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ORIGINAL ARTICLE

Predictors of postoperative pain and analgesic requirements following abdominal hysterectomy: an observational study

Marie T. Aouad[1] · Ghassan E. Kanazi[1] · Krystel Malek[1] · Hani Tamim[2] · Lama Zahreddine[1] · Roland N. Kaddoum[1]

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Abstract
Purpose A prospective observational study is conducted to identify independent predictors of pain and morphine consumption following abdominal hysterectomy.
Methods Preoperative State Trait Anxiety Inventory (STAI), Numerical Rating Scales (NRS) for anxiety and pain expectations, thermal pain thresholds and pain scores at forearm and incision site, and pain scores generated from the insertion of an intravenous catheter were measured in female patients undergoing abdominal hysterectomy. Pearson correlations between the predictors and the two outcome measures postoperative pain scores and morphine consumption were studied and multiple regression analysis was conducted to identify independent predictors (primary outcome). Secondary outcomes included cut-off values of predictive tools for morphine consumption.
Results Data from 60 patients were analyzed. STAI state anxiety, NRS pain expectations, and NRS anxiety scores were identified as independent predictors of postoperative morphine consumption. We identified a cut-off value of 4.5 (sensitivity 90 %, specificity of 60 %) for the NRS anxiety and a cut-off of 42.5 (sensitivity 70 %, specificity 70 %) for the state anxiety STAI score for increased postoperative morphine consumption.
Conclusions Preoperative STAI state anxiety scores and NRS pain expectations are independent predictors for increased morphine consumption following hysterectomy. The STAI state anxiety tool and NRS 0-10 anxiety tool can be used interchangeably. The NRS 0-10 anxiety is a much simpler tool than STAI state anxiety and is associated with a higher sensitivity for high morphine consumption. Thermal pain thresholds and IV pain scores were not predictive of postoperative morphine consumption.

Keywords Predictors · Postoperative pain · Morphine consumption

Introduction

Research in postoperative pain management has for more than two decades focused on pharmacotherapy and delivery methods. Despite the advancement achieved in this field, postoperative pain is still undertreated [1–4]. Inadequate treatment of postoperative pain may adversely affect patients' outcomes and may lead to development of chronic pain [5]. Therefore, the postoperative pain research has recently changed focus, investigating now the mechanisms behind insufficient pain relief, such as inadequate response to analgesics or increased response to pain in a susceptible subgroup of patients [6, 7], as well as investigating experimental pain models and clinical predictors of postoperative pain.

A recent qualitative systematic review [7] looked at the results of published studies and identified preoperative pain, anxiety, age, and type of surgery as significant predictors of postoperative pain. Also, it identified type of surgery, age, and psychological distress as significant predictors of analgesic consumption. Another systematic review analyzed the predictive value of experimental pain models, such as electrical, pressure, heat, or cold stimuli [8]. The authors found that psychological factors do not seem to

✉ Roland N. Kaddoum
rk16@aub.edu.lb

[1] Department of Anesthesiology, American University of Beirut Medical Center, PO Box 11-0236, Beirut, Lebanon

[2] Clinical Research Institute, American University of Beirut Medical Center, Beirut, Lebanon

be as efficient predictors of intensity of postoperative pain as quantitative testing of a patient's basal pain perception before surgery [8]. Some authors consider that a multifactorial model combining psychosocial as well as experimental pain models is required for the prediction of pain [9].

It is clear that results from different studies are conflicting [8] and a simple and reliable prognostic assessment method of postoperative pain is still to be defined. The application of experimental sensory tests is time-consuming and not applicable in a busy operating room. However, patients undergoing surgery may be subjected to multiple painful stimuli, such as needle sticks for blood withdrawal, invasive diagnostic procedures, insertion of peripheral, arterial, or central lines during the 24 h preceding the planned surgery. A previous study showed that similar to postoperative pain, the perception of pain generated from the insertion of peripheral venous catheters is different for each individual [10]. This finding is consistent with our clinical observations; the reaction to the painful stimulus generated by the insertion of a peripheral venous catheter varies widely among patients and seems to be closely related to the amount of pain experienced postoperatively. Subsequently, pain scores upon IV insertion may be considered as a potential simple and reliable predictor of the intensity of postoperative pain. Also, long psychometric questionnaires may be used to measure anxiety. However, the literature is not clear whether these complicated and time-consuming tools can be replaced by simpler 0—10 scales. Therefore, in view of the many uncertainties and controversies regarding an efficient and practical approach to predict postoperative pain in a busy clinical setup, we designed a study where demographic factors, psychological factors measured by simple numerical rating scales, as well as the lengthy STAI tool, thermal pain, and pain from IV insertion were evaluated with regard to their predictive values of postoperative pain and morphine consumption in females undergoing abdominal hysterectomy through a Pfannenstiel incision. The primary aim of this study was to identify which of these factors is an independent predictor of the intensity of postoperative pain and analgesic consumption. Our secondary aims were to identify appropriate and simple measurement tools and to identify cut-off values of the predictive tools for high morphine consumption.

Methods

Study population

This study was registered with the www.clinicaltrials.gov protocol registration system (NCT01449318). Ethical approval for the study (Anes. MA.13) was provided by the Institutional Review Board of the American University of Beirut Medical center, Beirut, Lebanon (Chairperson Professor Fuad Ziyadeh) on September 5, 2011. Written informed consent was obtained from all participants. Sixty female patients aged between 35 and 65 years (ASA class I–III) scheduled for abdominal hysterectomy for benign gynecological conditions performed by the same surgeon through a Pfannenstiel incision at the American University of Beirut Medical center during the period extending from September 2011 until September 2013 were enrolled in a prospective observational study. Exclusion criteria were patients with a history of psychiatric disease, diabetes, alcohol abuse (who may have impaired sensation due to peripheral neuropathies), chronic opioid or nonsteroidal anti-inflammatory drug use, or chronic pain conditions.

Data collection

One day before the planned surgery, skin testing as well as other study-related tests were performed in a quiet room. Patients received a detailed explanation of each testing procedure and were trained to the use of the numerical rating scale (NRS) to report pain intensity or other variables' intensities. Also, patients were educated on the use of the patient-controlled analgesia (PCA) pump.

Assessment of emotional and psychological state

All patients completed the Spielberger State-Trait Anxiety Inventory (STAI), a validated tool that measures trait (20 questions) and state (20 questions) anxiety. Using a NRS, patients were asked to rate their expectations about pain intensity where 0 indicates no pain expected and 10 indicates the worst pain expected. Similarly, patients were asked to rate their anxiety level using NRS (0 indicating no anxiety and 10 indicating the worst anxiety imaginable). Also, patients were asked to rate their pain during a previous surgical experience (if present), using the same NRS scale (0 indicating no pain experienced and 10 indicating the worst imaginable pain).

Assessment of thermal pain temperature thresholds and pain scores

Thermal stimuli was administered to the ventral surface of the dominant forearm and then to the lower abdomen (surgical site) with a Thermal Sensory Analyzer (Modular Sensory Analyzer, Senselab, Somedic Sales AB, Horby, Sweden) via a 35 × 20-mm contact thermode. Each thermal testing trial was separated by approximately 2 min and at a separate site to avoid sensitization or adaptation [11]. The thermode was applied to the ventral surface of the dominant forearm and the thermode temperature of 32 °C rose at a rate of 0.5 °C/s, to a maximum of 50 °C (built-in safety

cut-off temperature), as this rate of temperature change minimizes intra-individual variation [12]. Patients were asked to indicate the transition point at which the nonpainful heat sensation changed into a painful heat sensation by pressing a button. The thermode temperature was recorded electronically. The test was repeated successively four times and the mean threshold temperature was calculated. The test was repeated in the same manner by applying the thermode to the lower abdomen (surgical site). Patients were also asked to rate the pain from the application of a 5-s stimulus at the threshold temperature and to report the level of perceived pain intensity by means of the NRS at both sites.

Anesthesia protocol and postoperative pain management

On the day of the surgery, no premedication was given. In the induction room, a 20-gauge intravenous catheter was inserted in the dorsum of the hand by an experienced anesthesiologist. Patients were instructed to report the pain felt upon the IV insertion using the NRS. No topical or subcutaneous anesthetics were applied prior to insertion. When the IV insertion failed at the first trial, another vein was identified and cannulated, however, only the NRS generated from the first trial was recorded in order to have a uniform assessment of pain among all patients. A three-way stopcock was connected directly to the intravenous catheter and was used to connect the PCA morphine pump postoperatively. Standard monitors (ECG, non-invasive blood pressure, esophageal temperature, oxygen saturation, and capnography) were connected to the patient and anesthesia was induced as per anesthesia department's routine (midazolam 1–2 mg, lidocaine 1.5 mg/kg, propofol 2 mg/kg, fentanyl 100 μg, and rocuronium 0.6 mg/kg to facilitate tracheal intubation). Maintenance of anesthesia was achieved using sevoflurane (1–3 %) in a mixture of oxygen and nitrous oxide. Intraoperative fentanyl was titrated to keep patient's hemodynamics within 20 % of baseline values and the total amount of fentanyl used was recorded at the end of surgery.

Upon arrival to the Post Anesthesia Care Unit (PACU), a morphine PCA pump was started with a demand dose of 1 mg, a lockout interval of 6 min, and a 4-h limit of 30 mg. No baseline infusion of morphine was used. During the PACU stay, the nurse in charge was asked to titrate morphine through the PCA pump in order to achieve adequate pain control before discharge to the floor.

Morphine consumption was recorded before discharge from the PACU then every 12 h during the first 48 h. Also, NRS pain scores were recorded at the same time intervals. The NRS scores were obtained for pain at rest and during movement (changing from supine to sitting), as well as for visceral pain defined as colicky pain as opposed to incisional pain. Also, NRS scores were obtained for the overall level of pain and overall satisfaction with pain control. Patients received paracetamol 1 g IV every 6 h and were allowed to request diclofenac 100 mg suppository every 8 h in case of inadequate pain relief. The amount of diclofenac used was recorded.

Age, weight, height, body mass index, smoking status, recollection of pain scores from previous surgery, thermal pain thresholds and pain scores, trait and state STAI scores, NRS scores for anxiety, pain expectations, intraoperative fentanyl consumption, incision size, surgery duration, as well as pain scores from IV insertion were recorded and considered as potential predictors. These data were tested against the following outcome measures: postoperative pain scores (at rest, during movement, and visceral), and morphine consumption. The outcome measures were recorded upon arrival to the PACU (time 0), at discharge from PACU, at 12, 24, 36, and 48 h postoperatively.

Statistical analysis

Descriptive statistics were calculated for all variables, where mean and standard deviation (SD) were calculated for continuous variables and number and percent for categorical ones. Associations between different predictors and outcome variables were carried out by calculating the Pearson correlation coefficients (r). With an observed regression coefficient (R^2) of 0.17 for multiple regression model including three independent predictors at alpha level of 0.05 and a statistical power of 0.8, a sample size of 60 patients was calculated. Regression analysis was used to examine the relationship between predictive factors and outcome variables. More specifically, multivariate linear regression was used, where variables controlled for were those found to be statistically significant, or of clinical significance. Moreover, the area under the curve was calculated for the morphine consumption in relation with the STAI-Trait and NRS anxiety scores at different cut-off points. The best cut-off point was calculated using the Youden's index analyses. Receiver operating curves (ROC) were constructed as well. For all analyses, p value was set at 0.05 for statistical significance. Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 21 (SPSS Inc., Chicago, IL, USA).

Results

A total of 141 patients were assessed for eligibility. Forty-six patients were excluded because they had one or more exclusion criteria, nine patients refused to participate and 26 patients were not enrolled because they had their surgery rescheduled. Therefore, a total of 60 patients were

Table 1 Descriptive analysis for the demographics, history, predictors, and outcome variables

Variables			Mean (SD)	*N* (%)
Demographics	Age (years)		48.7 (7.0)	
	ASA	1		30 (50.0 %)
		2		26 (43.3 %)
		3		4 (6.7 %)
	Weight (kg)		69.4 (11.6)	
	Height (cm)		160.1 (6.5)	
	BMI (kg/m^2)		27.1 (4.5)	
	Smoking	No		38 (63.3 %)
		Yes		22 (36.7 %)
History	Previous surgery	No		15 (25 %)
		Yes		45 (75 %)
	NRS pain from previous surgery		6.9 (3.0)	
Predictors	Heat threshold forearm (°C)		46.9 (2.9)	
	Heat threshold abdomen (°C)		45.6 (3.3)	
	NRS pain thermal stimuli forearm		6.0 (2.1)	
	NRS pain thermal stimuli abdomen		6.1 (2.0)	
	STAI state		46.0 (13.2)	
	STAI trait		39.3 (11.6)	
	NRS anxiety		5.7 (3.0)	
	NRS expectation about pain		7.8 (1.8)	
	NRS pain from IV cannula insertion		5.6 (2.2)	
	Duration of surgery (min)		111.8 (34)	
	Duration of anesthesia (min)		136.6 (36.3)	
	Size of incision (cm)		15.6 (4.2)	
	Fentanyl consumption during surgery (μg)		240.4 (79.1)	
Outcomes	NRS pain time 0 at rest		7.6 (2.3)	
	NRS pain at discharge from PACU at rest		5.6 (2.3)	
	NRS pain at 12 h at rest		2.9 (2.6)	
	NRS pain at 24 h at rest		2.9 (2.7)	
	NRS pain at 36 h at rest		2.2 (2.5)	
	NRS pain at 48 h at rest		2.3 (2.7)	
	NRS pain at 12 h at movement		6.4 (2.2)	
	NRS pain at 24 h at movement		6.2 (2.3)	
	NRS pain at 36 h at movement		5.7 (2.2)	
	NRS pain at 48 h at movement		5.3 (2.1)	
	NRS visceral pain at discharge from PACU		3.7 (3.3)	
	NRS visceral pain at 12 h		3.2 (3.2)	
	NRS visceral pain at 24 h		2.3 (3.1)	
	NRS visceral pain at 36 h		1.8 (2.7)	
	NRS visceral pain at 48 h		2.2 (3.1)	
	Morphine consumption at discharge from PACU (mg)		13.9 (6.9)	
	Morphine consumption at 12 h (mg)		26.9 (12.5)	
	Morphine consumption at 24 h (mg)		35.6 (18.4)	
	Morphine consumption at 36 h (mg)		40.4 (21.9)	
	Morphine consumption at 48 h (mg)		47.6 (27.5)	
	Total morphine consumption (mg)		43.0 (25.8)	
	Morphine discontinuation time (hours)		36.9 (11.7)	
	Overall NRS pain		6.2 (1.9)	
	Overall NRS satisfaction with pain control		8.7 (1.4)	

NRS numerical rating scale, *PACU* post anesthesia care unit

Table 2 Variables with significant correlation with outcome variables using Pearson correlation

Variables	Outcome variables	*N*	Mean (SD)	Correlation coefficients	*p* value
Age	NRS visceral pain at 24 h	59	2.3 (3.1)	–0.310	0.02
	NRS visceral pain at 36 h	52	1.8 (2.7)	–0.361	0.008
	NRS visceral pain at 48 h	45	2.2 (3.1)	–0.348	0.02
NRS previous surgery	Morphine consumption at 12 h	38	26.9 (12.5)	0.36	0.03
	Morphine consumption at 24 h	36	35.6 (18.4)	0.35	0.04
	Morphine consumption at 36 h	33	40.4 (21.9)	0.42	0.01
	Morphine consumption at 48 h	36	47.6 (27.5)	0.45	0.02
STAI–state anxiety score	NRS visceral pain at 36 h	52	1.8 (2.7)	0.37	0.008
	NRS visceral pain at 48 h	45	2.2 (3.1)	0.52	<0.0001
	Morphine consumption at 12 h	60	26.9 (12.5)	0.32	0.01
	Morphine consumption at 24 h	58	35.6 (18.4)	0.38	0.003
	Morphine consumption at 36 h	50	40.4 (21.9)	0.38	0.007
	Morphine consumption at 48 h	42	47.6 (27.5)	0.40	0.009
	Total morphine consumption	60	43.0 (25.8)	0.39	0.002
	Overall NRS pain	51	6.2 (1.9)	0.34	0.02
NRS anxiety	NRS at 48 h at rest	44	2.3 (2.7)	0.38	0.01
	NRS at 36 h at movement	52	5.7 (2.2)	0.32	0.02
	NRS at 48 h at movement	45	5.3 (2.1)	0.33	0.03
	NRS visceral pain at 48 h	45	2.2 (3.1)	0.31	0.04
	Morphine consumption at 12 h	60	26.9 (12.5)	0.34	0.008
	Morphine consumption at 24 h	58	35.6 (18.4)	0.39	0.003
	Morphine consumption at 36 h	50	40.4 (21.9)	0.44	0.001
	Morphine consumption at 48 h	42	47.6 (27.5)	0.49	0.001
	Total morphine consumption	60	43.0 (25.8)	0.42	0.001
	Morphine discontinuation time	60	36.9 (11.7)	0.32	0.01
	Overall NRS pain	51	6.2 (1.9)	0.32	0.02
NRS expectations about pain	NRS visceral pain at discharge from PACU	60	3.7 (3.3)	0.35	0.007
	NRS visceral pain at 12 h	60	3.2 (3.2)	0.23	0.09
	NRS visceral pain at 24 h	59	2.3 (3.1)	0.33	0.01
	Morphine consumption at 12 h	60	26.9 (12.5)	0.36	0.005
	Morphine consumption at 24 h	58	35.6 (18.4)	0.45	<0.0001
	Morphine consumption at 36 h	50	40.4 (21.9)	0.43	0.002
	Morphine consumption at 48 h	42	47.6 (27.5)	0.44	0.004
	Total morphine consumption	60	43.0 (25.8)	0.45	<0.0001
	Morphine discontinuation time	60	36.9 (11.7)	0.34	0.008

NRS numerical rating scale, *PACU* post anesthesia care unit

enrolled in the study. Some of the patients elected to stop the PCA pump before the end of the 48-h study period. These patients elected to do so when the amount of pain experienced became negligible and they considered that they were not in need for morphine anymore. Therefore, the number of patients analyzed was less than 60 for some of the parameters. A descriptive analysis of the different predictors and outcome variables is depicted in Table 1. The median value of total morphine consumption was 37 mg. The variables that showed a significant correlation with one of the outcome variables using Pearson correlation are listed in Table 2. Multivariate analysis including state STAI scores, NRS scores for expectations about pain, and NRS scores for pain after IV insertion for the prediction of morphine consumption at the different time intervals were conducted. The results are presented in Table 3.

The association between NRS anxiety and state anxiety STAI scores showed statistical significance ($r = 0.7$, $p < 0.0001$). Therefore, a multivariate analysis was conducted using the same model but replacing STAI state anxiety by the NRS anxiety (Table 4). These two analyses showed that both variables can be used interchangeably with similar results.

Table 3 Multivariate analysis for the predictors of morphine consumption at different time intervals

Predictors	R^2	Unstandardized beta	p value
Morphine consumption at 12 h			
STAI State anxiety	0.22	0.28	0.02
NRS pain expectations		2.21	0.01
NRS IV		0.67	0.34
Morphine consumption at 24 h			
STAI State anxiety	0.32	0.48	0.004
NRS pain expectations		4.10	0.001
NRS IV		0.91	0.34
Morphine consumption at 36 h			
STAI State anxiety	0.30	0.57	0.008
NRS pain expectations		4.74	0.003
NRS IV		0.51	0.71
Morphine consumption at 48 h			
State anxiety	0.32	0.67	0.02
NRS pain expectations		6.34	0.004
NRS IV		–0.72	0.69
Total morphine consumption			
State anxiety	0.32	0.69	0.004
NRS pain expectations		5.92	0.001
NRS IV		0.36	0.79

NRS numerical rating scale

Table 4 Multivariate analysis for the predictors of total morphine consumption using NRS anxiety instead of STAI state anxiety scores

Predictors	Total morphine consumption		
	R^2	Unstandardized beta	p value
NRS anxiety	0.32	3.03	0.003
NRS pain expectations		5.39	0.002
NRS IV		0.79	0.56

NRS numerical rating scale

To identify the NRS anxiety and State anxiety STAI threshold values for high morphine consumption (defined as a morphine value above the median value of 37 mg), we realized ROC curves and analyzed the correlation between sensitivity and specificity of the two tests. We evidenced the proportion of true-positives (ordinate) and false-positives (abscissa) results. We identified a cut-off value of 4.5 with an area under the curve of 0.77 and a sensitivity of 90 % and a specificity of 60 % for the NRS anxiety and a cut-off of 42.5 with an area under the curve of 0.74 and a sensitivity of 70 % and a specificity of 70 % for the state anxiety STAI score.

Discussion

Our results showed that STAI state anxiety scores, NRS 0–10 anxiety scores, and expectations about pain 0–10 scores are independent predictors of morphine consumption at different time intervals and of total morphine consumption in females undergoing abdominal hysterectomy through a Pfannenstiel incision. Furthermore, our results showed that STAI state anxiety scores and NRS 0-10 anxiety scores can be used interchangeably as independent predictors of increased morphine consumption.

We eliminated possible confounders such as gender, preexisting pain, or surgical factors by enrolling females only with a narrow age range undergoing surgery through a Pfannenstiel incision and by considering preoperative pain as exclusion criteria. Predictors of post-hysterectomy analgesia consumption were also investigated by Pinto et al. [13]. Pre- and post-surgical factors that predict the provision of rescue analgesia following hysterectomy were studied. Although psychological factors were closely related to rescue analgesia consumption, these factors were different from our findings. In their study, preoperative anxiety was not associated with increased rescue analgesics, while preoperative fear and postoperative anxiety were. Of note, preoperative and postoperative anxiety not only affects postoperative analgesic consumption but also seems to affect persistent postsurgical pain 4 months after hysterectomy [14]. Also, different from our study, the authors chose to include pre-operative pain, whether acute or chronic, as a parameter that may influence the administration of rescue analgesics after hysterectomy; and reported a significant association between the presence of "other previous frequent pain states" not related to the surgery, and the provision of rescue analgesics [13]. Furthermore, our study focused on one anesthetic technique, while Pinto et al. compared the effect of the type of anesthesia on the rescue analgesic administration and reported less need for additional analgesics with a combined (general + loco-regional) technique [13].

Similar to demographic and psychological factors [15] and experimental pain models [8], we hypothesized that pain scores generated from the painful stimulus of an intravenous catheter insertion before the surgery may help identify the interindividual variability in pain perception. Patients who express an exaggerated pain response to IV cannulation might express a higher level of postoperative pain and subsequently require a larger amount of morphine to control their surgical pain. In our study, we were unable to establish a correlation between pain generated from IV insertion and postoperative morphine consumption. IV cannulation is considered a painful procedure [16]. However,

it is not associated with high pain scores. Robinson et al. reported a median VAS score of only 20 mm (95 % CI 10–25) on a scale from 0 to 100 mm in patients who did not receive analgesia for IV cannulation [17]. In our study, more than half of our patients (31 out of 60) had an NRS pain score of less than 5 during the insertion of a 20 G IV catheter. Despite the low pain scores, this invasive procedure is recognized as a major source of discomfort and anxiety in surgical patients [18]. Therefore, our study would have been able to identify discomfort from IV insertion as a predictor for postoperative morphine consumption, had we measured the level of anxiety generated from IV insertion rather than pain scores. Future studies are needed to confirm this hypothesis.

Previously published results regarding the predictive value of thermal pain thresholds are conflicting. Pan et al. found that thermal pain thresholds at the arm did not correlate with post caesarean section pain; whereas thermal pain threshold at the lower back near the dermatomes of the surgical wound was the most predictive factor for pain during activity and for recovery room analgesia requirement after caesarean delivery [9]. Granot et al., using the same post caesarean section pain model demonstrated that only suprathreshold thermal pain at the forearm especially at 48 °C correlates with post caesarean section pain and could not find any correlation between thermal pain threshold and postoperative pain [19]. In our study, we failed to demonstrate any significant correlation between morphine consumption and thermal pain threshold temperatures and pain scores either at the forearm or at the surgical site. Our results seem to be in accordance with the results of the systematic review by Werner et al. where the authors showed that suprathreshold noxious stimulation has a better predictive performance than pain thresholds in terms of postoperative pain and analgesic requirements [8].

It has been previously established that postoperative pain is influenced by variables such as state anxiety [7]. Kain et al. showed in patients undergoing hysterectomy that trait anxiety has no direct effects on postoperative pain, in contrast to preoperative state anxiety that was found to be a significant direct positive predictor to postoperative pain [20]. Similarly, we demonstrated a positive relationship between preoperative state anxiety and not trait anxiety and the amount of postoperative morphine consumption. Furthermore we demonstrated that the simple NRS 0–10 anxiety score has the same predictive value for postoperative morphine consumption as the more lengthy state anxiety STAI and therefore, might be more practical to use in busy operating rooms. Our finding is not supported by Carvalho et al. study that did not find any correlation between the Anxiety Sensitivity Index (ASI), a complex assessment tool made of 16 questions and the self-reported anxiety 0–100 [21]. This might be related to the fact that the post caesarean section pain model used by the authors has inherent differences with post hysterectomy pain, such as the pregnancy related changes in pain thresholds, the focus on the baby not on the pain and the use of spinal anesthesia rather than general anesthesia.

Values of 4.5 for NRS anxiety 0–10 and 42.5 for STAI state anxiety were identified as the cut-off values with the best sensitivity and specificity for the prediction of high morphine consumption. The NRS anxiety was associated with a higher sensitivity of 90 vs. 70 % for the STAI state anxiety. However, both tools were associated with low specificities (60 and 70 %).

As shown in Table 2, mean values of NRS scores were below 3 for pain at rest, around 3 for visceral pain and around 5 for pain at movement throughout the study period. Patients had the freedom to use as much morphine as needed through the PCA pump which translated into an adequate control of postoperative pain at the cost of higher morphine consumption, as evidenced by relatively low pain scores and a mean satisfaction score close to 9 on a scale of 10. For this reason pain scores at rest and during movement were not a useful outcome measure to identify pain predictors in our study.

In conclusion, our results suggest that preoperative STAI state anxiety, NRS pain expectations and NRS anxiety scores are independent predictors for increased morphine consumption following hysterectomy and that a simple NRS 0–10 anxiety tool has the same predictive value as the STAI state anxiety tool. Conversely, thermal thresholds and pain scores upon IV insertion are not useful. Our findings are specific to female patients undergoing hysterectomy through a Pfannenstiel incision under general anesthesia and therefore might not be generalizable to other conditions. In this setup, our findings may be useful in implementing efficient screening methods and in tailoring effective pain management plans specifically targeting individuals at high risk of experiencing severe postoperative pain. This strategy may translate into a better control of pain and improved patient satisfaction.

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Conflict of interest The author(s) declare that they have no competing interests.

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