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INCIDENCE OF POSTOPERATIVE NAUSEA AND VOMITING IN PATIENTS AT A UNIVERSITY HOSPITAL. WHERE ARE WE TODAY?

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Key words: Postoperative nausea and vomiting (PONV)/ Antiemetics/Risk factors/Questionnaire- and Interview-based study.

Aim. To determine the incidence of postoperative nausea and vomiting (PONV), identify risk factors, assess treatment and its effectiveness.

Design. A prospective, observational, questionnaire- and interview-based study.

Setting. Standard and intensive care units of the following university hospital departments: abdominal, thoracic and vascular surgery; gynecology; plastic and esthetic surgery; urology; and traumatology.

Material and methods. Adult patients scheduled for elective surgery who gave informed consent were enrolled. A questionnaire-based study was performed on the first postoperative day. The collected data relevant to PONV were statistically analyzed.

Conclusion. The incidence of PONV was significantly lower than generally presumed and was related to the patient gender, type of surgery and overall health status. PONV was more frequent in obese patients and when drugs antagonizing opioids or muscle relaxants were used. Early administration of antiemetic agents led to considerably less discomfort.

INTRODUCTION

Patients undergoing surgery are exposed to risks and complications arising from their primary diagnosis and type of surgery. If anesthesia is needed even more factors enter the stage. Postoperative nausea and vomiting still remains the most common complaint following surgery and anesthesia. The overall incidence of PONV in surgical patients is 25–30% (ref.[1–5])but among high-risk patients it can be as high as 70–80% (ref.[5,6]).

The objective of our survey was to determine the frequency and causative factors of PONV.

METHODS

The study protocol was approved by the university hospital and medical faculty ethics committee.

The sample included all patients in the departments of abdominal, thoracic and vascular surgery, plastic and esthetic surgery, traumatology, urology and gynecology, who gave informed consent and underwent elective surgical procedures in general anesthesia between the beginning of September 2007 and the end of December 2007. Doctors and nurses from the anesthesiology department were instructed to provide anesthetic care according to their usual practice. Data were collected by the department staff on the first postoperative day. For this purpose, a 3-part structured questionnaire was compiled.

- *Part 1:* Demographic data including gender, age, height, weight and ASA (American Society of Anesthesiologists) classification. BSA (body surface area) and BMI (body mass index) values were calculated from the data.
- *Part 2:* Spontaneously reported complaints of patients on the day of surgery.
- *Part 3:* Targeted items to record other types of patient discomfort, especially nausea and emetic episodes, but also postoperative sore throat, swallowing difficulties etc.[5,7], as well as patient smoking status and a history of motion sickness and PONV.

More information was acquired from anesthesia records – premedication, type of anesthesia, anesthetic agents used, airway management, perioperative nasogastric tube placement, type and length of surgery. The length of anesthesiologists' practice was also noted. Other data were elicited from patient records, such as perioperative use of analgesics and antiemetics. The results were converted into an electronic form using the Excel spreadsheet application (Microsoft Office 2003 SP3, Microsoft Corporation), and statistically analyzed. Patients with incomplete records or questionnaires, and/or missing data were discarded.

STATISTICAL ANALYSIS

The SPSS 15.0 statistical software (SPSS Inc., Chicago, USA) was used to analyze the collected data. The monitored quantitative parameters were described by basic statistical characteristics (mean, median, standard deviation, range). The qualitative parameters were defined by frequencies or contingency tables. The dependence of PONV incidence on qualitative parameters was assessed by the chi-square test. The normality of distribution was evaluated by the Kolmogorov-Smirnov test. In the case of low frequencies, Fisher's exact test was applied. To evaluate the dependence of PONV incidence on quantitative parameters, the Mann-Whitney U test was used due to abnormal data distribution. To identify independent factors important for PONV prediction, logistic regression analysis was used. The tests were processed at a significance level of 0.05. During multiple correlations, the Bonferroni correction was used.

RESULTS

From September to December 2007, a total of 1,954 patients underwent surgical procedures in general anesthesia in central and gynecological operating theatres of the University Hospital Olomouc (Table 1). Twelve patients had to be discarded from the study because of incomplete or missing records (especially anesthesia records). Thus, the final sample comprised 1,942 patients (Table 2).

Postoperative nausea was reported by 13.4% of patients. Women were afflicted more often than men (21.3% vs. 5.1%, $p < 0.0001$). Moreover, 8.6% of patients vomited, with women having more episodes than men (13.7% vs. 3.2%, $p < 0.0001$). The overall incidence of PONV was 15.5%, affecting 24.5% of women compared to 6.3% of men ($p < 0.0001$). Women were 4.6 times more likely to develop PONV than men. Shorter surgeries were accompanied by lower incidence of PONV than longer operations (over 60 minutes) ($p < 0.0001$). Whereas age had no influence on PONV incidence ($p = 0.893$), obesity (BMI > 30) was connected with a higher incidence of PONV (11.8% vs. 7.7%, $p = 0.008$). Patients suffering from motion sickness are predisposed to develop PONV ($p = 0.001$). On the other hand, smoking seemed to be a protective factor. In smokers, the risk of developing PONV was markedly lower (8.7%) when compared to non-smokers (17.7%, $p < 0.0001$). Thus, smoking reduced the chances of developing PONV 0.48 times. Perioperative use of a nasogastric tube had no influence on PONV incidence ($p = 0.369$) and neither had postoperative sore throat ($p = 0.477$). A relationship between PONV and airway management was demonstrated ($p < 0.0001$). The incidence of PONV was highest after orotracheal intubation (18.8%) but lower with face mask (8.9%) or laryngeal mask (6.2%) placement. Orotracheal intubation increased the chances of PONV 3.12 times. PONV incidence was also influenced by the type of surgical procedure ($p < 0.0001$). Most frequently, PONV was associated with laparoscopy (14.6%, $p = 0.0001$), transvaginal (16.8%, $p = 0.002$), transanal (15.5%, $p = 0.0001$) or breast (24.5%, $p = 0.0159$) surgery and strumectomy

Table 1. Demographic data of the study group.
Data given as mean ± standard deviation, median (in round brackets), range [in square brackets] and frequencies (ASA).

		Males	**Females**	**P-value**
n		944 (48.6 %)	998 (51.4 %)	
Age (years)		51.1 ± 17.8 (54) [16; 88]	51.7 ± 15.9 (53) [15; 87]	0.444
Weight (kg)		82.4 ± 16.1 (80) [35; 150]	69.7 ± 14.9 (68) [35; 140]	< 0.0001
Height (cm)		175.2 ± 7.6 (175) [150; 204]	163.5 ± 7.5 (164) [140; 193]	< 0.0001
Body surface (m^2)		1.99 ± 0.21 (2.00) [1.25; 2.73]	1.77 ± 0.20 (1.75) [1.23; 2.52]	< 0.0001
Body mass index (kg m^{-2})		26.81 ± 4.84 (26.46) [13.67; 48.98]	26.14 ± 5.75 (25.48) [14.57; 56.80]	0.006
ASA classification	I	327 (34.6 %)	342 (34.3 %)	0.8861
	II	430 (45.6 %)	526 (52.7 %)	0.0017
	III	178 (18.9 %)	125 (12.5 %)	0.0001
	IV or V	9 (1.0 %)	5 (0.5 %)	0.2890

Table 2. Summary of results.

Summary of results
Predisposing factors (increasing the risk of PONV)
Female gender
Longer surgeries (> 60 minutes)
Obesity
Motion sickness
Orotracheal intubation
Drugs used during anesthesia • nitrous oxide • naloxone • neostigmine
Type of surgery • laparoscopy • transvaginal surgery • breast surgery • strumectomy
No influence
Age
Nasogastric tube insertion
Postoperative sore throat
Volatile anesthetics
Propofol for induction
Corticosteroids
Protective factors (decreasing the risk of PONV)
Smoking

(30.4%, p = 0.0001). Whereas the use of volatile anesthetics had no effect on PONV (p = 0.838), nitrous oxide increased it (15.8% vs. 2.4%, p = 0.018). General anesthesia induced with propofol had no protective effect against PONV (p = 0.269). The same was true for perioperative application of corticosteroids (p = 0.082). Opioids effect reversed by naloxone significantly increased the chances of developing PONV (28.6% vs. 14.6%, p = 0.00005). The use of naloxone increased the incidence of PONV 2.34 times. The ASA physical status classification was related to the risk for PONV. Patients classified as ASA I or II (better physical status) suffered from PONV more often (16.3%) than those with co-morbidities classified as ASA III or more (11.7%). This difference was more pronounced in women. Women with ASA I or II suffered from PONV in 25.1%, but those with ASA III or more in 18.5% (p < 0.0001). In men, the difference in incidence between healthier ASA I or II patients and those with ASA III or more was not statistically significant (6.1% vs. 7.0%, p = 0.6162). From all 301 patients experiencing PONV, 189 (62.8%) were treated with antiemetics. Antiemetic therapy was successful in 168 patients (88.9%). No difference was found in effectiveness of the agents used (p = 0.63). Non-depolarizing muscle relaxants were given to 1,560 patients, of whom 483 (31.6%) were treated with neostigmine to reverse the muscle relaxant effect. Decurarization with neostigmine was connected with an increase in PONV incidence (20.1% vs. 14.0%, p = 0.001) regardless of the dose given (p = 0.403).

DISCUSSION

The role of PONV is often underestimated by anesthesiologists. Compared to other perioperative complications, it might seem to be of minor importance. It rarely kills the patient and almost never becomes chronic. But it is a very unpleasant experience for patients[1,8–10]. Many adults even consider PONV more distressing than postoperative pain[8,11]. Moreover, PONV may lead to more serious complications such as microaspiration of the stomach contents, hematomas and wound dehiscence, higher VAS *(visual analogue scale)*, mineral imbalance (hypokalemia, hyponatremic metabolic alkalosis). The most serious, albeit rare, complications are Mallory-Weiss syndrome, esophageal rupture (Boerhaave syndrome) and severe aspiration with Mendelson's syndrome[4]. All of these result in prolonged ICU stay, delayed discharge from the hospital and, last but not least, have an economic impact[10,12]. The day surgery boom led to even more urgent necessity to minimize the incidence of PONV so that patients could be discharged after surgery[13].

Relevant data about the therapeutic potential of antiemetics commonly used in past decades are still missing[14]. According to a systematic review published in the Cochrane database in 2008 (ref.[15]), eight commonly used drugs were effective in treating PONV: droperidol, metoclopramide, ondansetron, tropisetron, dolasetron, dexamethasone, cyclizine and granisetron. No valid evidence for differences in efficacy between these drugs was found. This finding is supported by other authors[16].

Discussion is still on-going about whether intervention for PONV should take place preoperatively or if symptoms should be treated[17]. Systematic reviews suggest that prophylaxis is not always successful. Even worse, it may induce adverse reactions that mitigate the positive effects of the therapy[18]. Therefore, treatment is possibly more cost-effective than prophylaxis[8,17].

The development of PONV is influenced by many factors – patient, surgical, anesthetic, postoperative. The main predictive patient factors for developing PONV are the female gender, non-smoking status, medical history of PONV or motion sickness, and obesity. Other conditions play a role in the development of PONV, such as age, decreased intestinal motility, medical history of migraine, postoperative pain, ambulation, early oral intake, hypotension and hypoxemia[1,4,5]. Some surgical procedures predispose to PONV more than others: abdominal, laparoscopic, eye, gynecological, neurological, plastic and esthetic or middle ear surgery, and strumectomy[5]. Also some pathological conditions, such as ileus, acute appendicitis, biliary disease and ovarian or testicular torsion,

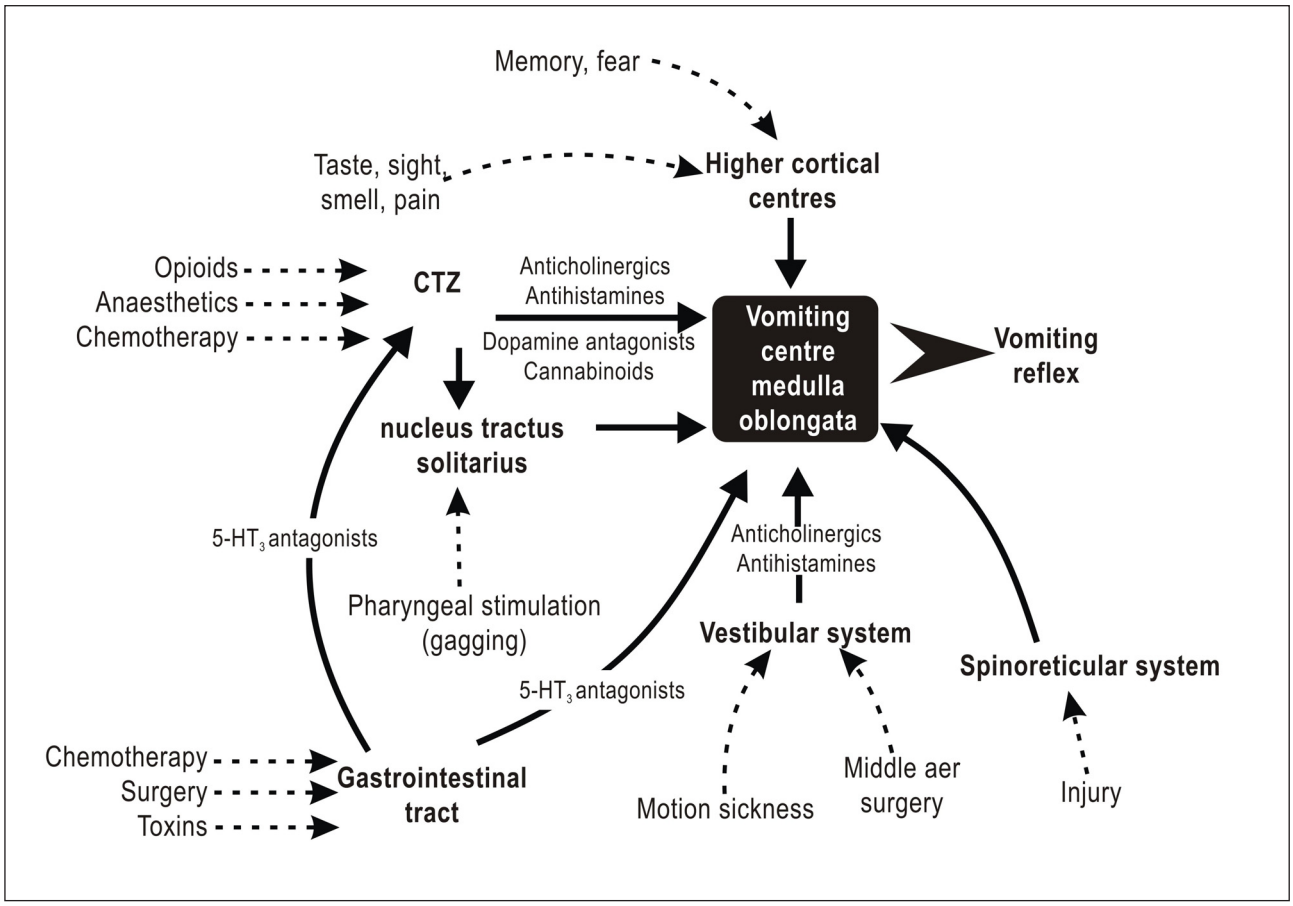

Fig. 1. Vomiting pathway (adopted with permission of PJ online).

are related to PONV. Additionally, preoperative fasting and the composition and amount of stomach contents may influence the development of PONV. Gastric juices as well as vomitus may have very low pH, which may be even more modified by oral intake. There is good evidence that administration of clear fluids is possible until two hours before elective surgery, leading to a decrease in stomach contents[19]. In many pathological conditions, gastric evacuation is slowed down and with the presence of emetic substances (fresh or digested blood, bile), the risk of nausea, vomiting and aspiration increases already prior to surgery. Anesthetic factors include premedication, type of anesthesia (general/ regional), induction agents as well as the use of volatile gases or nitrous oxide and opioids, nasogastric suction, muscle relaxation reversal, anesthesiologist's experience etc[4].

The pathophysiology of PONV is rather complex.

Nausea

Nausea is defined as a sensation associated with awareness of the urge to vomit[12]. It is accompanied by gastrointestinal tract (GIT) relaxation, duodenal peristalsis and vegetative symptoms. Generally, it precedes vomiting. The central nervous system (CNS) areas connected with balance, vasomotor activity, salivation, respiration and eye motion control are located close to the vomiting center. Moreover, these areas are interconnected. The proximity of these areas is responsible for physiological vegetative reactions observed in PONV, such as salivation, sweating, frequent gulping, pallor, tachypnea, tachycardia, heart rhythm disturbances, pupil dilation and motion sickness[4,14].

Vomiting and its mechanism

Vomiting is a neurologically conducted, coordinated reflex in which visceral reflexes in the medulla oblongata are integrated, including their coordination and time synchronization with somatic components[19]. It is the forceful expulsion of stomach contents through the mouth. The diaphragm is fixed during inspiration and the stomach wall muscles contract. Peristalsis is reversed; the duodenum contracts, the cardia relaxes and strong pressure is applied. The stomach is emptied into the esophagus. The upper esophageal sphincter opens and the soft palate lifts. At the same time, the epiglottis closes off the entrance to the lower airways, preventing aspiration. Breath is held approximately in the middle of inspiration. Vomiting is usually started by retching – rhythmical contractions of the respiratory muscles. Vomiting and retching are subjective patient symptoms. Both vomiting and retching are brain stem reflexes. On the other hand, nausea is coordinated from the cortex. Nausea and vomiting are protective reflexes to prevent the absorption of toxins (which trigger chemoreceptors in the GIT), but may also occur in response to olfactory, visual, vestibular and psychogenic stimuli[14].

Coordination of vomiting

Vomiting is coordinated by the vomiting center. It is located in the lateral reticular formation in the medulla oblongata of the mid-brainstem CNS in close proximity to the nucleus of the solitary tract and area postrema at the level of the dorsal motor nucleus of the vagus nerve and the olive nuclei[4,20]. This center gets impulses from the chemoreceptor trigger zone (CTZ) situated in the area postrema near the vomiting centre. The area postrema is a V-shaped tissue bundle at the lateral wall of the fourth ventricle close to the obex. It is a circumventricular organ and for many substances it is more permeable than the surrounding tissue of the medulla oblongata. Chemoreceptor cells induce vomiting after being excited by chemical substances or toxins circulating in the blood, e.g. when the patient suffers from uremia or radiation sickness. Other impulses come from the vestibular system (in motion sickness or middle ear disease), centers in the upper cortex (the diencephalon and limbic system), the vagus nerve (innervating the oropharynx, mediastinum, GIT, renal pelvis, peritoneum and genitals), the spinoreticular tract (causing nausea after physical injury) and the nucleus of the solitary tract (the afferent part of the gag reflex arch). Stimuli from the periphery are transmitted to the vomiting center by afferent neurons of the autonomic nervous system of the vagus nerve. The vagus and glossopharyngeal nerves transmit afferent impulses to the area postrema. Central brain stimuli are transferred directly through the CTZ, area postrema and nucleus of the solitary tract to the lateral reticular formation of the medulla oblongata and to the vomiting center[4] (Fig. 1).

Receptors involved

Numerous encephalin, opioid and dopamine D_2 receptors were found in the CTZ. The area postrema contains high concentrations of opioid, D_2 and serotonin ($5\text{-}HT_3$) receptors, while the nucleus of the solitary tract contains mainly encephalin, histamine, muscarinic and cholinergic receptors. These neuroreceptor areas serve as sensors and are stimulated by drugs, electrolytes and waste products of metabolism. This is how impulses transmitted to the vomiting center are generated and vomiting is initiated. The majority of antiemetics routinely used for treating PONV block these neuroreceptor zones.

Antiemetics

Traditional antiemetic therapy includes anticholinergics, antihistamines, D_2 agonists – phenothiazines, also sedatives/anxiolytics, butyrophenones, $5\text{-}HT_3$ antagonists, corticosteroids and their combinations. Setrons and neurokinin-1 antagonists are modern drugs only recently introduced in PONV therapy. However, given all the mechanisms activating the vomiting center, there is no single drug or drug group capable of suppressing PONV effectively on its own.

Anticholinergics

This first generation of antiemetics (e.g. scopolamine – nowadays administered in transdermal patches) inhibits stimulation of the vomiting centre by blocking acetylcholine and muscarinic receptors in the vestibular system, cerebral cortex and pons. Therefore, this group is effective against PONV arising from the vestibular system. In addition, they decrease gastric motility and afferent stimulation to the vomiting center. Their adverse effects include drowsiness, double vision, urinary retention and dry mouth and overdosing can lead to central anticholinergic syndrome. Transdermal scopolamine patch contains 1.5 mg of scopolamine and is effective if administered in the evening or at least 6 hours before surgery.

Antihistamines (promethazine, cyclizine)

They block H_1 and muscarinic receptors in the vomiting center. They are effective especially in PONV caused by vestibular system activation but are not so potent against vomiting from direct CTZ stimulation. The adverse effects – drowsiness and sedation – come from their antimuscarinic activity.

Dopamine antagonists (benzodiazepines, phenothiazines and butyrophenones)

They block D_2 receptors, the stimulation of which leads to vomiting. These receptors are in abundance in the CTZ. Dopamine receptor inhibition reduces impulses coming to the vomiting center. D_2 antagonists are most effective against substances stimulating the CTZ, such as opioids.

Benzamides. Benzamides, e.g. metoclopramide, domperidone and cisapride belong to prokinetics. They exert direct antiemetic effects by blocking D_2 receptors of the CTZ – a central effect. They are especially suitable for drug-induced PONV. In addition, they facilitate motility of the stomach and the upper part of the digestive system by blocking peripheral dopamine receptors. High-dose metoclopramide also has a slight inhibitory effect on $5\text{-}HT_3$ receptors. However, the agents should not be used in bowel obstruction and after intestinal suture. Abnormal peristalsis may lead to surgical complications. The agents pass through the blood-brain barrier and may induce extrapyramidal adverse effects. The usual dose of metoclopramide is 10 mg i.v. perioperatively or preoperatively for adults and 0.25 $mg.kg^{-1}$ i.v. for children[3]. Some authors question the effects of metoclopramide in this dosage. According to them, the effective dose is several times higher, as used during chemotherapy. Such high doses are accompanied by many adverse effects[21]. Domperidone is a central dopamine antagonist and has no effect on $5\text{-}HT_3$ receptors. As it does not cross the blood-brain barrier, it should be used in nauseated patients suffering from Parkinson's disease. Both agents are less suitable for geriatric patients[21].

Phenothiazines, e.g. chlorpromazine and prochlorperazine. Phenothiazines block mainly D_2 and $5\text{-}HT_3$ receptors in the CTZ. They have slight antimuscarinic effects on the vomiting and vestibular centers as well as antihistamine effects. They are used to counter the effect of substances directly stimulating the CTZ (opioids, cytotoxins and anesthetics) and emetic stimuli from the GIT.

They have antidopaminergic effects, causing akathisia, dystonia and dyskinesia. Prochlorperazine is the most frequently used phenothiazine for the treatment of PONV. It is available in oral, buccal, rectal and parenteral forms.

Butyrophenones, e.g. haloperidol. They block D2 receptors in the CTZ. These agents have characteristics similar to phenothiazines, but they are not used routinely. Droperidol was an effective and cheap antiemetic drug until it was put on the FDA "black list" in 2001 after its possible adverse effects were discussed. In some patients, the ECG QT interval was prolonged, leading to malignant arrhythmia[2]. But today doperidol is back. Baring in mind its adverse effects we can prescribe it again. Adults obtain 0,625 mg – 1,25 mg (seniors 0,625 mg), for children (over 2 years) the dose is 20–50 ucg/kg (max. dose 1,25mg).

Setrons

Serotonin (5-HT_3) antagonists, such as ondansetron, dolasetron, tropisetron or granisetrone, were shown to be effective in the treatment of nausea as well as vomiting with only a few adverse effects. They became the drug of first choice in antiemetic therapy in some countries. However, they are rather expensive and their routine administration is probably not considered cost-effective[2,18]. They block 5-HT_3 receptors selectively in the periphery – in the intestine (5-HT_3 receptors of the vagus nerve afferent branches) – as well as centrally. For example, PONV may be prevented by 8 mg of sublingual ondansetron one hour prior to surgery for adults, followed by another 2 doses of 8 mg each after eight hours. Alternatively, a single 4 mg dose of intravenous ondansetron is injected as a bolus during the induction of anesthesia. The adverse effects are minimal (headache, dizziness, liver tests elevation).

Corticosteroids

Dexamethazone is the most commonly used steroid in the therapy of PONV. It is effective only when used as prophylaxis. Once the PONV symptoms are present it is too late to start administration of the drug. Therefore, it should be applied during the induction of general anesthesia. Although it might be used as monotherapy in some procedures (e.g. tonsillectomy, abdominal hysterectomy and thyroidectomy), it is usually combined with other substances. The mechanism of its effect is not well understood. Possibly, it inhibits central prostaglandin production and/or decreases serotonin turnover in the CNS[21]. After a single dose, the risk of adverse effects is very low. The dosage varies from 5 to 10 mg i.v.[2,6,22].

Somatostatin analogues (e.g. octreotide)

They are used to prevent vomiting after intestinal surgery. They decrease GIT secretion and motility.

Synthetic cannabis derivatives

These substances have antiemetic effects and may also prevent vomiting caused by CTZ stimulation. They may be antagonized by naloxone.

Neurokinin-1 receptor antagonists

They work against substance P selectively[8].

If the patient recovering from anesthesia starts to vomit, "rescue therapy" should be initiated. Of importance is how the antiemetics are administered. The usual routes are parenteral, rectal or via the buccal cavity. Alternative approaches to PONV treatment include acupuncture and the use of ginger or peppermint.

Monotherapy may decrease the incidence of PONV by approximately 30% (ref.[14]). Combined substances are more effective so if monotherapy fails the next step is multi-modal therapy.

According to Tramér[7], there are 3 strategies for the prevention and treatment of PONV:

1. To reduce the basic risk (adequate premedication, restriction of opioids);
2. To abide, observe and treat only when necessary (e.g. "rescue therapy" with ondansetron);
3. To make effort to prevent PONV – in indicated cases, but effectively. Stratification of patient risk is the first step to cost-effectiveness and evidence-based multimodal approach to PONV.

The risk of developing PONV can be predicted with help of scoring systems (risk factors being – sex, age, history of previous PONV, motion sickness, duration of anesthesia, and use of postoperative opioids)[23].

1. Low-risk patients – although prophylaxis is not needed, dexamethazone may be widely recommended.
2. Medium-risk patients – dexamethazone may be prescribed as prophylaxis. If it fails, the use of serotonin antagonists should be considered.
3. The next step is aggressive therapy comprising a combination of antiemetics with different mechanisms of effect. In high-risk patients, prophylaxis should be initiated with dexamethazone and setron. If this prophylaxis fails, setrons should not be used again and a combination of other antiemetics should be applied instead. The use of total intravenous anesthesia (TIVA) and omission of nitrous oxide should be considered. Careful use of opioid reversal is needed. If possible, regional or combined anesthesia is used.

Generally, in the perioperative period, an eye must be kept on postoperative pain treatment[2]. After surgery, the patient should be kept in a slightly elevated position and should not be mobilized too early. Parenteral hydration, adequate serum mineral levels and acid-base status are essential. The oral intake must be restored slowly. Nasogastric tube placement for GIT decompression might be needed in some patients.

In our survey, the incidence of postoperative nausea and PONV was 13.4% and 15.5%, respectively. That is significantly lower than in other literary resources[1,6,9]. However, data published by other authors show a great variability. One of the reasons might be that some of the studies were performed on quite precisely specified groups of patients, e.g. groups with higher preoperative risk or patients undergoing procedures predisposing to PONV. For logistic reasons, not all hospital departments

were included in our study and ENT, ophthalmology and dental surgery patients were omitted. Moreover, children who normally have a higher risk of PONV than adults[24] were excluded as well. All the above-mentioned facts influenced our results. In accordance with other authors, we demonstrated a higher incidence of nausea as well as vomiting in women that may be a result of hormonal influence[5]. Some researchers were even concerned with the relationship between PONV incidence and phases of the menstrual cycle[25]. Our patients with BMI over 30 had higher incidence of PONV. This is supported by other studies published in the past. However, a 2001 systematic review by Kranke et al. provides a surprising explanation. By applying regression analysis on his colleagues' results he came to a conclusion that high BMI is not a risk factor for PONV[26]. A medical history of motion sickness or emesis predisposes to PONV since the reflex for vomiting is activated and the reflex arch is already created. Our results correspond with this theory. In our study, however, the risk of PONV did not decrease with age despite the existence of works suggesting the role of peripheral neuropathy, atherosclerosis and, last but not least, loss of hormonal influence in women of older age. Smoking proved to be a protective factor, probably thanks to the influence on enzyme induction[5,27]. A higher incidence of PONV in orotracheal intubation may be explained by several reasons. Tracheal intubation is used for longer and more complicated types of surgeries. Almost without exception, relaxation is used to facilitate intubation. The effect of muscle relaxants had to be reversed with neostigmine. In operations where the airways are secured with a laryngeal mask or only a facial mask, there is often an effort of anesthesiologists to retain spontaneous breathing. On the other hand, intubated relaxed patients are ventilated artificially. Especially during the induction of anesthesia, this may lead to unintentional distension of the stomach. A higher incidence of PONV in laparoscopic surgeries might be due to carbon dioxide absorption into the intestine and increased intraabdominal pressure. Moreover, laparoscopic surgeries, such as laparoscopic assisted hysterectomies, exploratory laparoscopy, cholecystectomy or ovarian surgery, are connected with a higher incidence of PONV because of vagus irritation. Parasympathetic irritation is responsible for an increased incidence of PONV in vaginal surgery, strumectomy and transanal surgery. In the latter, bleeding from the wound also plays a role if the blood gets into the stomach. Our results did not show the protective effect of propofol against PONV. On the other hand, nitrous oxide increased the risk of PONV as was expected. Although in his 2002 survey[23] Apfel claimed volatile anesthetics to be the main predisposing factor for PONV, especially in the early postoperative period, the results in our study did not support this. The protective effect of corticosteroids against PONV described in some resources did not work in our patients. Reason for it might be that only a limited number of patients received corticosteroids which were primarily prescribed for edema treatment. An increased incidence of PONV after naloxone application might be explained by its ability to bind to opioid receptors and rapid reversal of opioid effect followed by vegetative imbalance in patients, nevertheless we found no literature supporting this theory.

In our department, standards for PONV prevention and therapy have not been introduced yet. Antiemetics are not being prescribed routinely. The prescription of newer substances of setron and NK-1 inhibitor type is limited in our country. Nevertheless, our therapy of PONV was effective, irrespective of the drugs used.

CONCLUSION

Our findings indicate that the etiology of PONV is multifactorial. Our study showed no differences in efficacy between the commonly used antiemetics. Importantly, the application of neostigmine led to an increased incidence of PONV irrespective of the dosage. However, the incidence of postoperative residual curarization (PORC) is high in our patients and therefore the application of neostigmine in the absence of muscle relaxation monitoring is advisable[28].

The available antiemetics have different routes of action. Single-drug therapy is effective in only some patients. When multi-modal therapy combining drugs with a synergistic effect is used, the efficacy of antiemetic intervention may be increased.

The patient risk should be assessed preoperatively as, according to literature, routine administration of antiemetics is neither well-established nor cost effective[18].

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