ORIGINAL ARTICLE

The Quality of Postoperative Pain Therapy in German Hospitals

The Effect of Structural and Procedural Variables

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SUMMARY

Background: Many patients in German hospitals complain of inadequate treatment of their postoperative pain. Hospital-related structural and procedural variables may affect pain perception and patient satisfaction. We studied the association of individual variables with outcome quality.

Methods: Data from the years 2011 to 2014 from the world's largest acute pain registry (QUIPS) were evaluated. The analysis was performed with mixed linear regression models.

Results: We studied registry data from 138 German hospitals concerning four commonly performed types of operations (total number of operations, 21 114) and found that the intensity of pain, functional impairment, and satisfaction with postoperative pain therapy were all highly variable from one hospital to another. Patients in university hospitals complained more often than those in standard care facilities of highly intense pain (odds ratio [OR] 2.44; 95% confidence interval [CI] [1.18; 5.04]) and dissatisfaction (OR 3.58 [1.85; 6.93]). In specialized centers as well, pain intensity (OR 1.39 [1.06; 1.83]) and dissatisfaction (OR 1.59 [1.25; 2.02]) were higher. Pain-related limitation of movement was also reported more commonly in university hospitals (OR 2.12 [0.87; 5.16]) and specialized centers (OR 1.87 [1.33; 2.65]) than in standard care facilities. Less pain-related limitation of movement and higher satisfaction were reported in hospitals in which pain was documented in the patients' charts and the patients felt adequately informed about the treatment options.

Conclusion: The current state of postoperative pain therapy leaves much room for improvement. Quality indicators in the field of acute pain medicine might help improve patient care.

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Inadequate treatment of postoperative pain in hospital is still a common complaint by patients in Germany (1, 2). This is an unacceptable state of affairs. There has been an S3 guideline on postoperative pain therapy in Germany since 2007 (3) (expired 1 April 2014, currently undergoing revision). Despite improvements in some areas, severe deficits remain in the implementation of guideline-compliant recommendations, e.g., for availability of acute pain services, compliance with pain documentation, or use of evidence-based treatment procedures (1, 4–7).

However, evidence-based treatment does not necessarily lead to better treatment outcomes. For example, neither regular pain assessment nor guideline-compliant postoperative treatment is always associated with less pain (8, 9).

Subjective perception of pain is influenced by numerous, often hospital-specific variables: factors such as attention and empathy from hospital staff, as well as regular care by the same staff members (10, 11), provision of information to the patient (12), and the local physical environment (13), may all play a part.

The aim of this study was to investigate the impact of selected structural and procedural variables in German hospitals on the outcome quality of postoperative pain therapy from the viewpoint of the patient. Pain treatment and outcome after four frequently performed operations were evaluated.

Methods

We analyzed a sample of recent prospectively acquired registry data from the QUIPS initiative (*Qualitätsverbesserung in der postoperativen Schmerztherapie*; Quality Improvement in Postoperative Pain Therapy). QUIPS is the world's largest acute pain registry and contains data on parameters of process quality and outcome quality from the patient's perspective. The QUIPS project was set up in 2003 with funding from the German Federal Ministry of Health (14, 15) and approved by the ethics committee of the Jena University Hospital.

The hospitals participating in QUIPS acquire data from a sample of their patients on the first day after operation by means of a standardized procedure using a validated questionnaire (16). The outcome parameters recorded include, among others, pain

TABLE 1

Levels of care and numbers of patients

Level of care	Hospitals, n* (%)	Number of patients treated, n (%)				
		Laparoscopic cholecystectomy	Herniotomy	Hip joint replacement	Knee joint replacement	Total
Standard care	54 (43.2)	3344 (55.0)	1126 (50.6)	2672 (46.6)	2431 (48.4)	9573 (50.2)
Specialized center	38 (30.4)	1906 (31.4)	708 (31.8)	1897 (33.1)	1624 (32.3)	6135 (32.2)
University hospital (UH)	7 (5.6)	206 (3.4)	36 (1.6)	118 (2.1)	87 (1.7)	447 (2.3)
Maximum care other than UH	21 (16.8)	622 (10.2)	357 (16.0)	356 (6.2)	449 (8.9)	1784 (9.4)
Other	5 (4.0)	0 (0)	0 (0)	685 (12.0)	430 (8.6)	1115 (5.9)

*For 13 hospitals there were no data on level of care

intensity, negative consequences of pain, and adverse effects. Moreover, selected hospital-specific structural parameters and treatment process data are documented. The anonymized data are transmitted to a central registry.

The influence of hospital-specific structural variables was evaluated on the basis of QUIPS registry data for four frequently performed operations in the period 2011 to 2014: "laparoscopic cholecystectomy" (OPS 5–511.11), "laparoscopic herniotomy" or "endoscopic herniotomy" (OPS 5–530.31–32), "hip joint replacement" (OPS 5–820.00, 5–820.01, 5–820.02), and "knee joint replacement"(OPS 5–822.00, 5–822.01, 5.822.02, 5–822.11, 5.822.12). (The *Operationen- und Prozedurenschlüssel* [OPS] is the German modification of the International Classification of Procedures in Medicine (ICDM).) A high amount of consistent data were acquired in this 4-year period.

The chosen indicators of outcome quality from the patient's perspective were the patient's assessments of pain intensity (greatest intensity since operation [11-point numerical rating scale (NRS): 0 = no pain, 10 = worst imaginable pain), postoperative function (restriction of motion and mobilization by pain, yes/no), and satisfaction with postoperative pain therapy (16-point scale: 0 = completely unsatisfied, 15 = absolutely satisfied) (16).

Guided by previous publications (4, 17), we selected the following as hospital structural variables: hospital size (number of beds), ownership (confessional, communal, private, federal state), and level of care (standard, specialized, maximum care other than university hospital, university hospital).

The parameters pain documentation ("Pain documented in medical record?") and provision of information to the patient ("Were you informed about the various options for treating your pain?") were chosen as variables of treatment processes.

At patient level, the following characteristics were considered as variables potentially influencing outcome: patient's age and sex, pre-existing chronic pain, patient's physical condition (classified according to the American Society of Anesthesiologists [ASA]), and operating time.

The statistical procedures used for analysis were as follows (details can be found in the *eBox [eFigures 1–4, eTables 1–8]*): The differences in outcome quality among the hospitals were initially depicted descriptively. Generalized mixed linear regression models were used to explore the associations between the structural and process variables and outcome quality. Estimates of model quality can be found in *eTable 8*. Each potential variable of structure and the treatment process was initially considered alone, with adjustment for the individual hospital, for patient variables (age, sex, pre-existing chronic pain, ASA status), and for operating time (models I).

The structural variables were then adjusted for the two dichotomous variables of the treatment process, pain documentation and patient information (models II).

The analysis proceeded such that odds ratios (OR) >1 signified an outcome quality that was poorer from the patient's perspective. Two-sided p-values without correction for multiple comparisons were determined as the focus was on effect estimators and 95% confidence intervals (CI). The analyses were carried out using the software packages R 3.2.2 and SAS 9.4.

Results

The QUIPS registry contains data sets for 167 598 patients in the period 2011 to 2014, including 21 114 data sets from 138 hospitals for the selected operations. The ownership of the hospitals was as follows: confessional, n = 13; communal, n = 25; private, n = 83; federal state, n = 7; other/mixed, n = 5; unknown, n = 5. *Table 1* shows the distribution of the four operations according to level of care.

FIGURE 1

Maximum pain intensity (none [0] to worst imaginable [10])

Operation: Lap. cholecystectomy, Herniotomy, Hip joint replacement, Knee joint replacement

Distribution of mean responses for maximum pain intensity per hospital for the four operations analyzed in 103 hospitals with at least 20 data sets. The horizontal lines represent quartiles 1 to 3. Lap., laparoscopic
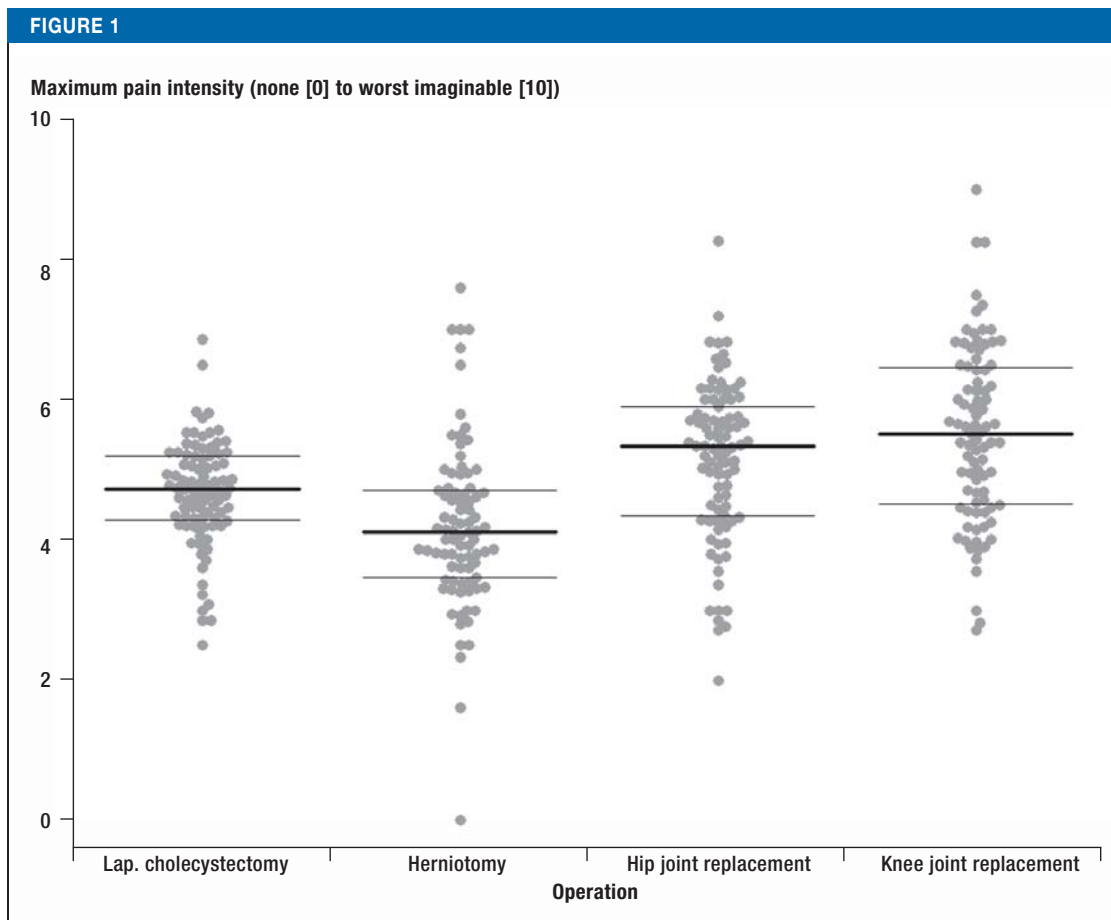
Postoperative pain intensity, pain-related functional restriction, and patient satisfaction varied widely among individual hospitals. Patients at the ten "worst" hospitals reported pain intensity of 6.3 ± 2.2, compared with 3.6 ± 2.1 at the ten "best" hospitals (11-point NRS; mean ± standard deviation). This large variation was independent of operation type *(Figure 1, eFigures 1–2)*. The distribution of the mean responses for the three dichotomized variables of outcome quality for all operations is shown in *eFigure 3*.

The findings of regression analysis of the dichotomized variables can be found in *Table 2*, expressed as OR with 95% CI. These figures summarize the potential influence of structural and process variables on the results after adjustment for hospital, patient characteristics, and operating time (models I).

Globally, the type of hospital ownership had practically no effect *(Table 2)*. Hospital size (number of beds) also played no essential part. The parameter with the greatest influence on outcome quality was level of care. Patients in university hospitals (OR 2.44 [1.18; 5.04]) and specialized centers (OR 1.39 [1.06; 1.83]) more frequently reported high intensity of pain than those in standard care facilities. They were also more likely to be dissatisfied (university hospitals: OR 3.58 [1.85; 6.93]; specialized centers: 1.59 [1.25; 2.02]). Pain-

related functional restriction was reported more often by patients in university hospitals (OR: 2.12 [0.87; 5.16]) and specialized centers (OR: 1.87 [1.33; 2.65]) than by those treated at standard care facilities *(Table 2 and eTable 1)*.

Those treated in hospitals that documented pain in the medical record and where patients reported having been informed of the various options for pain therapy stated lesser pain-related restriction and greater satisfaction *(Table 2)*.

Moreover, there were moderate correlations ($\rho_{Spearman} = 0.32$–0.51) among the three outcome variables (pain intensity, pain-related functional restriction, and satisfaction) *(eFigure 4)*.

When the process variables of pain documentation and perceived patient information were considered as explanatory covariables (models II), the differences among the levels of care were less pronounced *(eTable 2)*.

Discussion

The results of this study show clearly that the quality of postoperative pain therapy varies considerably in German hospitals. Patients rated the outcome quality of postoperative pain therapy higher in standard care facilities than they did in specialized centers and university

facilities. Documentation of pain in the medical record and particularly provision of information perceived by the patients as sufficient were associated with less pain, less frequent occurrence of pain-related functional restriction, and greater patient satisfaction. Since patient variables were always adjusted for, these differences cannot primarily be explained by mean differences among the patient populations.

Although many hospitals achieve high-quality treatment of postoperative pain in terms of pain intensity, pain-related functional restriction, and patient satisfaction, some display considerable deficits in this regard. The proportion of patients who reported severe postoperative pain (NRS ≥ 5) varied from 10% to 88% in individual hospitals. Reporting of pain-related functional restriction ranged between 27% and 95% *(eFigure 3)*.

Structural variables

Considerable variation in the management of postoperative pain has been described in Germany and elsewhere (1, 2, 18). In a nationwide German survey, more maximum-care facilities than standard-care hospitals claimed to have a qualified acute pain service (4).There were no differences, however, in the existence of written treatment plans, degree of organization, or definition of responsibilities. It should be pointed out that the cited study was confined to structural and process quality; outcome quality was not assessed.

One notable finding of our study is the fact that differences in outcome quality could not simply be explained by number of beds (as an indicator of hospital size). Moreover, the association persists even when taking account of factors in which the hospitals probably differ (e.g., patient age, type of surgery, and operating time). Furthermore, it seems unlikely that university hospitals are less well equipped or possess fewer medical or technical resources.

It may be that hospitals offering higher levels of specialization pay less attention to pain therapy processes. This could be indicated by the results of the extended regression models (models II), in which the differences between hospitals with different levels of care were weaker after adjustment for the process parameters pain measurement and patient information.

"Soft" factors such as higher fluctuation of personnel, lower staff education level, greater anonymity, and/or information and communication deficits could have an impact, as could different expectations on the part of the patients regarding the services offered by the various types of hospitals. Empathy, communication, and ascertainment of overall wellbeing (not just pain intensity) are important factors for perceived outcome quality and patients' satisfaction with pain therapy (10, 19).

Our study showed hardly any association between the type of hospital ownership and outcome quality. A recent publication reported that privately owned hospitals did not implement acute pain services, quality circles, or treatment standards for pain therapy more often than other hospitals (17). Investigations of treatment quality on the basis of the AQUA quality data found no relevant differences between privately owned and other hospitals (20). The association between hospital ownership, workplace atmosphere, and patient care was the subject of a recent controversial appraisal of health policy in *Deutsches Ärzteblatt* (21).

Procedural quality

The relevant guidelines strongly recommend regular measurement of pain as well as provision of information to the patient (3). Our study showed that informing the patient about postoperative pain therapy had a consistent positive association with outcome quality. This illustrates the importance of patient-centered treatment. Preoperative provision of information and involvement of the patient in treatment decisions have proven to be important predictors of patient satisfaction with postoperative pain therapy (22, 23).

In contrast, the association between routine documentation of pain and outcome quality, though consistent, was less pronounced. This confirms the findings of the European PAIN OUT registry (8).

On the one hand, this could be due to the low validity of pain measurement under routine conditions: large differences have repeatedly been demonstrated between standardized subjective ratings by patients and assessments by hospital staff (24).

On the other hand, it is conceivable that in many hospitals documentation of pain intensity is not always followed by the corresponding treatment. Whether this is due to a lack of treatment protocols or insufficient implementation of such protocols in practice cannot be ascertained from the available data.

Patient characteristics

In agreement with previous investigations, younger age, female sex, and chronic pain were associated with higher pain intensity (25). This observation underlines the importance of individual treatment planning and puts into perspective the concept of primary "procedure-specific" pain therapy with no attention paid to patient-related risk factors.

Limitations

The hospitals that participated and the patients included are not necessarily representative of German hospitals as a whole. We attempted to reduce the heterogeneity among the various groups of hospitals by focusing on four frequently performed operations. The operations were all distributed similarly over the different levels of care; this does not entirely exclude distortion by the different spectrum of operations, but makes it less likely.

The selection of the variables of outcome quality is open to criticism, first because they interact with one another, second because further variables (e.g., treatment effects, costs, or long-term consequences) could have been taken into account. The parameter "maximal" pain intensity was selected because it is probably the most commonly reported item in publications on acute pain therapy and reacts more sensitively than resting pain to changes in

TABLE 2

Outcome quality of postoperative pain therapy by structural and process variables: results for all four operations combined, adjusted for the patient characteristics age, sex, pre-existing chronic pain, ASA status, operating time, and hospital (models I)

Potential explanatory variables	Pain intensity	Pain-related restriction of movement	Dissatisfaction
	OR [95% CI] (p-value)	OR [95% CI] (p-value)	OR [95% CI] (p-value)
Structural variables			
Number of beds	(0.476[*1, *2]) N = 10 881	(0.188[*1, *2]) N = 10 762	(0.133[*1, *2]) N = 9471
Ownership (Ref. confessional)	(0.055[*2]) N = 10 809	(0.377[*2]) N = 10 721	(0.028[*2]) N = 9403
– Communal	0.64 [0.40; 1.04] (0.072)	0.66 [0.36; 1.23] (0.190)	0.69 [0.44; 1.08] (0.103)
– Private	0.71 [0.47; 1.09] (0.114)	0.90 [0.52; 1.55] (0.698)	0.73 [0.49; 1.09] (0.121)
– Communal and private	0.27 [0.09; 0.83] (0.022)	0.41 [0.10; 1.73] (0.223)	0.49 [0.17; 1.45] (0.199)
– Federal state	1.51 [0.66; 3.43] (0.328)	1.33 [0.47; 3.75] (0.587)	2.18 [0.99; 4.80] (0.053)
– Other	0.64 [0.27; 1.50] (0.304)	0.58 [0.18; 1.82] (0.347)	0.73 [0.33; 1.62] (0.440)
Level of care (Ref. standard care)	(0.035[*2]) N = 10 505	(0.006[*2]) N = 10 419	(< 0.0001[*2]) N = 9 109
– Specialized center	1.39 [1.06; 1.83] (0.017)	1.87 [1.33; 2.65] (0.001)	1.59 [1.25; 2.02] (0.001)
– University hospital	2.44 [1.18; 5.04] (0.016)	2.12 [0.87; 5.16] (0.098)	3.58 [1.85; 6.93] (0.001)
– Maximum care (other than university hospital)	1.10 [0.77; 1.58] (0.589)	1.15 [0.73; 1.80] (0.544)	1.38 [1.00; 1.91] (0.050)
– Other	1.03 [0.61; 1.73] (0.918)	1.48 [0.75; 2.91] (0.256)	0.76 [0.48; 1.20] (0.241)
Process variables			
Pain documentation (Ref. no)	0.79 [0.64; 0.97] (0.027) N = 9280	0.83 [0.66; 1.04] (0.111) N = 9189	0.49 [0.40; 0.60] (<0.0001) N = 7959
Information about postoperative pain therapy, perceived by patient[*3] (Ref. no)	0.59 [0.50; 0.69] (<0.0001) N = 11 136	0.61 [0.51; 0.74] (<0.0001) N = 11 030	0.47 [0.38; 0.57] (<0.0001) N = 9665

[*1]Was modeled both as a quantitative (linear) and as a categorical parameter; [*2]global effect for categorical modeling; [*3]"Were you informed about the various options for postoperative pain therapy in your case?"
OR, odds ratio; Ref., reference category; 95% CI, 95% confidence interval
In each case, analysis was performed such that an odds ratio >1 indicated worse outcome quality from the perspective of the patient

clinical procedure (1). Functional restriction by pain is viewed as clinically highly relevant in the postoperative phase (26). The importance of patient satisfaction can be debated. It is influenced not so much by pain intensity as by—alongside a number of factors unrelated to treatment—aspects of the perceived quality of treatment and interaction between treater and patient (22). Without wishing to overrate the importance of satisfaction, we believe it to be an adequate supplementary parameter that integrates various dimensions of treatment quality.

In choosing the structural variables, we followed previous publications (4, 17). It should be borne in mind that the parameter "number of beds" is not necessarily correlated with case numbers for specific operations, but rather with the numbers of employees and structural units (departments). Furthermore, the hierarchical data structure (factors at patient and hospital level) was taken into account and adjustment made for the covariables present at patient level. Nevertheless, the possibility cannot be excluded that the observed differences were determined to some extent by yet other variables that were neither measured nor allowed for. Thus, the observation of lower patient satisfaction in university hospitals and specialized centers may be the result of bias (e.g., residual confounding). Moreover, the findings represent associations and permit no conclusions as to cause.

Conclusion and outlook

The relatively large discrepancies among different hospitals in the outcome parameters pain intensity, functional restriction, and satisfaction with postoperative pain therapy show clearly that much still needs to be done in this field. Although there are realistic prospects for improvement, evidence-based treatment strategies, non-binding guidelines, and orientation on indicators with no adequate relation to outcome are not sufficient. Therefore, we welcome the proposal of the federal state health ministers' conference that quality indicators should be introduced for (acute) pain treatment in German hospitals (27).

Conflict of interest statement
Prof. Meißner has received consultancy payments from AcelRX, BioQ Pharma, Grünenthal, Medicines Company, and Menarini, as well as lecture honoraria from BioQ Pharma, Grünethal, Menarini, and Mundipharma. He has received third-party funding from Pfizer and financial support for clinical studies from Grünenthal.

The remaining authors declare that no conflict of interest exists.

REFERENCES

1. Maier C, Nestler N, Richter H, et al.: Qualität der Schmerztherapie in deutschen Krankenhäusern. Dtsch Arztebl Int 2010; 107: 607–14

2. Korczak D, Kuczera C, Rust M: Akutschmerztherapie auf operativen und konservativen Stationen. HTA-Bericht 2013; 126.

3. Deutsche Interdisziplinäre Vereinigung für Schmerztherapie: Behandlung akuter perioperativer und posttraumatischer Schmerzen. www.awmf.org/leitlinien/detail/ll/001–025.html (last accessed on 23 January 2017).

KEY MESSAGES

- Patients' reports of the outcome quality of postoperative pain therapy following four frequently performed standard interventions vary considerably across German hospitals.

- Routine documentation of pain and, particularly, provision of sufficient information on pain therapy to patients were associated with lower pain intensity, reduced pain-related functional restriction, and greater satisfaction.

- Even after adjustment for patient variables, the outcome quality was somewhat better in standard care facilities than in those with higher levels of care.

- Hospitals offering higher levels of care may pay less attention to treatment processes such as pain measurement and communication about pain.

4. Erlenwein J, Stamer U, Koschwitz R, et al.: Inpatient acute pain management in German hospitals: results from the national survey „Akutschmerzzensus 2012". Schmerz 2014; 28: 147–56.

5. Gerbershagen HJ, Aduckathil S, van Wijck AJ, Peelen LM, Kalkman CJ, Meissner W: Pain intensity on the first day after surgery: A prospective cohort study comparing 179 surgical procedures. Anesthesiol 2013; 118: 934–44.

6. Erlenwein J, Koschwitz R, Pauli-Magnus D, et al.: A follow-up on Acute Pain Services in Germany compared to international survey data. Eur J Pain 2016; 20: 874–83.

7. Erlenwein J, Emons M, Hecke A, et al.: Standardized treatment protocols in acute postoperative pain therapy: analysis of contents of standardized medicinal concepts. Anaesthesist 2015; 64: 218–26.

8. Zaslansky R, Rothaug J, Chapman CR, et al.: PAIN OUT: The making of an international acute pain registry. Eur J Pain 2015; 19: 490–502.

9. Chapman CR, Stevens DA, Lipman AG: Quality of postoperative pain management in American versus European institutions. J Pain Palliat Care Pharmacother 2013; 27: 350–8.

10. Beck SL, Towsley GL, Berry PH, Lindau K, Field RB, Jensen S: Core aspects of satisfaction with pain management: cancer patients' perspectives. J Pain Symptom Manage 2010; 39: 100–15.

11. Cano A, Williams AC: Social interaction in pain: reinforcing pain behaviors or building intimacy? Pain 2010; 149: 9–11.

12. Grawe JS, Mirow L, Bouchard R, Lindig M, Huppe M: Impact of preoperative patient education on postoperative pain in consideration of the individual coping style. Schmerz 2010; 24: 575–86.

13. Malenbaum S, Keefe FJ, Williams AC, Ulrich R, Somers TJ: Pain in its environmental context: implications for designing environments to enhance pain control. Pain 2008; 134: 241–4.

14. Meissner W, Mescha S, Rothaug J, et al.: Quality improvement in postoperative pain management—results from the QUIPS project. Dtsch Arztebl Int 2008; 105: 865–70.

15. Meissner W: QUIPS: quality improvement in postoperative pain management. Z Evid Fortbild Qual Gesundhwes 2011; 105: 350–3.

16. Rothaug J, Weiss T, Meissner W: External validity of pain-linked functional interference: are we measuring what we want to measure? Schmerz 2012; 26: 396–401.

17. Erlenwein J, Hinz J, Meissner W, Stamer U, Bauer M, Petzke F: Acute pain therapy in German hospitals as competitive factor. Do competition, ownership and case severity influence the practice of acute pain therapy? Schmerz 2015; 29: 266–75.

18. Stamer UM, Mpasios N, Stuber F, Maier C: A survey of acute pain services in Germany and a discussion of international survey data. Reg Anesth Pain Med 2002; 27: 125–31.

19. Chooi CS, White AM, Tan SG, Dowling K, Cyna AM: Pain vs comfort scores after Caesarean section: a randomized trial. Br J Anaesth 2013; 110: 780–7.

20. Augurzky B, Beivers A, Gülker R: Krankenhäuser in privater Trägerschaft. RWI Materialien 2015; 89.

21. Osterloh F: Krankenhäuser: Wenn Grundsatz auf Versorgung trifft. Dtsch Arztebl 2016; 113: 29–30.

22. Schwenkglenks M, Gerbershagen HJ, Taylor RS, et al.: Correlates of satisfaction with pain treatment in the acute postoperative period: results from the international PAIN OUT registry. Pain 2014; 155: 1401–11.

23. Niemi-Murola L, Poyhia R, Onkinen K, Rhen B, Makela A, Niemi TT: Patient satisfaction with postoperative pain management—effect of preoperative factors. Pain Manag Nurs 2007; 8: 122–9.

24. Klopfenstein CE, Herrmann FR, Mamie C, Van Gessel E, Forster A: Pain intensity and pain relief after surgery. A comparison between patients' reported assessments and nurses' and physicians' observations. Acta Anaesthesiol Scand 2000; 44: 58–62.

25. Gerbershagen HJ, Pogatzki-Zahn E, Aduckathil S, et al.: Procedure-specific risk factor analysis for the development of severe postoperative pain. Anesthesiol 2014; 120: 1237–45.

26. Kehlet H, Dahl JB: Assessment of postoperative pain—need for action! Pain 2011; 152: 1699–700.

27. Gesundheitsministerkonferenz der Länder: Beschlüsse der 88. GMK. wwwgmkonlinede/documents/Ergbnisniederschrift_externpdf 2015 (last accessed on 16 January 2017).

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CLINICAL SNAPSHOT

Iatrogenic Anticholinergic Overdose

An accidental atropine overdose in a gynecologist's office (20 mg IV) gave this young woman a classic anticholinergic overdose syndrome. The immediately recognizable manifestations produced by blockade of the body's muscarinic receptors have been given picturesque names: "red as a beet"—erythema due to vasodilation; "dry as a bone" and "hot as a hare"—inhibition of sweating, with impaired thermoregulation; "blind as a bat"—maximal mydriasis and impaired accommodation. Two further florid, though not visually evident, manifestations are "mad as a hatter"—delirium due to muscarinic blockade in the central nervous system, and "full as a flask"—impaired bladder emptying.

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eBOX

Supplement to statistics section

To explore links between the potential variables at hospital or process level and the outcome quality, we used generalized mixed linear regression models for complete data. The hospitals were included as a random factor ("random intercept") in all models; each potential variable of the structure and the treatment process was initially considered alone. Moreover, the reported results are also adjusted for patient variables (age, sex, pre-existing chronic pain, ASA status) and for operating time. We refer to these models collectively as models I. Each structural parameter was then adjusted for the two dichotomous variables of the treatment process, "pain documentation in the medical record" and "patient information" (models II).

These analyses were carried out first for all four selected operations combined *(Table 2 and eTable 2)* and then stratified for each individual operation in sensitivity analyses to verify the generalizability of the results *(eTables 3–6)*.

The dichotomous process variables were not transformed. Regarding the patient characteristics, pre-existing chronic pain was dichotomized (no or slight pain [NRS 0–4] versus moderate or severe pain [NRS 5–10]) and the operating time was incorporated logarithmically (untransformed incorporation led to no differing conclusions). The indicators of outcome quality were also included in the regression model as dichotomized parameters (logistic link function: no or slight pain [NRS 0–4] versus moderate or severe pain [NRS 5–10]; pain-related restriction of movement/mobilization [yes/no]; low satisfaction [NRS 0–12] versus high satisfaction [NRS 13–15], median rating: 13). In each case, analysis was performed such that an odds ratio >1 indicated worse outcome quality from the perspective of the patient.

As the next step, sensitivity analyses for untransformed quantitative variables were carried out for the final multiple models *(eTable 7)*.

Diagnostic checks were carried out for each regression model (e.g., to provide a rough quality-of-fit estimate of various models *[eTable 8]*; for reasons of space, no other checks are presented).

eTABLE 1

Descriptive statistics for the three variables of outcome quality of postoperative pain therapy depending on level of care

Level of care		Age (years)	Proportion of men	Maximum pain	Pain-related restriction of movement	Satisfaction
Standard care	Mean	61.56	0.45	4.54	0.58	13.03
	N	8796	8784	8865	8821	7812
	SD	14.10		2.40	0.493	2.26
Specialized center	Mean	62.48	0.44	5.00	0.69	12.56
	N	5443	5468	5485	5441	4818
	SD	14.35		2.34	0.46	2.36
University hospital	Mean	60.89	0.43	5.73	0.69	11.68
	N	447	444	444	439	419
	SD	15.56		2.77	0.47	3.01
Maximum care other than university hospital	Mean	59.70	0.48	4.84	0.52	12.49
	N	1734	1728	1739	1727	1627
	STD	16.04		2.53	0.50	2.66
Other	Mean	65.77	0.49	4.76	0.70	13.43
	N	862	872	874	860	759
	STD	11.17		2.54	0.46	1.93

SD, standard deviation
Pain intensity (highest intensity since operation), 11-point numeric rating scale (NRS): 0 = no pain; 10 = worst imaginable pain;
restriction of movement (% of "yes" responses); satisfaction (16-point NRS: 0 = completely unsatisfied; 15 = absolutely satisfied)

eTABLE 2

Outcome quality of postoperative pain therapy by structural variables: results for all four operations combined, adjusted for patient and process variables and hospitals (models II)

Potential explanatory variables	Pain intensity OR [95% CI] (p-value)	Pain-related restriction of movement OR [95% CI] (p-value)	Dissatisfaction OR [95% CI] (p-value)
Structural variables			
Number of beds	(0.926[*1, *2]) N = 8824	(0.508[*1, *2]) N = 8741	(0.527[*1, *2]) N = 7601
Ownership (Ref. confessional)	(0.100[*2]) N = 8765	(0.519[*2]) N = 8712	(0.351[*2]) N = 7544
– Communal	0.51 [0.29; 0.91] (0.021)	0.55 [0.28; 1.07] (0.078)	0.70 [0.43; 1.16] (0.164)
– Private	0.55 [0.33; 0.91] (0.021)	0.73 [0.40; 1.34] (0.312)	0.75 [0.48; 1.16] (0.191)
– Communal and private	0.22 [0.02; 2.99] (0.257)	0.61 [0.04; 8.83] (0.718)	1.35 [0.11; 16.92] (0.816)
– Federal state	1.07 [0.44; 2.62] (0.887)	1.03 [0.36; 2.95] (0.960)	1.39 [0.62; 3.12] (0.419)
– Other	0.44 [0.14; 1.42] (0.169)	0.70 [0.16; 3.06] (0.637)	1.01 [0.37; 2.77] (0.979)
Level of care (Ref. standard care)	(0.213[*2]) N = 8547	(0.059[*2]) N = 8491	(0.010[*2]) N = 7324
– Specialized center	1.26 [0.93; 1.71] (0.141)	1.57 [1.10; 2.26] (0.014)	1.48 [1.14; 1.92] (0.003)
– University hospital	2.10 [0.97; 4.56] (0.060)	1.82 [0.75; 4.43] (0.185)	2.16 [1.10; 4.24] (0.025)
– Maximum care (other than university hospital)	0.98 [0.64; 1.50] (0.912)	0.95 [0.58; 1.56] (0.844)	1.17 [0.81; 1.69] (0.408)
– Other	0.91 [0.52; 1.60] (0.743)	1.68 [0.86; 3.27] (0.129)	0.89 [0.55; 1.42] (0.613)

[*1]Was modeled both as a quantitative (linear) and as a categorical parameter; [*2]global effect for categorical modeling; [*3]"Were you informed about the various options for postoperative pain therapy in your case?"
OR, odds ratio; Ref., reference category; 95% CI, 95% confidence interval

eTABLE 3

Outcome quality of postoperative pain therapy by structural and process variables: models I for the three parameters of outcome quality for laparoscopic cholecystectomy, adjusted for patient characteristics and hospitals

Potential explanatory variables	Pain intensity	Pain-related restriction of movement	Dissatisfaction
	OR [95% CI] (p-value)	OR [95% CI] (p-value)	OR [95% CI] (p-value)
Structural variables			
Number of beds	(0.436[*1, *2]) N = 1894	(0.280[*1, *2]) N = 1878	(0.181[*1, *2]) N = 1683
Ownership (Ref. confessional)	(0.133[*2]) N = 1792	(0.601[*2]) N = 1778	(0.054[*2]) N = 1597
– Communal	0.67 [0.38; 1.17] (0.159)	0.55 [0.29; 1.05] (0.070)	0.68 [0.37; 1.27] (0.228)
– Private	0.71 [0.43; 1.16] (0.166)	0.66 [0.38; 1.14] (0.135)	0.78 [0.46; 1.32] (0.353)
– Communal and private	0.47 [0.13; 1.66] (0.239)	0.92 [0.21; 4.05] (0.908)	1.46 [0.33; 6.48] (0.617)
– Federal state	1.75 [0.72; 4.28] (0.219)	0.75 [0.29; 1.93] (0.546)	2.90 [1.07; 7.87] (0.036)
– Other	0.96 [0.45; 2.07] (0.924)	0.72 [0.29; 1.77] (0.476)	0.74 [0.32–1.72] (0.480)
Level of care (Ref. standard care)	(0.036[*2]) N = 1752	(0.289[*2]) N = 1735	(0.004[*2]) N = 1550
– Specialized center	1.37 [0.99; 1.89] (0.057)	1.42 [0.99; 2.03] (0.058)	1.42 [1.00; 2.01] (0.053)
– University hospital	2.68 [1.23; 5.81] (0.013)	1.30 [0.58; 2.88] (0.523)	4.29 [1.80; 10.21] (0.001)
– Maximum care (other than university hospital)	1.16 [0.75; 1.79] (0.501)	1.08 [0.67; 1.74] (0.746)	1.43 [0.90; 2.28] (0.134)
– Other	—	—	—
Process variables			
Pain documentation (Ref. no)	0.57 [0.38; 0.84] (0.005) N = 1595	0.73 [0.49; 1.08] (0.111) N = 1579	0.41 [0.26; 0.63] (<0.0001) N = 1423
Information about postoperative pain therapy, perceived by patient[*3] (Ref. no)	0.48 [0.35; 0.66] (<0.0001) N = 1895	0.62 [0.45; 0.84] (0.002) N = 1883	0.45 [0.31; 0.65] (<0.0001) N = 1683

[*1]Was modeled both as a quantitative (linear) and as a categorical parameter; [*2]global effect for categorical modeling; [*3]"Were you informed about the various options for postoperative pain therapy in your case?"
OR, odds ratio; Ref., reference category; 95% CI, 95% confidence interval

eTABLE 4

Outcome quality of postoperative pain therapy by structural and process variables: models I for the three parameters of outcome quality for herniotomy, adjusted for patient characteristics and hospitals

Potential explanatory variables	Pain intensity	Pain-related restriction of movement	Dissatisfaction
	OR [95% CI] (p-value)	OR [95% CI] (p-value)	OR [95% CI] (p-value)
Structural variables			
Number of beds	(0.862[*1, *2]) N = 494	(0.903[*1, *2]) N = 490	(0.165[*1, *2]) N = 446
Ownership (Ref. confessional)	(0.202[*2]) N = 497	(0.295[*2]) N = 493	(0.585[*2]) N = 449
– Communal	0.74 [0.31; 1.77] (0.495)	0.83 [0.29; 2.40] (0.729)	1.18 [0.37; 3.70] (0.783)
– Private	0.49 [0.25; 0.93] (0.030)	0.47 [0.21–1.06] (0.068)	0.67 [0.28; 1.64] (0.382)
– Communal and private	—	—	—
– Federal state	0.63 [0.08; 5.14] (0.661)	0.29 [0.02; 4.05] (0.353)	1.46 [0.09; 23.02] (0.789)
– Other	0.64 [0.29; 1.42] (0.266)	0.52 [0.17; 1.62] (0.258)	1.15 [0.30; 4.39] (0.836)
Level of care (Ref. standard care)	(0.844[*2]) N = 474	(0.350[*2]) N = 470	(0.099[*2]) N = 428
– Specialized center	0.97 [0.63; 1.50] (0.890)	1.24 [0.72; 2.105] (0.434)	2.07 [1.08; 3.95] (0.028)
– University hospital	1.17 [0.15; 8.84] (0.882)	0.55 [0.04; 6.89] (0.638)	2.55 [0.19; 35.13] (0.483)
– Maximum care (other than university hospital)	0.79 [0.47; 1.35] (0.386)	0.65 [0.33; 1.27] (0.210)	1.95 [0.91; 4.21] (0.088)
– Other	—	—	—
Process variables			
Pain documentation (Ref. no)	1.06 [0.59; 1.88] (0.857) N = 426	0.61 [0.30; 1.25] (0.175) N = 423	0.60 [0.29; 1.26] (0.178) N = 386
Information about postoperative pain therapy, perceived by patient[*3] (Ref. no)	0.64 [0.36; 1.15] (0.135) N = 489	0.52 [0.28; 0.99] (0.048) N = 486	0.48 [0.23; 0.97] (0.041) N = 442

[*1]Was modeled both as a quantitative (linear) and as a categorical parameter; [*2]global effect for categorical modeling; [*3] "Were you informed about the various options for postoperative pain therapy in your case?"
OR, odds ratio; Ref., reference category; 95% CI, 95% confidence interval

eTABLE 5

Outcome quality of postoperative pain therapy by structural and process variables: models I for the three parameters of outcome quality for hip joint replacement, adjusted for patient characteristics and hospitals

Potential explanatory variables	Pain intensity	Pain-related restriction of movement	Dissatisfaction
	OR [95% CI] (p-value)	OR [95% CI] (p-value)	OR [95% CI] (p-value)
Structural variables			
Number of beds	(0.644*[1], *[2]) N = 4604	(0.313*[1], *[2]) N = 4540	(0.275*[1], *[2]) N = 3949
Ownership (Ref. confessional)	(0.367 *[2]) N = 4535	(0.431 *[2]) N = 4496	(0.246 *[2]) N = 3905
– Communal	0.60 [0.28; 1.31] (0.202)	0.75 [0.31; .84] (0.534)	0.61 [0.31; 1.21] (0.155)
– Private	0.85 [0.44; 1.64] (0.628)	1.11 [0.52; 2.34] (0.791)	0.85 [0.48; 1.49] (0.564)
– Communal and private	0.25 [0.05; 1.31] (0.101)	0.29 [0.04; 1.90] (0.196)	0.31 [0.07; 1.28] (0.105)
– Federal state	1.10 [0.31; 3.88] (0.882)	2.26 [0.49; 10.53] (0.299)	1.66 [0.55; 5.02] (0.367)
– Other	0.42 [0.09; 2.07] (0.287)	0.96 [0.15; 6.08] (0.964)	0.81 [0.21; 3.09] (0.757)
Level of care (Ref. standard care)	(0.349*[2]) N = 4408	(0.015*[2]) N = 4370	(0.007*[2]) N = 3783
– Specialized center	1.57 [1.00; 2.46] (0.050)	2.24 [1.37; 3.66] (0.001)	1.59 [1.11; 2.26] (0.011)
– University hospital	1.63 [0.51; 5.16] (0.408)	3.07 [0.80; 11.81] (0.103)	2.45 [0.96; 6.26] (0.061)
– Maximum care (other than university hospital)	1.18 [0.65; 2.15] (0.585)	1.31 [0.69; 2.50] (0.408)	1.39 [0.85; 2.26] (0.188)
– Other	0.99 [0.47; 2.08] (0.970)	1.02 [0.46; 2.25] (0.968)	0.68 [0.38; 1.20] (0.183)
Process variables			
Pain documentation (Ref. no)	0.90 [0.64; 1.26] (0.537) N = 3978	0.75 [0.50; 1.12] (0.162) N = 3923	0.56 [0.41; 0.78] (0.001) N = 3345
Information about postoperative pain therapy, perceived by patient[3] (Ref. no)	0.60 [0.48; 0.75] (< 0.0001) N = 4743	0.64 [0.49; 0.84] (0.002) N = 4683	0.55 [0.41; 0.73] (< 0.0001) N = 4063

*[1]Was modeled both as a quantitative (linear) and as a categorical parameter; *[2]global effect for categorical modeling; *[3]"Were you informed about the various options for postoperative pain therapy in your case?"
OR, odds ratio; Ref., reference category; 95% CI, 95% confidence interval

eTABLE 6

Outcome quality of postoperative pain therapy by structural and process variables: models I for the three parameters of outcome quality for knee joint replacement, adjusted for patient characteristics and hospitals

Potential explanatory variable	Pain intensity	Pain-related restriction of movement	Dissatisfaction
	OR [95% CI] (p-value)	OR [95% CI] (p-value)	OR [95% CI] (p-value)
Structural variables			
Number of beds	(0.215[*1, *2]) N = 3887	(0.258[*1, *2]) N = 3854	(0.640[*1, *2]) N = 3393
Ownership (Ref. confessional)	(0.080[*2]) N = 3985	(0.115[*2]) N = 3954	(0.261[*2]) N = 3452
– Communal	0.51 [0.22; 16] (0.108)	0.48 [0.18; 1.32] (0.1536)	0.62 [0.31; 1.22] (0.167)
– Private	0.59 [0.29; 1.23] (0.158)	0.83 [0.34; 2.04] (0.690)	0.68 [0.38; 1.23] (0.200)
– Communal and private	0.25 [0.04; 1.59] (0.141)	0.10 [0.01; 1.00] (0.050)	0.31 [0.06; 0.58] (0.159)
– Federal state	5.40 [0.82; 35.63] (0.080)	2.52 [0.39; 16.41] (0.334)	1.82 [0.56; 5.91] (0.317)
– Other	0.43 [0.08; 2.31] (0.327)	0.60 [0.07; 4.98] (0.633)	0.81 [0.21; 3.06] (0.757)
Level of care (Ref. standard care)	(0.092[*2]) N = 3871	(0.035[*2]) N = 3844	(0.007[*2]) N = 3348
– Specialized center	1.38 [0.87; 2.18] (0.170)	2.26 [1.27; 4.01] (0.006)	1.69 [1.19; 2.40] (0.003)
– University hospital	10.59 [1.79; 62.83] (0.009)	4.79 [0.87; 26.26] (0.071)	3.59 [1.32; 9.73] (0.012)
– Maximum care (other than university hospital)	1.21 [0.66; 2.22] (0.529)	1.14 [0.55; 2.35] (0.733)	1.31 [0.81; 2.11] (0.269)
– Other	1.18 [0.48; 2.92] (0.715)	1.67 [0.55; 5.09] (0.367)	0.93 [0.47; 1.83] (0.830)
Process variables			
Pain documentation (Ref. no)	0.71 [0.47; 1.05] (0.085) N = 3281	1.17 [0.76; 1.82] (0.478) N = 3264	0.50 [0.35; 0.71] (< 0.0001) N = 2805
Information about postoperative pain therapy, perceived by patient[*3] (Ref. no)	0.47 [0.30; 0.74] (0.001) N = 4009	0.42 [0.25; 0.72] (0.002) N = 3978	0.30 [0.18; 0.50] (< 0.0001) N = 3477

[*1]Was modeled both as a quantitative (linear) and as a categorical parameter; [*2]global effect for categorical modeling; [*3]"Were you informed about the various options for postoperative pain therapy in your case?"
OR, odds ratio; Ref., reference category; 95% CI, 95% confidence interval

eTABLE 7

Outcome quality of postoperative pain therapy by structural and process variables: models I for the two quantitative parameters of outcome quality for all four operations combined, adjusted for patient characteristics and hospitals

Potential explanatory variable	Pain intensity	Satisfaction
	OR [95% CI] (p-value)	OR [95% CI] (p-value)
Structural variables		
Number of beds	(0.197*[1], *[2]) N = 10 881	(0.035*[1], *[2]) N = 9471
Ownership (Ref. confessional)	(0.005*[2]) N = 10 809	(0.050*[2]) N = 8403
– Communal	−0.71 [−1.32; −0.11] (0.021)	0.59 [−0.04; 1.22] (0.067)
– Private	−0.51 [−1.04; −0.02] (0.059)	0.53 [−0.02; 1.08] (0.059)
– Communal and private	−2.09 [−3.49; −0.69] (0.003)	1.36 [−0.14; 2.86] (0.075)
– Federal state	0.52 [−0.46; 1.51] (0.298)	−0.61 [−1.64; 0.43] (0.251)
– Other	−0.59 [−1.70; 0.52] (0.299)	0.36 [−0.79; 1.51] (0.538)
Level of care (Ref. standard care)	(0.008*[2]) N = 10 505	(0.001*[2]) N = 9109
– Specialized center	0.47 [0.13; 0.81] (0.007)	−0.49 [−0.84; −0.14] (0.007)
– University hospital	1.25 [0.39; 2.11] (0.005)	−1.38 [−2.28; −0.49] (0.002)
– Maximum care (other than university hospital)	0.31 [−0.15; 0.76] (0.183)	−0.76 [−1.23; −0.29] (0.001)
– Other	0.02 [−0.66; 0.69] (0.961)	0.21 [−0.49; 0.90] (0.562)
Process variables		
Pain documentation (Ref. no)	−0.35 [−0.57; −0.12] (0.002) N = 9280	0.94 [0.71; 1.17] (< 0.0001) N = 7959
Information about postoperative pain therapy, perceived by patient[3] (Ref. no)	−0.70 [−0.87; −0.53] (< 0.0001) N = 11 136	1.19 [0.98; 1.40] (< 0.0001) N = 9665

[1] β > 0 indicates lower outcome quality in units of the parameter ranging from no pain (0) to worst imaginable pain (10);
[2] β < 0 indicates lower outcome quality in units of the parameter ranging from 0 = completely unsatisfied (0) to absolutely satisfied (15)
*[1]Was modeled both as a quantitative (linear) and as a categorical parameter; *[2]global effect for categorical modeling; [3]"Were you informed about the various options for postoperative pain therapy in your case?"
OR, odds ratio; Ref., reference category; 95% CI, 95% confidence interval

eTABLE 8

Quality of regression models (models I) as measured with McFadden's pseudo-R^2 statistic*

|	Dichotomized variables			Untransformed quantitative variables	
	Pain intensity	Pain-related restriction of movement	Dissatisfaction	Pain intensity	Satisfaction
Structural variables					
Number of beds	0.462	0.470	0.476	0.467	0.480
Ownership	0.466	0.472	0.480	0.470	0.485
Level of care	0.481	0.487	0.496	0.485	0.501
Process variables					
Pain documentation	0.542	0.550	0.560	0.545	0.567
Information about postoperative pain therapy, perceived by patient	0.450	0.457	0.465	0.455	0.473

*In each case the restricted maximum log (pseudo-)likelihood estimator of the model with fixed and random effects and the model with only random effects was used

eFIGURE 1

Pain-related restriction of movement (%)
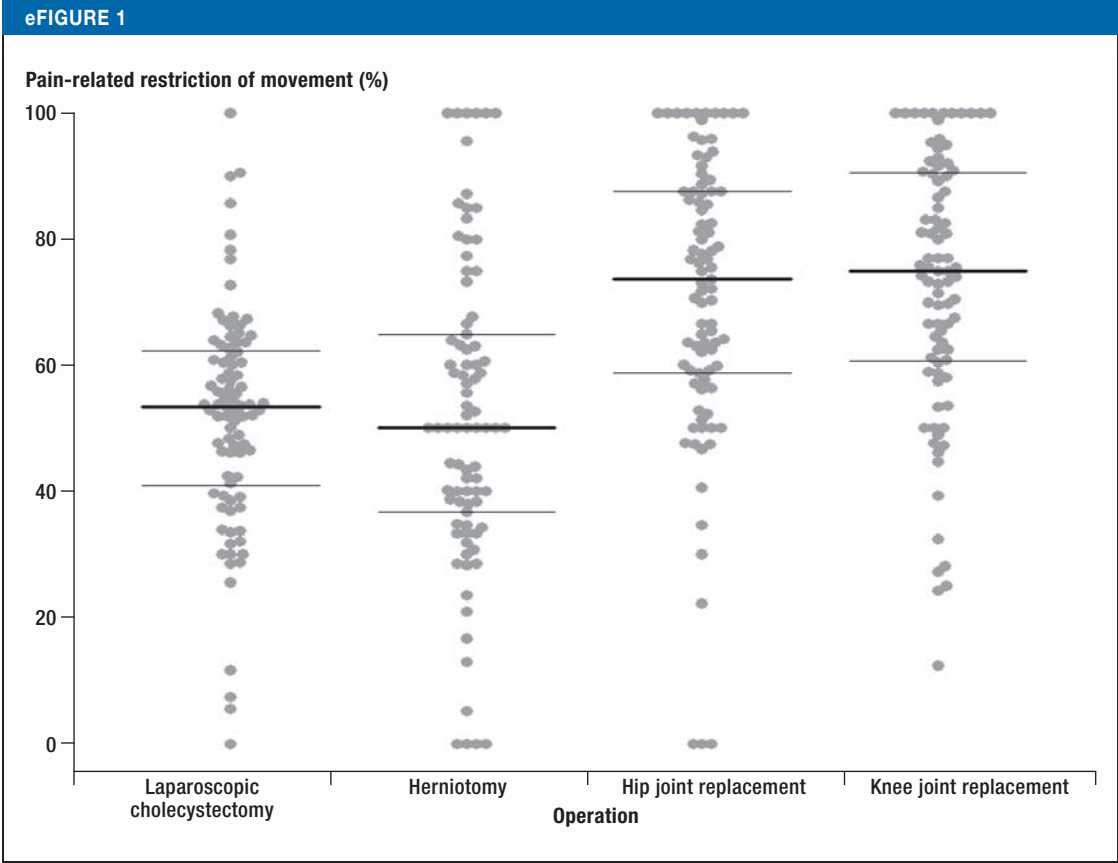
Distribution of mean responses for pain-related restriction of movement [yes/no] expressed as percentage of "yes" responses per hospital for the four operations analyzed (laparoscopic cholecystectomy, herniotomy, hip joint replacement, and knee joint replacement) in 103 hospitals with at least 20 data sets. The horizontal lines represent quartiles 1 to 3

eFIGURE 2

Satisfaction with postoperative pain therapy (0–15 [maximal])
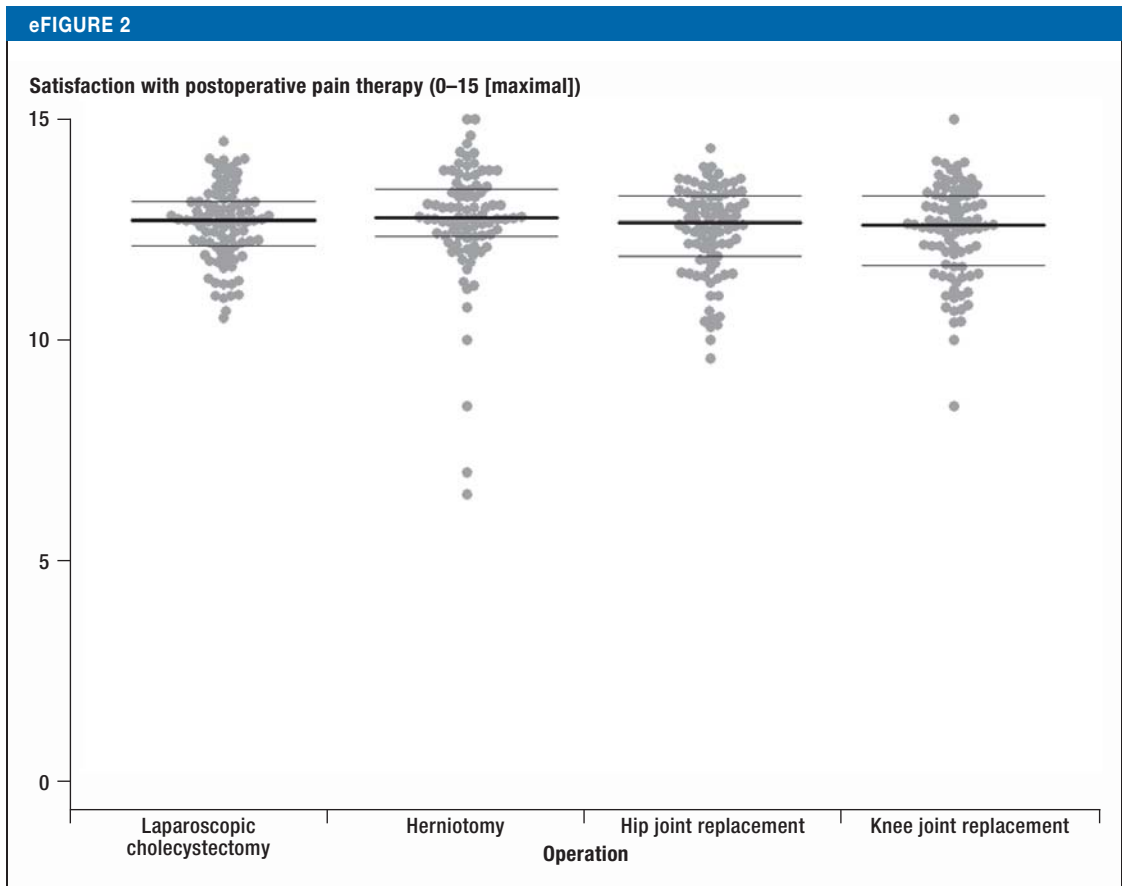
Distribution of mean responses for satisfaction with postoperative pain therapy [0 = completely dissatisfied; 15 = absolutely satisfied] per hospital for the four operations analyzed (laparoscopic cholecystectomy, herniotomy, hip joint replacement, and knee joint replacement) in 103 hospitals with at least 20 data sets. The horizontal lines represent quartiles 1 to 3

eFIGURE 3

a) Higher pain intensity (%)

b) Pain-related restriction of movement present (%)

c) Lower satisfaction (%)
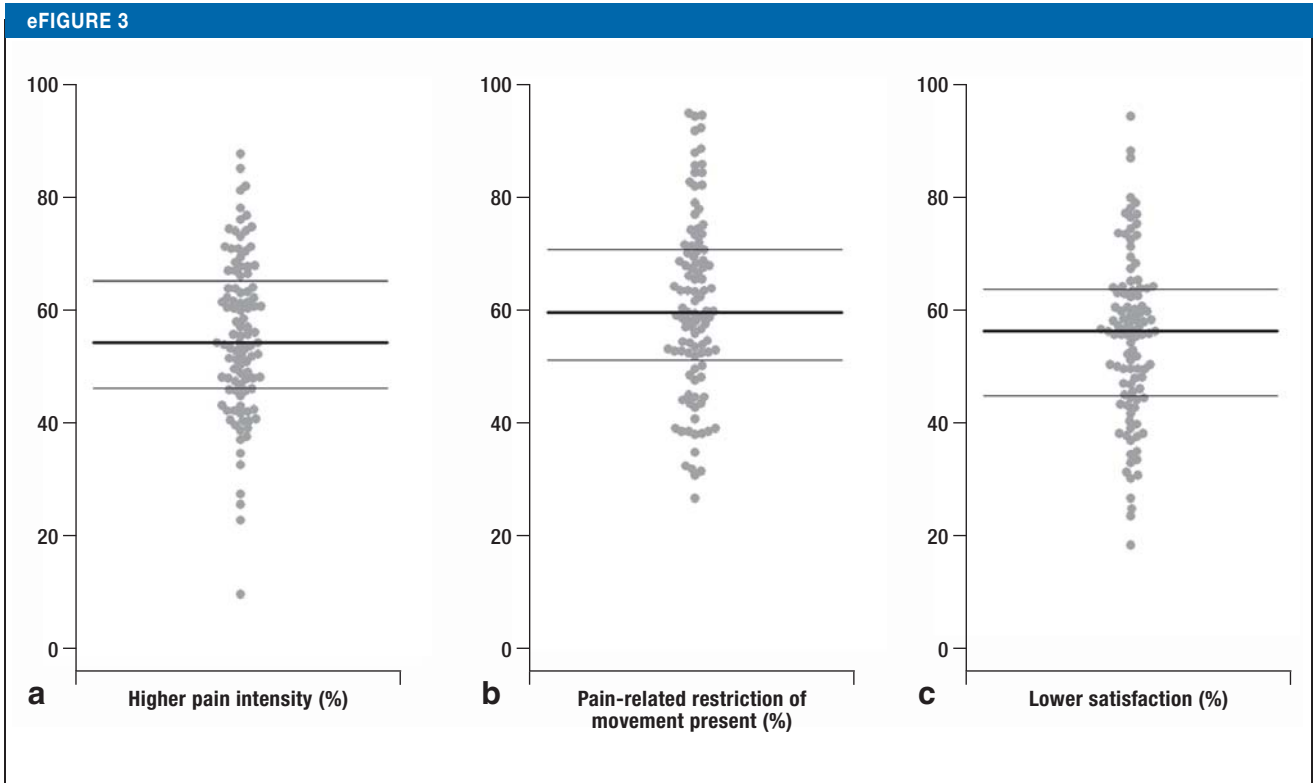
Distribution of mean responses for the three dichotomized variables of outcome quality for the four operations analyzed. Each dot represents the percentage of patients for a specific hospital (N = 103). The horizontal lines represent quartiles 1 to 3.
a) Proportion with pain rated >4 on the NRS
b) Proportion who feel restricted in their movements
c) Proportion who report lower satisfaction

eFIGURE 4
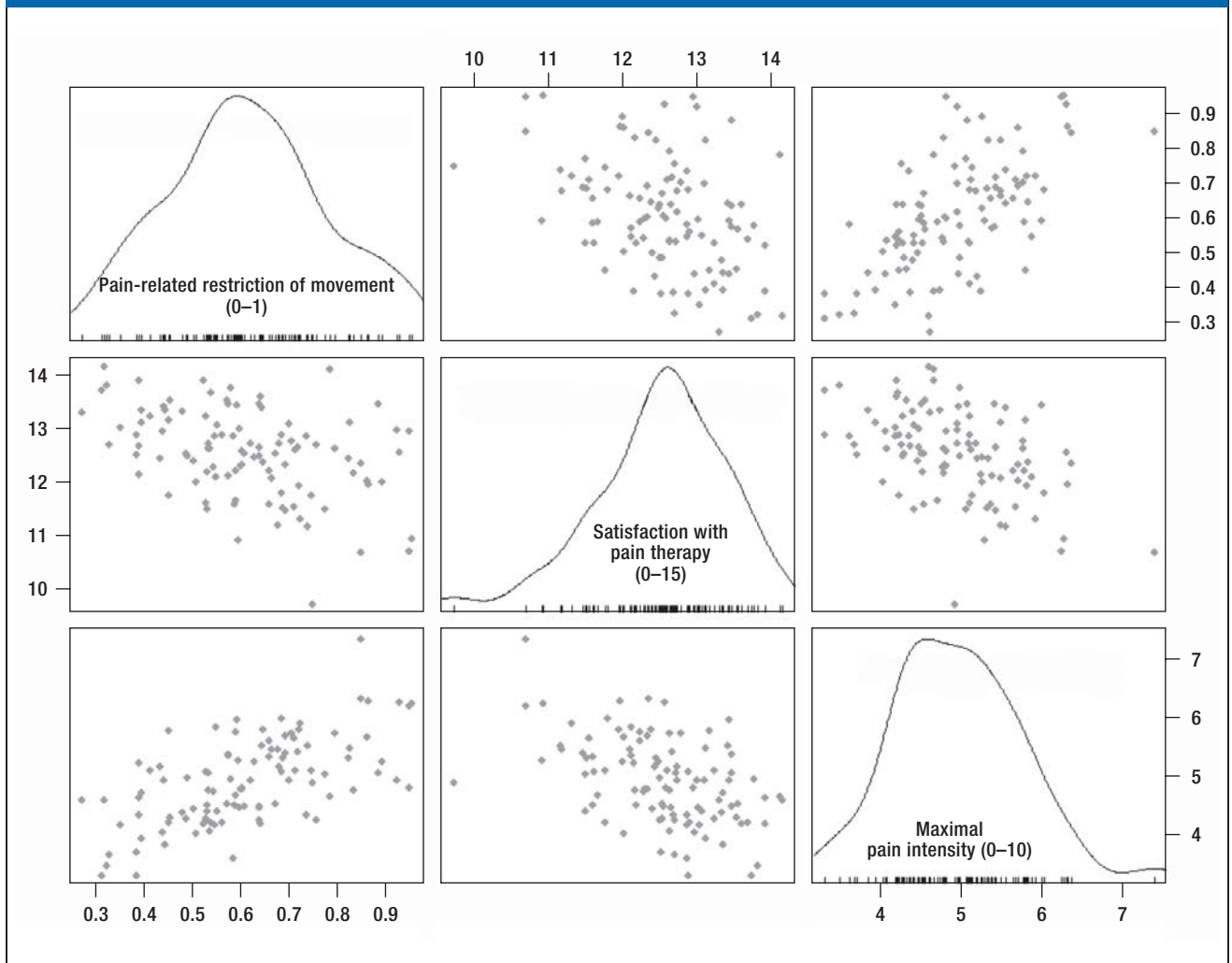
Uni- and bivariate distribution of mean responses for the three untransformed parameters of outcome quality from the patient's perspective for the four operations analyzed. Each dot summarizes one hospital (N = 103); the univariate distributions (expressed as estimated density distributions) are shown along the diagonals