its validity, thus enriching this assessment tool. Compared with the current evaluation of preoperative anxiety in China, the new PAS-7 was well-targeted, easy to use, had fewer items and needed less time. It also assessed
somatic anxiety, thus making the assessment more comprehensive. In addition, the PAS-7 was suitable for Chinese patients.

**Abbreviations**

PAS-7  
Perioperative Anxiety Scale-7  
GAD-7  
Generalized Anxiety Disorder-7 scale  
APAINS  
Amsterdam Preoperative Anxiety and Information Scale  
STAI  
State-Trait Anxiety Inventory  
HAMA  
Hamilton Anxiety Scale  
ROC  
receiver-operating characteristic curve  
AUC  
area under the curve

**Declarations**

**Ethics approval and consent to participate**

Ethical approval for this study was granted by the Institutional Review Board (IRB) of Ruijin Hospital, Shanghai Jiao Tong University School of Medicine (Ethical approval reference number: KY2019-27). Verbal informed consent was obtained from all individual participants included in the study and was approved by the ethics committee.

**Consent for publication**

Not Applicable

**Availability of data and material**

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.
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Authors' contributions

CZ was responsible for data analysis and draft writing. XL led the statistical analysis correcting, draft revising and manuscript writing. They contributed equally to this work and should be considered co-first authors. TH contributed to the data collection of pre and formal investigations. FZ and LP, as relevant experts, participated in panel discussion and helped to confirm the items. YL was responsible for design and data collection arrangement. ZW was the funding acquisition, who contributed to the design and arrangement of the whole study. YL and ZW were both corresponding authors. All authors read and approved the final version of the manuscript.

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### Table 1

**Item analysis of the Preoperative Anxiety Scale**

| Item | High group | Low group | $t$ | Item | High group | Low group | $t$ |
|------|------------|-----------|-----|------|------------|-----------|-----|
| 1    | 1.710±1.126 | 0.200±0.406 | 7.482*** | 8    | 1.110±0.963 | 0.030±0.169 | 6.568*** |
| 2    | 1.540±1.010 | 0.060±0.236 | 8.475*** | 9    | 1.230±1.165 | 0.030±0.158 | 6.029*** |
| 3    | 1.400±1.193 | 0.200±0.406 | 5.633*** | 10   | 0.910±1.173 | 0.090±0.284 | 4.063*** |
| 4    | 2.140±1.167 | 0.370±0.490 | 8.281*** | 11   | 1.600±1.063 | 0.060±0.236 | 8.385*** |
| 5    | 2.200±1.158 | 0.170±0.382 | 9.840*** | 12   | 1.260±0.886 | 0.060±0.236 | 7.744*** |
| 6    | 1.370±0.770 | 0.060±0.236 | 9.654*** | 13   | 1.890±1.105 | 0.030±0.169 | 9.825*** |
| 7    | 0.710±0.987 | 0.000±0.000 | 4.280*** | 14   | 0.710±0.825 | 0.000±0.000 | 5.122*** |

*p* < 0.05, **p** < 0.01, ***p*** < 0.001

### Table 2

**Exploratory factor loading matrix of the Preoperative Anxiety Scale (n = 128)**

| Item | Factors | Common degrees |
|------|---------|----------------|
|      | F1      | F2             |
| 1    | 0.848   | 0.739          |
| 4    | 0.843   | 0.727          |
| 2    | 0.818   | 0.763          |
| 5    | 0.804   | 0.777          |
| 7    | 0.859   | 0.774          |
| 14   | 0.839   | 0.739          |
| 10   | 0.786   | 0.682          |
| Eigenvalue | 2.879 | 2.321        |
| Contribution (%) | 41.131 | 33.163 | 74.294 |
Table 3

Perioperative Anxiety Scale-7 (PAS-7)

Instructions: This scale will assess your attitudes and feelings about your operation. Please carefully read each item, and then, according to your state in the past few days, circle the appropriate response.

| Item                                                                 | Not at all | Some | Moderate | Relatively obvious | Very obvious |
|---------------------------------------------------------------------|------------|------|----------|--------------------|--------------|
| 1. I'm worried about the effect of operation.                       | 0          | 1    | 2        | 3                  | 4            |
| 2. I'm worried about accidents during the operation.                | 0          | 1    | 2        | 3                  | 4            |
| 3. I'm worried about pain caused by the operation.                  | 0          | 1    | 2        | 3                  | 4            |
| 4. Thinking about the operation makes me more nervous and worried than usual. | 0          | 1    | 2        | 3                  | 4            |
| 5. Thinking about the operation makes my hands tremble.             | 0          | 1    | 2        | 3                  | 4            |
| 6. Thinking about the operation makes my face become hot and blushed and my hands and feet sweat. | 0          | 1    | 2        | 3                  | 4            |
| 7. Thinking about the surgery makes my breathing difficult.        | 0          | 1    | 2        | 3                  | 4            |

Figures
Figure 1

Confirmatory factor analysis path diagram for the Preoperative Anxiety Scale (n = 128) MA: Mental anxiety; SA: Somatic anxiety
Figure 2

ROC curve (n = 256) abscissa=1-specificity, ordinate=sensitivity