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ORIGINAL STUDIES
ORIGINALNI NAUČNI RADOVI

ASSESSMENT OF POSTOPERATIVE NAUSEA AND VOMITING IN THE EARLY POSTOPERATIVE PERIOD

PROCENA POSTOPERATIVNE MUČNINE I POVRAĆANJA U RANOM POSTOPERATIVNOM PERIODU

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Abstract

Introduction. Postoperative nausea and vomiting remain common complications following general anesthesia and are a significant source of concern for patients prior to surgery. Numerous studies have aimed to identify risk factors that predict the likelihood of postoperative nausea and vomiting. **Material and Methods.** This cross-sectional observational study included 150 adult patients. Data collection occurred 15 to 45 minutes post-surgery, once patients were fully awake and oriented. Pain and nausea were assessed using the Numerical Rating Scale. Relevant data was obtained from patients' medical histories and anesthesia records and documented in the research protocol. **Results.** Postoperative nausea was recorded in 36 patients (24%). The most frequently reported intensity of nausea was 3 on the Numerical Rating Scale. Identified risk factors for postoperative nausea and vomiting included a history of motion sickness, postoperative opioid use, and the use of anti-diabetic medications. A significant correlation was observed between the severity of acute postoperative pain and the presence of nausea, as well as between the Apfel score and the occurrence of postoperative nausea. **Conclusion.** The incidence of postoperative nausea and vomiting in this study was 24%. The most significant predictors of early postoperative nausea and vomiting were a history of motion sickness, use of opioids postoperatively, and anti-diabetic therapy. The occurrence and severity of early postoperative nausea were associated with the intensity of acute postoperative pain.

Key words: Postoperative Nausea and Vomiting; Postoperative Period; Anesthesia, General; Risk Factors

Sažetak

Uvod. Postoperativna mučnina i povraćanje je i dalje česta komplikacija opšte anestezije i značajan uzrok preoperativne zabrinutosti kod pacijenata. Mnoge studije su istraživale faktore rizika koji mogu uticati na pojavu ove komplikacije. **Materijal i metode.** Istraživanje je sprovedeno kao opservaciona studija preseka koja je obuhvatila 150 odraslih bolesnika. Uzimala se kratka anamneza u periodu od 15 do 45 minuta nakon operacije, pod uslovom da su bolesnici bili potpuno budni i svesni. Pomoću Numeričke skale bola i Numeričke skale mučnine ispitivana je jačina bola i jačina mučnine. Uzeti su relevantni podaci iz istorije bolesti i protokola anestezije i evidentirani su u protokol istraživanja. **Rezultati.** Od 150 bolesnika, postoperativna mučnina se javila kod 36 bolesnika (24%). Bolesnici su najčešće ocenjivali jačinu mučnine ocenom tri (3) na numeričkoj skali. Faktori rizika koji su dovedeni u vezu sa pojavom postoperativne mučnine i povraćanja su istorija kinetoza, upotreba opioida postoperativno i upotreba antidijabetesne terapije. Prisutna je korelacija između jačine akutnog postoperativnog bola i postoperativne mučnine, kao i između Apfel skora i postoperativne mučnine. **Zaključak.** Incidencija postoperativne mučnine i povraćanja je 24%. Najznačajniji faktori u predikciji rane postoperativne mučnine i povraćanja su: postojanje kinetoza, postoperativna primena opioida i primena antidijabetesne terapije. Pojava i jačina rane postoperativne mučnine je povezana sa jačinom akutnog postoperativnog bola.

Ključne reči: postoperativna mučnina i povraćanje; postoperativni period; opšta anestezija; faktori rizika

Introduction

Postoperative nausea and vomiting (PONV) is a frequent complication of general anesthesia, affecting approximately 20-30% of patients. It is defined as the occurrence of nausea, retching, or vomiting within the first 24 to 48 hours following surgery [1]. In individuals without identifiable risk factors, the incidence of PONV is around 10%, whereas in those with three or more risk factors, it can rise to 60-80% [2]. PONV is typically classified as early or delayed, although a universally accepted definition of early PONV is lacking. Some authors define early PONV as occurring within the first 2 hours after surgery [3], while others extend this period to 4 or even 24 hours postoperatively [4,5]. Although often self-limiting, PONV re-

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Abbreviations
PONV – postoperative nausea and vomiting
ASA – American Society of Anesthesiologists

mains one of the leading causes of preoperative anxiety, with many patients reporting greater fear of experiencing nausea and vomiting than postoperative pain itself [6]. While most cases of PONV are mild, it can lead to serious complications such as dehydration, electrolyte imbalance, bleeding, wound dehiscence, aspiration of gastric contents, esophageal rupture, aspiration pneumonia, and arrhythmias. These complications can negatively affect overall morbidity, the surgical outcome, treatment costs, and the length of hospital stay [7–9]. In an effort to reduce the incidence of PONV, numerous studies have investigated its underlying risk factors, leading to the development of predictive tools for the optimal prophylactic use of antiemetics. One of the most widely accepted models is the Apfel score [10], which identifies four independent risk factors: female sex, non-smoking status, history of PONV or motion sickness, and postoperative opioid use. Additional studies have proposed other contributory factors, including intraoperative hypotension [11–13] and acute postoperative pain [14]. Despite extensive research, the pathophysiology of PONV remains incompletely understood, largely due to its complexity and the interplay of multiple risk factors. This study aims to examine the incidence of PONV during the early postoperative period, identify the most relevant risk factors for its prediction, and explore the relationship between acute postoperative pain and early PONV.

Material and Methods

This cross-sectional observational study was conducted at the Clinic of Anesthesia and Intensive Care of the University Clinical Center of Vojvodina to assess postoperative nausea and vomiting (PONV) in the immediate postoperative period. Ethical approval was granted by the Ethics Committee of the University Clinical Center of Vojvodina on December 1, 2023 (Reference No. 00-288). The study included 150 consecutive adult patients scheduled for elective surgical procedures in the fields of abdominal, plastic, maxillofacial, vascular, or neurosurgery. Eligible patients received either general endotracheal anesthesia or a combination of general and regional anesthesia and had provided written informed consent to participate. Following surgery, patients were transferred to the post-anesthesia care unit and assessed between 15 and 45 minutes postoperatively, provided they were fully awake, alert and oriented. A brief medical interview was conducted to evaluate early PONV and acute postoperative pain. Clinical data were extracted from medical histories and anesthesia records and entered into the research protocol. Collected variables included: age, sex, type of surgery, body weight, height, American Society of Anesthesiologists (ASA) physical status classification, smoking status, history of PONV and/or motion sickness, duration of anesthesia, intraoperative use of vasopressors, use of non-opioid analgesics, corticosteroids, antiemetics, and postoperative opioids. The total intraoperative opioid dose, type of anesthesia (general or combined), and anesthetic technique (balanced or total intravenous anesthesia were also recorded. Body mass index (BMI) was calculated using the standard formula based on weight and height. Comorbidities documented included cardiovascular diseases, thyroid dysfunction, chronic gastritis, obesity, diabetes mellitus, hyperlipidemia, and chronic lung diseases. Due to their low incidence, fatty liver disease, pancreatitis, and Parkinson's disease were excluded from statistical analyses. Regular use of chronic medications was also noted. Preoperative systolic blood pressure and the lowest intraoperative systolic blood pressure were obtained from anesthesia protocols. Intraoperative hypotension was defined as a ≥20% decrease in systolic blood pressure from the preoperative baseline lasting at least 5 minutes. The Apfel score was calculated using four criteria: female sex, smoking status, history of PONV or motion sickness, and postoperative opioid use [10]. Pain and nausea intensity were assessed using the Numerical Rating Scale (NRS), a horizontal scale ranging from 0 to 10, where 0 indicated no pain or nausea, and 10 represented the most severe pain or nausea. Data analysis employed descriptive statistics, correlation analyses, and predictive modeling. Descriptive statistical methods included measures of central tendency (mean), measures of variability (standard deviation), and relative numbers (structural indicators). Spearman's rank correlation coefficient (ρ) correlation coefficient was used to assess associations between variables. Binary logistic regression was applied to evaluate predictors of early PONV. Hypotheses were tested at a statistical significance level (α level) of 0.05. Data was processed using standard statistical software packages (IBM SPSS Statistics, version 26).

Results

A total of 150 patients were included in the study, comprising 69 males (46%) and 81 females (54%). The age of participants ranged from 18 to 82 years, with a mean of 54.91±37.98 years. Body mass index (BMI) values ranged from 16.91 to 40.12, with a mean BMI of 27.08±4.51. According to ASA classification, 18

Table 1. Frequency of nausea severity in all patients

NRS Nausea	Frequency	Percentage
0	114	76.0
1	0	0.0
2	1	0.7
3	11	7.3
4	5	3.3
5	6	4.0
6	0	0.0
7	2	1.3
8	4	2.7
9	4	2.7
10	3	2.0

Legend: NRS – Numerical rating scale

Table 2. Model of binary logistic regression of risk factors as predictors of nausea

Model	df	χ^2	p	McFaden	Negelkerke	Tjur	Cox&Snell
H0	149						
H1	134	36.156	0.002	0.216	0.318	0.242	0.214

Table 3. Posterior classification matrix of participants

	Prediction model		
Nausea	NO	YES	Accuracy
NO	107	6	92.92%
YES	22	15	43.24%
Overall accuracy			80.67%

patients (12%) were classified as ASA I, 80 (53.3%) as ASA II, and 52 (34.7%) as ASA III. Among the cohort, 39 individuals (26%) were smokers. Cardiovascular disease was the most common comorbidity, affecting 79 patients (52.7%), followed by diabetes mellitus in 20 patients (13.3%). Chronic medication use was reported by 87 patients (58%). A history of PONV was documented in 11 patients (7.3%), while 35 patients (23.3%) reported a history of motion sickness. Intraoperative hypotension occurred in 53 patients (35.3%). Postoperative opioids were administered to 16 patients (10.7%), and intraoperative antiemetic prophylaxis was used in 93 patients (62%). The mean duration of anesthesia was 87.37±37.98 minutes. The mean intraoperative dose of strong opioids was 195.46 ± 84.41 μg. Acute postoperative pain was reported by 134 patients (89.3%), with pain intensities most commonly rated as 3 or 5 on the NRS. PONV occurred in 36 patients (24%), with nausea intensity most frequently rates as 3, followed by 5 on the NRS **(Table 1).** Vomiting was observed in one patient (0.67%). The most frequently observed Apfel score was 1 (39.3%), while 21.3% of patients were categorized as high-risk (Apfel score > 2). Of 150 patients, 148 received general anesthesia and 2 (1.33%) received combined general and regional anesthesia. Balanced general anesthesia was administered to 146 patients (97.3%), while 4 patients (2.67%) received total intravenous anesthesia. Due to the small sample size in these subgroups, they were excluded from further statistical analysis. Regarding surgical procedures, 82 patients (54.67%) underwent abdominal surgery, 17 patients (11.33%) underwent neurosurgical procedures, 18 (12%) underwent maxillofacial surgeries, 18 (12%) had plastic surgeries, 5 (3.33%) underwent vascular surgery, and 10 patients (6.67%) had endocrine surgery. Laparoscopic techniques were used in 24% of cases. Binary logistic regression indicated that the model incorporating relevant risk factors significantly predicted PONV occurrence ($\chi^2 = 32.188$; $p < 0.01$), with pseudo R^2 values ranging from 0.214 to 0.318 **(Table 2)**. The model achieved an overall classification accuracy of 80.67%, with high specificity (92.92%) but relatively low sensitivity (43.24%) **(Table 3).** Among the predictors analyzed, only a history of motion sickness and postoperative opioid use showed statistically significant association with PONV occurrence **(Table 4).** Specifically, a history of motion sickness increased the risk of PONV by 4.2 times, while postoperative opioid use raised the risk by 5.7 times.

Table 4. Partial regression coefficients of risk factors and their statistical significance

Risk Factor	Regression coeff	Odd ratio	Wald test	p
Age	-0.117	0.992	0.164	0.686
Female gender	-0.273	1.716	1.344	0.246
BMI	-0.261	0.941	1.294	0.255
ASA status II	0.169	0.972	0.001	0.972
ASA status III	0.540	0.511	0.418	0.518
Chronic diseases	-0.029	0.685	0.204	0.651
Chronic medication	-0.672	1.735	0.507	0.476
History of PONV	-0.379	1.648	0.418	0.518
Motion sickness	0.551	4.205	9.434	0.002*
Anesthesia duration (min	0.500	0.993	0.865	0.352
Intraoperative hypotension	1.436	1.753	1.219	0.270
Intraoperative use of strong opioids (μg)	0.561	1.002	0.564	0.453
Postoperative use of opioids	1.736	5.673	7.039	0.008*
Use of antiemetics	0.353	1.424	0.469	0.493
Use of corticosteroids	-1.178	0.308	3.618	0.057

Legend: BMI – Body mass index, ASA status - The American Society of Anesthesiologists (ASA) physical status classification system

Table 5. Partial regression coefficients of risk factors and their statistical significance

Risk factor	Regression coeff.	Odd ratio	Wald test	p
Smoking	-0.016	0.788	0.162	0.688
Cardiovascular diseases	-0.971	0.618	0.252	0.616
Thyroid diseases	-0.239	0.524	0.180	0.672
Chronic gastritis	-0.482	2.537×10^{-7}	8.383×10^{-5}	0.993
Obesity	-0.647	0.525	0.296	0.586
Diabetes	-15.187	9.500	2.837	0.092
Hyperlipidemia	-0.644	1.450	0.177	0.674
Lung diseases	2.251	0.258	1.207	0.272
Antihypertensives	0.372	2.131	0.671	0.413
Diuretics	-1,356	0.779	0.111	0.739
Thyroid medication	0.757	5.468	1.039	0.308
Antidiabetics	-0.249	0.008	6.022	0.014*

Table 6. Correlation of pain and Apfel score with Nausea

		NRS Nausea	NRS Pain	Apfel score
NRS Nausea	Correlation coefficient	1.00	0.32**	0.29**
	Significance (p)	-	0.001	0.001
	N	150	150	150
NRS Pain	Correlation coefficient	0.32**	1.00	0.10
	Significance (p)	0.001	-	0.21
	N	150	150	150
Apfel score	Correlation coefficient	0.29**	0.10	1.00
	Significance (p)	0.001	0.21	-
	N	150	150	150

Legend: NRS – Numerical Rating Scale

Among chronic illnesses and long-term medication use, only anti-diabetic medication use was significantly associated with increased PONV risk **(Table 5)**. There is a positive correlation between nausea and pain ($\rho = 0.32$; $p = 0.001$), as well as between nausea and the Apfel score ($\rho = 0.29$; $p = 0.001$) **(Table 6)**.

Discussion

In this study, the incidence of PONV was 24%, which aligns with previously published rates, typically ranging between 20% and 40%. Some studies have reported lower incidences, as low as 9.6% [4],

while others have documented rates exceeding 70% [15,16]. This variation is likely attributable to differences in patient populations, antiemetic prophylaxis strategies, surgical types, and other factors. Over half of the patients in our cohort (54.67%) underwent abdominal surgery, a well-established high-risk category for PONV [17]. Furthermore, 24% of procedures were laparoscopic, which is associated with a heightened risk of PONV due to multiple contributing mechanisms: mechanical effects of pneumoperitoneum (e.g., gastric and intestinal distension), parasympathetic nerve stimulation, and Co_2-induced irritation [18]. In addition, 23.1% of patients were classified as high-risk based on the Apfel score, which likely contributed to the observed PONV incidence. The timing of data collection may have also influenced results. Different studies have collected data at different time intervals after surgery, ranging from 0 to 24 hours [3–5]. In our study, data were collected within the first 15 to 45 minutes after surgery. Previous studies have shown that PONV incidence can vary depending on the postoperative interval evaluated, with some reporting lower rates in the first two hours and higher rates later [19,20], while others found the highest incidence within the first two hours [21]. The majority of patients in our study rated nausea at an intensity of 3, with only 19 patients (12.67%) reporting severe nausea (≥5 on the NRS). This relatively low severity may reflect the effectiveness of intraoperative antiemetic prophylaxis administered in 62% of patients. Consistent with the literature [22,23], statistical analysis revealed that motion sickness was associated with a higher incidence of early PONV in our cohort. This risk factor is also incorporated into the Apfel score [10]. Similarly, postoperative opioid use was associated with a higher incidence of early PONV, as demonstrated in several previous studies. For instance, one study found a 6% reduction in PONV with 50% reduction in postoperative opioid dosage [24], while Silva et al. reported a 2.7-fold increase in PONV among opioid users [25]. Our study found an even stronger association, with a 5.7-fold increased risk. Regarding chronic diseases and medication use, our study showed that the use of anti-diabetic medications significantly increased the risk of early PONV. Diabetic patients often experience delayed gastric emptying, often due to autonomic neuropathy or glycemic fluctuations, is a recognized risk factor for PONV [17, 26,27]. Additionally, some of anti-diabetic agents, notably metformin and GLP-1 agonists, are known to cause gastrointestinal side effects such as nausea, vomiting, diarrhea, and bloating [28], with some studies reporting nausea in 11.7% and vomiting in 5.8% of users [29]. The mechanisms are not fully understood, though gut microbiota alternations and delaying glucose absorption in the intestines, which may lead to increased lactate production in the gut and contribute to gastrointestinal symptoms, are implicated [30]. Similarly, GLP-1 receptor agonists, which slow gastric emptying, have been associated with nausea in up to 51% and vomiting in 19% of patients, due to effects on gastric motility and direct impact on the central nervous system [31,32]. However, our study lacked detailed data regarding diabetes control (e.g., HbA1c), diabetic complications (e.g., neuropathy), or specific anti-diabetic medication types, which represents a limitation. The relationship between anti-diabetic medications and PONV is certainly a very interesting result and could inspire future research on this topic. Previous studies have linked intraoperative hypotension to increased PONV risk [11–13] suggesting that adrenaline release, as a sympathetic response to blood pressure drop, may lead to "triggered emesis" [33]. Other studies found that perioperative hypoperfusion and subsequent gastrointestinal lining ischemia may trigger the release of serotonin – one of the most significant mediators of nausea and vomiting [34], while reduced blood flow to the brainstem may lead to dizziness, nausea, and vomiting [12]. Our study did not demonstrate a statistically significant association between intraoperative hypotension and early PONV. This may be due to variations in how baseline blood pressure is defined. In our study, 35.3% of patients had at least one episode of intraoperative hypotension. However, the systolic blood pressure values we used as baseline were usually recorded before the patient entered the operating room, often during the preoperative visit. Other studies have used blood pressure values measured at the time of anesthesia induction or immediately after induction, which may explain the different results. Our statistical analysis revealed a correlation between the occurrence of PONV and the severity of acute postoperative pain. Some studies have shown a strong correlation between postoperative pain, particularly visceral and pelvic pain, and PONV [14,17]. Trauma and pain increase the concentration of circulating catecholamines, which can trigger nausea, as is often seen in patients with various injuries who experience nausea and intense pain simultaneously. It remains unclear whether PONV is driven by pain itself or by the opioids administered for pain control. Some studies even suggest that postoperative opioid use reduces both pain and nausea [35], while others show that postoperative opioid use is a significant risk factor for PONV. This duality warrants further clarification. Lastly, our statistical analysis showed a connection between PONV and the Apfel score, which is consistent with numerous studies

that have confirmed the Apfel score as a simple and reliable predictor of PONV risk [36–38].

Conclusion

In conclusion, the incidence of postoperative nausea and vomiting in the immediate postoperative period is 24% in patients undergoing elective surgeries under balanced general anesthesia in abdominal, plastic, maxillofacial, vascular, and neurosurgery programs. The most significant predictors of early postoperative nausea and vomiting in this cohort were a history of motion sickness, postoperative opioid use, and the use of anti-diabetic medications. Furthermore, the intensity of nausea was associated with the severity of acute postoperative pain.

References

1. Elvir-Lazo OL, White PF, Yumul R, Cruz Eng H. Management strategies for the treatment and prevention of postoperative/postdischarge nausea and vomiting: an updated review. F1000Res.2020;9:F1000 Faculty Rev-983.

2. Gan TJ, Belani KG, Bergese S, Chung F, Diemunsch P, Habib AS, et al. Fourth Consensus guidelines for the management of postoperative nausea and vomiting. Anesth Analg. 2020;131(2):411-48.

3. Apfel CC, Kranke P, Katz MH, Goepfert C, Papenfuss T, Rauch S, et al. Volatile anaesthetics may be the main cause of early but not delayed postoperative vomiting: a randomized controlled trial of factorial design. Br J Anaesth. 2002;88(5):659-68.

4. Johansson E, Hultin M, Myrberg T, Walldén J. Early postoperative nausea and vomiting: a retrospective observational study of 2030 patients. Acta Anaesthesiol Scand. 2021;65(9):1229-39.

5. White PF, Sacan O, Nuangchamnong N, Sun T, Eng MR. The relationship between patient risk factors and early versus late postoperative emetic symptoms. Anesth Analg. 2008;107(2):459-63.

6. Fero KE, Jalota L, Hornuss C, Apfel CC. Pharmacologic management of postoperative nausea and vomiting. Expert Opin Pharmacother. 2011;12(15):2283-96.

7. Pierre S, Whelan R. Nausea and vomiting after surgery. Continuing Education in Anaesthesia Critical Care & Pain. 2013;13(1):28-32.

8. Drašković B, editor. Anestezija sa perioperativnom medicinom. Novi Sad: Medicinski fakultet Novi Sad; 2019.

9. Gvozdić B, Jovičić J, Lađević N. Prevencija postoperativne mučnine i povraćanja kombinacijom ondansetrona i deksametazona u urologiji - prevencija postoperativne mučnine i povraćanja. Serbian Journal of Anesthesia and Intensive Therapy. 2016;38(1-2):9-17.

10. Apfel CC, Läärä E, Koivuranta M, Greim CA, Roewer N. A Simplified risk score for predicting postoperative nausea and vomiting. Anesthesiology. 1999;91(3):693-700.

11. Maleczek M, Laxar D, Geroldinger A, Kimberger O. Intraoperative hypotension is associated with postoperative nausea and vomiting in the PACU: a retrospective database analysis. J Clin Med. 2023;12(5):2009.

12. Nakatani H, Naito Y, Ida M, Sato M, Okamoto N, Nishiwada T, et al. Association between intraoperative hypotension and postoperative nausea and vomiting: a retrospective analysis of 247 thyroidectomy cases. Braz J Anesthesiol. 2023;73(5):635-40.

13. Pusch F, Berger A, Wildling E, Tiefenthaler W, Krafft P. The effects of systolic arterial blood pressure variations on postoperative nausea and vomiting. Anesth Analg. 2002;94(6):1652-5.

14. Elsaid RM, Namrouti AS, Samara AM, Sadaqa W, Zyoud SH. Assessment of pain and postoperative nausea and vomiting and their association in the early postoperative period: an observational study from Palestine. BMC Surg. 2021;21(1):177.

15. Rashad AE, El Hefnawy E, Elmorshedi M, Abuyousif YA, Salem A, Attia M, et al. Prevalence, risk factors, and management of postoperative nausea and vomiting after laparoscopic sleeve gastrectomy (a retrospective multicentric study). Obes Surg. 2023;33(10):3237-45.

16. Oderda GM, Senagore AJ, Morland K, Iqbal SU, Kugel M, Liu S, et al. Opioid-related respiratory and gastrointestinal adverse events in patients with acute postoperative pain: prevalence, predictors, and burden. J Pain Palliat Care Pharmacother. 2019;33(3-4):82-97.

17. Vučović D, editor. Anesteziologija I. Beograd: Zavod za udžbenike; 2014.

18. Klockgether-Radke A, Piorek V, Crozier T, Kettler D. Nausea and vomiting after laparoscopic surgery: a comparison of propofol and thiopentone/halothane anaesthesia. Eur J Anaesthesiol. 1996;13(1):3-9.

19. Ahlström SE, Bergman PH, Jokela RM, Olkkola KT, Kaunisto MA, Kalso EA. Clinical and genetic factors associated with post-operative nausea and vomiting after propofol anaesthesia. Acta Anaesthesiol Scand. 2023;67(8):1018-27.

20. Ishikawa E, Hojo T, Shibuya M, Teshirogi T, Hashimoto K, Kimura Y, et al. Risk factors for postoperative nausea and vomiting in patients of orthognathic surgery according to the initial onset time: a cross-sectional study. J Dent Anesth Pain Med. 2023;23(1):29-37.

21. Chen J, Yang T, Cao S, Zheng X, Tian H, Chen Y, et al. Prevalence and time course of postoperative nausea and vomiting and severe pain in patients under general anesthesia with patient-controlled intravenous analgesia. Heliyon. 2024;10(3):e25160.

22. Son J, Yoon H. Factors affecting postoperative nausea and vomiting in surgical patients. J Perianesth Nurs. 2018;33(4):461-70.

23. Choi DH, Ko JS, Ahn HJ, Kim JA. A Korean predictive model for postoperative nausea and vomiting. J Korean Med Sci. 2005;20(5):811-5.

24. Roberts GW, Bekker TB, Carlsen HH, Moffatt CH, Slattery PJ, McClure AF. Postoperative nausea and vomiting are strongly influenced by postoperative opioid use in a dose-related manner. Anesth Analg. 2005;101(5):1343-8.

25. Silva AC, O'Ryan F, Poor DB. Postoperative nausea and vomiting (PONV) after orthognathic surgery: a retrospective study and literature review. J Oral Maxillofac Surg. 2006;64(9):1385-97.

26. Horowitz M, O'Donovan D, Jones KL, Feinle C, Rayner CK, Samsom M. Gastric emptying in diabetes: clinical significance and treatment. Diabet Med. 2002;19(3):177-94.

27. Lerman J. Surgical and patient factors involved in postoperative nausea and vomiting. Br J Anaesth. 1992;69(7 Suppl 1):24S-32.

28. Grunberger G. Should side effects influence the selection of antidiabetic therapies in type 2 diabetes? Curr Diab Rep. 2017;17(4):21.

29. Kahn SE, Haffner SM, Heise MA, Herman WH, Holman RR, Jones NP, et al. Glycemic durability of rosiglitazone, metformin, or glyburide monotherapy. New Engl J Med. 2006;355 (23):2427-43.

30. Bonnet F, Scheen A. Understanding and overcoming metformin gastrointestinal intolerance. Diabetes Obes Metab. 2017;19(4):473-81.

31. Liu L, Chen J, Wang L, Chen C, Chen L. Association between different GLP-1 receptor agonists and gastrointestinal adverse reactions: a real-world disproportionality study based on FDA adverse event reporting system database. Front Endocrinol (Lausanne). 2022;13:1043789.

32. Bettge K, Kahle M, Abd El Aziz MS, Meier JJ, Nauck MA. Occurrence of nausea, vomiting and diarrhoea reported as adverse events in clinical trials studying glucagon-like peptide-1 receptor agonists: a systematic analysis of published clinical trials. Diabetes Obes Metab. 2016;19(3):336-47.

33. Tatić MR, Škorić S, Mišković S, Komarčević M, Dobanovački D, Tomić G. Postoperative nausea and vomiting. Med Pregl. 2003; 56(9-10):431-5.

34. Ali SZ, Taguchi A, Holtmann B, Kurz A. Effect of supplemental pre-operative fluid on postoperative nausea and vomiting. Anaesthesia. 2003;58(8):780-4.

35. Andersen R, Krohg K. Pain as a major cause of postoperative nausea. Can Anaesth Soc J. 1976;23(4):366-9.

36. Apfel CC, Kranke P, Eberhart LH, Roos A, Roewer N. Comparison of predictive models for postoperative nausea and vomiting. Br J Anaesth. 2002;88(2):234-40.

37. Pierre S, Benais H, Pouymayou J. Apfel's simplified score may favourably predict the risk of postoperative nausea and vomiting. Can J Anaesth. 2002;49(3):237-42.

38. Sherif L, Hegde R, Mariswami M, Ollapally A. Validation of the Apfel Scoring System for identification of high risk patients for PONV. Karnataka Anaesthesia Journal. 2015;1(3):115-7.

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