# Pain Intensity on the First Day after Surgery

## *A Prospective Cohort Study Comparing 179 Surgical Procedures*

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## ABSTRACT

**Background:** Severe pain after surgery remains a major problem, occurring in 20–40% of patients. Despite numerous published studies, the degree of pain following many types of surgery in everyday clinical practice is unknown. To improve postoperative pain therapy and develop procedure-specific, optimized pain-treatment protocols, types of surgery that may result in severe postoperative pain in everyday practice must first be identified.

**Methods:** This study considered 115,775 patients from 578 surgical wards in 105 German hospitals. A total of 70,764 patients met the inclusion criteria. On the first postoperative day, patients were asked to rate their worst pain intensity since surgery (numeric rating scale, 0–10). All surgical procedures were assigned to 529 well-defined groups. When a group contained fewer than 20 patients, the data were excluded from analysis. Finally, 50,523 patients from 179 surgical groups were compared.

**Results:** The 40 procedures with the highest pain scores (median numeric rating scale, 6–7) included 22 orthopedic/trauma procedures on the extremities. Patients reported high pain scores after many “minor” surgical procedures, including appendectomy, cholecystectomy, hemorrhoidectomy, and tonsillectomy, which ranked among the 25 procedures with highest pain intensities. A number of “major”


### What We Already Know about This Topic

- The amount of pain that following many types of surgery remains unknown, as does pain variation among procedures

### What This Article Tells Us That Is New

- The investigators evaluated postoperative pain in 50,523 patients from 105 German hospitals, and compared pain scores among 179 surgical groups
- Pain scores were often high and, generally speaking, were worst in “minor” procedures, including appendectomy, cholecystectomy, hemorrhoidectomy, and tonsillectomy
- Many relatively small operations are associated with considerable pain, perhaps because these patients are given less analgesia than needed

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Received from the Department of Anesthesiology, Intensive Care and Emergency Medicine, University Medical Center Utrecht, Utrecht, The Netherlands. Submitted for publication June 11, 2012. Accepted for publication November 29, 2012. This project was supported by a grant of the German Ministry of Health (Berlin, Germany; grant No. 217-43794-6/3). Participating hospitals pay a fee for technical and administrative support of the Quality Improvement in Postoperative Pain Treatment registry (Jena, Germany).

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 Anesthesiology 2013; 118:934-44

◇ This article is featured in “This Month in Anesthesiology.” Please see this issue of Anesthesiology, page 9A.

◆ This article is accompanied by an Editorial View. Please see: Joshi GP, Kehlet H: Procedure-specific pain management: The road to improve postsurgical pain management? Anesthesiology 2013; 118:780–2.

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abdominal surgeries resulted in comparatively low pain scores, often because of sufficient epidural analgesia.

**Conclusions:** Several common minor- to medium-level surgical procedures, including some with laparoscopic approaches, resulted in unexpectedly high levels of postoperative pain. To reduce the number of patients suffering from severe pain, patients undergoing so-called minor surgery should be monitored more closely, and postsurgical pain treatment needs to comply with existing procedure-specific pain-treatment recommendations.

SEVERE postoperative pain remains a widespread but still underestimated problem. Extensive studies have demonstrated that despite present-day improvements in pain treatment, many patients still suffer from moderate to severe postoperative pain.[1,2] Severe pain is associated with decreased patient satisfaction, delayed postoperative ambulation, the development of chronic postoperative pain,[3] an increased incidence of pulmonary[4,5] and cardiac complications,[6] and increased morbidity and mortality.[7] Therefore, it is of great importance that surgical procedures that result in severe pain and optimal analgesic strategies for these procedures can be identified.

To date, no comprehensive comparison of pain intensities among surgical procedures has been performed. One reason is a lack of pain studies for surgical procedures that are performed infrequently or for "minor" procedures that have been assumed to result in little or no postoperative pain. Another problem is the variability of pain assessment methods between studies, including different time periods for data collection and/or different types of pain measurements such as "pain on movement" or "pain at rest."[8]

We hypothesized that a systematic and standardized comparison of pain after all types of surgery might identify procedures where patients suffer from severe postoperative pain and could benefit from additional pain-treatment modalities such as regional anesthesia (RA). In this cohort study, we aimed to provide an estimate of pain intensities that can be expected after most types of surgical procedures in relation to the applied pain treatment and to identify procedures where current pain therapy is likely to be insufficient.

## Materials and Methods

### Quality Improvement in Postoperative Pain Treatment Registry

The present cohort study was part of the Quality Improvement in Postoperative Pain Treatment (QUIPS) registry. The QUIPS registry was started as a benchmark initiative to compare pain outcome parameters among participating German hospitals. This study was supported by the German Society of Anesthesiologists, the German Society of Surgeons, and their professional organizations.[9] Each surgical patient completed the validated 15-item QUIPS questionnaire. Worst pain intensity since surgery and pain during movement were measured using a numeric rating scale (NRS) of 0–10 (0 = no pain and 10 = worst pain imaginable). Further information on the type of surgery, anesthesia, and pain treatment was collected by study nurses.

The personnel were trained to collect data in a standardized manner and were not part of the responsible surgical or anesthesia team. To reduce selection bias, data collection took place on randomly selected days. These dates were not known in advance to the medical staff, and on a survey day all patients who had been operated on the day before were considered for inclusion. Approval was obtained from the University Ethics Committee of the University of Jena (Jena, Thuringia, Germany). All patients gave their written informed consent before entering the study.

### Patients

All patients admitted between May 2004 and May 2010 were included in this analysis. Exclusion criteria as defined by the QUIPS project were as follows: The patient (1) has been transferred to another ward after surgery; (2) is not present in his or her room at the time of data collection or has been discharged; (3) refuses participation in the study; (4) cannot communicate in German; (5) has cognitive deficits; or (6) is sedated or asleep. Additional exclusion criteria for this study were (7) missing or incorrect German Surgical Procedure Coding (OPS), which precisely defines the type of surgery performed; (8) age younger than 18 years; and (9) only patients who completed the questionnaire on the first postoperative day were included.

### Definition and Selection of Surgical Procedures

To compare pain intensities from various types of surgery, homogeneous surgical groups were created. The type of surgery was documented using the OPS, which includes some 21,000 surgical codes. These OPS codes were assigned to 529 surgical groups based on the extent of tissue lesions of the specific anatomic site as well as the surgical access method (*e.g.*, laparoscopic, open, endoscopic). Minor differences in the extent of surgical lesions were assigned to one surgical group (*e.g.*, partial thyroidectomy, hemithyroidectomy, total thyroidectomy). Very rare operations such as retrosternal thyroidectomy with sternotomy were disregarded. The type of material used for fixation of fractures or type of prosthesis was not taken into account.

Surgical groups were selected for comparison when they contained at least 20 procedures. In selected cases, the minimum number of patients was set at 10 to allow comparison between open and laparoscopic surgeries and to permit procedures with particularly high pain scores (median worst pain NRS $\geq$ 6) to be shown.

For eight organ systems and surgical sites (*e.g.*, eye, ear, and brain and skull surgery), insufficient numbers of patients were available to create homogeneous surgical groups. However, to permit analysis of as broad a spectrum of surgeries and surgical disciplines as possible, exceptions were made by pooling different types of these surgeries into heterogeneous groups.

The surgical codes of all patients were examined individually for the presence of multiple procedures. Thus, 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 (*e.g.*, left hemicolectomy with an additional sigmoid resection).

### Analgesics

Morphine equivalents were calculated to compare pain treatments for the different surgical procedures. The opioid consumption on the surgical ward after discharge from the postanesthesia care unit was measured. To calculate oral morphine equivalents, the following conversion factors were used: IV morphine (3×), oral oxycodone (2×), piritramide (2×), tramadol (0.1×), meperidine (0.4×), oral hydromorphone (7.5×), IV hydromorphone (22.5×), and IV fentanyl (100×). The use of nonopioids was analyzed by comparing the application of none, one, or two different analgesics.[10,11]

### Statistical Analysis

The primary analysis of pain scores was descriptive. For each surgical group, median and interquartile range (IQR) are presented. The surgical groups are ranked by their median worst pain intensity since surgery. Surgical groups with the same median pain score were subranked according to their mean pain score.

For the initial ranking of pain intensities of surgery, the type of anesthesia was not considered because it was our aim to mirror the true everyday clinical situation. As RA is generally thought to result in lower pain scores, in a separate analysis, surgeries with general anesthesia (GA) alone (GA without any RA) and surgeries with RA (with or without GA) were examined separately. When information on the type of anesthesia was missing, patients were excluded from the comparison between the RA and GA groups. RA included epidural anesthesia (EA) with a catheter technique, peripheral nerve block (local anesthetic [LA] administered as a single injection or continuously *via* a catheter), and spinal anesthesia. To avoid very small patient groups, pain intensities of patients with RA were only shown when RA groups contained at least 10 patients. For analysis, statistical software package SPSS 20 (IBM Corp., Armonk, NY) was used.

## Results

Data were collected from 115,775 surgical patients on 578 surgical wards in 105 German hospitals. Participating centers included primary, secondary, and tertiary hospitals.

Numbers and reasons for exclusion are presented in figure 1. A total of 70,518 patients were eligible for further analysis. Gender and age distribution are listed in table 1. The median worst pain intensity since surgery was NRS 5.0 (IQR, 3.0–7.0) and pain during movement NRS 4.0 (IQR, 2.0–5.0). GA alone was applied in 53,066 patients (75.3%), RA with or without GA was applied in 6,015 patients

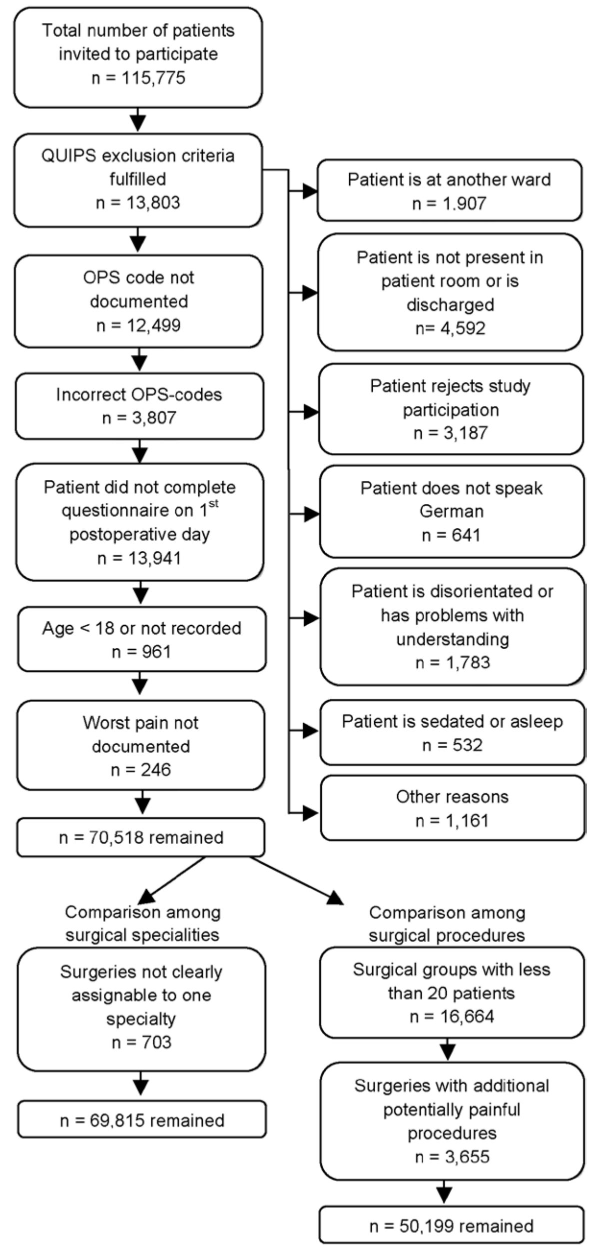



**Fig. 1.** Exclusion criteria for comparison of postoperative pain intensities between surgical wards and surgical procedures. OPS = German Surgical Procedure Coding; QUIPS = Quality Improvement in Postoperative Pain Treatment.

(8.5%), and information on the type of anesthesia was missing for 11,437 patients (16.2% of the cases).

### Comparison between Surgical Specialties

For comparison of surgical specialties, 69,815 patients were analyzed. In 703 cases, the surgical procedure could not be assigned to a particular department (*e.g.*, biopsies, skin débridement, or diagnostic procedures). These were mainly minor surgical procedures. Pain intensities according to surgical discipline are presented in figure 2. The high pain intensity of neurosurgery was mainly associated with spinal

**Table 1.** Demographic Data (n = 70,518)

| | No. | % |
|---|---|---|
| Female sex | 38,823 | 55.0 |
| Age, yr | | |
| 18–20 | 1,811 | 2.6 |
| 21–30 | 5,360 | 7.6 |
| 31–40 | 6,779 | 9.6 |
| 41–50 | 12,248 | 17.4 |
| 51–60 | 13,628 | 19.3 |
| 61–70 | 15,772 | 22.4 |
| 71–80 | 12,110 | 17.1 |
| 81–90 | 2,810 | 4.0 |

surgery. Tonsillectomies considerably influenced the otolaryngologic (ear, nose, and throat) group, as this was by far the most frequently performed procedure (n = 402 [21.4%]) and the one that resulted in the highest pain scores (median worst pain NRS 6.0 [IQR, 5.0–7.0]). Excluding tonsillectomies, the ear, nose, and throat group would have had a median worst pain score of NRS 3.0 (IQR, 2.0–4.0).

### *Comparison between Surgical Groups*

A total of 50,199 patients were selected for comparison of pain intensities in 179 surgical groups. These included the following: (1) 164 homogeneous surgical groups comprising more than 20 patients; (2) seven groups with fewer than 20 patients; and (3) eight heterogeneous groups (fig. 3). The distributions of pain scores for all 179 surgeries as well as fractions of patients with NRS greater than or equal to 6 and greater than or equal to 8 has been calculated (see Supplemental Digital Content 1, http://links.lww.com/ALN/A915, which is a table listing the distribution of the pain scores of all 179 surgical procedures).

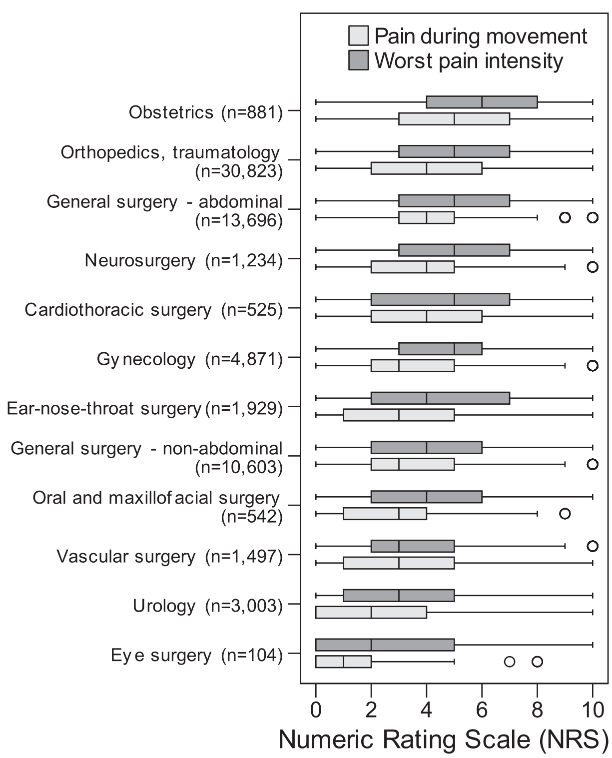



**Fig. 2.** Comparison of pain intensities between surgical specialties. Worst pain and pain during movement since surgery were assessed on the first postoperative day.

### *Analgesic Use*

Data on opioid use were recorded in 72% of cases. Patients without RA received opioids on the ward after discharge from the postanesthesia care unit in 38% of cases, compared to 39% of patients with RA.

In 79% of the cases, data on nonopioid use were available. Among these patients, none, one, and two nonopioid analgesics (*e.g.*, acetaminophen, metamizol, nonsteroidal antiinflammatory drugs, cycoloxygenase-2 inhibitors) were used in 16.4%, 58.2%, and 25.4% of cases, respectively. In general, the higher the postoperative pain intensity, the more often one or two nonopioids were administered. In 49 of 179 surgical procedures, more than 20% of the patients did not receive nonopioid analgesics. These procedures were predominantly less painful surgeries that lay within the lowest one third of the pain ranking list. Orthopedic and trauma patients most frequently received a second nonopioid analgesic.

### *Major Thoracic/Abdominal Surgery*

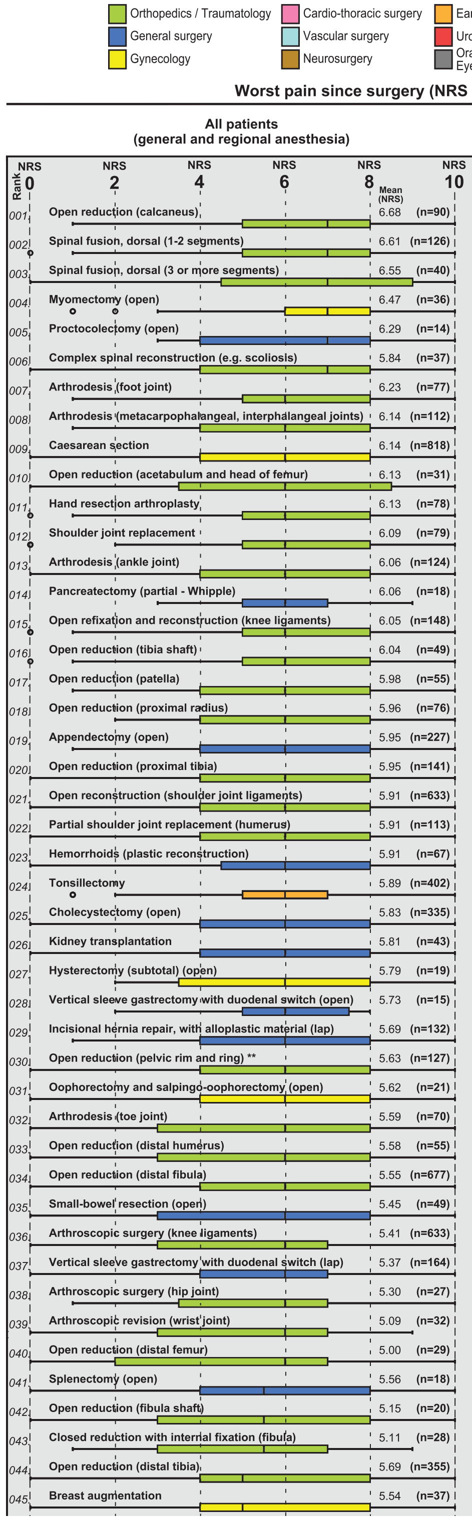
For a number of "major" open thoracic and abdominal surgeries, low pain scores with NRS less than or equal to 4 were reported. In those surgeries, the percentage in which EA was used was high, often 50% or more. The average opioid consumption of patients without EA in most of these surgical groups was greater than 35 mg: open left hemicolectomy (rank, 109), open lung resection (rank, 118), (sub)total gastrectomy (rank, 120), rectum resection (rank, 133), open adrenal surgery (rank, 136), total bladder resection (rank, 142), or radical prostatectomy (rank, 163).

### *Laparoscopic Surgery*

In laparoscopic surgeries with high postoperative pain scores, comparably low opioid doses were used. These included incisional hernia repair (rank, 29; $15 \pm 23$ mg), appendectomy (rank, 47; $7 \pm 18$ mg), extrauterine pregnancy (rank, 57; $5 \pm 12$ mg), salpingo-oophorectomy (rank, 76; $2 \pm 9$ mg), myomectomy (rank, 78: $3 \pm 8$ mg), and cholecystectomy (rank, 94; $10 \pm 25$ mg). In the above-mentioned laparoscopic groups, on average, 72% of the patients did not receive any opioids.

### *Major Orthopedic Surgery*

Three of the six surgeries with a median pain score of NRS 7 were major spinal procedures. Among the 40 highest ranked surgeries (median NRS 6 or 7) were 22 orthopedic/trauma




| Rank | Procedure (all patients, general and regional anesthesia) | Mean (NRS) | n | General anesthesia only: Rank | NRS Median (IQR) | n | Morphine equivalent mg (mean) (SD) | Regional-anesthesia w or w/o general anesthesia: NRS Median (IQR) | n | No. of hospitals |
|---|---|---|---|---|---|---|---|---|---|---|
| 001 | Open reduction (calcaneus) | 6.68 | (n=90) | 5. | 7.0 (5-8) | 65 | 40 (32) | | | 24 |
| 002 | Spinal fusion, dorsal (1-2 segments) | 6.61 | (n=126) | 4. | 7.0 (5-8) | 126 | 37 (89) | | | 22 |
| 003 | Spinal fusion, dorsal (3 or more segments) | 6.55 | (n=40) | 6. | 7.0 (5.5-9) | 40 | 27 (39) | | | 11 |
| 004 | Myomectomy (open) | 6.47 | (n=36) | 2. | 7.5 (6-8) | 32 | 24 (29) | | | 20 |
| 005 | Proctocolectomy (open) | 6.29 | (n=14) | 114. | 4.0 (4-7) | 5 | 28 (32) | | | 8 |
| 006 | Complex spinal reconstruction (e.g. scoliosis) | 5.84 | (n=37) | 7. | 7.0 (4-8) | 37 | 29 (36) | | | 15 |
| 007 | Arthrodesis (foot joint) | 6.23 | (n=77) | 22. | 6.0 (4.5-8) | 44 | 12 (20) | | | 24 |
| 008 | Arthrodesis (metacarpophalangeal, interphalangeal joints) | 6.14 | (n=112) | 23. | 6.0 (4-8) | 61 | 10 (20) | 7.0 (6-10) | 13 | 17 |
| 009 | Caesarean section | 6.14 | (n=818) | 16. | 6.0 (4.5-8) | 203 | 27 (33) | 6.0 (4-8) | 253 | 34 |
| 010 | Open reduction (acetabulum and head of femur) | 6.13 | (n=31) | 14. | 6.0 (4-8) | 26 | 31 (27) | | | 10 |
| 011 | Hand resection arthroplasty | 6.13 | (n=78) | 18. | 6.0 (5-8) | 25 | 11 (17) | 7.0 (5-8) | 19 | 17 |
| 012 | Shoulder joint replacement | 6.09 | (n=79) | 39. | 6.0 (5-7) | 25 | 25 (23) | 7.0 (5-9) | 29 | 32 |
| 013 | Arthrodesis (ankle joint) | 6.06 | (n=124) | 33. | 6.0 (4-8) | 82 | 19 (22) | 6.0 (4-7) | 13 | 33 |
| 014 | Pancreatectomy (partial - Whipple) | 6.06 | (n=18) | 8. | 7.0 (5-7) | 3 | 18 (8) | 6.0 (5-7) | 14 | 7 |
| 015 | Open refixation and reconstruction (knee ligaments) | 6.05 | (n=148) | 15. | 6.0 (5-8) | 105 | 26 (32) | | | 31 |
| 016 | Open reduction (tibia shaft) | 6.04 | (n=49) | 9. | 6.5 (4.5-8) | 32 | 12 (25) | | | 19 |
| 017 | Open reduction (patella) | 5.98 | (n=55) | 27. | 6.0 (4.8) | 37 | 19 (26) | | | 28 |
| 018 | Open reduction (proximal radius) | 5.96 | (n=76) | 21. | 6.0 (4-8) | 51 | 10 (15) | | | 29 |
| 019 | Appendectomy (open) | 5.95 | (n=227) | 26. | 6.0 (4-8) | 196 | 14 (22) | | | 40 |
| 020 | Open reduction (proximal tibia) | 5.95 | (n=141) | 29. | 6.0 (4-8) | 104 | 23 (28) | | | 39 |
| 021 | Open reconstruction (shoulder joint ligaments) | 5.91 | (n=633) | 20. | 6.0 (4-8) | 349 | 26 (32) | 5.0 (4-7) | 109 | 55 |
| 022 | Partial shoulder joint replacement (humerus) | 5.91 | (n=113) | 25. | 6.0 (4-8) | 63 | 24 (26) | 6.0 (5-8) | 16 | 38 |
| 023 | Hemorrhoids (plastic reconstruction) | 5.91 | (n=67) | 19. | 6.0 (5-8) | 65 | 13 (22) | | | 13 |
| 024 | Tonsillectomy | 5.89 | (n=402) | 28. | 6.0 (5-7) | 401 | 7 (15) | | | 26 |
| 025 | Cholecystectomy (open) | 5.83 | (n=335) | 30. | 6.0 (4-8) | 285 | 28 (33) | 6.0 (4-8) | 11 | 52 |
| 026 | Kidney transplantation | 5.81 | (n=43) | 17. | 6.0 (4-9) | 38 | 17 (23) | | | 3 |
| 027 | Hysterectomy (subtotal) (open) | 5.79 | (n=19) | 1. | 7.5 (6-8) | 14 | 30 (44) | | | 10 |
| 028 | Vertical sleeve gastrectomy with duodenal switch (open) | 5.73 | (n=15) | 32. | 6.0 (5-8) | 14 | 53 (35) | | | 2 |
| 029 | Incisional hernia repair, with alloplastic material (lap) | 5.69 | (n=132) | 36. | 6.0 (4-8) | 123 | 16 (23) | | | 33 |
| 030 | Open reduction (pelvic rim and ring) ** | 5.63 | (n=127) | 24. | 6.0 (4-8) | 96 | 21 (29) | | | 33 |
| 031 | Oophorectomy and salpingo-oophorectomy (open) | 5.62 | (n=21) | 12. | 6.0 (5-8) | 17 | 19 (24) | | | 13 |
| 032 | Arthrodesis (toe joint) | 5.59 | (n=70) | 40. | 6.0 (3-8) | 37 | 16 (25) | 5.0 (3-8) | 17 | 31 |
| 033 | Open reduction (distal humerus) | 5.58 | (n=55) | 43. | 6.0 (3-7) | 40 | 24 (39) | | | 25 |
| 034 | Open reduction (distal fibula) | 5.55 | (n=677) | 55. | 5.0 (3-8) | 461 | 17 (23) | 7.0 (5-8) | 49 | 59 |
| 035 | Small-bowel resection (open) | 5.45 | (n=49) | 13. | 6.0 (5-8) | 29 | 22 (25) | 4.0 (2-6) | 12 | 21 |
| 036 | Arthroscopic surgery (knee ligaments) | 5.41 | (n=633) | 37. | 6.0 (4-8) | 396 | 13 (21) | 6.0 (3.5-7) | 60 | 61 |
| 037 | Vertical sleeve gastrectomy with duodenal switch (lap) | 5.37 | (n=164) | 42. | 6.0 (4-7) | 162 | 19 (28) | | | 5 |
| 038 | Arthroscopic surgery (hip joint) | 5.30 | (n=27) | 41. | 6.0 (4-7) | 21 | 3 (8) | | | 5 |
| 039 | Arthroscopic revision (wrist joint) | 5.09 | (n=32) | 46. | 6.0 (3-7) | 29 | 7 (19) | | | 8 |
| 040 | Open reduction (distal femur) | 5.00 | (n=29) | 48. | 5.5 (2.5-6) | 20 | 32 (39) | | | 17 |
| 041 | Splenectomy (open) | 5.56 | (n=18) | 3. | 7.0 (5.5-8) | 11 | 20 (28) | | | 12 |
| 042 | Open reduction (fibula shaft) | 5.15 | (n=20) | 11. | 6.5 (3-8) | 16 | 17 (24) | | | 11 |
| 043 | Closed reduction with internal fixation (fibula) | 5.11 | (n=28) | 45. | 6.0 (3-7) | 21 | 7 (17) | | | 15 |
| 044 | Open reduction (distal tibia) | 5.69 | (n=355) | 50. | 5.0 (4-8) | 236 | 22 (27) | 7.0 (5-8) | 22 | 45 |
| 045 | Breast augmentation | 5.54 | (n=37) | 53. | 5.0 (4-8) | 37 | 3 (7) | | | 15 |

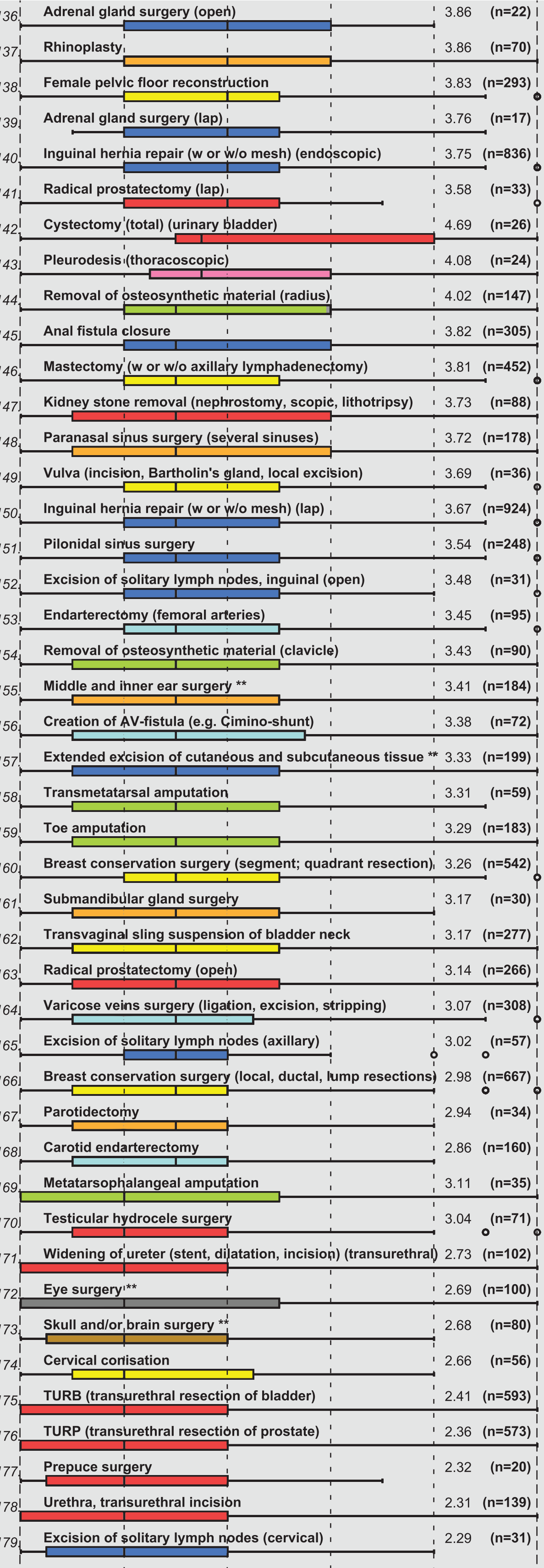
**Fig. 3.** Pain scores on the first postoperative day after 179 surgical procedures. *Horizontal box plots* indicate worst pain since surgery on a numeric rating scale (NRS) from 0 = no pain at all to 10 = worst pain imaginable. *Box edges* indicate 25th and 75th percentiles. *Whiskers* indicate 5th and 95th percentiles. Columns to the right of box plots indicate pain scores in patients receiving only general anesthesia (GA) and patients receiving regional anesthesia (RA) with or without GA. Procedures are ranked in descending order of median pain severity. Mean scores (also shown) were used to rank surgical groups with identical median NRS scores. Opioid concentration was calculated as oral morphine equivalents. Opioid doses are presented only for patients under GA without RA. Open reduction of distal or proximal bones means that fracture includes joint region. ** Heterogeneous surgical group (pooled on basis of surgery on an organ system or surgical site). IQR = interquartile range; w or w/o = with or without.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 046 | Knee joint replacement (revision, exchange, removal) ** | 5.41 | (n=351) | 34. | **6.0** (4-8) | 162 | **24** (39) | **5.0** (3-7) | 100 | 51 |
| 047 | Appendectomy (lap) | 5.38 | (n=1198) | 60. | **5.0** (4-7) | 1081 | **8** (18) | | | 70 |
| 048 | Open reduction (distal radius) | 5.35 | (n=996) | 65. | **5.0** (4-7) | 568 | **13** (22) | **6.0** (4-8) | 101 | 59 |
| 049 | Open reduction (metatarsal bone) | 5.34 | (n=103) | 64. | **5.0** (4-7) | 73 | **8** (15) | | | 27 |
| 050 | Open reduction (clavicle) | 5.34 | (n=240) | 62. | **5.0** (3-7) | 240 | **14** (22) | | | 46 |
| 051 | Incisional hernia repair, with alloplastic material (open) | 5.31 | (n=413) | 47. | **5.5** (4-8) | 336 | **18** (30) | **5.0** (1-6) | 41 | 66 |
| 052 | Sternotomy (cardiac surgery) | 5.31 | (n=134) | 68. | **5.0** (4-7) | 131 | **28** (20) | | | 5 |
| 053 | Knee joint replacement | 5.30 | (n=4439) | 51. | **5.0** (4-8) | 1233 | **32** (33) | **5.0** (3-8) | 1336 | 75 |
| 054 | Open reconstruction (ankle joint ligaments) | 5.30 | (n=77) | 44. | **6.0** (3-7) | 57 | **4** (10) | | | 24 |
| 055 | Arthroscopic surgery (shoulder ligaments) | 5.25 | (n=1083) | 70. | **5.0** (3-7) | 737 | **11** (19) | **6.0** (3-8) | 185 | 68 |
| 056 | Open reduction (humerus shaft) | 5.24 | (n=46) | 56. | **5.0** (4-7) | 39 | **28** (37) | | | 24 |
| 057 | Extrauterine pregnancy (lap) | 5.21 | (n=34) | 57. | **5.0** (4-7) | 28 | **5** (12) | | | 17 |
| 058 | Closed reduction with internal fixation (tibia) | 5.20 | (n=182) | 69. | **5.0** (3-7) | 135 | **19** (26) | | | 39 |
| 059 | Implantation or exchange of an adjustable gastric band (lap) | 5.20 | (n=25) | 78. | **5.0** (4.5-7) | 23 | **15** (25) | | | 6 |
| 060 | Open reduction (femur shaft) | 5.19 | (n=73) | 58. | **5.0** (4-7) | 56 | **21** (25) | | | 29 |
| 061 | Closed reduction with internal fixation (clavicle) | 5.18 | (n=298) | 73. | **5.0** (3-7) | 291 | **17** (23) | | | 41 |
| 062 | Pancreatectomy (partial - w or w/o resection of duodenum) | 5.16 | (n=43) | 10. | **6.5** (4-8) | 12 | **31** (27) | **5.5** (3-8) | 28 | 11 |
| 063 | Lower leg amputation | 5.13 | (n=61) | 72. | **5.0** (3-8) | 29 | **33** (35) | **6.0** (4-8) | 13 | 23 |
| 064 | Open reduction (proximal humerus) | 5.11 | (n=402) | 71. | **5.0** (3.5-7) | 280 | **17** (22) | **6.0** (3-8) | 27 | 51 |
| 065 | Sigmoidectomy (open) | 5.10 | (n=119) | 63. | **5.0** (4.5-7) | 72 | **18** (24) | **5.0** (5-6) | 29 | 27 |
| 066 | Surgical correction procedures (metatarsus and toes) | 5.10 | (n=209) | 95. | **5.0** (3-7) | 120 | **8** (16) | **4.5** (2-7) | 14 | 41 |
| 067 | Thoracoscopic lung resection (atypical, segmental, lobar) | 5.08 | (n=60) | 49. | **5.0** (4-7) | 23 | **35** (37) | | | 18 |
| 068 | Spinal fusion, ventral (1-2 segments) | 5.03 | (n=95) | 79. | **5.0** (3-7) | 95 | **31** (43) | | | 20 |
| 069 | Closed reduction with internal fixation (humerus) | 5.00 | (n=126) | 88. | **5.0** (3-7) | 102 | **14** (23) | | | 37 |
| 070 | Closed reduction with internal fixation (radius) | 4.97 | (n=118) | 90. | **5.0** (3-7) | 78 | **9** (17) | | | 28 |
| 071 | Open reduction (metacarpal bone) | 4.97 | (n=95) | 67. | **5.0** (3-8) | 59 | **6** (14) | | | 28 |
| 072 | Incisional hernia repair, with reconstruction | 4.97 | (n=158) | 75. | **5.0** (4-6) | 144 | **13** (20) | | | 25 |
| 073 | Sigmoidectomy (lap) | 4.94 | (n=127) | 38. | **6.0** (4-8) | 65 | **23** (30) | **4.0** (2-6) | 39 | 40 |
| 074 | Open reduction (carpal bones) | 4.92 | (n=50) | 77. | **5.0** (3.5-6) | 31 | **16** (30) | | | 16 |
| 075 | Hysterectomy (open, vaginal) | 4.91 | (n=2401) | 83. | **5.0** (3-7) | 2087 | **24** (17) | **5.0** (2-7) | 90 | 56 |
| 076 | Oophorectomy and salpingo-oophorectomy (lap) | 4.90 | (n=52) | 74. | **5.0** (3.5-7) | 39 | **2** (9) | | | 16 |
| 077 | Liver resection (atypical), w or w/o cholecystectomy (open) | 4.90 | (n=51) | 35. | **5.0** (4-7) | 29 | **27** (29) | **4.0** (2-6) | 16 | 19 |
| 078 | Myomectomy (lap, vaginal laparoscopically assisted) | 4.89 | (n=56) | 96. | **5.0** (3-7) | 52 | **3** (8) | | | 22 |
| 079 | Open reduction (ulnar shaft) | 4.88 | (n=26) | 59. | **5.0** (4-7) | 16 | **10** (12) | | | 15 |
| 080 | Open reduction (proximal ulna) | 4.86 | (n=107) | 93. | **5.0** (3-6) | 81 | **12** (17) | | | 35 |
| 081 | Hip joint replacement (revision, exchange, removal) ** | 4.86 | (n=411) | 84. | **5.0** (3-7) | 329 | **26** (36) | **5.0** (2-7.5) | 44 | 60 |
| 082 | Hip joint replacement | 4.86 | (n=4208) | 82. | **5.0** (3-7) | 2725 | **26** (36) | **5.0** (2-7) | 511 | 76 |
| 083 | Incisional hernia repair, without reconstruction | 4.85 | (n=66) | 81. | **5.0** (3-7) | 62 | **16** (22) | | | 26 |
| 084 | Removal of osteosynthetic material (ulnar) | 4.84 | (n=55) | 87. | **5.0** (3-7) | 45 | **6** (11) | | | 19 |
| 085 | Enterostomy as independent procedure | 4.83 | (n=86) | 89. | **5.0** (4-6) | 70 | **24** (29) | **4.0** (3-7) | 13 | 31 |
| 086 | Removal of osteosynthetic material (femur w/o femoral neck) | 4.82 | (n=193) | 80. | **5.0** (3-7) | 152 | **17** (27) | **3.0** (3-8) | 10 | 41 |
| 087 | Resection of rectum with sphincter preservation (open) | 4.78 | (n=182) | 92. | **5.0** (3-6.5) | 81 | **36** (38) | **5.0** (3-7) | 74 | 30 |
| 088 | Reduction mammoplasty | 4.77 | (n=146) | 98. | **5.0** (3-7) | 135 | **4** (13) | | | 30 |
| 089 | Epigastric hernia repair (lap) | 4.77 | (n=13) | 108. | **5.0** (2-6) | 10 | **4** (9) | | | 9 |
| 090 | Spinal canal decompression (2 segments) | 4.77 | (n=167) | 99. | **5.0** (3-6) | 158 | **38** (49) | | | 19 |

**Fig. 3.** continued

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 091 | Laminectomy, hemilaminectomy (cervical, ventral, 1-2 seg.) | 4.76 | (n=88) | 97. | 5.0 (3-6.5) | 88 | 26 (36) | | | 15 |
| 092 | Right hemicolectomy (open) | 4.76 | (n=163) | 61. | 5.0 (4-7) | 80 | 34 (41) | 4.0 (2-7) | 60 | 32 |
| 093 | Femoral hernia repair (open) | 4.76 | (n=79) | 117. | 4.0 (3-6) | 66 | 6 (12) | | | 27 |
| 094 | Cholecystectomy (lap) | 4.76 | (n=4460) | 91. | 5.0 (3-6) | 4091 | 10 (25) | 3.5 (2-6) | 12 | 82 |
| 095 | Closed reduction with internal fixation (metacarpal bones) | 4.75 | (n=36) | 134. | 4.0 (2-5.5) | 19 | 4 (5) | | | 15 |
| 096 | Resection of rectum with sphincter preservation (lap) | 4.74 | (n=150) | 76. | 5.0 (4-7) | 107 | 23 (26) | 3.5 (2-6) | 38 | 22 |
| 097 | Hemorrhoids, excision (e.g. Milligan-Morgan) | 4.74 | (n=143) | 112. | 4.5 (3-7) | 136 | 12 (21) | | | 45 |
| 098 | Fallopian tube (insufflation, chromopertubation) (lap) | 4.74 | (n=23) | 111. | 4.5 (3-6) | 22 | 0 | | | 10 |
| 099 | Closed reduct, internal fixation (femur or neck of femur) | 4.68 | (n=59) | 94. | 5.0 (3-6) | 46 | 15 (26) | | | 19 |
| 100 | Arthroscopic surgery (shoulder joint) | 4.68 | (n=96) | 102. | 5.0 (3-7) | 61 | 15 (22) | 5.0 (3-9) | 13 | 33 |
| 101 | Shunt or bypass (femoral and/or popliteal artery) | 4.62 | (n=248) | 100. | 5.0 (3-6) | 175 | 18 (57) | 4.0 (2-6) | 34 | 35 |
| 102 | Liver resection (anatomical) (seg., biseg., hemihepatectomy) | 4.61 | (n=62) | 54. | 5.0 (5-7) | 21 | 27 (31) | 5.0 (3-6) | 37 | 14 |
| 103 | Arthroscopic surgery (knee) (excl. ligaments and meniscus) | 4.61 | (n=1003) | 124. | 4.0 (3-6) | 634 | 6 (14) | 5.0 (3-6) | 96 | 68 |
| 104 | Open reduction (proximal femur) | 4.60 | (n=108) | 105. | 5.0 (3-6) | 87 | 24 (31) | | | 27 |
| 105 | Open reduction (finger) | 4.59 | (n=69) | 123. | 5.0 (3-7) | 35 | 6 (11) | | | 16 |
| 106 | Hemorrhoids (stapler procedure) | 4.56 | (n=130) | 106. | 5.0 (2-6) | 124 | 6 (15) | | | 39 |
| 107 | Nephrectomy (open) | 4.54 | (n=158) | 52. | 5.0 (4-8) | 49 | 35 (33) | 4.0 (0-6) | 76 | 27 |
| 108 | Liver resection (atypical), w or w/o cholecystectomy (lap) | 4.45 | (n=40) | 107. | 5.0 (2-5.5) | 36 | 14 (38) | | | 21 |
| 109 | Left hemicolectomy (open) | 4.75 | (n=53) | 115. | 4.0 (3-7) | 21 | 40 (45) | 5.0 (2-8) | 20 | 20 |
| 110 | Umbilical hernia repair (lap) | 4.73 | (n=22) | 116. | 4.0 (3-7) | 21 | 12 (22) | | | 10 |
| 111 | Arthroscopic surgery (ankle joint) | 4.70 | (n=79) | 143. | 3.0 (2-6) | 44 | 6 (12) | 7.0 (3-8) | 13 | 21 |
| 112 | Spinal canal decompression (1 segment) | 4.70 | (n=407) | 119. | 4.0 (3-6.5) | 399 | 24 (71) | | | 28 |
| 113 | Open reduction (radius shaft) | 4.69 | (n=29) | 85. | 5.0 (3-5) | 25 | 8 (13) | | | 21 |
| 114 | Removal of osteosynthetic material (tibia w or w/o fibula) | 4.60 | (n=397) | 101. | 5.0 (3-6) | 293 | 9 (17) | 3.0 (3-5) | 13 | 58 |
| 115 | Trans-femoral amputation | 4.58 | (n=53) | 120. | 4.0 (2-6) | 37 | 41 (54) | 4.0 (4-6) | 11 | 19 |
| 116 | Laminectomy, hemilaminectomy (lumbar, 1-2 segments) | 4.53 | (n=867) | 122. | 4.0 (3-5) | 865 | 19 (28) | | | 35 |
| 117 | Epigastric hernia repair (open) | 4.50 | (n=125) | 125. | 4.0 (3-6) | 114 | 13 (30) | | | 31 |
| 118 | Open lung resection (atypical, segmental, lobar) | 4.48 | (n=80) | 142. | 3.0 (2.5-7) | 19 | 72 (77) | 3.5 (1.5-8) | 20 | 16 |
| 119 | Right hemicolectomy (lap) | 4.47 | (n=15) | 109. | 4.5 (4-7) | 8 | 26 (28) | | | 10 |
| 120 | Gastrectomy (total or subtotal) | 4.45 | (n=98) | 110. | 4.5 (3-6.5) | 36 | 38 (40) | 5.0 (2.5-6) | 47 | 25 |
| 121 | Hysterectomy (subtotal) (lap) | 4.44 | (n=106) | 121. | 4.0 (3-6) | 89 | 5 (9) | | | 19 |
| 122 | Submucosal resection und plastic reconstr. of nasal septum | 4.43 | (n=388) | 126. | 4.0 (2-6.5) | 388 | 1 (5) | | | 32 |
| 123 | Inguinal hernia repair (w or w/o mesh) (open) | 4.37 | (n=941) | 127. | 4.0 (3-6) | 714 | 6 (14) | 4.0 (3-6) | 37 | 73 |
| 124 | Fundoplication (lap) | 4.37 | (n=153) | 129. | 4.0 (3-6) | 149 | 5 (13) | | | 18 |
| 125 | Removal of osteosynthetic material (fibula) | 4.35 | (n=150) | 113. | 4.5 (2-6) | 118 | 6 (14) | | | 40 |
| 126 | Surgical wound debridement ** | 4.32 | (n=618) | 128. | 4.0 (2-6) | 490 | 13 (56) | 5.0 (3-8) | 25 | 64 |
| 127 | Thyroid (total, hemi, partial resection) | 4.27 | (n=2362) | 130. | 4.0 (3-6) | 2358 | 7 (17) | | | 73 |
| 128 | Nephrectomy (lap) | 4.24 | (n=34) | 118. | 4.0 (3-5.5) | 12 | 19 (22) | | | 10 |
| 129 | Hand tendon repair | 4.23 | (n=192) | 104. | 5.0 (2-6) | 94 | 9 (17) | 3.0 (2-5) | 15 | 33 |
| 130 | Umbilical hernia repair (open) | 4.20 | (n=378) | 131. | 4.0 (2-6) | 345 | 4 (12) | | | 48 |
| 131 | Orchidectomy | 4.16 | (n=74) | 135. | 4.0 (2-5.5) | 52 | 9 (24) | | | 27 |
| 132 | Removal/reconstruction of teeth | 4.11 | (n=37) | 132. | 4.0 (2-6) | 37 | 0 | | | 7 |
| 133 | Resection of rectum without sphincter preservation | 4.11 | (n=47) | 86. | 5.0 (3.5-6) | 23 | 29 (34) | 3.0 (2-5) | 18 | 18 |
| 134 | Breast reconstruction (muscle or skin flap) | 4.09 | (n=11) | 133. | 4.0 (1.5-6) | 11 | 4 (10) | | | 7 |
| 135 | Reduction of facial bone fractures ** | 3.87 | (n=578) | 138. | 4.0 (2-6) | 578 | 1 (5) | | | 17 |

**Fig. 3.** continued



| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 136 | Adrenal gland surgery (open) | 3.86 | (n=22) | 66. | **4.0** (3-5) | 8 | **42** (35) | **3.0** (1.5-4.5) | 11 | 13 |
| 137 | Rhinoplasty | 3.86 | (n=70) | 139. | **4.0** (2-6) | 70 | **1** (4) | | | 14 |
| 138 | Female pelvic floor reconstruction | 3.83 | (n=293) | 140. | **4.0** (1-4.5) | 164 | **13** (21) | **2.0** (2-6) | 26 | 39 |
| 139 | Adrenal gland surgery (lap) | 3.76 | (n=17) | 136. | **4.0** (2-5) | 13 | **13** (25) | | | 9 |
| 140 | Inguinal hernia repair (w or w/o mesh) (endoscopic) | 3.75 | (n=836) | 141. | **4.0** (2-5) | 794 | **1** (6) | | | 32 |
| 141 | Radical prostatectomy (lap) | 3.58 | (n=33) | 137. | **4.0** (3-5) | 23 | **8** (21) | | | 5 |
| 142 | Cystectomy (total) (urinary bladder) | 4.69 | (n=26) | 179. | **-** | 0 | **-** | **4.5** (2-8) | 18 | 9 |
| 143 | Pleurodesis (thoracoscopic) | 4.08 | (n=24) | 31. | **6.0** (4.5-7) | 11 | **2** (5) | | | 12 |
| 144 | Removal of osteosynthetic material (radius) | 4.02 | (n=147) | 144. | **3.0** (2-6) | 116 | **7** (16) | | | 29 |
| 145 | Anal fistula closure | 3.82 | (n=305) | 145. | **3.0** (1-6) | 293 | **7** (19) | **2.0** (1-5) | 11 | 55 |
| 146 | Mastectomy (w or w/o axillary lymphadenectomy) | 3.81 | (n=452) | 146. | **3.0** (1-5) | 449 | **8** (23) | | | 42 |
| 147 | Kidney stone removal (nephrostomy, scopic, lithotripsy) | 3.73 | (n=88) | 147. | **3.0** (1-6) | 70 | **3** (10) | | | 26 |
| 148 | Paranasal sinus surgery (several sinuses) | 3.72 | (n=178) | 149. | **3.0** (1-6) | 178 | **3** (18) | | | 22 |
| 149 | Vulva (incision, Bartholin's gland, local excision) | 3.69 | (n=36) | 148. | **3.0** (2-5) | 34 | **2** (8) | | | 16 |
| 150 | Inguinal hernia repair (w or w/o mesh) (lap) | 3.67 | (n=924) | 150. | **3.0** (2-5) | 830 | **5** (15) | | | 61 |
| 151 | Pilonidal sinus surgery | 3.54 | (n=248) | 151. | **3.0** (2-5) | 225 | **5** (13) | | | 49 |
| 152 | Excision of solitary lymph nodes, inguinal (open) | 3.48 | (n=31) | 154. | **3.0** (2-4) | 26 | **8** (26) | | | 20 |
| 153 | Endarterectomy (femoral arteries) | 3.45 | (n=95) | 153. | **3.0** (2-5) | 66 | **7** (21) | | | 29 |
| 154 | Removal of osteosynthetic material (clavicle) | 3.43 | (n=90) | 152. | **3.0** (1-5) | 81 | **2** (7) | | | 27 |
| 155 | Middle and inner ear surgery ** | 3.41 | (n=184) | 155. | **3.0** (1-5) | 184 | **5** (38) | | | 17 |
| 156 | Creation of AV-fistula (e.g. Cimino-shunt) | 3.38 | (n=72) | 163. | **3.0** (1-5) | 34 | **0** | | | 17 |
| 157 | Extended excision of cutaneous and subcutaneous tissue ** | 3.33 | (n=199) | 156. | **3.0** (1-5) | 172 | **8** (19) | | | 42 |
| 158 | Transmetatarsal amputation | 3.31 | (n=59) | 159. | **3.0** (1-5) | 40 | **9** (22) | | | 20 |
| 159 | Toe amputation | 3.29 | (n=183) | 157. | **3.0** (1-5) | 127 | **10** (18) | **5.0** (1-7) | 16 | 37 |
| 160 | Breast conservation surgery (segment; quadrant resection) | 3.26 | (n=542) | 158. | **3.0** (2-5) | 538 | **6** (15) | | | 40 |
| 161 | Submandibular gland surgery | 3.17 | (n=30) | 160. | **3.0** (1-5) | 30 | **0** | | | 15 |
| 162 | Transvaginal sling suspension of bladder neck | 3.17 | (n=277) | 162. | **3.0** (1-5) | 225 | **3** (10) | **5.5** (0-8.5) | 12 | 44 |
| 163 | Radical prostatectomy (open) | 3.14 | (n=266) | 103. | **5.0** (3-6) | 62 | **15** (19) | **2.0** (0-4) | 154 | 23 |
| 164 | Varicose veins surgery (ligation, excision, stripping) | 3.07 | (n=308) | 161. | **3.0** (1-4) | 293 | **3** (12) | **3.0** (1-7) | 14 | 41 |
| 165 | Excision of solitary lymph nodes (axillary) | 3.02 | (n=57) | 164. | **3.0** (2-4) | 57 | **2** (12) | | | 17 |
| 166 | Breast conservation surgery (local, ductal, lump resections) | 2.98 | (n=667) | 166. | **3.0** (1-4) | 664 | **2** (7) | | | 44 |
| 167 | Parotidectomy | 2.94 | (n=34) | 167. | **3.0** (1-4) | 33 | **1** (4) | | | 13 |
| 168 | Carotid endarterectomy | 2.86 | (n=160) | 165. | **3.0** (1-4) | 82 | **10** (22) | **3.0** (2-4) | 10 | 22 |
| 169 | Metatarsophalangeal amputation | 3.11 | (n=35) | 178. | **1.0** (0-3) | 21 | **8** (18) | | | 15 |
| 170 | Testicular hydrocele surgery | 3.04 | (n=71) | 168. | **2.5** (1-4) | 50 | **3** (11) | | | 24 |
| 171 | Widening of ureter (stent, dilatation, incision) (transurethral) | 2.73 | (n=102) | 171. | **2.0** (0-4) | 89 | **3** (12) | | | 16 |
| 172 | Eye surgery** | 2.69 | (n=100) | 169. | **2.0** (0-5) | 100 | **5** (38) | | | 13 |
| 173 | Skull and/or brain surgery ** | 2.68 | (n=80) | 170. | **2.0** (3-6.5) | 80 | **5** (14) | | | 12 |
| 174 | Cervical conisation | 2.66 | (n=56) | 173. | **2.0** (1-4) | 50 | **0** (2) | | | 15 |
| 175 | TURB (transurethral resection of bladder) | 2.41 | (n=593) | 174. | **2.0** (0-4) | 548 | **1** (4) | **1.5** (0-4) | 39 | 30 |
| 176 | TURP (transurethral resection of prostate) | 2.36 | (n=573) | 175. | **2.0** (0-4) | 484 | **1** (7) | **1.5** (0-4) | 88 | 30 |
| 177 | Prepuce surgery | 2.32 | (n=20) | 172. | **2.0** (0.5-4) | 12 | **0** | | | 10 |
| 178 | Urethra, transurethral incision | 2.31 | (n=139) | 177. | **1.0** (0-3) | 108 | **1** (5) | | | 23 |
| 179 | Excision of solitary lymph nodes (cervical) | 2.29 | (n=31) | 176. | **2.0** (2-4) | 31 | **5** (18) | | | 19 |

**Fig. 3.** continued

surgeries on the extremities. In these groups, RA was used in only 537 of 3,462 cases (15.5%).

### *Minor Orthopedic Surgery*

A number of hand and foot surgeries resulted in high pain scores. The average morphine equivalent dose administered was below 10 mg in all of the following surgical groups: arthrodesis of foot joint (rank, 7), arthrodesis of metacarpophalangeal joints (rank, 8), hand resection arthroplasty (rank, 11), arthroscopic wrist revision (rank, 39), open reduction of metatarsal bone (rank, 49), open reconstruction of ankle ligaments (rank, 54), and surgical correction of metatarsus and toes (rank, 66).

## Discussion

To our knowledge, this is the largest prospective cohort study to date comparing standardized pain intensity scores obtained after a wide range of surgical procedures performed in a large number of hospitals. This standardized assessment provides insight into the painfulness of everyday surgical interventions in relation to the treatment provided.

Our findings show that, depending on the pain treatment received, in many surgical procedures the incision size and extent of tissue trauma were not related to postoperative pain intensity. On the one hand, above-knee amputation, open lung resection, total gastrectomy, mastectomy, or radical prostatectomy, which are certainly major procedures in terms of the extent of tissue trauma, all received sufficient pain treatment, as they resulted in median worst-pain scores of NRS 4 or less and ranked lower than position 115 for pain intensity. On the other hand, tonsillectomy, hemorrhoidectomy with plastic reconstruction, open appendectomy, and open cholecystectomy ranked among the highest 25 surgeries.

The mainstay of good acute pain treatment is careful individual titration of analgesics while minimizing adverse effects. It has repeatedly been demonstrated that medical staff commonly misjudge the pain intensity that patients are experiencing.[12,13] Therefore, the administration of analgesics should be adjusted according to the individual patient's reported pain scores and desire for additional medication. In the present study, we were able to demonstrate that patients undergoing minor surgeries typically received no or low doses of opioids. However, many patients indicated high pain scores. It is thus conceivable that high pain intensities were often ignored or not taken seriously, so that analgesic administration was delayed and/or insufficient.

In most surgical groups, pain intensities after laparoscopic access were lower compared with the open route, as would be expected.[14–16] However, some laparoscopic surgeries were nevertheless associated with high postoperative pain intensities: after laparoscopic appendectomy, patients' pain ratings were similar to those after knee joint replacement and sternotomy. After many laparoscopic surgeries, patients often reported severe pain but did not receive any opioids at all or received opioids only in low doses, which supports the presumption that the painfulness of some laparoscopic interventions is underestimated.

Similar results were observed in "minor" surgeries of the hand and foot in orthopedics and traumatology: low amounts of opioid use indicate inadequate titration of analgesics and low percentages of RA demonstrate possibilities for future improvement of pain treatment in those surgeries.

Good pain relief was achieved after many major abdominal surgeries: a high incidence of use of EA and oral morphine equivalent doses of around 30–50 mg after discharge from the postanesthesia care unit resulted in acceptable worst-pain scores of NRS 4 for many procedures.

In contrast, major orthopedic surgery was frequently associated with high pain scores. Pain treatment after major spinal surgery (fusions and scoliosis surgery: ranks 2, 3, and 6) was commonly insufficient. EA had not been used, and mean opioid doses were low compared with those in trials using patient-controlled IV analgesia that demonstrated an average consumption of 150 mg oral morphine equivalents within the first 24 hours.[17,18] Even though open reduction of the calcaneus—the procedure with the highest pain score in this study—was associated with a comparatively high opioid administration of 40 mg, another trial demonstrated that patients used on average 167 mg IV morphine *via* patient-controlled anesthesia (approximately 500 mg oral morphine equivalents) during the first 24 h.[19]

EA and peripheral nerve blocks are known to reduce postoperative pain intensity.[20] For many procedures, especially those that are known to cause severe postoperative pain, guidelines from many countries recommend the use of RA for postoperative pain control.[21–24] Interestingly, however, for some procedures such as open reduction of a calcaneus fracture, which was ranked highest, effective pain-treatment alternatives such as sciatic nerve block were not used.[19] Additional examples where RA was neglected included open reconstruction of knee ligaments (rank, 15) and hemorrhoid resections with plastic reconstruction (rank, 23), which are both known to be painful procedures. Although randomized controlled trials (RCTs) have demonstrated clinically significant pain reduction after femoral nerve blocks[25] and wound infiltration with local anesthesia,[26] in our study population these techniques were hardly ever used.

There are some limitations of this study. First, we 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 pain perception. Second, pain after reduction of fractures must be interpreted with care, as the type of fracture and soft-tissue damage are likely to influence postoperative pain. Third, participation in the benchmarking survey was entirely voluntary, and was associated with additional effort for the hospital. This factor may have resulted in a selection that influenced the generalizability of our findings, because the participating hospitals may be more actively striving to improve their postoperative pain management. This type of selection could have led to underestimation of the true incidence of inadequate postoperative pain relief. Fourth, for the majority of the surgical groups, many different hospitals contributed patient data sets (fig. 3). Exceptions included sternotomy, laparoscopic and open vertical-sleeve gastrectomy, laparoscopic radical prostatectomy, and kidney transplantation, which were performed only in a subset of hospitals.

A number of risk factors are known to increase postoperative pain intensity (*e.g.*, younger age, female sex, and the presence of preoperative pain).[27–29] Pain scores were intentionally not adjusted for these variables, because pain intensities within a surgical group should represent all patients who are typical of this patient cohort; otherwise, pain intensity in older men undergoing radical prostatectomy might be corrected to erroneously high scores, whereas younger patients after appendectomy might show erroneously low pain scores.

A strength of the presented data is that the German invoicing system for hospitals is based on OPS codes; thus, the accuracy of OPS documentation is strictly monitored in each hospital by the financial control system. Furthermore, incentives for hospitals to report lower pain scores than those reported by the patients in the QUIPS registry are unlikely, as the collected data are for internal use only and comparisons between hospitals are performed anonymously.

Pain intensities collected in cohort studies may differ from those obtained in RCTs. A RCT can be considered state-of-the-art for identifying the best analgesic modality for a specific type of surgery. However, RCTs are of limited use to ascertain the degree of postoperative pain after a particular procedure in everyday clinical practice, as estimates obtained from RCTs may be considerably biased. For example, RCT participants usually have easy access to rescue medication or receive additional IV patient-controlled anesthesia pumps. Most RCTs have generous exclusion criteria (*e.g.*, medical and mental comorbid conditions). These more favorable terms limit the generalizability of many RCTs that deal with postoperative pain. Integrating the results of RCTs with our results should demonstrate where the implementation of RCT recommendations may result in particular advantages for the patient and where this might not be the case. On the one hand, the use of sciatic nerve catheters after reduction of calcaneus fractures[19] or epidural catheters after spinal fusion and scoliosis surgery[30] (the two surgeries with the highest pain scores in this study population) may be of particular benefit. On the other hand, paravertebral nerve blocks have been shown in a meta-analysis to be superior to systemic analgesics after mastectomy surgery.[31] However, in our study, patients without RA had low median worst-pain scores of NRS 3.

The aim of our pain ranking is not to assign a specific rank to a particular surgical procedure, as many procedures were associated with only minimal differences in mean pain scores. Consequently, the exact rank number has no clinical significance but is intended to simplify comparison between the large number of surgeries included in the study. The results offer a comprehensive and impartial view of postoperative pain intensity ratings. Estimates of postsurgical pain by medical staff members are mainly based on their clinical experience. Physicians and nurses may underestimate the patient's requirement for analgesic medication, especially after so-called minor surgical procedures. Awareness of the average postoperative pain intensity after various procedures may thus contribute to improved postoperative care by facilitating the implementation of procedure-specific pain-treatment protocols.

In conclusion, this cohort study demonstrates that for a large number of everyday surgical procedures, many patients experience high postoperative pain intensities. Some laparoscopic procedures and "minor" surgeries involving small incisions require additional vigilance. This study reveals a number of surgeries associated with high pain scores where more frequent adherence to evidence-based pain-treatment recommendations could improve quality of care. By incorporating these measures into comprehensive postoperative pain protocols, the adverse effects of inadequate pain control may be reduced or prevented.

This project was performed under the patronage of the German Societies of Anesthesiology and Surgery and their professional organizations (Deutsche Gesellschaft für Anästhesiologie und Intensivmedizin (Nürnberg, Germany), Berufsverband Deutscher Anästhesisten (Nürnberg, Germany), Deutsche Gesellschaft für Chirurgie (Berlin, Germany), and Berufsverband der Deutschen Chirurgen (Berlin, Germany)).

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