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Review

Controlling postoperative nausea and vomiting

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Postoperative nausea and vomiting (PNV) in the ambulatory surgical unit is a continuing and vexing problem. Delayed discharges and patient discomfort have major impact in an outpatient setting. An understanding of the causes and aetiologies of PNV including anaesthetic, surgical and patient factors is critically important in the management of these patients. Therapy begins with a good history, identification of patients at risk, and the use of appropriate anaesthetic technique and agents, as well as prophylactic treatment. Aggressive postoperative treatment is also a necessity and good communication between the staff, and the patient and their family, is essential. Postoperative nausea and vomiting can be controlled in the outpatient setting, leading to better patient outcome and satisfaction, as well as a smoother and more efficiently functioning ambulatory unit.

Key words: Postoperative emesis, ambulatory surgery, anaesthesia complications, postoperative nausea/vomiting aetiology and treatment

The dramatic increase in outpatient surgery in the United States over the past 15 years, has led to the development of a new set of challenges for the anaesthesiologist. The major focus of ambulatory anaesthesia involves the delivery of a safe anaesthetic coupled with a timely discharge home. This is profoundly different from inpatient surgery where minor problems such as postoperative sedation, or nausea and vomiting, are nothing more than minor annoyances. In the ambulatory setting these problems become major concerns, because the patient is not able to go home. This dramatically affects the patient's perception of their ambulatory surgical experience as well as having an impact on the flow and efficiency of the ambulatory surgical unit.

Postoperative nausea and vomiting is a very common problem which has been around for a very long time. The first issue of *Anesthesia and Analgesia*, published in 1914, featured an article on its front cover entitled 'Prophylaxis of postanesthetic vomiting'[1]. Almost eight decades later the subject is still one of the major concerns that we face in the postanaesthesia care unit (PACU) and is a topic that is being continually studied by experts in the field.

Postoperative nausea and vomiting are the most common complications reported from ambulatory surgery centres[2] and is a primary factor associated with unexpected hospital admission after outpatient surgery[3].

Given the impact that the problem of postoperative nausea and vomiting has on ambulatory surgery patients, it is important that a thorough understanding of the aetiologic factors, and methods of control available, are understood. This article will focus first on the different causes and aetiologies of postoperative nausea and vomiting and will then discuss the options for prophylaxis and treatment.

Causes of postanaesthetic nausea and vomiting

There are, unfortunately, many predisposing factors in the aetiology of postanaesthetic nausea and vomiting (Table 1). However, an understanding of what these causative factors are will allow the anaesthesiologist to tailor the anaesthetic so as to minimize the chances of a patient having postanaesthesia nausea and vomiting. Knowing which patients and which surgical procedures are prone to postoperative nausea and vomiting will help target specific patients for prophylactic medication. Some of the factors to be discussed are controversial,

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Table 1. Factors associated with postoperative nausea and vomiting (PNV)

Anaesthetic technique
General (vs. regional) anaesthesia
Gastric distension (mask ventilation)
Anaesthetic agents
Narcotics
Nitrous oxide
Etomidate/ketamine
Thiopental (vs. propofol)
Neostigmine (vs. edrophonium)
Glycopyrrolate (vs. atropine)
Patient factors
Previous PNV
Young age
Female gender
Obesity
Menstrual phase
Motion sickness
Surgical procedure
Laparoscopy
Postoperative
Pain
Ambulation

with conflicting data in the anaesthesia literature, as will be pointed out.

Anaesthetic technique

Discussions about the choice of anaesthesia as a predisposing factor for postoperative nausea and vomiting has usually revolved around the choice of general versus regional anaesthesia. Over the past two years, however, we have seen the introduction of a major new intravenous anaesthetic, propofol, that has been shown to have significantly less nausea and vomiting than other general anaesthetic modalities. There are no studies yet available comparing propofol to regional anaesthesia, however, since neither technique is suited to all patients, having a choice is highly advantageous. We will first discuss the use of regional anaesthesia in outpatient surgery and its effects on postoperative nausea and vomiting, and then turn to a discussion of general anaesthesia.

Regional anaesthesia has frequently been advocated for ambulatory surgical patients because of improved postoperative pain control, decreased postoperative somnolence and recovery times, and lower unexpected hospital admissions[3–5]. It was also suggested that there is a lower incidence of nausea or vomiting from regional anaesthesia, when compared to general anaesthesia[6,7]. Epidural anaesthesia has recently been compared to general anaesthesia for outpatient arthroscopic surgery[8]. It was found that discharge times were shorter in the epidural group, as was the incidence of pain (24.1% *versus* 49.7%) and nausea and vomiting in the epidural group (8.9% *versus* 32%). Patient satisfaction was equally high in both groups and it was felt that epidural anaesthesia was a viable alternative to general anaesthesia for outpatient arthroscopic knee surgery, offering the advantages of fewer side effects and earlier discharge times.

Regional anaesthesia, however, is not always practical in busy ambulatory surgical facilities and clearly cannot be used for all types of surgical procedures. To be successful, there are a number of factors which can be very helpful, including the availability of a holding area where blocks can be placed in advance, so there are no delays in waiting for the block to set. Furthermore, support of the surgical and nursing staff in the facility is important, as is good communication with the patient, since many patients have preconceived fears regarding certain regional techniques such as spinal anaesthesia[9].

General anaesthesia

A discussion of factors predisposing to postoperative nausea and vomiting under general anaesthesia is a complex topic, because of the multiple agents that are commonly used nowadays in a typical 'balanced' anaesthetic. There are however a number of different studies addressing the specific agents that are commonly used during general anaesthesia, and we will discuss these in turn.

Narcotics

The use of a narcotic-based technique for the induction or maintenance of anaesthesia has definitely been shown to increase the incidence of postoperative nausea and vomiting. Numerous studies have compared fentanyl or alfentanil with the potent inhaled anaesthetics and have shown a significantly increased incidence of postoperative nausea and vomiting with the narcotic techniques[10–12]. A comparison of fentanyl with isoflurane for outpatient laparoscopy, in which patients were randomly assigned to receive either isoflurane with nitrous oxide or fentanyl 300 μg with nitrous oxide following induction with thiopental was done by Rising et al.[11]. They found a significantly higher incidence of nausea (60%) and vomiting (28%) in the fentanyl patients compared with the isoflurane patients (16% and 12%, respectively). A significantly greater number of patients in the fentanyl group (48%) required treatment with anti-emetic drugs postoperatively when compared to the isoflurane group (16%). In a comparison of enflurane, isoflurane, and a fentanyl infusion, Melnick et al.[12] showed a significantly greater incidence of nausea and vomiting (24%) in the fentanyl group than the enflurane or isoflurane groups (4%).

The studies showing an increased incidence of postoperative nausea and vomiting in narcotic-based techniques, involve cases which are heavily weighted towards narcotics, or predominantly narcotic based. This does not preclude the judicious use of narcotics to control postoperative pain. In fact, small amounts of intravenous opioid analgesics in the outpatient setting have been well documented to be highly efficacious, without increasing the incidence of side effects. Pandit and Kothary[13] studied the use of potent intravenous opioid analgesics as premedicants and found they were able to decrease patient anxiety, reduce anaesthetic requirements, and provide pain relief early in the postoperative period. They used fentanyl (1–2 μg kg^{-1}), sufentanil

(0.1–0.25 μg kg^{-1}), and alfentanil (7.5–15.0 μg kg^{-1}), and found neither prolongation of recovery time nor increased postoperative side effects. Similarly, Hunt et al.[14] premedicated a group of outpatients scheduled for a dilatation and curettage with intravenous fentanyl in doses ranging from 75–125 μg. They found a significantly reduced incidence of abdominal pain in the postoperative period and during the first evening at home, without any increase in the incidence of nausea and vomiting.

Given the data suggesting that postoperative pain has been associated with postoperative nausea and vomiting, at least in certain types of surgery, it seems prudent to use judicious amounts of potent intravenous opioids as a supplement to general and even regional anaesthesia.

There are no consistent data available to suggest among morphine or any of its newer derivatives, (fentanyl, alfentanil, and sufentanil) that there are any significant differences in the incidences of nausea and vomiting[15,16]. Certain patients, however, may be more susceptible to one specific narcotic than another, and it is prudent to change narcotics if a patient has a history of nausea and vomiting with any particular agent[17]. Among the combination agonist and antagonist drugs including butorphanol, nalbuphine, and dezocine there are conflicting reports in the literature, showing variable incidences of postoperative nausea and vomiting[18–21]. The use of the new nonsteroidal and anti-inflammatory agent, ketorolac, a potent non-narcotic analgesic, has been shown to be as effective as narcotics for postoperative pain control following ambulatory surgery[22], with a lower incidence of postoperative nausea and vomiting when compared to morphine and dezocine[23].

Nitrous oxide

Nitrous oxide has classically been implicated as being a major cause of postoperative nausea and vomiting, although this has been quite controversial[24–28]. There have been several mechanisms postulated to explain why nitrous oxide causes postoperative emetic symptoms. Nitrous oxide diffuses into the gastrointestinal tract more quickly than nitrogen can diffuse out, which may result in bowel distension and subsequent nausea and vomiting[29]. Similarly, nitrous oxide may diffuse into the middle ear, causing increased pressure[30] with stimulation of the vestibular system leading to a 'motion sickness' type of nausea and vomiting. Lastly it may interact centrally with the endogenous opioid receptor system[31,32] which can stimulate nausea and vomiting centrally.

With numerous conflicting studies involving numerous different procedures and anaesthetic techniques and the multifactorial aetiology of postoperative nausea and vomiting, it is impossible to make a definitive statement regarding nitrous oxide. Despite this controversy, however, nitrous oxide with its acceptable odour and rapid induction and emergence, is an important agent in the outpatient anaesthesiologist's armamentarium, and continues to be the main adjunctive drug for both inhalational and intravenous anaesthesia in the ambulatory setting.

It should be noted that among the different inhalational agents themselves, there is no data suggesting any difference in the incidence of postoperative nausea and vomiting. In fact even the new less soluble inhaled agents desflurane and sevoflurane have not demonstrated any significant differences regarding postoperative emesis[33,34].

Induction agents

Among the current most commonly utilized induction agents, etomidate[35] and ketamine have been found to have significantly higher incidences of postoperative nausea and vomiting. Etomidate has been utilized most often in patients with limited cardiac reserves, and is appropriate for this patient population, who if stable, may be undergoing minor outpatient procedures. However, these patients should then be targeted for prophylaxis of postoperative nausea and vomiting. Ketamine has similarly been found to have a higher incidence of postoperative nausea and vomiting when compared to the barbiturates[36] and these patients should also be targeted for prophylaxis.

Propofol

While the barbiturates have been shown to have lower incidences of postoperative nausea and vomiting when compared to etomidate and ketamine, they do have a significantly higher incidence of postoperative nausea and vomiting in comparison to the new intravenous induction agent propofol. Propofol is chemically unrelated to the barbiturates and is a milky white substance from the alkyl-phenol family. It is formulated as an emulsion in an intralipid-type substance that has only rarely been reported to cause allergic reactions[37]. Due to its extensive redistribution and rapid elimination it has become particularly well suited for outpatient anaesthesia. Numerous studies have compared propofol to other intravenous anaesthetic induction agents, as well as to other maintenance techniques. The results have consistently shown that propofol has a lower incidence of postoperative nausea and vomiting both in paediatric outpatients[38,39] and adults[40–42]. In some part, because of its low incidence of postoperative nausea and vomiting, propofol has been shown to have significantly more rapid recovery and shorter discharge times, as well as having patients experiencing a sense of well being after their anaesthetic, in comparison to thiopental[40,43]. A recent comparison of total intravenous anaesthesia with propofol and alfentanil versus propofol induction and maintenance with nitrous oxide and enflurane, found significantly lower incidences of nausea, retching and vomiting in the total intravenous group[44]. They also found that requirements for anti-emetic therapy postoperatively were lower in the total intravenous group as well as a significantly lower incidence of unplanned admissions for overnight stay in the hospital postoperatively.

The lower incidences of postoperative nausea and vomiting seen in these numerous studies with propofol has led to questions of whether propofol actually has anti-emetic properties, or was simply not as pro-emetic

as other anaesthetic agents. Scher and colleagues[45] looked at propofol for the prevention of chemotherapy-induced nausea and vomiting in oncology patients. They found that the use of low dose continuous propofol infusions, utilizing a bolus of 0.1 mg kg^{-1} followed by a continuous infusion of 1 mg kg^{-1} h^{-1}, was effective in both prevention and treatment of nausea and vomiting. Similarly, in the anaesthesia literature Borgeat et al. studied the use of propofol in the postoperative setting. They randomized patients to receive either 10 mg propofol or intralipid placebo, and found that patients treated with propofol experienced a significantly greater reduction in nausea and vomiting postoperatively (81% *versus* 35% success rate), and concluded that propofol had significant direct anti-emetic properties[46].

Neuromuscular blocking agents

The use of muscle relaxants in outpatient surgery varies depending on the type of surgical procedure, the type of anaesthesia, the length of the procedure and the inclinations of the anaesthesiologist. There is no data to suggest that there are any differences among the muscle relaxants in regards to their propensity to cause postoperative nausea and vomiting. However the use of acetylcholinesterase blocking drugs as reversal agents has been shown to increase the incidence of nausea and vomiting, because of the muscarinic effects of these agents which can increase gastrointestinal motility. King et al.[47] studied patients undergoing elective hip or knee surgery and randomly allocated patients to receive either neostigmine and atropine, or placebo. They found a significantly higher incidence of vomiting in the group that received neostigmine in comparison to the group that did not (47% *versus* 11%).

A more recent study[48] compared reversal of atracurium with either edrophonium and atropine, neostigmine and atropine, pyridostigmine and atropine or no reversal therapy, and found significantly more postanaesthesia nausea and vomiting with the neostigmine group. Another study[49] compared the use of glycopyrrolate to atropine when used with neostigmine reversal. They found a significantly higher incidence of nausea (28%) in the patients receiving glycopyrrolate as opposed to those receiving atropine (8%). They speculated that the inability of glycopyrrolate to cross the blood-brain barrier, because of its quaternary nitrogen structure, prevents inhibition of vagal tone centrally which may be a contributing factor in the genesis of nausea and vomiting. The implication of vagal tone as a factor in postoperative nausea is suggested by the effectiveness of scopolamine in preventing postoperative nausea, which presumably blocks increased vagal tone often experienced in the perioperative period. Based on the above data it seems prudent to utilize reversal agents only when necessary, and the available literature, though sparse, does suggest that the use of edrophonium and atropine may be preferable to the use of neostigmine and glycopyrrolate, at least in regards to the incidence of postoperative nausea and vomiting.

Patient factors

There are a number of predisposing factors specific to patients that have been associated with increased incidences of postoperative nausea and vomiting. These include young age and female gender. Women have been shown to be two to four times more likely to experience postoperative nausea and vomiting than men[29]. Recently investigators have found that the incidence of postoperative nausea and vomiting in women is increased if the procedure is performed during the menses[50,51].

Obesity has also been implicated as a causative factor in postoperative nausea and vomiting because of increased sequestration of drugs in fat compartments, slower metabolism, and prolonged release of anaesthetics. However, recent studies have shown that body mass index is not associated with increased postoperative nausea and vomiting, when ventilation by mask is avoided prior to the induction of anaesthesia[24]. It is hypothesized that by eliminating positive pressure ventilation by face mask, one decreases the likelihood of gastrointestinal distention from forced gas, which would be more likely to happen in obese patients who are generally more difficult to ventilate.

It has also become clear that patients with a preoperative history of nausea and vomiting from previous surgical procedures, or patients with a history of motion sickness, have increased incidences of postoperative nausea and vomiting. This can be an important factor in patients travelling home after their procedure as is the norm in ambulatory patients. These patients may be very likely to experience postoperative nausea and vomiting after they leave the facility, even if they did not have any symptoms in recovery. It is important to identify these patients beforehand so that they can be targeted for prophylaxis.

Type of surgical procedure

The incidence of postoperative nausea and vomiting is influenced by the type of surgical procedure when performed under general anaesthesia. In the paediatric population, it has been shown that strabismus and orchidopexy surgery is associated with a significantly higher incidence of postoperative nausea and vomiting. Caldamone and Rabinowitz[52] found that up to 5% of their patients undergoing outpatient orchidopexy needed to be admitted to the hospital for either nausea, vomiting, drowsiness or more extensive surgery. They found that a 4–6 hour recovery room stay was the rule rather than the exception. In the paediatric population, tonsillectomies and adenoidectomies as well as middle ear surgery and otoplasty, have also been shown to have a higher incidence of postoperative emesis[53]. In the adult population, increased frequencies of postoperative emesis have also been reported in patients undergoing otologic procedures as well as ophthalmic and gastrointestinal procedures[54,55]. Recently Pataky et al.[56] found that laparoscopic surgery, such as laparoscopic ovum retrieval, had the highest incidences of postoperative nausea and vomiting in an ambulatory surgical setting. They also

found that the length of stay in the PACU was 50% greater in patients who had postoperative nausea and vomiting. They suggested that administrators establish ideal scheduling principles in which patients scheduled for procedures with higher incidences for emesis be scheduled early in the day, and that a separate step down recovery unit would be desirable to have for these patients so that their presence would not disrupt the function or capacity of the ambulatory unit.

Postoperative factors

Pain has frequently been quoted as a major reason for postoperative nausea and vomiting. Andersen and Krohg[57] are the source of this widely quoted aetiology, and this would seem to be supported by the increased incidence of emesis following naloxone antagonism of narcotic mediated pain relief[58]. However, their study only examined inpatients undergoing abdominal surgery, which may not be applicable to other surgical procedures in ambulatory settings. Recently, in a study looking at ambulatory arthroscopic knee surgery[59] a relationship between pain and nausea and vomiting could not be established. It is likely that the degree of pain, the site, and the type of pain, i.e. visceral or peripheral, all contribute towards the likelihood of producing postoperative nausea and vomiting.

Ambulation postanaesthesia is a frequent cause of postoperative nausea and vomiting, and may be due to postural hypotension in the postoperative period, either from residual vasodilatation from anaesthetic drugs, or residual sympathectomy after regional anaesthesia. Sudden movement may also stimulate the vestibular system which can be sensitized by the prior use of opioids. These postoperative factors are probably the reason for the success of ephedrine in preventing postoperative nausea and vomiting by reversing postural hypotension and residual vasodilatation[60].

Prophylaxis and treatment of postoperative nausea and vomiting

It is ideal that the problem of postoperative nausea and vomiting be managed with a prophylactic approach, particularly in those patients identified to be at risk. It is not necessary that all outpatients be prophylaxed because many of the agents have side effects. However, small doses given prophylactically may reduce the overall discomfort and inconvenience experienced by ambulatory patients. Outpatients, often less sedated than their inpatient counterparts are eagerly waiting to go home, making them more likely to be upset by postoperative nausea and vomiting.

Unfortunately, preventive therapy will not be able to eliminate totally the incidence of postoperative nausea and vomiting, and timely intervention is therefore very important. The anaesthesiologist should write for postoperative anti-emetics when the patient is brought to the PACU, or standing orders should be available for the PACU nurses. This will avoid delays that are so common in trying to reach the anaesthesiologist or surgeon to give specific orders each time. Preprinted order forms with strict guidelines will allow prompt treatment of postoperative nausea and vomiting.

Table 2. Agents utilized for postoperative nausea and vomiting

Benzquinamide (Emete-Con)
Hydroxyzine (Vistaril)
Prochlorperazine (Compazine)
Trimethobenzamide (Tigan)
Transderm scopolamine
Diphenhydramine (Dramamine)
Droperidol (Inapside)
Metoclopramide (Reglan)
Ephedrine
Ondansetron (Zofram)

Specific agents

Over the years there have been numerous agents utilized for the control of postoperative nausea and vomiting in the PACU (Table 2). Many of these agents are of historical value only and have found limited efficacy in the postoperative setting. A major problem with these agents is over-sedation which is an exceedingly important consideration in the ambulatory setting.

The two agents most commonly used by anaesthesiologists for postoperative nausea and vomiting are droperidol and metoclopramide. Droperidol is a highly effective anti-emetic agent when given in a low dose intravenously and does not appear to affect discharge times significantly[61]. Dosage guidelines for low dose intravenous droperidol range from 0.625 mg to 0.125 mg for the average adult. In the paediatric population, 20 μg kg^{-1} i.v. of droperidol has also been found to be efficacious[62]. Droperidol is a long acting medication and can be given prophylactically at the beginning of the case or it can be used to treat emetic symptoms postoperatively. Droperidol in higher doses has been reported to cause sedation and can also potentiate other central nervous system depressants that are given either intraoperatively or postoperatively. Droperidol is also an α blocker which may cause vasodilatation and postoperative hypotension. It should be used cautiously in patients who are hypovolaemic, dizzy upon standing or who have low blood pressure. Rarely, droperidol may also cause an acute dysphoric reaction as well as extra-pyramidal symptoms such as dystonia or oculogyric crisis. Should this occur, the treatment is benztropine (Cogentin 1–2 mg), or diphenhydramine (Benadryl 25–50 mg). Recently, Melnick et al.[63] reported delayed side effects from droperidol after general anaesthesia for minor outpatient procedures. They found that patients given droperidol reported anxiety or restlessness significantly more often than patients who did not receive droperidol. They suggested that the routine prophylactic use of droperidol in all outpatients may not be appropriate, and should probably be reserved for those patients at high risk. This is, however, an isolated report that has not been resubstantiated.

Metoclopramide has central anti-dopaminergic effects similar to droperidol, however, it is the only anti-emetic that also specifically acts on the upper gastrointestinal tract. Metoclopramide is a gastro-prokinetic drug, which sensitizes the upper gastrointestinal tissues to the action of acetylcholine, thereby stimulating gastric motility. Metoclopramide also increases the resting tone of the lower oesophageal sphincter, relaxes the pyloric sphincter and duodenal bulb during gastric contractions, and simultaneously increases peristalsis of the proximal small bowel. The net result is an accelerated gastric emptying time and small bowel transfer time. This medication therefore has applications in the preanaesthetic period to help eliminate gastric contents and prevent aspiration, while also helping to decrease the incidence of nausea and vomiting. Prior treatment with anticholinergic drugs do not inhibit the gastric prokinetic actions of metoclopramide in normal patients as it does in obese patients, though the reasons for this difference are not clear[64,65].

Because metoclopramide is a relatively short-acting medication with a duration of about 2 hours, it may need to be repeated at the end of a long procedure or in the PACU. The usual doses of metoclopramide are 10–20 mg 70 kg^{-1} for the average adult patient. Much higher doses are utilized for prevention and treatment of chemotherapy induced nausea and vomiting, with doses up to 1 mg kg^{-1}. The use of lower doses in the postoperative setting may explain why some studies have not found significant anti-emetic effects from metoclopramide in outpatient settings[66,67]. Metoclopramide is much less likely to cause side effects or extra-pyramidal symptoms, though these have been reported[68] and are more likely to occur at higher doses. Should extra-pyramidal symptoms occur the treatment would be similar to droperidol (i.e. benztropine or diphenhydramine). It must be remembered that metoclopramide, with its gastro-prokinetic action, is contraindicated in patients with bowel obstruction or partial bowel obstructions, and both droperidol and metoclopramide are contraindicated in patients with Parkinson's disease, because of their central anti-dopaminergic activity.

While droperidol and metoclopramide therapy have been found to be useful in the postoperative ambulatory surgical setting, they are not always completely effective nor do they always prevent postoperative nausea and vomiting. Combination therapy has been suggested as a method of increasing the amount of anti-emetic drug given without a concomitant increase in the incidence of sedation or side effects. Doze et al.[69] compared droperidol to the combination of droperidol and metoclopramide and found that the combination was more effective in preventing nausea and vomiting than droperidol alone.

Other investigators have approached the problem of postoperative nausea and vomiting from the perspective of motion sickness. It has been well documented that a history of motion sickness is a strong predictive factor in postoperative nausea and vomiting. Dimenhydrinate (Dramamine) is a commonly used anti-motion sickness drug that has been found to decrease the incidence of postoperative nausea significantly, in comparison to droperidol (8% *versus* 21%) and placebo (8% *versus* 34%)[70]. Dimenhydrinate is an antihistamine and its anti-motion sickness effect is thought to be due to a combination of its primary H^1-blocking effect and central anti-cholinergic action.

Ephedrine has also been studied for the prevention of postoperative nausea and vomiting in outpatients. Rothenberg et al.[70] found ephedrine (0.5 mg kg^{-1} i.m.) to be as effective as droperidol (0.04 mg kg^{-1} i.m.) in reducing the incidence of nausea and late vomiting, with significantly less postoperative sedation in the ephedrine group. Ephedrine has been found effective in the prevention of motion sickness in astronauts[71], and is commonly used to treat nausea and vomiting following hypotension after spinal and epidural anaesthesia, where it reverses the hypotension from the induced sympathectomy. The mechanism for ephedrine in the prophylaxis of motion sickness is postulated to be the altering of unusual vestibular inputs, and applicable to other classes of sympathomimetics and parasympatholytic agents. After a general anaesthetic, patients are frequently volume depleted or may have residual vasodilatation from inhalational anaesthetic agents, which may cause nausea and vomiting when patients are sat upright or try to ambulate. This of course would be reversed by ephedrine, which may explain some of its efficacy for postoperative nausea and vomiting.

Ondansetron

A new medication that has recently been introduced into anaesthesia practice for controlling postoperative emesis is ondansetron. This is a new class of anti-emetic that has been utilized for chemotherapy-induced nausea and vomiting for a number of years. It is a serotonin receptor ($5\text{-}HT_3$) antagonist, which has both central and peripheral mechanisms of action. Ondansetron (Zofram) was found to be highly effective compared to placebo in the postoperative setting when used in a dose of 8 mg intravenously[72]. Leeser and Lip[73] studied the prophylactic effect of ondansetron for postoperative nausea and vomiting utilizing a 16 mg oral dose and found a significantly decreased incidence of nausea and vomiting (17% and 12%) *versus* the placebo group (52% and 40%). They repeated their dose 8 hours after the initial dose and found similar differences throughout the entire 24 hour study period after recovery. Unfortunately, the drug is currently expensive, though if it prevents an unduly long recovery stay or an unanticipated hospital admission it would be well worth the cost.

Nonpharmacologic approaches

A new nonpharmacologic approach to the control of postoperative nausea and vomiting is acupressure and/or acupuncture[74]. Dundee et al. studied women undergoing minor gynaecologic operations with manual and electrical acupuncture and found a markedly reduced incidence of postoperative nausea and vomiting in the first 6

hours after surgery compared with untreated controls. They also found that noninvasive stimulation via a conducting stud or pressure, were equally as effective as invasive acupuncture during the early postoperative period, though less effective than invasive acupuncture. In patients undergoing chemotherapy they found that the duration of action could be prolonged by application of pressure every 2 hours to the acupuncture point with a duration up to 24 hours[75]. A commercially available product called Sea-Band (Travel Accessories, Solen, Ohio), is available for travellers and consists of an elastic band with a bead stud that rests over the P6 (Neiguan) acupuncture point, and has been reported to be efficacious for postoperative vomiting[76]. In the paediatric population, however[77], investigators were not able to find any significant anti-emetic effect from the acupressure point in ambulatory strabismus surgery patients. Further investigations for the role of this modality are needed.

Conclusions

Persistent postoperative nausea and vomiting in the PACU may require repeated doses of anti-emetics and may also require that more than one type of anti-emetic be utilized. Standing orders should be available for prompt and rapid institution of such therapy and careful attention must be given to pain control and the patient's volume status. It should be remembered that intravenous fluids should be increased to account for fluid losses and should be maintained until all fluids are tolerated.

It is important that there is good communication between the anaesthesiologist, the patient and the patient's family. The patient should be warned prior to the procedure, during the preoperative interview, that nausea and vomiting are common side effects of anaesthesia and surgery. If warned in advance, patients will be much more receptive should postoperative emesis become a problem, and will be better able to handle it from a psychological point of view. Although rare, there will be the occasional patient for whom postoperative nausea and vomiting will be refractory to all efforts to control it. Patients with persistent nausea and vomiting should be treated with maximal doses of anti-emetics, notwithstanding the fact that postoperative sedation may be increased. It is preferable to admit a patient for oversedation with controlled nausea and vomiting, than unsedated with uncontrolled nausea and vomiting.

In summary, it appears clear that postoperative nausea and vomiting continues to remain an important and clinically significant problem in the ambulatory surgery setting. An understanding of the factors that predispose patients to postoperative nausea and vomiting can help target patients who are high risk, as well as help the anaesthesiologist tailor an anaesthetic to minimize postoperative nausea and vomiting. The use of regional anaesthesia or general anaesthesia with propofol seems to be associated with lower incidences of postoperative nausea and vomiting. Small doses of multiple anti-emetic agents as well as the use of newer agents such as ondansetron hold promise for improved control of postoperative nausea and vomiting. Recognition of the problem, and prompt treatment in the PACU, ideally with the use of standing orders, is imperative. The problem of postanaesthetic nausea and vomiting requires a cooperative effort among the anaesthesiologist, the PACU nurse, and the patient, all working toward the goal of decreasing or preventing patient morbidity and improving patient safety, comfort and recovery.

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