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Operation-specific risk of postoperative nausea: a cross-sectional study comparing 72 procedures

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ABSTRACT

Objectives Determination of the procedure-specific, risk-adjusted probability of nausea.

Design Cross-sectional analysis of clinical and patient-reported outcome data. We used a logistic regression model with type of operation, age, sex, preoperative opioids, antiemetic prophylaxis, regional anaesthesia, and perioperative opioids as predictors of postoperative nausea.

Setting Data from 152 German and Austrian hospitals collected in the Quality Improvement in Postoperative Pain Treatment (QUIPS) registry from 2013 to 2022. Participants completed a validated outcome questionnaire on the first postoperative day. Operations were categorised into groups of at least 100 cases.

Participants We included 78 231 of the 293 947 participants from the QUIPS registry. They were 18 years or older, willing and able to participate and could be assigned to exactly one operation group.

Main outcome measures Adjusted absolute risk of nausea on the first postoperative day for 72 types of operation.

Results The adjusted absolute risk of nausea ranged from 6.2% to 36.2% depending on the type of operation. The highest risks were found for laparoscopic bariatric operations (36.2%), open hysterectomy (30.4%), enterostoma relocation (29.8%), open radical prostatectomy (28.8%), laparoscopic colon resection (28.6%) and open sigmoidectomy (28%). In a logistic regression model, male sex (OR: 0.39, 95% CI 0.37 to 0.41, p<0.0001), perioperative nausea and vomiting prophylaxis (0.73, 0.7 to 0.76, p<0.0001), intraoperative regional anaesthesia (0.88, 0.83 to 0.93, p<0.0001) and preoperative opioids for chronic pain (0.74, 0.68 to 0.81, p<0.0001) reduced the risk of nausea. Perioperative opioid use increased the OR up to 2.38 (2.17 to 2.61, p<0.0001).

Conclusions The risk of postoperative nausea varies considerably between surgical procedures. Patients undergoing certain types of operation should receive special attention and targeted prevention strategies. Adding these findings to known predictive tools may raise awareness of the still unacceptably high incidence of nausea in certain patient groups. This may help to further reduce the prevalence of nausea.

Trial registration number DRKS00006153; German Clinical Trials Register; https://drks.de/search/de/trial/DRKS00006153

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study is based on a large set of real-world data.
⇒ Regression models are used to identify surgeries with a high risk of postoperative nausea.
⇒ The work does not include all known predictors of postoperative nausea and vomiting.

INTRODUCTION

Although preventive and therapeutic interventions are widely used, postoperative nausea and vomiting (PONV) still affects 20% to 40% of patients.[1 2] In high-risk patients, it can be as high as 80%.[1] PONV can interfere with postoperative recovery, delay enteral nutrition, prolong hospital stay, and result in unplanned readmissions. For some patients, it can be more distressing than pain or the surgical procedure itself.[3]

Predictive scores can help to identify patients at risk and guide the use of prophylactic antiemetic medication.[1] The commonly used simplified Apfel score describes four major risk factors for PONV[4]: female sex, non-smoking status, history of PONV and planned postoperative use of opioids. However, many other factors may potentially increase the risk of PONV. Among these, the effect of surgical procedure/technique is less clear. Some studies have shown an increased risk of PONV after cholecystectomy, gynaecologic, bariatric and laparoscopic surgery.[2 5] However, a comprehensive comparison of the operation-specific risk of PONV using a standardised methodology is lacking. It could be very useful for clinicians and hospitals to identify specific risk groups based on procedures. Such procedure-related information could complement the patient-related risk classification like the Apfel score, allow for additional preventive measures in patients at risk and avoid overtreatment in patients at lower risk.

Table 1 Analysed predictors

Domain	Variable	Description
Patient characteristics	Age	In years, categorical: 18–20, 21–30, 31–40, 41–50, 51–60, 61–70, 71–80, 81–90, >90
	Sex	Male vs female
	Medication for preexisting chronic pain	Yes vs no: opioid medication that the patient used to treat preoperative pain that lasted for 3 months or longer
	Operation group	Combination of corresponding OPS operation codes, as described above
Process variables	PONV prophylaxis	Yes vs no: whether patient received intraoperative nausea and vomiting prophylaxis
	Perioperative phases with opioid	0, 1, 2 or 3: every operation phase from (preoperative, recovery room, ward) adds 1 if any opioid was given during that phase
	Operation duration	Time between incision and suture, in minutes, interval-scaled
	Intraoperative regional anaesthesia	Yes vs no: whether patient received regional anaesthesia during the operation (exclusively or in combination with general anaesthesia)

OPS, German Operation and Procedure keys System; PONV, postoperative nausea and vomiting.

The aim of this study was to compare a large number of surgical procedures with respect to their operation-specific, risk-adjusted probability of nausea. The results will help to understand the contribution of the surgical procedure to the overall risk of PONV. This could be easily translated into clinical practice and may ultimately reduce the burden of PONV on patients.

METHODS

Data source: postoperative patient-reported outcome registry QUIPS

We used data collected from January 2013 to December 2022 in the Quality Improvement in Postoperative Pain Treatment (QUIPS) project.[6] QUIPS collects information on patient-reported outcomes and processes related to pain treatment in German and Austrian hospitals. Hospitals voluntarily participate in QUIPS to improve their postoperative pain management. The project is overseen by the German and Austrian Societies of Anaesthesiologists and Surgeons and led by Jena University Hospital (JUH).

In participating hospitals, trained surveyors approach patients on the ward on the first postoperative day. If the patients consent to participate, the surveyors hand out a questionnaire (on paper or on smartphone/tablet) and collect the patients' clinical data. They input the data into a web form hosted on servers at JUH.

Pain-related outcomes were assessed using the validated 15-item QUIPS questionnaire.[7 8] This questionnaire was completed by the patient on the first postoperative day on the ward. It covers pain intensity, pain-related interference, side effects and patient involvement and satisfaction. The incidence of nausea was assessed by the question 'Have you suffered from nausea since your operation?', answered with yes or no. Demographic and clinical data were also collected (age, sex, type of operation (regional) anaesthesia and pain management).

The type of operation was coded according to the German Operation and Procedure keys System (OPS).[9] It is an adaptation of the International Classification of Procedures in Medicine, which is part of the International Classification of Health Interventions of the World Health Organisation.[10] The OPS coding is the official German classification system used in every medical institution for health claims/cost reimbursement.

In QUIPS, patients have to meet the following:

Inclusion criteria:

- Age: 18 years or older.
- Currently on the ward.
- Willing to participate.
- Treatment on surgical ward.

Exclusion criteria:

- Not able to communicate.
- Cognitively impaired.
- Sedated or dazed.

Operation groups

OPS codes were designed for health claims/cost reimbursement. Thus, some clinically similar operations are coded differently. Furthermore, the OPS system contains about 20 000 procedure codes. It is impossible to analyse each code individually as the number of patients per code would be too small. Therefore, we combined OPS codes in operation groups similar to the method described by Gerbershagen[11] and Komann.[12 13] Briefly, all operation and procedure codes (German OPS codes) that indicated minor variations of an operation were assigned to one operation group (eg, open hysterectomy with uterine resection alone as well as with unilateral or bilateral salpingo-oophorectomy were grouped as 'open hysterectomy'). Open and laparoscopic approaches were considered as separate operation groups.

The perception of nausea may vary between individuals. This is why it is important to analyse a large number of cases in order to be close to the incidence of the whole

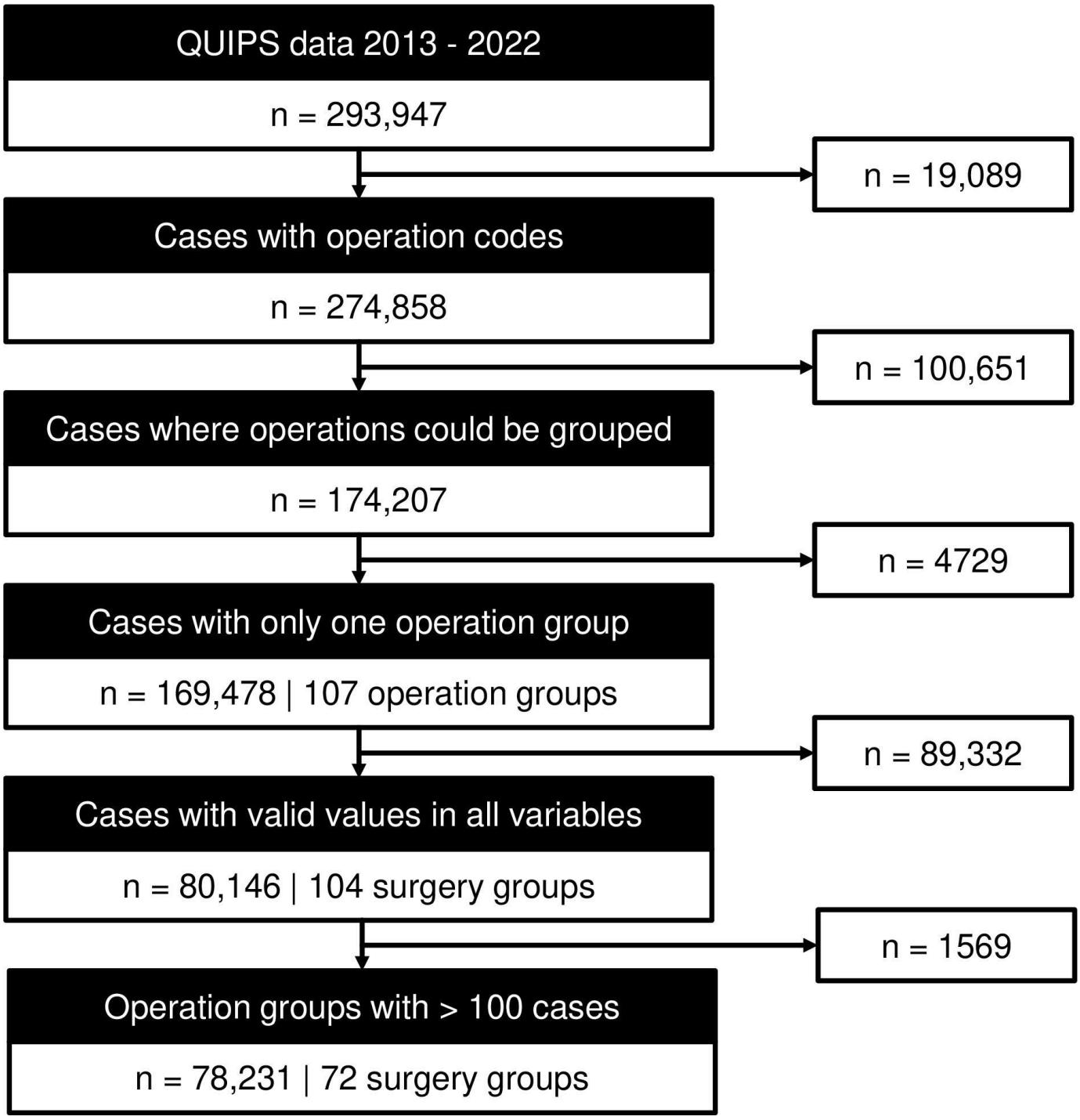

Figure 1 Flow chart of excluded cases and final study population.

population. Therefore, operation groups were only included in the analysis if they contained at least 100 cases in the data sample.

Primary endpoint and predictors

The primary endpoint was patient-reported nausea on the first postoperative day.

Details of the variables included in the analysis are shown in table 1. Sex and opioid use are included according to the Simplified Apfel Score.[4] QUIPS does not collect information on smoking, history of PONV or motion sickness.

Data analysis

Descriptive statistics for all analysed variables including the endpoint are presented first. We report absolute and relative frequencies of nominal-scaled and ordinal-scaled variables for all patients as well as for patients with and without nausea. For interval-scaled variables, mean and SD are reported.

Table 2 Descriptive statistics of nausea for patient characteristics and process/treatment variables

Predictor	Value	Nausea: no (n)	Nausea: yes (n)	Total (n)	Relative frequency
Sex	Male	28108	3851	31959	12.0%
	Female	34723	11549	46272	25.0%
Age	18–20	815	286	1101	26.0%
	21–30	4532	1308	5840	22.4%
	31–40	6725	1747	8472	20.6%
	41–50	7214	2083	9297	22.4%
	51–60	13282	3102	16384	18.9%
	61–70	14116	3197	17313	18.5%
	71–80	12576	2985	15561	19.2%
	81–90	3462	669	4131	16.2%
	>90	109	23	132	17.4%
PONV prophylaxis	yes	39475	9711	49186	19.7%
	no	23356	5689	29045	19.6%
Phases with opioids	0	14395	1990	16385	12.1%
	1	24312	5859	30171	19.4%
	2	21424	6503	27927	23.3%
	3	2700	1048	3748	28.0%
Chronic pain medication	Yes	3320	681	4001	17.0%
	No	59511	14719	74230	19.8%
Intraoperative regional anaesthesia	Yes	24455	5275	29730	17.7%
	No	38376	10125	48501	20.9%

PONV, postoperative nausea and vomiting.

Associations between the primary outcome nausea and patient characteristics and process variables were analysed using a multivariable binary logistic regression model.[14] Nausea was entered as the dependent variable and all putative predictors from table 1 were simultaneously entered into the model as independent variables. For age, we used the median age category (51–60 years) as reference. P values of 0.05 or less were considered significant.

We report the results of the Wald χ^2 test for all independent variables included in the logistic regression model. The main result adjusted risks of postoperative nausea per operation group were determined by estimating the marginal means of the model.[14] Patient characteristics and process/treatment effects are reported as ORs. ORs are presented with 95% CIs . Means and estimates are presented with their respective SEs. All p-values are reported.

No data were imputed. Only data sets with no missing values for any variable were used. Selection of data, operation grouping, choice of endpoint and the statistical approach were determined a priori. All analyses were performed using SAS V.9.4 statistical software (SAS Institute, Cary, North Carolina).

RESULTS

Data from 78231 patients from 152 hospitals collected between 2013 and 2022 were included in the analysis (see figure 1). They were assigned to 72 operation groups. Overall, 19.7%±0.4% of patients reported nausea on the first postoperative day.

Descriptive statistics

Table 2 shows descriptive statistics for nominal-scaled and ordinal-scaled variables. Mean operation duration for patients without nausea was 74.1 min±48.9 min. For patients with nausea, the mean operation duration was 77.2 min±48.2 min.

Descriptive nausea statistics for the 72 operation groups are presented in online supplemental table 1. The most frequent operation groups were knee joint replacement (n=11721, unadjusted nausea frequency=20.2%), hip joint replacement (9957, 23.1%), laparoscopic cholecystectomy (7120, 24.1%), spine surgery (6344, 16.9%), caesarean section (5776, 14.5%) and shoulder operation (3219, 18.6%).

Regression model

The logistic regression model was statistically highly significant (p<0.0001). All predictive variables, including the operation groups, showed statistical significance (p<0.0001, each). ORs for all predictors except operation group are shown in table 3.

Figure 2 illustrates the adjusted risks for all analysed operation groups, ranked from highest to lowest. Detailed figures are shown in online supplemental table 2.

Table 3 OR estimates and CIs of the logistic regression model with postoperative nausea as dependent variable

Effect	OR	95% Wald confidence limits	
Sex: male vs female	0.388	0.371	0.406
Age: 18–20 vs 51–60	1.887	1.614	2.206
Age: 21–30 vs 51–60	1.761	1.613	1.922
Age: 31–40 vs 51–60	1.491	1.380	1.610
Age: 41–50 vs 51–60	1.197	1.120	1.279
Age: 61–70 vs 51–60	0.948	0.895	1.004
Age: 71–80 vs 51–60	0.954	0.899	1.012
Age: 81–90 vs 51–60	0.764	0.694	0.841
Age: >90 vs. 51–60	0.815	0.513	1.295
Operation duration	1.001	1.000	1.001
PONV prophylaxis: yes vs no	0.726	0.698	0.756
Phases with opioid: 1 vs 0	1.572	1.485	1.665
Phases with opioid: 2 vs 0	1.945	1.835	2.062
Phases with opioid: 3 vs 0	2.378	2.171	2.605
Chronic pain medication: yes vs no	0.740	0.677	0.810
Intraoperative regional anaesthesia: yes vs no	0.881	0.834	0.930

PONV, postoperative nausea and vomiting.

We observed the highest adjusted risks for laparoscopic bariatric operation (adjusted risk=36.2%), open hysterectomy uterus only (30.4%), enterostoma relocation (29.8%), open prostatectomy (28.8%), laparoscopic partial colon resection (28.6%), and open sigmoidectomy (28%).

The lowest adjusted risks of nausea were found for toe amputation (6.2%), partial parotidectomy (6.5%), caesarean section (6.9%), pilonidal sinus excision (7.2%), nasal operation (9.2%) and perinea surgery (9.3%).

The most common operation groups had the following adjusted risk of nausea: knee joint replacement (19.2%), hip joint replacement (21.3%), laparoscopic cholecystectomy (19.7%), caesarean section (6.9%) and shoulder operation (19.1%).

DISCUSSION

Principal findings

Based on more than 78 000 patients, this study compared the adjusted risk of developing postoperative nausea in 72 different operations. Overall, 19.7% of patients reported nausea on the first day after surgery. There was a large variability between operations, with risks ranging from 6.2% to 36.2%.

Predictors

For previously known predictors, our study showed the expected results: male sex was a strong protective factor, whereas younger age was a risk factor.[1 15] PONV prophylaxis reduced the risk of nausea by about a quarter and opioid use increased it dramatically.[16] Regional anaesthesia had a relatively small protective effect.[17] This effect may be explained by collinearity with reduced opioid consumption. However, it was still visible in our model after adjustment for opioid use. One finding of our study was that preoperative opioid medication for chronic pain also reduced the risk of nausea by about a quarter, probably because patients developed opioid tolerance.[18] All of these findings are clinically relevant. The duration of an operation was not associated with the risk of nausea to a clinically relevant extent.

High-risk operations

Laparoscopic bariatric operations were associated with the highest adjusted risk of postoperative nausea. The high incidence persisted despite the fact that bariatric operations are known to be a high-risk procedure,[1] which should lead to frequent use of antiemetic prophylaxis. The frequency of PONV prophylaxis in our bariatric operation group was 82.7% compared with 62.9% overall. The clinical message of these findings is that PONV prophylaxis and PONV-reducing anaesthetic strategies should be further intensified in this patient population.

Other operations with an increased risk of nausea included gynaecologic, urologic and intestinal operations, involving the peritoneal and retroperitoneal spaces. Laparoscopic approach per se did not appear to be a protective factor compared with open operation, as laparoscopic colon resection and sigmoidectomy were associated with a high risk of nausea.

Interestingly, and not previously reported in the literature, we observed a high risk of nausea in some extra-abdominal operations such as thyroidectomy, open shoulder ligament reconstruction, knee replacement and tonsillectomy. Some of these operations are known to be extremely painful.[11] Severe pain may contribute to the risk of nausea, either through the pain itself or through increased use of opioids.

Strengths and weaknesses of the study

This study was based on a relatively large number of data sets. It allowed for previously unreported findings and the analysis of less frequent operations. The comparison of a large number of procedures was new and may contribute to a better understanding of postoperative nausea.

The granularity of the operation groups is debatable. It is possible that we grouped operations into one group that were different in terms of nausea. On the other hand, fewer categories may have contributed to better interpretability. For these reasons, we based our grouping procedure on previous publications.[11 12]

The data source (QUIPS registry) was compiled by trained personnel according to a defined protocol.[6] However, it had some shortcomings. First, QUIPS did not collect data on known predictors of PONV, that is, smoking status and history of PONV.[1 4] Therefore, the

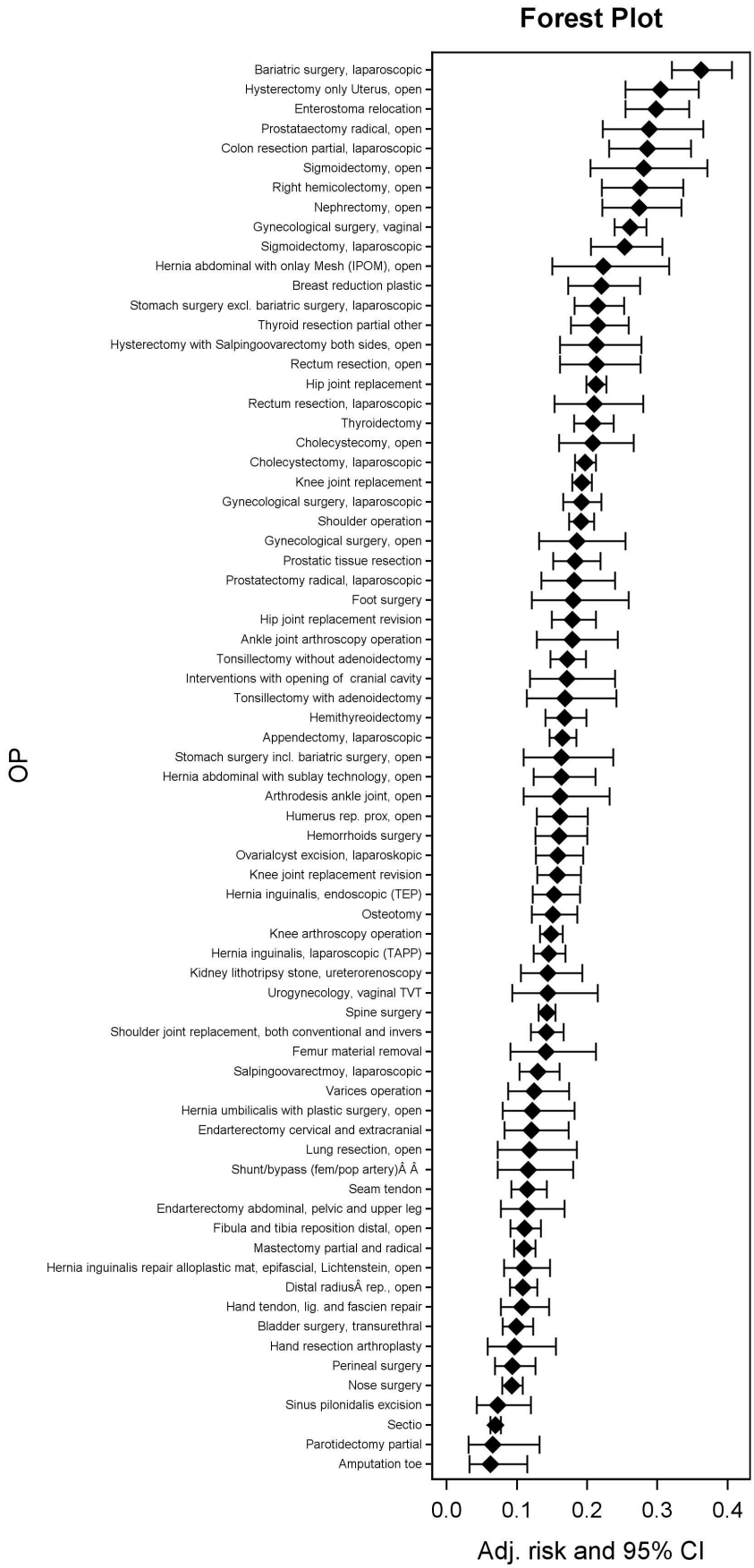

Figure 2 Forest plot of adjusted risk adjusted risks and 95% CIs of post-operative nausea for all 72 operation groups. Squares depict the absolute adjusted risk and whiskers represent CIs. Abbreviations: IPOM: Intraperitoneal Onlay-Mesh, TEP: Totally extra-peritoneal, TAPP: Trans-abdominal pre-peritoneal, TVT: Tension-free vaginal tape.

statistical model of this study may be missing important information. Second, literature discusses postoperative nausea plus vomiting.[1] This study only investigated nausea as the QUIPS questionnaire did not ask about vomiting. However, nausea is more common than vomiting and is, therefore, more sensitive to detect emetic risks of interventions. Furthermore, there is a strong association between nausea (especially severe nausea) and vomiting.[19]

Meaning of the study: extension of the common approach

Today, the Apfel Score is used in many departments. It does not take into account the type of operation, as this was not a dominant factor in the regression analysis at that time.[4] Other clinicians take a more holistic approach with a general multimodal prevention strategy. In any case, our analysis shows that the risk of nausea varies greatly from operation to operation. Failure to take this into account could lead to significant under or overestimation of the risk of nausea.

The results presented here call for better monitoring of 'high-risk' operation populations and, ultimately, improved antiemetic strategies in these patients. For clinicians, the results of this study are complementary to existing prognostic tools and should be considered in daily routine. We suggest adding an extra point to the Apfel Score for patients undergoing one of the high-risk operations, that is, bariatric, open hysterectomy, enterostoma relocation, open prostatectomy, colon resection and open sigmoidectomy.

Unanswered questions and future research

As previously shown,[1 15] perioperative opioid use had a large effect on postoperative nausea. This study did not consider morphine-equivalent doses of opioids, but the number of perioperative phases in which opioids were given. Calculating doses may have provided a better understanding of the impact of opioid medication on each operation group.

The data source (QUIPS) did not record the use of opioids during the intraoperative phase. This study was not able to analyse whether an anaesthetic strategy that minimises the use of opioids reduces the incidence of nausea. Further research should evaluate the effect of these factors on PONV.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Jena University Hospital's Ethics Committee (approval number 2722-12/09) Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer-reviewed.

Data availability statement Data are available upon reasonable request.

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