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Prediction of Postoperative Pain using Path Analysis in Older Patients

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Abstract

Purpose—Effective postoperative pain management is important for older surgical patients since pain affects perioperative outcomes. A prospective cohort study was conducted to describe the direct and indirect effects of patient risk factors and pain treatment in explaining levels of postoperative pain in older surgical patients.

Methods—We studied patients who were 65 years of age or older and were scheduled for major non-cardiac surgery with a postoperative hospital stay of at least 2 days. The numeric rating scale (0 = no pain, 10 = worst possible pain) was used to measure pain levels before surgery and once daily for 2 days after surgery. Path analysis was performed to examine the association between predictive variables and postoperative pain levels.

Results—Three hundred fifty patients were studied. The results reveal that preoperative pain level, use of preoperative opioids, female gender, higher ASA physical status, and postoperative pain control methods were the strongest predictors of postoperative pain as measured the first day after surgery. Younger age, greater preoperative symptoms of depression and lower cognitive function also contributed to higher postoperative pain levels. Pain levels on the second day after surgery were strongly predicted by preoperative pain level, use of preoperative opioids, surgical risk, and pain and opioid dose on postoperative day 1. However, younger age, female gender, higher ASA physical status, greater preoperative symptoms of depression, lower cognitive function and postoperative pain control methods indirectly contributed to pain levels on the second day after surgery.

Conclusion—Although preoperative pain and use of preoperative opioids have the strongest effects on postoperative pain, clinicians should be aware that other factors such as age, gender, surgical risk, preoperative cognitive impairment and depression also contribute to reported postoperative pain. Based on significant statistical correlations, these study results can contribute to more effective postoperative care for those patients having the risk factors studied here. Preoperative treatment/intervention based in part on factors such as preoperative pain, use of preoperative opioids and depression may improve postoperative pain management.

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Keywords

aged; 80 and over; aging; pain; postoperative

Introduction

Since 1999, when the Joint Commission on Accreditation of Healthcare Organizations set the standards for the appropriate assessment and management of pain, pain has been recognized as the fifth vital sign in the United States [1]. Appropriate assessment and management of pain is an important component of perioperative care for older surgical patients, because appropriate pain control may contribute to better postoperative outcomes [2,3]. In contrast, inadequate pain control may increase sympathetic nervous system tone and contributes to cardiovascular complications such as myocardial ischemia or dysrhythmias [4]. Poorly managed pain may also lead to inadequate respiration and subsequent atelectasis or pneumonia [4]. In addition, in older patients, postoperative pain management is an important factor related to delirium [5]. Furthermore, inadequate pain control in acute postoperative period may result in chronic postsurgical pain [6,7].

In many previous studies, elderly patients are excluded from clinical studies, so that factors that affect postoperative pain in older patients are not well understood. Identifying which predictors are associated with postoperative pain perception may enable the management of older patients in a more evidence-based fashion.

The aims of the present study were to identify predictors of postoperative pain levels in older surgical patients which we hypothesize will be affected by preoperative factors (age, gender, American Society of Anesthesiologists physical status classification (ASA PS), preoperative pain levels, preoperative use of opioid, depressive symptoms and baseline cognitive status), intraoperative factors (surgical risk [8] which includes type of surgery, length of surgery and blood loss) and postoperative factors (postoperative pain control methods) (Figure 1). These factors were selected based on results from previous studies [9–12], and also based on a plausible biologic link between possible predictors and postoperative pain. The primary outcomes in this study are pain levels on postoperative day one (POD1) and day two (POD2) as reported by patient using the numerical rating scale (NRS).

Methods

Patient Recruitment

The study was approved by the Institutional Review Board of the University of California, San Francisco, and was part of a larger study examining the pathophysiology of postoperative cognitive changes conducted from 2001–2006 at the University of California, San Francisco Medical Center.

To be included in the study, patients had to be at least 65 yr of age and undergone elective non-cardiac surgery requiring a postoperative stay of at least 2 days. They also had to speak English and to be able to provide written informed consent. The attending physicians determined the type of anesthesia given and the method of postoperative pain management used. No aspect of clinical care was modified specifically for this study. Patients who received intravenous patient-controlled analgesia (IV-PCA) or oral pain medications postoperatively were included in the study. We excluded patients who received postoperative neuraxial analgesia or peripheral nerve blocks for postoperative analgesia to minimize confounding effects of additional postoperative pain management methods. Data

for a subset of patients in this study (n = 331) were included in a previous paper evaluating the effect of pain and pain management on postoperative cognition [5].

Preoperative Assessment

The preoperative interview was conducted by a trained research assistant in the preoperative anesthesia clinic, typically less than 2 weeks prior to surgery. The patient's health information and the potential covariates associated with postoperative pain, including age, ASA-PS, preoperative pain levels, preoperative depressive symptoms and use of preoperative opioids were obtained.

Patients were asked to rate their pain levels at rest using the 11-point numeric rating scales (NRS) from "no pain" to "worst possible pain" [13]. Preoperative symptoms of depression were measured using the 15-item Geriatric Depression Scale (GDS) [14]. The GDS was selected because it is a valid depression screen that is easy to administer in the preoperative period [15]. The score on the GDS reflects the total number of depressive symptoms reported by the patient. Baseline cognitive status was assessed in person or over the phone preoperatively using the Telephone Interview for Cognitive Status (TICS) [16]. TICS is an 11-item test (maximum 41 points) which correlates well with the Mini-Mental State Examination and widely used for screening of dementia. Scores below 30 on the TICS are considered to be cognitively impaired [17].

Intraoperative data

Data including type of surgery, length of surgery, and intraoperative blood loss were measured. Surgical risk was determined for each patient based on collected data and divided into 3 levels (low, intermediate and high) [8]. Definition of surgical risk levels is noted in Appendix 1.

Postoperative Assessment of Pain and Pain Management

Postoperative interviews were performed once a day for the first 2 postoperative days. The same trained research assistant conducted the interviews, which occurred between approximately 9 a.m. and 12 p.m., in the patient's hospital room. Pain levels at rest were measured in the same way as the preoperative evaluation, using the NRS. Information about postoperative pain management (use of IV-PCA or oral opioids) was obtained through review of medical records. Hydromorphone is the standard opioid used in our institution for IV-PCA administration. The typical IV-PCA was set to deliver 0.2 mg intravenous bolus of hydromorphone per demand, lockout time of 6 minutes without continuous background infusion. Dosages for PCA administration were not modified based on age. If hydromorphone was not used (for example because of patient allergy or sensitivity), morphine sulfate or fentanyl was used. Morphine sulfate and fentanyl doses were converted to hydromorphone using the conversion formula: 5 mg of morphine sulfate = 1mg of hydromorphone, 50 mcg of fentanyl = 1 mg of hydromorphone. Oral pain medication (e.g., hydrocodone with acetaminophen (5mg/500mg)) was given every 4–6 hours as needed.

Statistical Analysis

Path analysis was performed to examine the relationship among postoperative pain, use of postoperative opioids and multiple variables (age, ASA PS, preoperative antidepressants, preoperative GDS scores, preoperative TICS, preoperative pain levels, surgical risk, and postoperative pain control methods). Path analysis is an extension of multiple regression, which can provide estimates of the magnitude and significance of hypothesized causal connections between sets of variables [18]. In path analysis, hypotheses about relationships among variables are often depicted in a path diagram. Figure 2 represents a path diagram to

investigate our hypothesis. In contrast to multiple regression analysis, path modeling allows assessment of the direct and indirect effects of predictors on the dependent variables. Also, in contrast to multiple regression analysis which involves the computation of one model for each dependent variable, path modeling can be used to analyze multiple dependent variables simultaneously and provides an overall test of model fit. Preoperative GDS scores and opioid dose on POD1 and POD2 were not normally distributed. Therefore, to reduce variation and also to satisfy the assumption of multivariate normality, they were transformed by log (x+0.0001). If 70% of items of TICS and GDS were present, missing imputation with itemized mean was applied. Standardized regression weights (path coefficients) were reported on each arrow. The significance of a path coefficient was tested by using t-test that evaluates if the coefficient is significantly different than zero. A value of zero for a coefficient would indicate no association. When a variable has an arrow directed toward a dependent variable, it is said to have a direct effect. When a variable has an effect on the dependent variable through another variable, it is said to have an indirect effect.

We evaluated the goodness of fit of the hypothesized model shown in Figure 2. The χ^2 value, corresponding P value, goodness-of-fit test index (GFI), the root mean square error of approximation (RMSEA), standardized root mean squared residual (SRMR), non-normed fit index (NNFI), and comparative fit index (CFI) were taken as indicators for the overall goodness of fit of the model. Non-significant χ^2, values of the RMSEA less than 0.06, and values of the SRMR less than 0.08 are considered to indicate a very good fit. The GFI, NNFI, and CFI should be 0.90 or higher for a good fit [18]. According to these indices, the overall model fit of the path model was satisfactory (χ^2 (46, N = 350) = 60.325, P = 0.051; SRMR = 0.045; RMSEA = 0.033; GFI = 0.986; NNFI = 0.954; CFI = 0.970). All analyses were performed in SAS 9.2 (SAS Institute, Inc., Cary, NC).

Results

We studied 350 patients. The mean age was 73.4 ± 6.2 yr (range, 65–96 yr): 33.4% of patients were 65–69 yr old, 49.4% were 70–79 yr old, and 17.2% were 80 yr old or older. The incidence of preoperative opioid use was 31.7%. Mean preoperative pain levels, postoperative pain levels, postoperative intravenous opioid usage and additional clinical data are listed on Table 1.

Path Analysis

As shown in Figure 2 and Appendix 2, use of preoperative opioids (0.262; $P < 0.001$)), being female (0.129; $P < 0.05$), and greater number of preoperative depressive symptoms (GDS) (0.110; $P < 0.05$)) were associated with higher preoperative pain. Higher cognitive function (TICS ≥ 30) was associated with lower preoperative pain (−0.097; $P = 0.054$). The seven dotted lines in Figure 2 were included to show the expected associations between the exogenous variables. For example, female gender was associated with lower cognitive functioning (−0.143; $P < 0.01$), use of preoperative opioids (0.196; $P < 0.001$), and use of IV-PCA (0.196; $P < 0.001$). Higher ASA PS was negatively associated with use of IV-PCA (−0.169; $P < 0.01$) but positively associated with more preoperative depressive symptoms (0.148; $P < 0.01$) and age ≥ 80 (0.142; $P < 0.01$). Use of preoperative opioids was positively associated with use of IV-PCA (0.210; $P < 0.001$).

Predictors of postoperative pain on POD1—Six predictors were identified (Figure 2). Use of preoperative opioids (0.212; $P < 0.001$), higher ASA PS (0.144; $P < 0.01$), greater preoperative pain (0.206; $P < 0.001$), female (0.138; $P < 0.01$), and use of IV-PCA (0.125; $P < 0.01$) were associated with higher postoperative pain levels on POD1. Different from other predictors, 80 years or older (−0.111; $P < 0.05$) was negatively associated with postoperative

pain, which indicates that patients 80 years or older reported lower postoperative pain on POD1. Intraoperative factors (surgical risk, which includes type of surgery, length of surgery and blood loss) were not found to be a significant predictor. Pain on POD1 was also indirectly affected by preoperative psychological state with higher cognitive functioning contributing to lower pain levels and higher number of depressive symptoms contributing to higher POD1 pain levels (Appendix 2).

Predictors of postoperative pain on POD2—Preoperative pain (0.260; $P < 0.001$), pain level (0.389; $P < 0.001$) and opioid dose (0.139; $P < 0.01$) on POD1, and higher surgical risk (0.124; $P < 0.01$) affected postoperative pain on POD2. In addition, predictors for postoperative pain on POD1 also indirectly affected postoperative pain on POD2 (younger age, female, higher ASA PS, greater number of preoperative depressive symptoms, lower cognitive functioning and use of IV-PCA analgesia indirectly).

Postoperative opioid dose on POD1and POD2—Figure 2 also shows that pain level on POD1 (0.185; $P < 0.001$) and use of IV-PCA analgesia (0.327; $P < 0.001$) were associated with opioid dose on POD1. All the predictors of postoperative pain except higher preoperative TICS had indirect effects on opioid dose on POD 1. For example, use of preoperative opioids (0.049; $P < 0.01$), preoperative pain (0.038; $P < 0.01$), female (0.030; $P < 0.01$), and higher ASA PS (0.027; $P < 0.05$) had effects on opioid dose on POD 1 through postoperative pain.

In addition to the variables associated with opioid dose on POD1, opioid dose on POD1 (0.518; $P < 0.001$), pain level on POD2 (0.145; $P < 0.01$), and higher ASA PS (0.108; $P < 0.05$) were associated with opioid dose on POD2.

Discussion

Clinicians have intuitively understood that pathways to postoperative pain are complex due to the multiple causes of postoperative pain and the interrelationships between them. This study provides empirical evidence of that many interrelated pre and postoperative patient factors both directly and indirectly affect self-reported postoperative pain levels and opioid use in older surgical patients. The results in the path model demonstrate how patient's physical and psychological statuses directly contribute to preoperative pain and both directly and indirectly contribute to postoperative pain. Further, the model elucidates how these patient-related factors combine to affect postoperative dose of opioids. Unlike traditional regression models, use of a path model allowed simultaneous modeling of both the direct and indirect predictors of postoperative pain and opioid dose the first two days after elective surgery. For example, factors that have a direct association with pain on POD1 include age, preoperative pain levels, preoperative opioid use, ASA PS, and the type of postoperative pain management (IV-PCA). Factors that indirectly affected postoperative pain were patient's preoperative physical and psychological statuses. The results of the model provide a basis for the development of a heuristic model of the causes of post-operative pain in older surgical patients. Our study shows that preoperative pain is an important predictor of postoperative pain. This result is consistent with previous studies reporting that preoperative pain is a predictor of postoperative pain [9,10,19,20]. A possible explanation is that preoperative pain could induce changes in pain processing, i.e., central sensitization or neuroplasticity [19,20]. Wilder-Smith et al. [21] studied the sensory change (neuroplasticity) accompanying back surgery by measuring pain thresholds to transcutaneous electric stimulation. They concluded that preoperative back pain is associated with significant changes in central nervous nociceptive processing and induces diverse manifestation of central neuroplasticity, depending on the nature of the pain, its predominant site, and its chronicity. Our study also shows that ASA PS was associated with higher postoperative

pain. A possible explanation is that patients with higher ASA PS are more likely to be chronically ill and have co-existent chronic pain. To our knowledge, only a few studies have examined the relationship between ASA PS and postoperative pain. Caumo et al. [9] who studied patients undergoing elective abdominal surgery, similarly reported that higher ASA PS was associated with increased postoperative pain. In contrast, Chung et al. [22] reported that, in an ambulatory surgery setting, ASA 1 patients had a higher incidence of severe pain than sicker patients, i.e., ASA 2 or 3 patients. However, this study did not measure pain beyond the day of surgery and did not separately evaluate the impact of preoperative burden of illness on older patients. It is not immediately apparent why surgical risk was associated with pain on POD2 only. Overall surgical risk includes type of surgery, length of surgery and intraoperative blood loss. Therefore, it is a more comprehensive way to categorize the severity of surgery.

Similar to our results, the recent review by Ip et al. [23] suggests that older age is associated with less postoperative pain. The explanation as to why older age is associated with lower self-reported pain is not apparent. Previous research suggests that this age related differences in pain might be due to change in pain processing and pain modulation mechanisms [24]. However, definitive studies are lacking to determine whether older individuals under-report pain or truly have lower pain sensitivity.

In our study, postoperative IV-PCA usage was associated with higher postoperative pain levels when compared with use of oral analgesics. The need for IV-PCA vs. oral analgesics is probably a surrogate marker for more intense postoperative pain, as oral analgesics are typically useful only for mild to moderate acute postoperative pain.

There are several potential limitations to this study. First, self-reported pain may not completely capture the whole spectrum of pain perception, however, the NRS is still the most commonly used pain assessment tool in clinical setting. Second, we measured pain once daily for postoperative periods. Because acute postoperative pain is dynamic, we may not have captured the potential fluctuation of this parameter. However, from our experience, pain assessment once in the morning vs. twice a day assessments showed no significant difference in pain scores. In a separate pilot study of 20 patients evaluating the potential differences in pain scores between once a day vs. twice a day assessments, we found that only 2% of pain scores were significantly different between the two methods. Third, we did not include the measurement of other psychological and emotional factors (e.g., anxiety or fear) that may modulate pain [10,25]. Fourth, we did not differentiate between acute nociceptive and chronic neuropathic pain. Fifth, generalizability of findings is limited to only patients who received IV-PCA opioids for postoperative management. This was done to minimize potential bias of use of additional pain adjuvant techniques such as epidural or peripheral nerve blocks. Although the use of IV-PCA has been typically directed toward those with anticipated moderate to severe postoperative pain, attending physicians' discretionary choice of postoperative pain management may have influenced the results of this study. In addition, the results shown here may not be directly applicable to patients who had relatively minor surgeries.

Despite these limitations, the study provides a novel method for understanding the strength of both direct and indirect contributors to postoperative pain and opioid dose. For example, both pain on POD2 and surgical risk were strong predictors of opioid dose on POD2. However, there were multiple pathways to pain on POD2 including both the direct effects of prior pain and the indirect effects of age and opioid dose on the prior day. These multiple pathways to POD2 pain contributed to opioid dose on POD2. These results suggest that opioid dosing is due to a complex set of prior, current, direct, and indirect factors. The

findings of this study may provide a better understanding of additional factors that affect acute postoperative pain, opioid dose, and pain management.

Because postoperative pain control is critical to surgical outcomes, anticipating which patients may be more likely to report severe postoperative pain is important. Our study shows that there are many direct and indirect factors associated with postoperative pain.

In summary, in a group of older patients undergoing major non-cardiac surgery, preoperative pain, use of preoperative opioids, age, ASA PS and postoperative pain control methods (use of IV-PCA) were the most important predictors of postoperative pain. However, gender, patients' preoperative psychological status also directly contributed to preoperative pain and indirectly contributed to postoperative pain. Further investigation is necessary to determine whether intensifying preoperative pain management and/or associated factors with preoperative pain (e.g., depression) may lower acute postoperative pain.

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Appendix 1

High risk surgery

1. Aortic vascular surgery
2. Peripheral vascular surgery
3. Prolonged procedures associated with large fluid shifts and/or blood loss (any intra-abdominal procedures such as bowel resection which is 6 hours in duration, other than appendectomy, any procedures with blood loss of > 1000ml, radical cystectomy with ileal loop are high risk

Intermediate risk surgery

1. Carotid endarterectomy
2. Head and neck surgery (Ear - Nose - Throat surgery)
3. Intraoperitoneal and intrathoracic surgeries (total pneumonectomy are high risk and lobectomy, partial lung resection are intermediate risk)
4. Prostate surgery (TURP and radical prostatectomy except when the latter involves large blood loss as defined previously)
5. Orthopedic surgery
6. One to two level laminectomies (multiple levels with spinal fusion with larger blood loss of >1000 ml are high risk)
7. Craniotomies with blood loss < 1000 ml, parotidectomy, radical neck dissection and parathyroidectomy

Low risk surgery

1. Breast surgery
2. Plastic surgery

3. Any “superficial” surgeries, include voice prosthesis; inguinal hernia; endoscopic surgeries.

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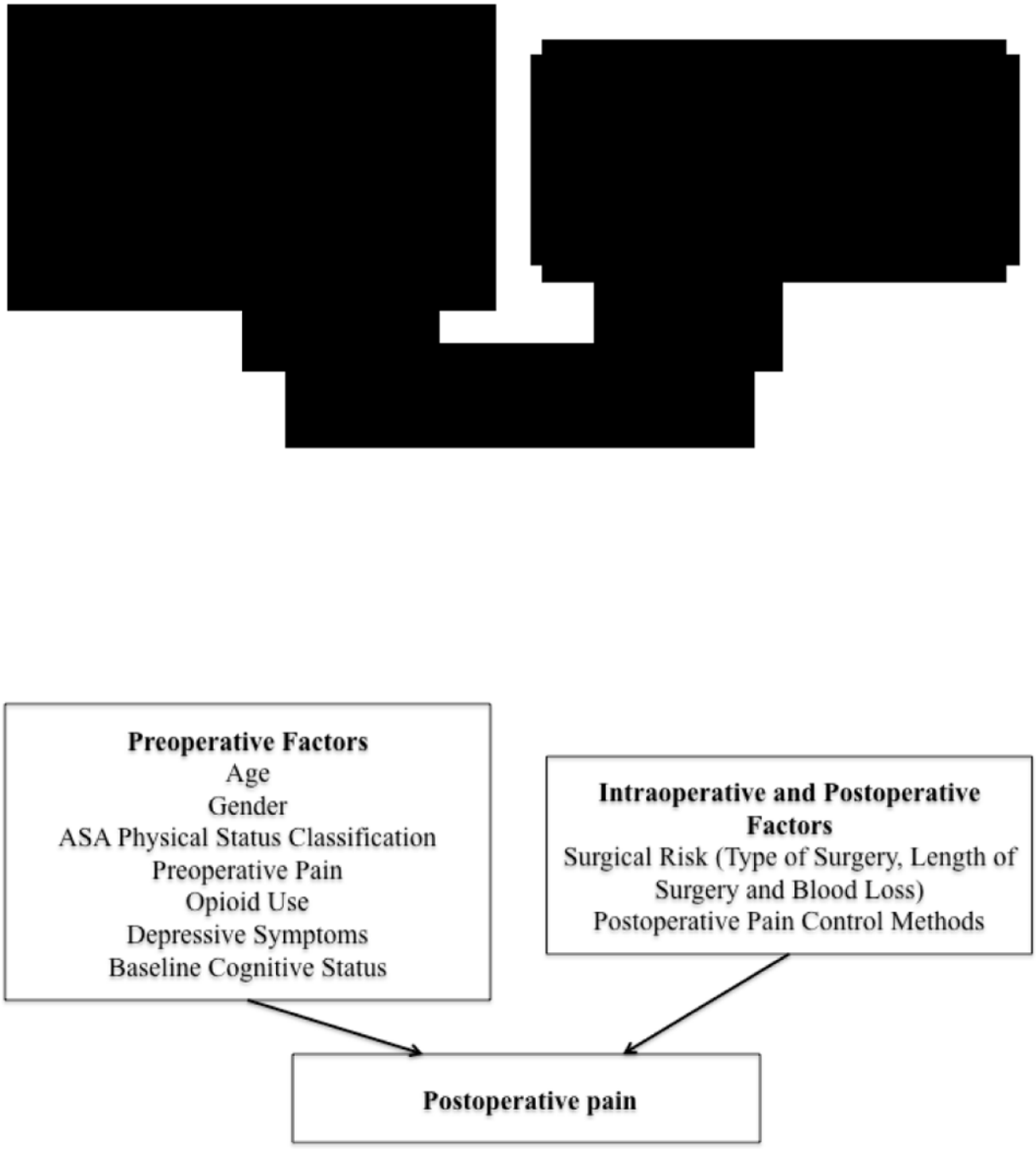

Fig. 1.
Conceptual framework for prospective cohort study of possible predictors of postoperative pain. *ASA* American Society of Anesthesiologists

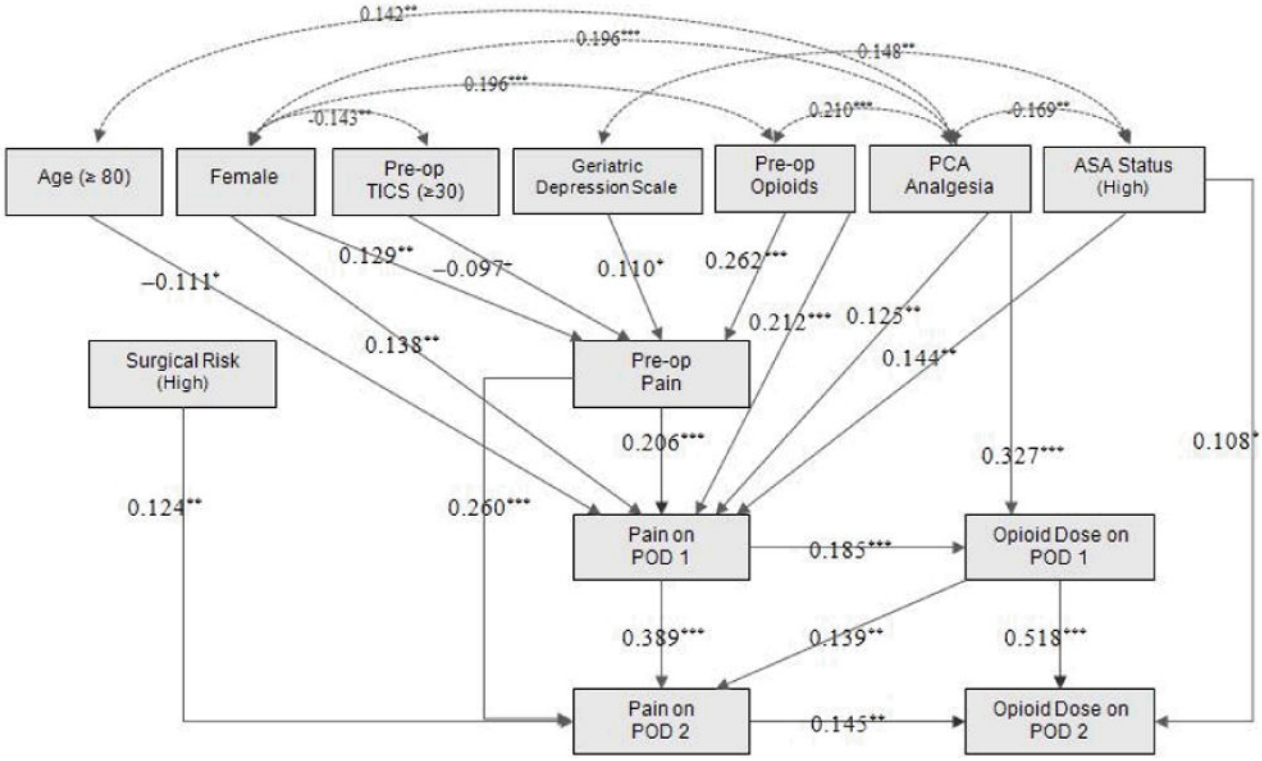

Fig. 2.

Postulated path model for postoperative pain. Association between multiple variables and postoperative pain is shown by arrows extending from each variables to pain on POD1 and POD2. Numbers on each arrow are standardized path coefficients. The higher the coefficients indicate the stronger the association.

Table 1

Demographics and perioperative data (N = 350)

Variables	Patients N (%) or Mean ± SD
Age	
64–69 yr	117 (33.4%)
70–79 yr	173 (49.4%)
≥ 80 yr	60 (17.1%)
Gender	
Female	172 (49.1%)
Male	178 (50.9%)
ASA PS	
1 and 2	176 (50.3%)
≥ 3	174 (49.7%)
Preoperative antidepressant	
No	292 (83.4%)
Yes	58 (16.6%)
Preoperative opioids	
No	239 (68.3%)
Yes	111 (31.7%)
Preoperative pain at rest (NRS)	2.2± 2.8
Geriatric Depression Scale (GDS)	2.9 ± 2.6
< 6	298 (85.1%)
≥ 6	52 (14.9%)
TICS Scores	32.4 ± 3.6
< 30	64 (18.3%)
≥ 30	286 (81.7%)
Type of Surgery *	
Ear-Nose-Throat	4 (1.1%)
General	22 (6.3%)
Gynecological	27 (7.7%)
Neurologic	46 (13.1%)
Orthopedic	178 (50.9%)
Plastic	3 (0.9%)
Thoracic	14 (4.0%)
Urologic	36 (10.3%)
Vascular	20 (5.7%)
Intraoperative Blood Loss (mL)	738.1 ± 1363.5
Surgical Risk	
Low	7 (2.0%)
Intermediate	278 (79.4%)
High	65 (18.6%)
Analgesia	

Variables	Patients N (%) or Mean ± SD
IV-PCA analgesia	261 (74.6%)
Oral analgesia	89 (25.4%)
Pain at rest on POD 1 (NRS)	3.5 ± 2.8
Pain at rest on POD 2 (NRS)	2.8 ± 2.8
Opioid dose * on POD 1	6.3 ± 9.5 (mg) **
Opioid dose * on POD 2	3.0 ± 5.9 (mg) **

ASA PS = American Society of Anesthesiologists Physical Status Classification; NRS = numeric raing scale; IV-PCA = intravenous patient controlled analgesia; POD = postoperative day; SD = standard deviation; TICS = telephone interview of cognitive status.

* The results are shown in dose of hydromorphone.

Appendix 2

Standardized direct and indirect effects on pain and opioid dose

Effect	Direct	Indirect	Total
Pre-op pain			
Gender (Female)	0.129 *		0.129 *
Use of pre-op opioids	0.262 ***		0.262 ***
Pre-op TICS over 30	−0.097 +		−0.097 +
Geriatric Depression Scale	0.110 *		0.110 *
Pain on POD 1			
Pre-op pain	0.206 ***		0.206 ***
Age over 80	−0.111 *		−0.111 *
High ASA PS	0.144 **		0.144 **
Gender (Female)	0.138 **	0.027 *	0.165 ***
Geriatric Depression Scale		0.023 +	0.023 +
Use of pre-op opioids	0.212 ***	0.054 **	0.266 ***
IV-PCA analgesia	0.125 **		0.125 *
Pre-op TICS over 30		−0.020 +	−0.020 +
Pain on POD 2			
Pre-op pain	0.260 ***	0.085 ***	0.345 ***
Pain on POD 1	0.389 ***	0.026 *	0.415 ***
Opioid dose on POD 1	0.139 **		0.139 **
Age over 80		−0.046 *	−0.046 *
Gender (Female)		0.102 ***	0.102 ***
High ASA PS		0.060 **	0.060 **
Geriatric Depression Scale		0.038 *	0.038 *
Use of pre-op opioids		0.179 ***	0.179 ***
IV-PCA analgesia		0.097 ***	0.097 ***
Pre-op TICS over 30		−0.034 +	−0.034 +
High surgical risk	0.124 **		0.124 **
Opioid dose on POD1			
Pre-op pain		0.038 **	0.038 **
Pain on POD 1	0.185 ***		0.185 ***
Age over 80		−0.021 *	−0.021 *
Gender (Female)		0.030 **	0.030 **
High ASA PS		0.027 *	0.027 *

Effect	Direct	Indirect	Total
Geriatric Depression Scale		0.004^{+}	0.004^{+}
Use of pre-op opioids		0.049**	0.049**
IV-PCA analgesia	0.327***	0.023*	0.350***
Pre-op TICS over 30		−0.004	−0.004
Opioid dose on POD 2			
Opioid dose on POD 1	0.518***	0.020*	0.538***
Pre-op pain		0.070***	0.070***
Pain on POD 1		0.156***	0.156***
Pain on POD 2	0.145**		0.145**
Age over 80		−0.017*	−0.017*
Gender (Female)		0.031**	0.031**
High ASA PS	0.108*	0.022*	0.130**
Geriatric Depression Scale		0.008^{+}	0.008^{+}
Use of pre-op opioids		0.051***	0.051***
IV-PCA analgesia		0.196***	0.196***
Pre-op TICS over 30		−0.007^{+}	−0.007^{+}
High surgical risk		0.018*	0.018*

Geriatric Depression Scale, Opioid Dose on POD1 and Opioid Dose on POD2 were log transformed.

$^{***}P < 0.001$;

$^{**}P < 0.01$;

$^{*}P < 0.05$;

$^{+}P < 0.10$.

ASA PS = American Society of Anesthesiologists Physical Status Classification; NRS = numeric rating scale; IV-PCA = intravenous patient controlled analgesia; POD = postoperative day; Pre-op = preoperative; SD = standard deviation; TICS = telephone interview of cognitive status.