

# Characterization of self-anticipated surgical pain prior to general anesthesia - a prospective observational study

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## Research article

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# Abstract

**Background:** Current postoperative pain management principles are primarily based on the type and extent of surgical interventions. This clinical study measured patient's self-anticipated pain score before surgery and compared the scores with the pain levels and analgesic requirements after surgery.

**Methods:** This prospective observational study recruited consecutive patients who received general anesthesia for elective surgeries in E-Da Hospital (Taiwan) between June and August 2018. Patients were asked to subjectively rate their highest anticipated pain level (numerical rating scale, NRS 0-10) for their scheduled surgical intervention during their preoperative anesthesia assessment. After the operation, the actual pain intensity (NRS 0-10) experienced by the patient in the post-anesthesia care unit (PACU) and the total dose of opioids administered during the perioperative period were recorded. Pain scores  $\geq 4$  on the NRS were regarded as being unacceptable levels of anticipated or postoperative pain.

**Results:** A total of 857 patients were included in the study. The final database included 49.2% males, and 73.7% of them have had previous operations. The mean anticipated pain score was  $4.9 \pm 2.5$  and 72.2% of the patients reported an anticipated NRS  $\geq 4$  before their operations. Females anticipated significantly higher overall pain intensities than male patients (adjusted odds ratio 1.695, 95% confidence interval 1.252-2.295;  $P=0.001$ ). Patients over 40 years of age reported significantly lower overall anticipated NRS scores ( $4.78 \pm 2.49$  vs  $5.36 \pm 2.50$ ;  $P=0.003$ ). Patients scheduled to receive more invasive surgical procedures were more likely to anticipate high pain intensity in the preoperative period ( $P<0.001$ ). Higher anticipated pain scores (preoperative NRS $\geq 4$ ) were associated with higher actual postoperative pain levels ( $P=0.032$ ) in the PACU and higher total equivalent opioid use ( $P=0.001$ ) for acute pain management during the perioperative period.

**Conclusion:** This observational study found that females, younger patients ( $\leq 40$  years), and patients scheduled for more invasive surgeries anticipate significantly higher surgery-related pain. Therefore, appropriate preoperative counseling for analgesic control and management of exaggerated pain expectation in these patients are necessary to improve the quality of anesthesia delivered and patient's satisfaction.

## Background

Inadequate postoperative pain management can lead to physical and psychological distress in patients as well as impact surgical wound healing [1-2] and increase the risk of developing postoperative delirium [3] and cardiopulmonary and thromboembolic events [4]. Although numerous clinical pathways and strategies have been implemented to improve postoperative pain management, such as the introduction of the enhanced recovery after surgery (ERAS) program and multimodal analgesia (MMA), rates of inadequate postoperative pain management remain as high as 40-56.4% in the general surgical population [5-8].

Several perioperative factors such as age, catastrophic pain scores, gender, psychological distress, and operation type have been suggested to be closely associated with the postoperative pain intensity and analgesic usage [9-11]. It has been found that for breast cancer patients undergoing mastectomies or conserving surgeries, higher postoperative pain expectations and high preoperative distress can predict more intense postoperative pain [12-13]. A prospective observational study conducted in females undertaking hysterectomies also showed that pre-surgical fears of the immediate consequences of surgery was associated with increased postoperative rescue analgesia requirements (odds ratio, 1.306; 95% confidence interval, 1.031-1.655) [14]. However, very few large scale clinical studies have investigated the relationship between the surgical patient's preoperative anticipated pain and the actual pain intensity experienced after operations in the general surgical population. Therefore, this clinical observational study aimed to determine the patient characteristics and perioperative factors influencing the subjective anticipated pain intensities in patients scheduled for common elective surgical procedures under general anesthesia. The anticipated pain scales were also compared with the actual pain intensity experienced and analgesia required by the patients after surgery.

## Methods

### Study population and study protocol

This prospective observational study was approved by the ethics committee and the institutional review board of E-Da Hospital, Taiwan (approval number EMRP107018). Patients that underwent elective surgeries between June 2018 and August 2018 were included in this study and patients scheduled for regional anesthesia, emergency operations, or those who required postoperative intensive care were excluded (Figure 1). Patients were invited to voluntarily respond to a quantitative questionnaire during their preoperative anesthesia assessment. The patients were asked to rate their highest subjective anticipated postoperative pain intensity (numeric rating scale (NRS) 0-10). After their operations, patients were admitted to the postoperative care unit (PACU). The nurse specialists in the PACU recorded patients' pain levels by asking each patient's subjective NRS (1-10) at 15-minute intervals. The severity of postoperative pain assessed in the PCAU was defined as low (NRS 1-3) or moderate-to-high (NRS <sup>3</sup>4). The total analgesic dosages administered in the operating room and in the PACU were also recorded. All anesthetic and surgical interventions administered in this study, including procedures and medications, followed standard clinical practice protocol or physician's decision. The equivalent doses of opioids used during the perioperative period was calculated according to the updated practical opioid rotation and equianalgesic tables [15]. A culturally relevant depression screening questionnaire, the Taiwanese Depression Questionnaire (TDQ), was used to assess for depression in patients admitted to the surgical wards [16]. This 18-item screening tool has a reported sensitivity of 0.89 and a specificity of 0.92 at a cutoff score of 19 for depression screening in the general Taiwanese public [16].

### Statistics

An anticipated pain intensity (NRS) of  $\geq 4$  during preoperative assessment was defined as a moderate-to-high pain level and a pain intensity (NRS)  $\geq 4$  measured in PACU was defined as an unacceptable pain level that required analgesic intervention [17]. Patients who reported an expected NRS  $\geq 4$  in the preoperative period were associated with a significantly increased risk of postoperative pain up to postoperative day 4 [18]. The relationships between patients' anticipated pain intensity and their demographical data and types of operation were analyzed. Types of surgical procedures that were associated with different levels of expected postoperative pain intensity were graded according to a clinical prediction rule established by Jessen et al [19]. The risk of developing severe postoperative pain was graded by the invasiveness of the procedure, clinical observation, current practice, and opinions of surgeons and anesthesiologists. A total of 27 groups of surgical procedures were classified into 5 levels: lowest, low, moderate, high, and highest expected pain (supplementary table 1) [19]. Variance inflation factors (VIF) were computed for the covariates that are potentially affected the preoperative anticipated pain intensities. A VIF of 1.0 indicates that the particular variable of interest is not significantly correlated to the other covariates. The values of continuous variables were compared using an Mann-Whitney U test or Kruskal-Wallis test, as appropriate. Categorical variables were compared using chi-square or Fisher's exact test. A stepwise regression model was adopted to evaluate the factors of interest (patient demographic and clinical variables) and the preoperative anticipated pain scales. Statistical significance was accepted at a level of  $P < 0.05$ . All statistical analyses were performed using the SAS software, version 9.1 (SPSS software, version 24.0 (IBM, Armonk, NY)).

## Results

### General outcomes

A total of 857 eligible patients were included in the study, one patient was excluded due to incomplete data (Figure 1). The mean time interval between preoperative and postoperative pain assessment was  $1.8 \pm 6.1$  (range 0-108) days. The mean age of the study population was  $50.4 \pm 15.4$  years and 49.2% of the patients were male (Table 1). Most of these patients (73.7%) had at least one previous surgery (Table 1). Types of operation are listed in Table 1. The mean anticipated pain intensity (NRS) before surgery was  $4.9 \pm 2.5$  (range 0-10) and 72.2% of the patients anticipated developing high pain intensity (NRS  $\geq 4$ ) after their operations (Table 1).

### Patient characteristics and surgical-related factors

Female patients anticipated significantly higher overall pain levels than male patients (NRS  $5.34 \pm 2.48$  vs  $4.52 \pm 2.47$  respectively;  $P < 0.001$ ). Compared to male patients, the adjusted odds ratio (AOR) for female patients to anticipate higher pain levels (NRS  $\geq 4$ ) was 1.695 (95% confidence interval (CI) 1.252-2.295,  $P < 0.001$ ) (Table 2). Patients over 41 years of age had significantly lower overall anticipated pain levels than those younger than 40 years of age (Table 2,  $P = 0.003$ ). The patient's medical condition (defined as the ASA status), history of previous operations, education level, regular use of benzodiazepine at bedtime, and depression did not affect anticipated pain scores (Table 2).

Compared with higher expected pain procedures, patients scheduled for procedures with the lowest expected pain levels anticipated a significantly lower mean NRS (Table 2). There was a linear relationship of increasing intensity of anticipated pain with different classifications of surgical procedures (Table 2 and Figure 2).

### **Association between preoperative anticipated pain and postoperative pain**

Before surgery, 72.4% of patients anticipated moderate-to-high pain intensity (NRS  $\geq 4$ ) (Table 3), but the actual NRS recorded by PACU nurses showed that 52.3% of patients had adequate pain control (highest NRS <4) within one hour after surgery (Table 3). Patients who anticipated high NRS during preoperative period were associated with significantly higher actual NRS in PACU ( $P=0.032$ ) and also received significantly higher total equivalent opioid doses during the perioperative period ( $P=0.001$ ) (Table 4).

## **Discussion**

A major limitation in postoperative pain management has been the fact that a patient's personal perception of pain may not always be taken into account during preoperative pain counseling. Acute postoperative pain is a subjective and multidimensional experience that is extremely hard to measure and manage optimally. In fact, a previous study found that pre-exposure to a stressed or anxious condition significantly increased the subjective pain perception to a standard noxious stimulation than those who were pre-exposed to a happy condition [20].

Gender is commonly considered as a strong predictor of pain perception and analgesic requirements after surgery [21-22]. However, some systematic reviews have not found gender to be an independent predictor for postoperative pain levels or analgesic requirements [11]. The results of our survey suggest that female patients anticipated significantly higher pain levels preoperatively than male patients. These results support the findings of numerous previous studies [23-25]. Our analysis also found that older patients (>40 years) anticipated a lesser degree of surgical-related pain during their preoperative assessments as compared to those who were younger. We suggest that this observation may be due to the elderly having a lesser degree of preoperative anxiety and that they usually request for less information regarding their operations [26-28]. Our results are also consistent with previous prospective observational studies in patients receiving breast surgery, indicating that age had a negative impact on the prediction of acute postoperative pain [13, 29].

Previous studies have suggested that patients with psychophysical and psychosocial disorders (*e.g.* anxiety, depression, sleep disturbance, and catastrophizing pain) can have a decreased tolerance of or anticipate higher postoperative pain [29-33]. We collected patient information on regular benzodiazepine use for sleep disorders and the presence of depressive symptoms (screened by the Taiwanese Depression Questionnaire) during the preoperative assessment. Our results did not find any significant effects of sleep disturbance or depressive symptoms on preoperative pain anticipation. Since we used simple and short questionnaires to screen for the presence of these psychophysical disorders, this study may have been underpowered to isolate depression or sleep disturbance as predictors for the anticipation of high

postoperative pain. This study also did not find significant effects of other patient variables, such as educational levels, marital status, and socioeconomic status on surgical pain intensity anticipation.

Classification of surgery type has been shown to be a clinically meaningful predictor of acute postoperative pain, as the invasiveness and incision size of procedure relate with the anticipated pain intensity [19]. We used the clinical prediction rule established by Janssen et al., in which types of surgery were graded from the lowest to the highest in regards to expected pain levels [19]. Our analysis showed a clear positive relationship between the type of operation and the patient's anticipated pain intensity, suggesting that the invasiveness and complexity of procedure affects patients' anticipated perception of surgical-related pain in the preoperative period [11, 19].

Preoperative anticipated pain intensity was compared with the highest postoperative pain intensity recorded in PACU and the total equivalent dose of opioids prescribed perioperatively. Our analysis found that patients who anticipated moderate-to-high pain intensity before operations were associated with significantly higher actual pain scores in the PACU and also required significantly higher doses of analgesics during the perioperative period compared to those who reported a lower preoperative pain anticipation. In current practice, anesthesiologists are more likely to prescribe postoperative analgesics based on the type and duration of the operation rather than the patient's subjective perception of pain [34, 35]. Our results suggest that patient's self-anticipated pain intensity may provide complementary clinical considerations for adequate management of acute pain after surgery.

After extensively reviewing 48 studies, Ip *et al.* identified several independent perioperative factors for predicting actual levels of postoperative pain and analgesic usage [11]. These predictive factors include the presence of preoperative pain, anxiety, age, and type of surgery (*i.e.* major joint, thoracic, and open abdominal surgery) and are associated with higher postoperative pain scores. Surgery type, age, and psychological distress were found to be significant predictors of analgesic usage. Ip and colleagues' systematic review found that gender had a neutral effect on postoperative pain levels and analgesic requirements. However, the results of our study indicated that females anticipated more postoperative pain preoperatively. This major discrepancy could be due to the general understanding that female patients can react more emotionally to physical distress, but the distress is no less authentic and they are not less ill than the male patients [36-38].

The results of this study must be interpreted in light of several limitations. Firstly, patients were invited to voluntarily rate their anticipated pain intensity during their preoperative anesthesia assessment. Therefore, the knowledge, educational levels, and motives of the individual patient might impact their response to the quantitative question. Secondly, patients' preoperative psychological conditions are routinely assessed using a culturally relevant depression screening questionnaire, the Taiwanese Depression Questionnaire (TDQ) in our hospital. This short questionnaire was designed to be simple and practical so that it could be applied to the general population in a time-efficient manner. The comprehensive versions for diagnosing depression and chronic insomnia were not used in this study. Furthermore, the use of a structured self-rating Pain Sensitivity Questionnaire may also provide higher

sensitivity to predict the development of acute postoperative pain [13, 39]. Thirdly, several potential predicting factors, such as patient's pain catastrophism, pain sensitivity, preoperative opioid intake, full history of past surgeries and traumas, and ethnicity were not investigated in this study. Although total equianalgesic doses of opioids administered during perioperative period was calculated, the use of non-opioid analgesics were not taken into account for the overall surrogate indicator for postoperative pain. Lastly, our results were not generalized to critically ill patients who were scheduled for postoperative intensive care or emergent surgery.

## Conclusion

Our study demonstrated that female gender, younger age ( $\leq 40$  years), and who scheduled to receive more invasive surgical procedures anticipate significantly higher pain intensity before surgery, and are associated with higher actual pain scores and increased analgesic requirements during the perioperative period. Therefore, these patients may require additional assessments and pain management counseling during their pre-anesthesia consultation. Appropriate preoperative counseling for analgesic control (especially the introduction of multimodal analgesia) and the management of unnecessary anticipated pain levels could improve the quality of anesthesia delivery and patient perioperative satisfaction.

## Abbreviations

AOR: adjusted odds ratio; ASA PS: American Society for Anesthesiologist physical statuses; BMI: body mass index; CI: confidence interval; ERAS: enhanced recovery after surgery; MMA: multimodal analgesia; NRS: numeric rating scale; PACU: postanesthesia care unit; TDQ: the Taiwanese Depression Questionnaire; VAS: visual analogue scale

## Declarations

**Ethics approval and consent to participate:** The study protocol was approved by the institutional review board of the E-Da Hospital, Kaohsiung, Taiwan (EMRP107018). Written informed consents were obtained from the patients or their legal representatives.

**Consent for publication:** not applicable

**Availability of data and material:** The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

**Competing interests:** The authors declare that they have no competing interests.

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**Authors' contributions:** WSC, SCC, CFL and YCT designed the study. WSC, YTH, MCC, and YCC collected the questionnaires and data acquisition. WSC, TSC, CFL and YCT contributed to the statistical analysis and interpretation of data. WSC, YTH, MCC, CFL and YCT contributed to drafting the manuscript. All authors read and approved the final version of manuscript. CFL and YCT contributed equally to the work.

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## Tables

**Table 1. Patient demographical data (n=857)**

Characteristics	n (%) or mean±SD
Age (years, mean)	50.4±15.4
Age groups (years)	
£40	227(26.5%)
>40	630(73.5%)
Gender	
Male	422(49.2%)
Female	435(50.8%)
Body mass index (kg/cm <sup>2</sup> , mean)	25.7±4.9
Body mass index (kg/cm <sup>2</sup> )	
<18.5	38(4.4%)
18.6~24.9	385(44.9%)
>24.9	434(50.6%)
Educational levels	
Illiteracy	33(3.9%)
< College or high school	552(64.4%)
<sup>3</sup> University	272(31.7%)
Depression (yes)	86(10.0%)
Surgical history (yes)	632(73.7%)
Mean anticipating NRS	4.9±2.5
Anticipating higher pain intensity (NRS <sup>3</sup> 4)	619 (72.2%)
ASA physical status	
I-II	711 (83.0%)
III-V	146 (17.0%)
Types of surgery	
Lowest expected pain	63 (7.4%)
Low expected pain	144 (16.8%)
Moderate expected pain	79 (9.2%)
High expected pain	282 (32.9%)

Highest expected pain	289 (33.7%)
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ASA: American Society of Anesthesiologists; NRS: numerical rating scale

**Table 2. Analysis of the associations between patient's anticipated pain intensity and patient's characteristic or surgical-related factors**

	Anticipated mean NRS	n	P value	Anticipated moderate-to high pain <sup>†</sup>		
				AOR	95% CI	P value
Gender			<0.001			
Male	4.52±2.47	422		Ref		
Female	5.34±2.48	435		1.695	1.252-2.295	0.001
Age (years)			0.003			
0-40	5.36±2.50	227		Ref		
>40	4.78±2.49	630		0.713	0.501-1.016	0.061
Prior surgical history			0.311			
No	5.11±2.52	225		Ref		
Yes	4.87±2.50	632		0.905	0.641-1.276	0.567
Body mass index			0.746			
<18.5	5.05±2.60	38		Ref		
18.5~24.9	5.02±2.41	385		1.205	0.576-2.521	0.620
>24.9	4.85±2.58	434		0.963	0.464-2.000	0.920
Regular use of benzodiazepines			0.273			
No	4.90±2.52	741		Ref		
Yes	5.13±2.42	115		1.530	0.949-2.465	0.081
Depression <sup>#</sup>			0.724			
No	4.97±2.50	771		Ref		
Yes	4.74±2.54	86		1.120	0.673-1.865	0.663
Educational levels			0.322			
Illiteracy	5.42±3.03	33		Ref		
< High school	4.84±2.44	552		0.825	0.364-1.869	0.645
<sup>3</sup> University	5.06±2.56	272		0.841	0.363-1.946	0.685
ASA physical status			0.288			
I-II	4.98±2.43	711		Ref		
III-V	4.71±2.79	146		0.741	0.505-1.087	0.125
Types of surgery with different expected pain			<0.001			

Lowest	3.56±2.60	63		Ref		
Low	4.67±2.48	144	*	1.938	1.060-3.542	0.032
Moderate	4.82±2.37	79		2.510	1.250-5.040	0.010
High	5.21±2.47	282	**	3.049	1.734-5.360	<0.001
Highest	5.13±2.47	289	**	3.134	1.783-5.508	<0.001

AOR: adjusted odd ratio; ASA: American Society of Anesthesiologists; CI: confidence interval; NRS: numerical rating scale. #the presence of depressive symptoms was screened using a culturally relevant depression screening questionnaire, the Taiwanese Depression Questionnaire (TDQ) [16]. †Moderate-to-high anticipated pain was defined as a NRS <sup>3</sup>4. Data of anticipated NRS were analyzed by the nonparametric Wilcoxon rank-sum test or Kruskal-Wallis test, and are presented as mean±SD \*P=0.043 and \*\*P<0.001 compared with lowest expected pain using the Dunn's post-hoc test. A stepwise regression model was used to determine the values of AOR and 95% CI for each associated factor. The degrees of multicollinearity among the covariates that might potentially affect preoperative anticipated pain were measured for the variance inflation factors (VIF), which ranged from 1.012 to 1.1195 (supplementary table 2).

**Table 3. Comparison between patient's preoperative self-anticipating pain and postoperative pain score measured in PACU**

Highest pain score at PACU	Preoperative self-anticipating pain score		P value
	NRS <4	NRS 4-10	
NRS <4	138 (59%)	306 (49.8%)	0.016
NRS 4-10	96 (41%)	309 (50.2%)	
Total patients (n=849)*	234	615	

NRS: numerical rating scale; PACU: post-anesthesia care unit. \*A total of 849 datasets were analyzed due to missing of the NRS in the PACU. Data were analyzed by chi-square test.

**Table 4. Analysis of the associations between patient's preoperative self-anticipated pain intensity and the actual postoperative pain at PACU or analgesic requirement during perioperative period (n=849)**

	Preoperative self-anticipated pain score		P value
	NRS <4 (n=234)	NRS 4-10 (n=615)	
Highest NRS at PACU	2.76±1.79	3.09±1.92	0.032
Equivalent dose of opioid (mg) during perioperative period	14.74±7.36	16.70±8.51	0.001

NRS: numerical rating scale; PACU: post-anesthesia care unit. Data were analyzed by the Mann-Whitney U test, and results are presented as mean±SD.

## Figures

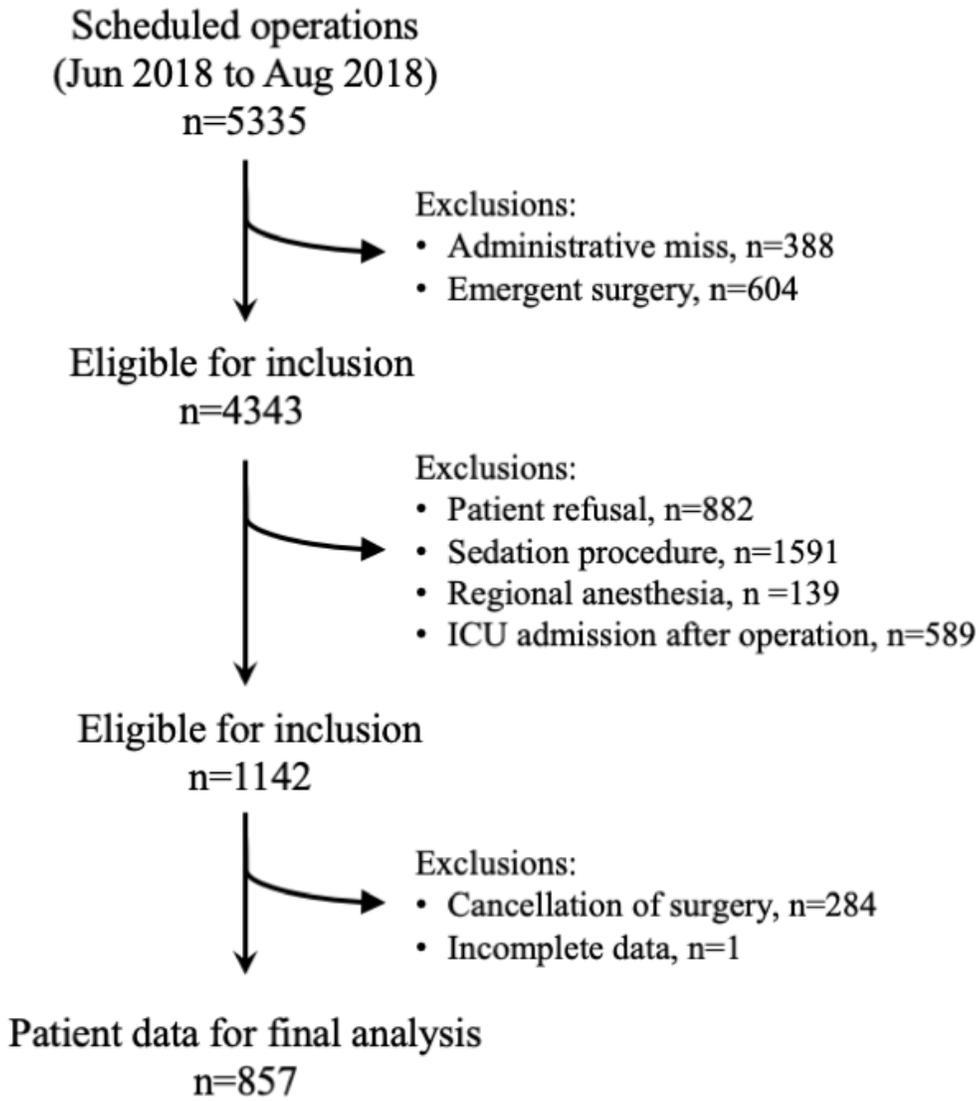
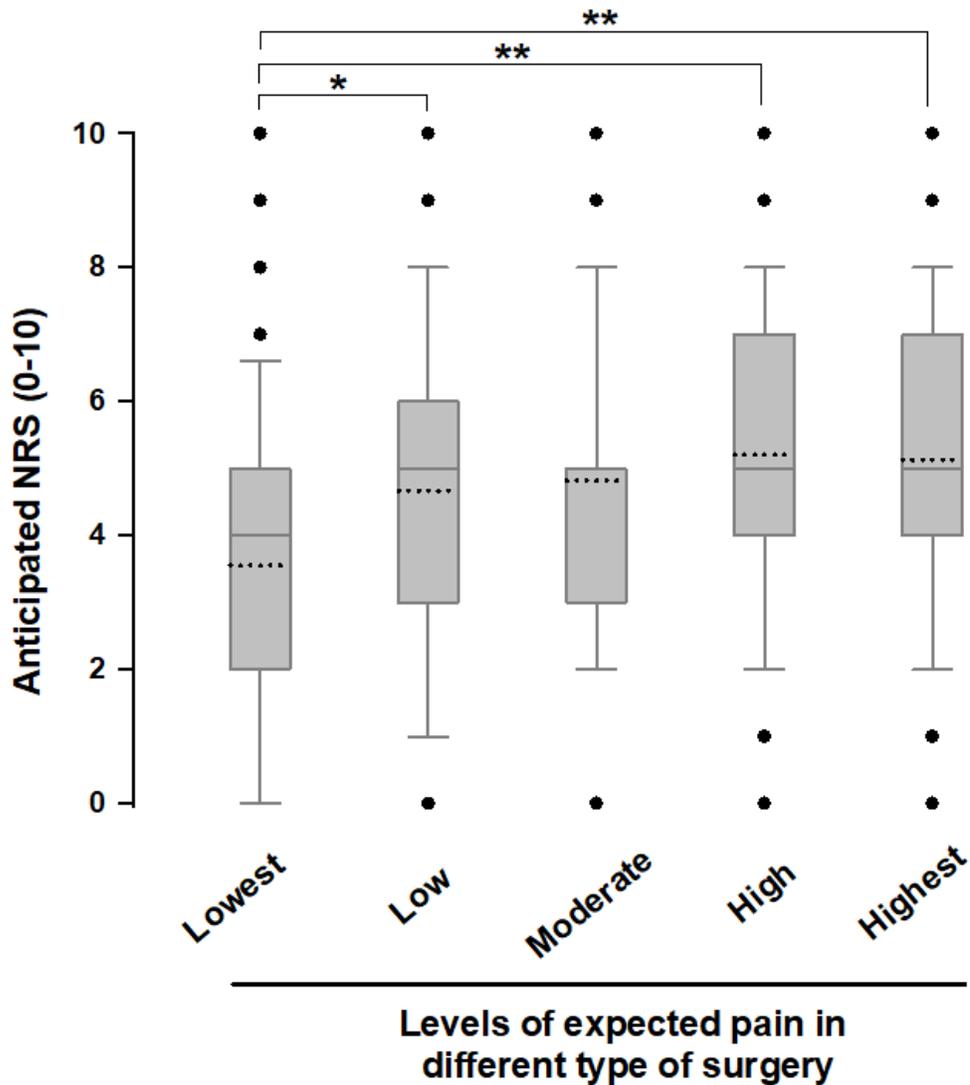


Figure 1

Study flow diagram.



**Figure 2**

Graphical presentation of relationships between types of the scheduled surgery and patient’s anticipated pain. The invasiveness of surgical procedures graded by a clinical prediction model established by Janssen et al [19], as types of operation were grouped into the lowest, low, moderate, high and highest expected pain surgery. The median value of anticipated numerical rating scale (NRS) in the lowest expected pain surgery group was significantly increased in comparison to the other 3 groups (\*P=0.043 and \*\*P<0.001; as analyzed using the Kruskal-Wallis test, followed by the Dunn’s post-hoc test). Results are presented as box-and-whisker plots, in which the horizontal solid lines of boxes indicate the 75th percentile, median and 25th percentile of the distribution, and the upper and lower whiskers indicate the maximal and minimal values. Dotted lines indicate the mean values. Number of patients in each group are stated in Table 2.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Supplementarytable1.docx](#)
- [supplementarytable2.docx](#)