

# Procedure-specific Risk Factor Analysis for the Development of Severe Postoperative Pain

Hans J. Gerbershagen, M.D., Ph.D., Esther Pogatzki-Zahn, M.D., Ph.D., Sanjay Aduckathil, M.D., Linda M. Peelen, Ph.D., Teus H. Kappen, M.D., Albert J. M. van Wijck, M.D., Ph.D., Cor J. Kalkman, M.D., Ph.D., Winfried Meissner, M.D., Ph.D.

## ABSTRACT

**Background:** Many studies have analyzed risk factors for the development of severe postoperative pain with contradictory results. To date, the association of risk factors with postoperative pain intensity among different surgical procedures has not been studied and compared.

**Methods:** The authors selected precisely defined surgical groups (at least 150 patients each) from prospectively collected perioperative data from 105 German hospitals (2004–2010). The association of age, sex, and preoperative chronic pain intensity with worst postoperative pain intensity was studied with multiple linear and logistic regression analyses. Pooled data of the selected surgeries were studied with random-effect analysis.

**Results:** Thirty surgical procedures with a total number of 22,963 patients were compared. In each surgical procedure, preoperative chronic pain intensity and younger age were associated with higher postoperative pain intensity. A linear decline of postoperative pain with age was found. Females reported more severe pain in 21 of 23 surgeries. Analysis of pooled surgical groups indicated that postoperative pain decreased by 0.28 points (95% CI, 0.26 to 0.31) on the numeric rating scale (0 to 10) per decade age increase and postoperative pain increased by 0.14 points (95% CI, 0.13 to 0.15) for each higher score on the preoperative chronic pain scale. Females reported 0.29 points (95% CI, 0.22 to 0.37) higher pain intensity.

**Conclusions:** Independent of the type and extent of surgery, preoperative chronic pain and younger age were associated with higher postoperative pain. Females consistently reported slightly higher pain scores regardless of the type of surgery. The clinical significance of this small sex difference has to be analyzed in future studies. (**ANESTHESIOLOGY 2014; 120:1237-45**)

SOME 240 million surgical procedures are performed annually worldwide.<sup>1</sup> Severe pain after surgical procedures is a major factor causing patients' dissatisfaction, delayed recovery, immobility, and prolonged hospital stay in the postoperative period and is associated with severe complications, such as chronic pain.<sup>2,3</sup> A recent study indicated that severe pain is an issue not only after major but also after many minor surgeries.<sup>4</sup> Optimal perioperative pain management is not only an ethical but also a medical as well as an economic issue. Much effort has been made to improve postoperative pain treatment: implementing guidelines on postoperative pain, providing acute pain services, and increasing the use of regional anesthesia techniques are known to be the most effective efforts for reducing postsurgical pain. Despite these efforts, many patients continue to suffer severe postoperative pain.<sup>3,5,6</sup>

Some major reasons for this unsatisfactory situation have recently been elucidated, one of them being that different surgical procedures may have different mechanisms which produce pain and pain-related consequences. Therefore,

### What We Already Know about This Topic

- Although predictors of severity of acute postoperative pain have been previously examined, no study has examined predictors across a large dataset of multiple surgical procedures

### What This Article Tells Us That Is New

- In a review of over 22,000 German patients across a wide variety of surgical procedures, predictors of severity of acute postoperative pain were reproducible
- Younger age, female sex, and preoperative pain intensity all were associated with statistically significant, but small increases in postoperative pain across procedures

surgical procedure-specific pain treatment is regarded as the next step toward further improvement of pain management.<sup>7-9</sup> Another problem is that some patients may present certain risk factors for developing more severe postoperative pain than others.<sup>10</sup> The identification of patients at risk may help to permit effective treatment strategies to be initiated at an early stage to prevent severe pain in these patients.

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Demographic, clinical, and psychological factors have been identified that could be relevant risk factors for the development of severe postoperative pain.<sup>10</sup> However, study designs were nonhomogeneous and results were—at least for most risk factors—equivocal. Differences in associations of risk factors with postoperative pain between various types of surgical procedure have not been determined as yet. Risk factor analyses for postoperative pain have mainly been performed in major abdominal and orthopedic procedures in which it was expected that patients would have severe postoperative pain. Risk factors have been analyzed in both small cohorts of selected surgeries<sup>11</sup> and larger cohorts with mixed surgical procedures.<sup>12</sup> To date, however, no procedure-specific comparison of risk factors has been performed that might help to further determine optimal procedure- and patient-specific pain treatment.

The aim of this study was to analyze the associations of age, sex, and preoperative chronic pain with postoperative pain intensity and to compare these associations among various surgical procedures.

## Materials and Methods

### Quality Improvement in Postoperative Pain Treatment Registry

The analysis was based on the data from the Quality Improvement in Postoperative Pain Treatment (QUIPS) project, which was started as a benchmark initiative to compare pain outcome parameters among participating German hospitals. The QUIPS project is supported by the German Societies and Professional Associations of Anesthesiologists and Surgeons.<sup>13</sup> Patients completed the validated 15-item QUIPS questionnaire on the first postoperative day. Patient-reported data were completed by information on the type of surgery, anesthesia, and pain treatment. Data assessment was carried out by trained study personnel which was not involved in routine care, and pain data were collected in a standardized manner on randomly selected days that were unknown to the medical staff before data collection. On the survey day, all patients who had been operated upon the day before were considered for inclusion. Patients were informed in written form as well as orally by the study personnel that data collection was voluntary and anonymous, and that they could refuse to be included at any time. Informed consent was documented by filling in the questionnaire. The project was approved by the Ethics Committee as well as the Data Security Board of Jena University Hospital, Jena, Germany, and all participating sites obtained approval from their respective Ethics Committees.

### Outcome Factor and Influencing Variables

The outcome parameter was defined as worst pain intensity since surgery, measured with the numeric rating scale (NRS) of 0 to 10 (0 = no pain, 10 = worst pain imaginable). The association of age, sex, and preoperative chronic pain with worst postoperative pain intensity was analyzed. Age was

documented as 10-yr categories. Preoperative chronic pain was defined as persisting for longer than 3 months before surgery in any location.

### Patients

All patients having completed the QUIPS questionnaire between May 2004 and May 2010 were used for analysis. The inclusion and exclusion criteria were defined by the QUIPS project. Broad inclusion criteria were the day after surgery and admission to a surgical ward. Exclusion criteria were the patient (1) had been transferred to another ward after surgery; (2) was not present in his room or had been discharged at the time of data collection; (3) refused to participate in the study; (4) could not communicate in German; (5) had cognitive deficits; or (6) was sedated or asleep. Additional exclusion criteria for the analysis of the current analysis were: (7) missing or incorrect German Surgical Procedure Coding (OPS), which precisely defines the kind of surgery performed; (8) age younger than 18 yr; and (9) patients assessed later than the first postoperative day. Further exclusion factors for procedure-specific risk factor analysis were (10) use of regional anesthesia; and (11) trauma surgery.

### Selection of Surgical Procedures

To analyze risk factors for acute postoperative pain, precisely defined surgical groups were formed. The type of surgery was recorded using the OPS, which includes more than 21,000 surgical codes. On the basis of a specific surgical site, organ system, and surgical access, for example, laparoscopic, open, and endoscopic, 529 detailed surgical groups were defined. Minor differences in the extent of surgical lesions were assigned to one surgical group, for example, partial, hemi-, or total thyroidectomy. Very rare procedures such as retrosternal thyroidectomy with sternotomy were disregarded.

All patients assigned to one of the 529 groups were individually examined and excluded in case of multiple surgeries. Thus, for example, patients were excluded from the cholecystectomy group if an additional appendectomy was performed. Patients were also not included if they underwent a more extensive procedure than the one precisely defined by the surgical group, for example, left hemicolectomy with an additional sigmoid resection.

As regional anesthesia regularly results in lower postoperative pain scores, only patients undergoing general anesthesia were included to generate comparable study groups. Trauma patients were excluded from procedure-specific risk factor analysis, as different types of fractures, differences in soft-tissue damage, and differing surgical techniques could have influenced postoperative pain scores. For the analysis, only surgical groups with more than 150 patients were included.

### Statistical Analysis

The influences of age, sex, and preoperative chronic pain intensity on worst postoperative pain were analyzed by

multiple linear regression models containing these three variables as independent risk factors and worst postoperative pain as the outcome. To arrive at procedure-specific estimates, this was done for each surgical group with more than 150 patients separately.

Patients with severe pain are of special interest, because they suffer the most and could benefit the most from sufficient pain treatment. Therefore, we also report the associations of the three risk factors with the development of severe postoperative pain (NRS  $\geq 7$ ). Logistic regression analysis was used to represent the odds ratios (ORs) of each influencing variable.

Patients from all surgical groups with more than 150 patients were pooled into one dataset to analyze the total effect of the influencing variables. Because clustering was expected on a procedural level and because specific surgical procedures were likely to have their own specific pain profiles, additional linear and logistic mixed-effect regression analyses were performed (glmer, lme4 library, [R software, 2013, R Foundation for Statistical Computing, Vienna, Austria, www.R-project.org]). All the three influencing factors were included as fixed effects. Because the relationship among influencing variables and postoperative pain intensity was expected to be procedure dependent (cluster dependent), a random slope was included in the mixed-effects model for each of the three factors in addition to a random intercept. In addition to procedure-specific estimates for age, sex, and preoperative pain derived from separate models for each surgical procedure, we also included procedure-specific estimates directly derived from the random-effect model; obtained by combining fixed and random effects for each procedure.

Before statistical analyses, pre- and postoperative NRS variables were tested for nonlinearity using restricted cubic splines.<sup>14</sup> For this assessment, predicted postoperative NRS values as calculated from a simple regression model using preoperative NRS values were visually compared with predicted postoperative NRS values from a regression model using restricted cubic splines to model preoperative NRS values.

Missing data were multiply imputed ( $n = 10$ ). Imputation of missing variables was based on risk factors, outcome variables, and other perioperative data.<sup>15–17</sup> The type of surgical procedure was added as an extra variable to the imputation model to take into account the multilevel structure of the data. Estimates from the imputation sets were combined using Rubin rule.<sup>18</sup>

## Results

Data were collected from 115,437 surgical patients on 578 surgical wards in 105 German hospitals. The number and type of exclusion criteria are presented in figure 1. For the procedure-specific risk factor analysis, the inclusion criteria were met by 30 surgical groups comprising 22,963 patients (13 general surgery, 6 gynecology, 4 orthopedics, 2 otolaryngological surgery, 2 neurosurgery, 2 urology, and 1 vascular surgery) (fig. 2). Demographic and clinical data are shown in

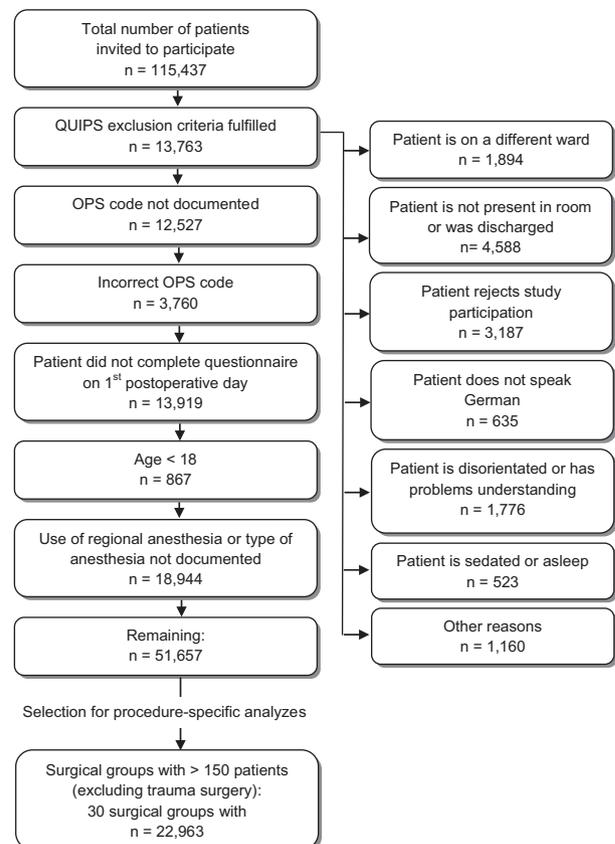
table 1. The mean worst pain intensity for all included patients since surgery was NRS of 4.6 (SD, 2.5). Overall, 24.5% of the 22,963 patients reported severe pain of NRS of 7 or higher.

### Procedure-specific Risk Factor Analysis

In all 30 surgical groups, preoperative chronic pain intensity was positively related to higher postoperative pain intensity (range of regression coefficients, 0.05 to 0.33) (fig. 2). Twenty of the 30 surgical groups had regression coefficients between 0.1 and 0.25 (fig. 2). Postoperative pain intensity decreased consistently with higher age categories for all surgical procedures. Regression coefficients ranked between  $-0.06$  and  $-0.53$ . In 20 of the 30 surgical procedures, the regression coefficients ranked between  $-0.15$  and  $-0.35$ .

Females reported higher postoperative pain intensities for all but two surgical procedures: pain intensity was 0.1 to 0.5 NRS points higher for 15 of 23 procedures (range of all surgical procedures,  $-0.31$  to 0.71) (fig. 2). Data of pain intensity, frequency of preoperative pain, distribution between the sexes, and regression coefficients per surgical group are presented in Supplemental Digital Content 1, <http://links.lww.com/ALN/B23>.

The influence of the three risk factors on the development of severe pain defined as NRS of 7 or higher was calculated using logistic regression analyses. In figure 3, the adjusted



**Fig. 1.** Number of patients and exclusion criteria. OPS = German Surgical Procedure Coding; QUIPS = Quality Improvement of Postoperative Pain Treatment project.

**Table 1.** Demographic and Clinical Data (n = 22,963)

	Raw Data		Imputed Data	
	n	%	n	%
<b>Sex</b>				
Male	9,211	40.1	9,224	40.2
Female	13,719	59.8	13,739	59.8
Missing	33	0.1	—	—
<b>Preoperative chronic pain intensity</b>				
No pain	13,603	59.2	14,987	65.3
NRS 1	141	0.6	156	0.7
NRS 2	302	1.3	329	1.4
NRS 3	619	2.7	675	2.9
NRS 4	725	3.2	786	3.4
NRS 5	1,024	4.5	1,115	4.9
NRS 6	889	3.9	958	4.2
NRS 7	1,022	4.5	1,101	4.8
NRS 8	1,365	5.9	1,466	6.4
NRS 9	592	2.6	646	2.8
NRS 10	688	3.0	744	3.2
Missing	1,983	8.6	—	—
<b>Age (yr)</b>				
18–20	516	2.2		
21–30	1,362	5.9		
31–40	2,137	9.3		
41–50	4,536	19.8		
51–60	4,597	20.0		
61–70	5,187	22.6		
71–80	3,843	16.8		
>80	785	3.4		

NRS = numeric rating scale.

OR for each of the three risk factors are presented per surgical procedure.

The relations between the three risk factors and postoperative pain are demonstrated by the findings for the total study population (fig. 4) and the four most often performed procedures each including more than 1,200 patients (laparoscopic cholecystectomy, total hip replacement, thyroidectomy, and vaginal hysterectomy; fig. 5). In the total study population and in all of the four procedures, a nearly linear decline in pain intensity was observed with increasing age. The difference in postoperative pain intensity between chronic and nonchronic pain patients remained almost constant over the different age categories in all surgical groups. Females reported higher pain intensities which was observed consistently over all age groups and patients with preoperative chronic pain, as shown for the total population (fig. 4), and were similar in the three largest surgical groups (data not shown).

### Analysis of Data from 30 Pooled Surgical Groups

Thirty surgical procedures were included for procedure-specific risk factor analysis. The random-effect analysis that adjusted for the type of surgery indicated significant associations of age, sex, and preoperative chronic pain with postoperative pain intensity. It was demonstrated that

postoperative pain decreased by 0.28 NRS points (95% CI, 0.26 to 0.31) per increase of one age category (decade) (fig. 2). Postoperative pain intensity increased by 0.14 NRS points (95% CI, 0.13 to 0.15) for each higher score on the preoperative chronic pain scale. Females reported 0.29 NRS points (95% CI, 0.22 to 0.37) higher mean pain intensity than that of males.

The adjusted OR to develop severe postoperative pain (NRS  $\geq 7$ ) was 1.13 (95% CI, 1.11 to 1.15) with each point higher on the preoperative chronic pain scale (fig. 3). Older age was associated with less pain (adjusted OR, 0.79 [95% CI, 0.76 to 0.82] for each 10 yr of increase in age). The adjusted OR for severe pain in females was 1.27 (95% CI, 1.17 to 1.38) compared with that of males (fig. 3).

Derived from the random-effect model, additional procedure-specific estimates for age, sex, and preoperative chronic pain for each of the 30 surgical procedures were analyzed (see Supplemental Digital Content 2, <http://links.lww.com/ALN/B24>).

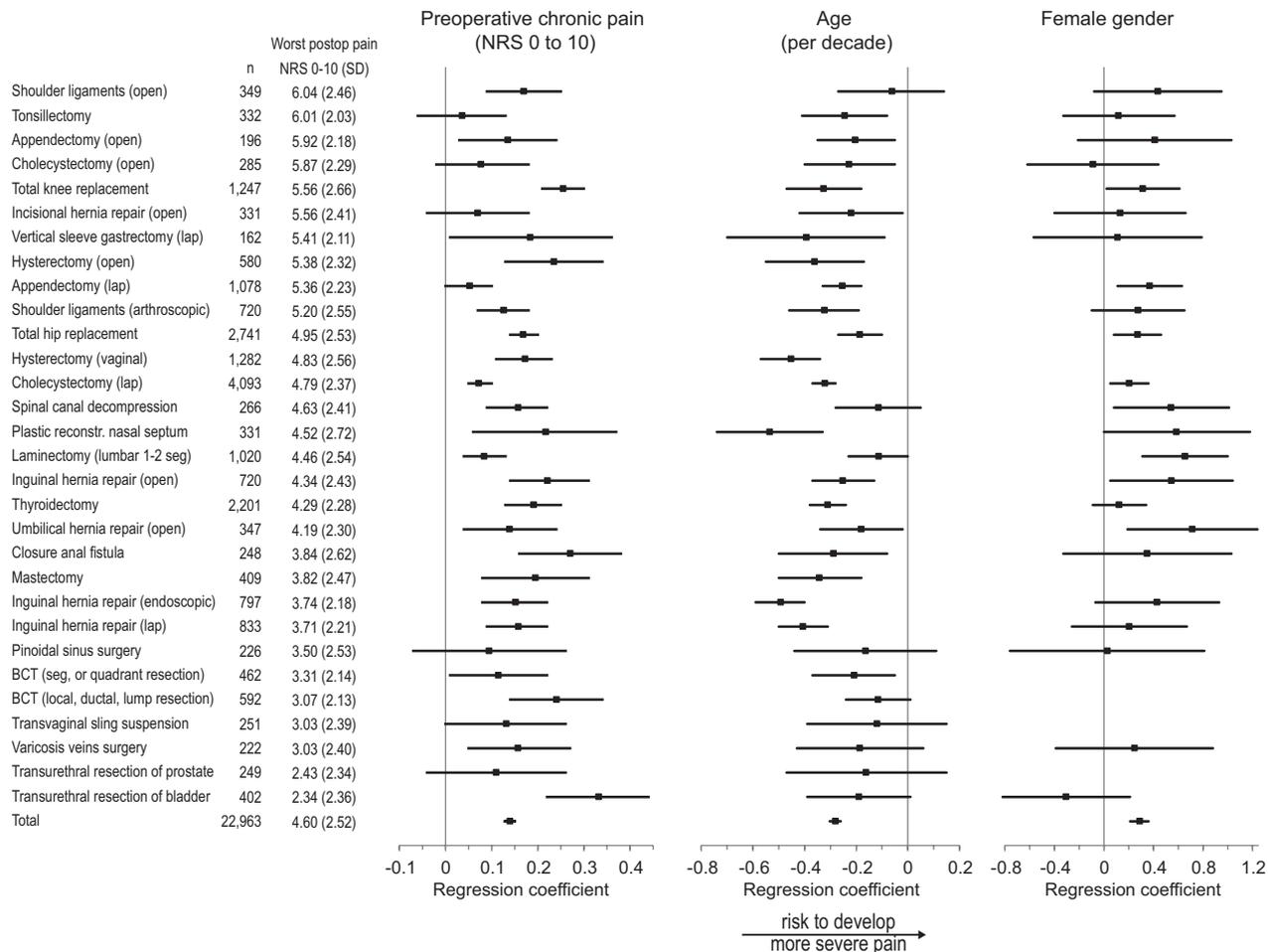
### Preoperative Chronic Pain Intensity

Data of preoperative chronic pain were available for 91.4% of the patients (table 1). Of those with complete data, preoperative chronic pain in any location was reported by 40.6%. Postoperative pain intensity increased in proportion to preoperatively estimated chronic pain intensity. Patients without preoperative chronic pain reported mean postoperative pain scores of NRS of 4.23 (95% CI, 4.19 to 4.27), whereas patients with maximum preoperative chronic pain of NRS of 10 reported mean scores of NRS of 5.84 (95% CI, 5.67 to 6.02) after surgery (fig. 6).

### Discussion

In this study, we analyzed data from 22,963 surgical patients assessed in a highly standardized manner and identified preoperative chronic pain intensity, younger age, and female sex to be associated with higher postoperative pain scores. These relations were consistently present in 30 precisely defined surgical procedures independent of the type of surgery, the surgical specialty, and the painfulness of the surgical procedure. Postoperative pain increased parallel to preoperative chronic pain intensity and decreased linearly with increasing age. These findings were comparable in both males and females. For each 1.0-point increase in preoperative chronic pain intensity, postoperative pain increased by 0.14 NRS points (95% CI, 0.13 to 0.15); similarly, postoperative pain decreased by 0.28 points (95% CI, 0.31 to 0.26) per decade older age. Females reported slightly higher mean pain intensities by 0.29 points (95% CI, 0.22 to 0.37).

The adjusted OR to develop severe postoperative pain (NRS  $\geq 7$ ) was 1.13 (95% CI, 1.11 to 1.15) with each point higher on the preoperative chronic pain scale (fig. 3); thus a patient with preoperative chronic pain of NRS of 7 has a higher risk of OR 1.84 to have severe postoperative



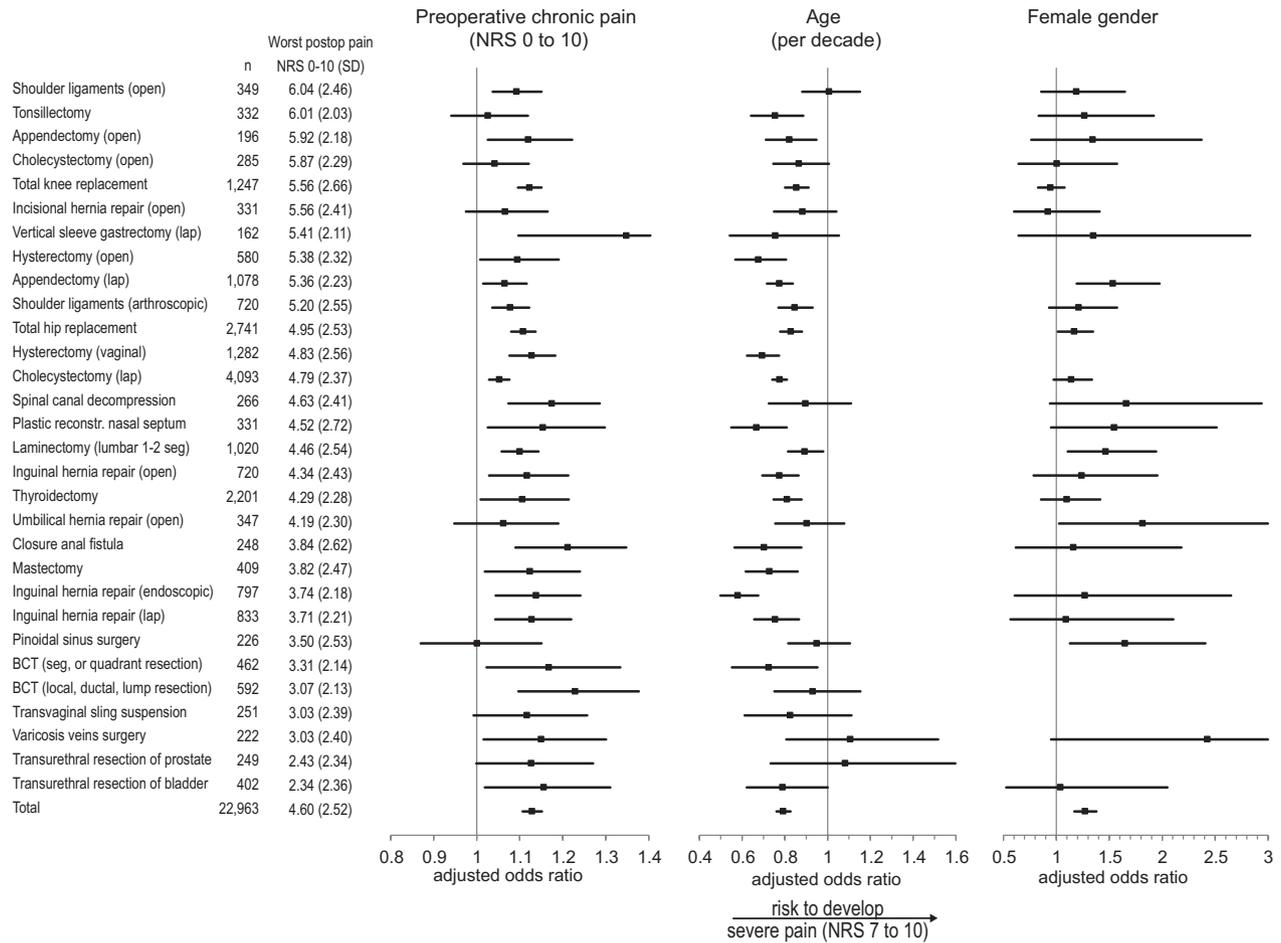
**Fig. 2.** Comparison of the three risk factors age, preoperative chronic pain intensity, and female sex on postoperative pain intensity. The 30 surgical procedures that included more than 150 patients who received general anesthesia without regional anesthesia were selected. Plots show regression coefficients (95% CI) of multiple linear regression analysis of each surgical procedure. The analysis of the total study population (n = 22,963) is based on mixed-effect linear regression analysis with random slope and random intercept adjusting for the type of surgery. Age categories: 18–20, 21–30, 31–40, 41–50, 51–60, 61–70, 71–80, and >80 yr. Preoperative chronic pain intensity: numeric rating scale (NRS) 0 to 10 (0 = no pain and 10 = worst pain imaginable). BCT = breast conservative therapy; lap = laparoscopic; OPS = German Surgical Procedure Coding; QUIPS = Quality Improvement in Postoperative Pain Treatment project; seg = segmental.

pain (NRS  $\geq 7$ ) compared with a patient with preoperative chronic pain intensity of NRS of 2. Older age was associated with less pain (adjusted OR, 0.79 [95% CI, 0.76 to 0.82] for each 10 yr of increase in age); thus a 70-yr-old patient has a lower risk of OR 0.39 for postoperative pain of NRS of 7 or higher compared with a 30-yr-old patient. The adjusted OR for severe pain in females was 1.27 (95% CI, 1.17 to 1.38).

Risk factors for the development of postoperative pain have been analyzed in many studies with contradictory results. A few studies have analyzed the influence of the type of surgery on postoperative pain. However, all previous studies assigned the types of surgery to broad anatomical regions or surgical disciplines such as abdominal, thoracic, laparoscopic, or minor and major surgery<sup>12,19–21</sup> or used the duration of surgery and incision length as surrogates for the extent of surgery and tissue damage,<sup>22</sup> which is of questionable validity

for many types of procedures. Differences in the influence of age, sex, and preoperative chronic pain on postoperative pain intensity among various types of surgery by using the exact OPS codes for categorizing a specific surgical site, organ system, and surgical access have not previously been analyzed and compared. So-called minor surgeries in which low postoperative pain intensities are expected have not been analyzed with regard to risk factors for postoperative pain. Our results demonstrate that the impact of age, preoperative chronic pain, and sex on postoperative pain is similar among various types of surgery regardless of the postoperative pain intensity and type and extent of tissue trauma. A linear association between postoperative pain and age as well as preoperative chronic pain was exemplarily shown in the four largest surgical groups with more than 1,200 patients each.

Most of the larger studies regarding risk factors of postoperative pain have used different pain intensity cutoff points



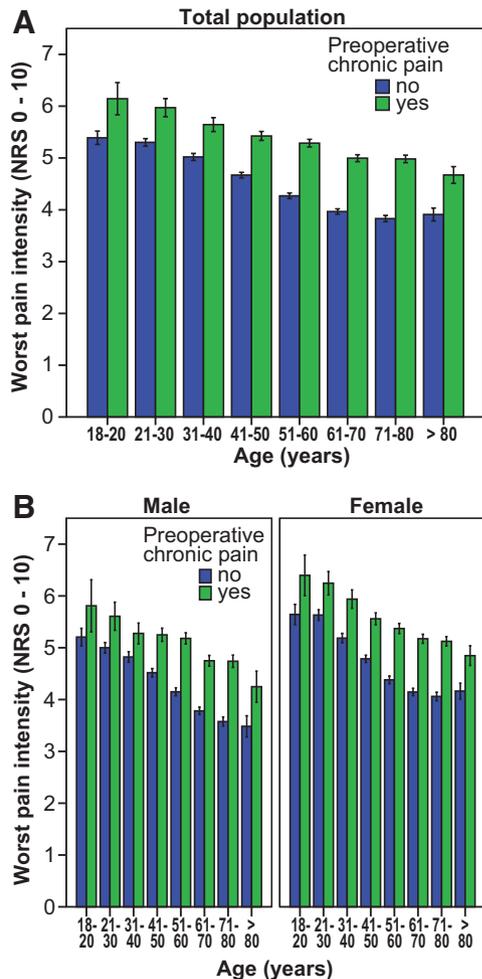
**Fig. 3.** Comparison of the three risk factors age, preoperative chronic pain intensity, and female sex on postoperative pain intensity. The 30 surgical procedures that included more than 150 patients who received general anesthesia without regional anesthesia were selected. Plots show odds ratios (95% CI) for severe pain (NRS ≥ 7) for each surgical procedure. The analysis of the total study population (n = 22,963) is based on mixed-effect logistic regression analysis with random slope and random intercept adjusting for the type of surgery. Age categories: 18–20, 21–30, 31–40, 41–50, 51–60, 61–70, 71–80, and >80 yr. Preoperative chronic pain intensity: numeric rating scale (NRS) 0–10 (0 = no pain, 10 = worst pain imaginable). Odds ratio for preoperative chronic pain in vertical sleeve patients is 1.35 (1.10–1.66) and for female sex in varicosis veins surgery is 2.43 (0.95–6.21). BCT = breast conservative therapy; lap = laparoscopic; OPS = German Surgical Procedure Coding; QUIPS = Quality Improvement in Postoperative Pain Treatment project; seg = segmental.

such as NRS of 3 or higher, NRS of 4 or higher, NRS of 5 or higher, and NRS of 8 or higher as an outcome variable, which makes comparison of these groups difficult.<sup>12,19–21</sup> For primary data analysis, we did not use an arbitrarily chosen cutoff point, as this would have resulted in loss of information.<sup>23</sup> However, as clinicians are often interested in patients with severe pain, we used the cutoff point of NRS of 7 or higher to calculate adjusted OR per risk factor and surgical procedure. Although the choice of such a cutoff point is always somewhat arbitrary, we have chosen the threshold value of 7 as this is commonly used.

A systematic review has demonstrated that preoperative pain is the most consistent risk factor for the development of severe postoperative pain (7 of 8 studies).<sup>10</sup> Preoperative pain has been analyzed according to pain intensity (NRS of 0 to 10),<sup>12</sup> the presence of preoperative pain (yes or no),<sup>19–21,24</sup> and the presence of preoperative chronic pain (yes or no).<sup>19</sup>

Information on the duration of pain persistence and its location(s) as well as relation to the surgical site is generally missing, which also makes comparison difficult. In this study, preoperative pain was defined as chronic pain persisting for more than 3 months in any location. We could indicate that independent of the type of surgery, preoperative chronic pain is related to more severe postoperative pain. Furthermore, we could demonstrate that the intensity of preoperative chronic pain is correlated with more severe postoperative pain. This is in accordance with a previous study, showing the association between the degree of preoperative pain chronicity and postoperative pain intensity in patients with radical prostatectomy.<sup>25</sup>

In the same systematic review, six studies showed decreasing pain with older age and three found no significant differences.<sup>10</sup> More recent studies were not able to clarify the question of age as a risk factor for severe postoperative



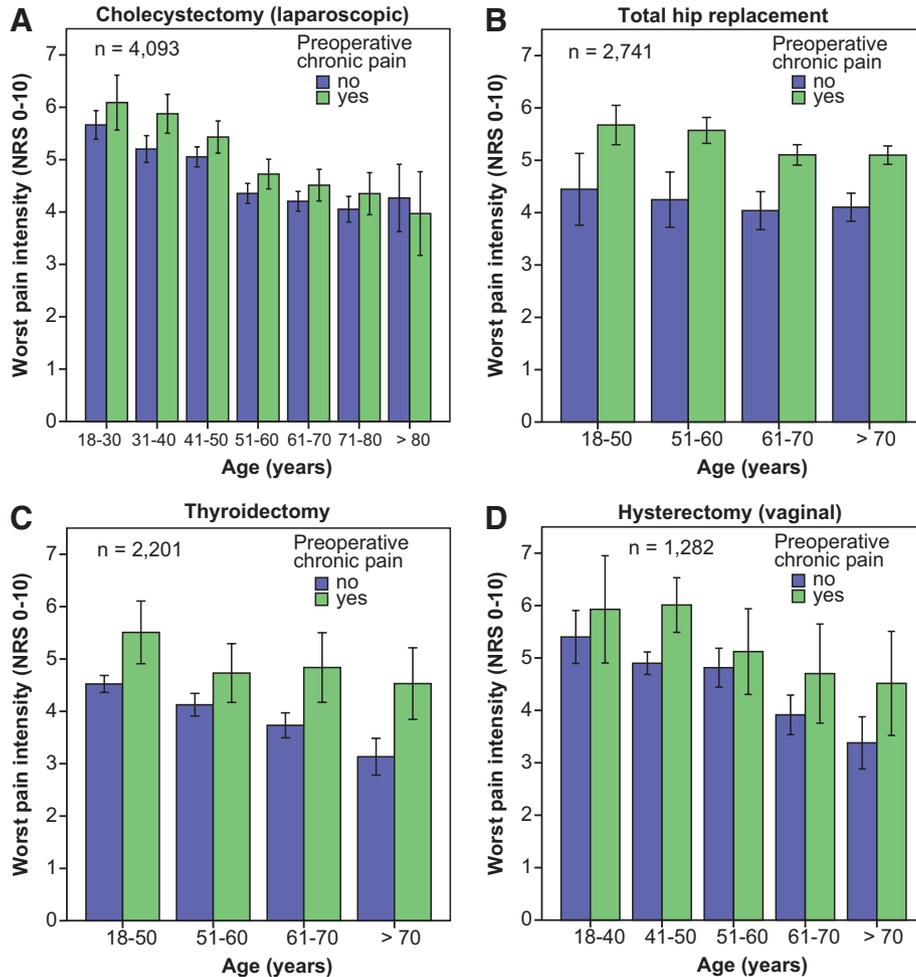
**Fig. 4.** Associations of severe postoperative pain intensity (numeric rating scale [NRS] >7), since surgery on the first postoperative day, with age and preoperative chronic pain intensity (NRS 0–10). (A) Analysis of the total study population ( $n = 22,963$ ) and (B) comparison between men and females. Patients with regional anesthesia were excluded.

pain.<sup>20,21,24,26</sup> However, the numbers of patients studied were rather low and various dichotomous cutoff points for the age groups were chosen, which may have contributed to the inconsistent results. To our knowledge, this study is the first to examine age not only as a dichotomous variable. We could demonstrate a continuous decrease in postoperative pain with increasing age: Pain decreased by 0.28 points (95% CI, 0.31 to 0.26) per decade older age. A mean overall difference of 1.5 NRS points (22,963 patients) was shown between the youngest (18 to 20 yr) and the oldest age groups (>80 yr). This was, again, consistent throughout the most surgeries as shown for the four major surgical procedures. Many factors could influence the pain differences with age, such as bio-psychosocial and life-stage factors<sup>26</sup> as well as changes in the complex cascade of immune, inflammatory, and neural responses.<sup>27</sup> In addition to those factors, insufficient titration of analgesics should also be considered. It is well known that

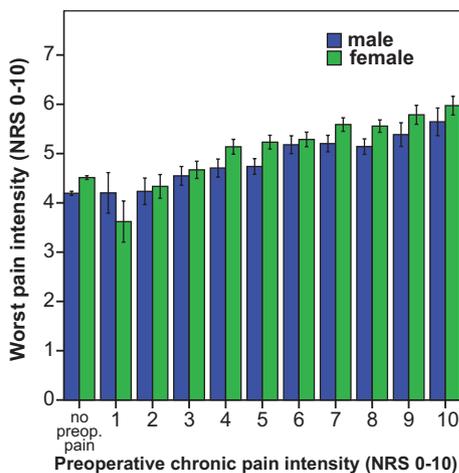
during the postoperative period, younger patients generally need higher doses of opioids than older ones.<sup>28,29</sup> This fact may not have been considered in daily clinical practice if a fixed standard pain treatment regimen was followed without individual adaptation.

The review by Ip *et al.* and more recent studies did not find consistent results of the influence of sex on acute pain. Some indicated female sex to be associated with higher pain scores,<sup>12,24,29–33</sup> whereas others did not find statistical differences.<sup>19–21,34,35</sup> Only in one study did males report higher pain scores, however, females with minor gynecological surgeries were overrepresented.<sup>22</sup> Although some studies found statistical differences and others did not, in most studies females reported slightly higher pain scores. These results are in concordance with our data: In 21 of 23 surgical procedures, females had higher pain scores, ranging between 0.13 and 0.73 NRS points. Thus, the negative findings in some studies are not surprising as the differences in NRS scores are small and statistical significance is dependent on sample size. Although the differences in pain intensities were small, it is of note that they were very consistent among our surgical groups. From the clinical point of view, several causes of the sex differences could be hypothesized. First, pain intensity difference is a result of insufficient pain treatment in females compared with men. Second, as indicated by Schnabel *et al.*,<sup>33</sup> female patients may use (epidural) patient-controlled opioid treatment less frequently because of increased side effects of the opioids compared with males. Third, slightly higher pain scores do not reflect less sufficient pain treatment in females but are related to causes such as different use of the NRS or social and cultural differences. The actual clinical significance of this small difference in pain intensity should be analyzed in future studies applying different postoperative quality–outcome factors such as side effects or patient satisfaction.

There are some limitations of this study: (1) We analyzed the data from patients treated with systemic analgesia after surgery only. Thus, the influence of the risk factors cannot be generalized to patients with regional anesthesia. A recent large study indicated, similar to our current results, slightly higher pain scores in female patients when patient-controlled epidural anesthesia was used in the perioperative period.<sup>33</sup> Although sex differences were statistically significant, the difference in NRS score was small regardless what type of analgesia was used; (2) Our study measured postoperative pain in surgical patients treated in hospitals from a single Western European country. Thus, it was not possible to evaluate cross-national cultural influences on the association between the risk factors and pain perception; and (3) Other risk factors such as psychological distress (anxiety, depression) and pain perception have not been included in this analysis; however, in a prediction model for postoperative pain intensity, preoperative pain and age have been shown to be the risk factors with the largest predictive values on postoperative pain.<sup>12</sup>



**Fig. 5.** Associations of worst postoperative pain, since surgery (numeric rating scale [NRS] 0–10) on the first postoperative day, with age and preoperative chronic pain intensity (NRS 0–10). Patients undergoing general anesthesia are shown; those with regional anesthesia were excluded. The four most often performed procedures were selected for graphic presentation: (A) laparoscopic cholecystectomy, (B) total hip replacement, (C) thyroidectomy, and (D) vaginal hysterectomy. Error bars indicate 95% CI of the mean. Due to differences in age distribution in the various surgical procedures, differing age groups were combined.



**Fig. 6.** Association of preoperative chronic pain intensity (numeric rating scale [NRS] 0–10) with worst postoperative pain intensity since surgery and sex (n = 22,963).

An open access to the QUIPS database is not possible. According to the consortium agreement of QUIPS, data access is available for participants only.

In conclusion, this study demonstrates that younger age, preoperative chronic pain intensity, and female sex are associated with higher postoperative pain intensities and that these associations are consistent over a large number of different types of surgeries. The clinical relevance of the statistically significant but only slightly higher pain scores in females compared with males will require further research.

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## Competing Interests

The authors declare no competing interests.

## Correspondence

Address correspondence to Dr. Gerbershagen: Department of Anesthesiology and Intensive Care Medicine, University Medical Center Utrecht, Local Mail: Q04.2.312, PO Box 85500, 3508 GA Utrecht, The Netherlands. h.j.gerbershagen@umcutrecht.nl. Information on purchasing reprints may be found at [www.anesthesiology.org](http://www.anesthesiology.org) or on the masthead page at the beginning of this issue. ANESTHESIOLOGY'S articles are made freely accessible to all readers, for personal use only, 6 months from the cover date of the issue.

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