

## SURGICAL AND PATIENT FACTORS INVOLVED IN POSTOPERATIVE NAUSEA AND VOMITING

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Seventy-five years ago, Flagg suggested that postoperative vomiting may result from causes other than anaesthetics: "there are at least three kinds of vomiting", the first of which he attributed to anaesthetics such as ether, the second to reflex responses, that is pain or ovarian surgery, and the last to opioids, for example morphine [30]. Before this report, anaesthetics alone were thought to be responsible for most postoperative nausea and vomiting (PONV). Subsequent investigations unfolded a spectrum of non-anaesthetic factors in the pathogenesis of PONV including age, gender, motion sickness, body habitus, surgical site and postoperative feeding procedures. This review summarizes our current understanding of the roles of two categories of non-anaesthetic factors, patient and surgical factors, in the pathogenesis of PONV.

Despite the recent advances in modern anaesthesia, only modest progress has been made in our understanding and treatment of PONV. Early studies reported incidences of PONV as high as 75-80% after opioid premedication and prolonged ether anaesthesia [4, 11, 13, 47, 83, 84]. In many of these reports, the patient population, premedication, anaesthetic and the surgical procedure were not controlled. In the second half of this century, however, these incidences have decreased by almost 50% for various reasons [7, 8, 16, 17, 24, 31, 45, 46, 59, 62, 70, 74, 80, 85]. Although the most common reason proffered for this dramatic reduction in PONV has been a change in anaesthetic practice from opioid premedication and deep ether anaesthesia to non-opioid or supplemented opioid premedication, lighter non-ether anaesthesia and barbiturates [34, 70], there have been no studies to support this hypothesis. Indeed the difficulty we have in explaining this reduction in the incidence of PONV in the past 30 years is symptomatic of the difficulty in understanding this entire area of the anaesthetic literature. It is evident that PONV is affected by many factors, including age and gender of the patient, premedication, anaesthetic technique and medication, postoperative analgesia and regional blocks, and type of surgery. The paucity of con-

trolled, randomized, blinded studies makes it extremely difficult to establish the contribution of any of these factors, in whole or in part, to the incidence of PONV. In addition, there is lack of standardization of such basic issues as the period of observation in the post-anaesthetic period (ranging in some studies from 2 to 48 h) [7, 17, 22, 25, 34, 40, 53, 55, 57, 59, 72, 74] and the definition of nausea and vomiting [21, 34, 50]. As a consequence, the benefits of more sophisticated statistical analysis such as meta-analysis to identify causative factors in PONV has not been possible. More recently, investigators have undertaken scientifically rigorous studies under rigid and controlled conditions to identify the role of patient, surgical and anaesthetic factors in the incidence of PONV, thereby avoiding many of the problems of previous studies. It is my expectation that the contributions of patient and surgical factors to the incidence of PONV will be firmly established in the near future by the results of these rigorous scientific studies.

As the proportion of surgery has changed from inpatient to day-case surgery, the importance of factors associated with post-anaesthetic morbidity such as PONV has received increasing attention. The reason for this is a 1% incidence of unanticipated admission after day-case surgery [66]. Of the factors responsible for this admission rate, several merit consideration, including general anaesthesia, PONV, lower abdominal and urological surgery, anaesthetic and surgical time exceeding 1 h and age [33].

The incidences of PONV have remained fairly constant at 10% in the recovery room and 30% for the first 24 h after anaesthesia in several large series of patients for the past several decades. There may be several reasons for our lack of progress in reducing the incidence of this problem. The first is the vague definitions of PONV in the literature. Nausea remains a subjective complaint that requires patients to express their feelings. This complaint is difficult to elicit in children. In contrast, vomiting is an objective finding that ranges in severity from retching to protracted vomiting and may be quantitated in all age groups, including infants and children. In some studies, nausea, vomiting and

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(Br. J. Anaesth. 1992; 69 (Suppl. 1): 24S-32S)

### KEY WORDS

*Surgery. Vomiting: nausea.*

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TABLE I. Patient and surgical factors affecting PONV

Patient factors	Surgical factors
Age	Site of surgery
Body habitus	Adenotonsillectomy
Gender	Ocular
Delayed gastric emptying	Strabismus
Anaesthetic history	Gastric suction
Motion sickness	Mask ventilation
Anxiety	Gynaecological
	Duration of surgery
	Miscellaneous
	Postoperative fluids

retching were recorded whereas in others, only vomiting was recorded. These inconsistencies have limited the significance of interstudy analyses. The second reason is the non-rigorous nature of many of these studies on PONV. Many of the early studies on PONV were retrospective and there was no standardization of anaesthetic technique, patient population and surgical procedure; in some instances control groups and randomization of treatments were omitted. Because of these inconsistencies in study design, meta-analysis has been of limited value in clarifying the roles of these factors in PONV. The third reason was the relative low priority given to PONV as a postoperative complication. As PONV was not usually a life-threatening postoperative complication and because most patients were admitted to hospital for at least one night after surgery, there was little incentive to pursue this problem.

In the last two decades, however, there has been a renewed interest in the mechanisms of PONV, and pharmacological and non-pharmacological interventions that may reduce the incidence. Furthermore, recent studies have focused on manipulating only one variable at a time in controlled, blinded and randomized studies, thereby providing scientifically rigorous data on PONV. In addition, the rapid and dramatic shift from inpatient to day-case surgery in the past decade has resulted in a critical reappraisal of all postoperative complications, particularly those that delay discharge from the recovery room unit and those that lead to an unanticipated admission to hospital such as PONV.

This review examines two categories of factors that affect PONV: patient and surgical factors (table I).

#### PATIENT FACTORS

##### Age

The relationship between the incidence of PONV and age has been difficult to clarify from the literature, partly because of the effects of confounding uncontrolled variables such as premedication, gender, surgical case mix, anaesthetic technique and the duration of postoperative data collection. In spite of the effects of these confounding variables, there is evidence that the incidence of PONV changes with age: the incidence is least (5%) in infants (< 12 months of age) [19], increases to 20% in children less than 5 yr of age [19, 71, 86], to a maximum of 34–51% in late childhood (6–16 yr of age) [19, 71, 72, 74, 80, 86] (fig. 1), remains constant

or decreases slightly throughout adulthood (14–40%) [8, 16, 17, 20, 24, 46, 68, 74, 80, 85] and into the eighth decade [8, 47, 59, 74].

The incidence of PONV in adults is approximately 25%, ranging between 5% and 75% [13, 17, 20, 21, 47, 68, 74]. The lowest incidence reported (5%) reflects only those patients in whom PONV was greater than expected and required treatment [21]. A recent multicentre study reported incidences of PONV between 11 and 21% for a wide range of surgical procedures and patients [20]. These probably reflect more accurately the current incidence of PONV in clinical practice.

The incidence of PONV in children varies between 9 and 38% [19, 80]. Patel and Hannallah reported only a 9% incidence in their 3-yr review which may represent a different case mix (ambulatory surgery that excluded tonsillectomies) [66]. Few studies have compared the incidences of PONV in children and adults under controlled conditions, (i.e. similar premedication, anaesthetics and surgery). Vance, Neill and Norris reported their experience with plastic surgery and found that the incidence of PONV in children (up to 12 yr of age) (38%) was twice that in adults (17%) [80]. The results of the latter study are consistent with those of a more recent very large review [19]. In the same study, the results were clear and uncomplicated as all children were unpremedicated and opioids were used sparingly. The greater incidence of PONV in children [19] compared with adults [21], however, must be interpreted with caution as the postoperative follow-up data were not collected prospectively for 24 h in all patients. Nevertheless, the infrequent use of premedication and opioids in their paediatric cohort suggested that PONV was caused by other factors, such as patient and surgical factors. These include characteristics unique to paediatric surgery (i.e. strabismus and tonsil surgery), anxiety, fear and pain [19]. Further studies are required to elucidate the importance of each of these factors in determining the incidence of PONV.

The small incidence of PONV in the infant age group may reflect an increased threshold for PONV, surgical factors such as the case mix, lack of effects of premedication or increased frequency of tracheal intubation [19, 71]. We have had a similar experience with the incidence of PONV in infants and children undergoing strabismus surgery [89].

##### Body habitus

Several reports have suggested that body habitus is an important determinant of the incidence of PONV, that is the incidence of PONV is greater in obese patients than in asthenic patients [4, 8, 74, 83]. However, these studies too were flawed by the presence of confounding variables. A possible relationship between PONV and body habitus was investigated in a well designed study of females undergoing first trimester abortion controlled for many of these variables [54]. Their results supported the existence of such a relationship. In spite of these studies, however, no relationship could be found between body mass index and the incidence of PONV in a recent large and carefully controlled trial

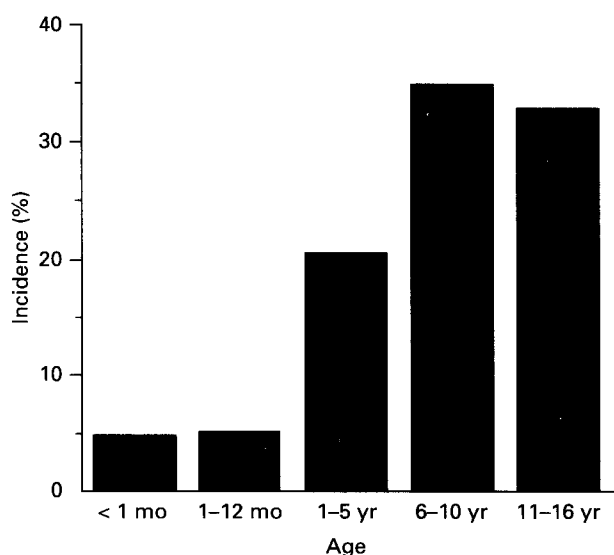


FIG. 1. Relationship between age and the incidence of PONV from infancy to adolescents after a wide range of types of surgery.

[59]. It is notable in the latter study that the lungs of these patients were not ventilated by mask before tracheal intubation. In fact, it is unclear if the relationship between body habitus and PONV reported in the above studies resulted from difficulties in anaesthetizing these patients (i.e. hypoxaemia, hypercapnia, hypotension or gastrointestinal distension leading to PONV) or obesity itself. On balance, at the present time there is insufficient evidence to conclude that a relationship between body mass index and PONV exists. Further studies are required to firmly establish a relationship between body habitus and PONV.

#### Gender

The incidence of PONV in adult females is approximately two to three times that in adult males [8, 17, 23, 29, 47, 59, 68, 74, 78, 90] and the severity of vomiting greater than that in males [68]. It has been suggested that this difference depends, in part, on the type of surgery: the incidence of PONV in females is similar to that in males after extra-abdominal surgery, but greater than that in males after abdominal surgery [27]. In surgery not normally associated with a high incidence of PONV, such as orthopaedic surgery, females have a high incidence of PONV (55% nausea and 40% vomiting) [48]. The greater incidence of PONV in females compared with males has been attributed to fluctuations in female sex hormone concentrations during the menstrual cycle [7, 74]. The greatest incidence of PONV in adult females occurs during the third and fourth week of the menstrual cycle [7]. Two recent retrospective studies explored the relationship between the incidence of PONV and the phase of the menstrual cycle. Both groups of women underwent gynaecological laparoscopy with similar anaesthetic techniques. In the first study [6], the overall incidence of PONV was 46%: the incidence was greater during the luteal phase (periodical data (Pd) 20-24, 77%) compared with that during the follicular (Pd 8-12, 32%) and pre- and menstrual

phases (Pd 25-6, 18%). Nausea, retching and emesis were recorded during the 24 h after surgery. In the second study [38], the incidence of PONV was only 28%: the incidence was greater during the menstrual period (Pd 1-8, 51.6%) compared with that during the remainder of the menstrual cycle (21.6%). The discrepancy in results between these two studies may be attributed in part to the following: Beattie and colleagues reported PONV only during the first 2 h after surgery [6] whereas Honkavaara reported the incidence during the first 24 h [38]; and in both studies the serum concentrations of female sex hormones were not measured. If a relationship between PONV and the menstrual cycle exists, a prospective study in which PONV and female sex hormone concentrations are determined at the time of surgery is recommended.

The relationship is limited to adults as there appears to be no gender predilection for PONV in children less than 11 yr of age [7, 71, 74] or in the elderly in the eighth decade. This is consistent with similar concentrations of sex hormones in males and females in these age groups.

#### Delayed gastric emptying

The likelihood of PONV increases when gastric motility and emptying is retarded. Conditions associated with delayed gastric emptying include gastrointestinal obstruction, pyloric stenosis, collagen vascular disorders (i.e. scleroderma), endocrinopathies (i.e. diabetes mellitus), neuropathies, myopathies, uremia, raised intracranial pressure and pregnancy [66]. Premedication with, for example opioids and barbiturates, given to allay preoperative anxiety, may also delay gastric emptying thereby predisposing to PONV.

#### History of PONV after anaesthesia or motion sickness

Several investigations have suggested that patients with a history of PONV after previous anaesthesia, or motion sickness, are more susceptible to PONV than those without a history [4, 17, 40, 44, 59, 68]. In one study, patients with a previous history of PONV experienced a three-fold greater incidence of PONV after a subsequent anaesthetic when the follow-up period was 24 h [68]. When the post-operative follow-up period was restricted to 6 h, a history of PONV did not correlate with an increased incidence of PONV [68, 70]. Susceptibility to motion sickness and adaptation to this phenomenon varies from individual to individual [76]. Further studies are required to clarify this relationship.

#### Anxiety

The importance of preoperative anxiety as a determinant of PONV has not been established. Preoperative anxiety is believed to delay gastric motility (and emptying) and increase gastric fluid volume, possibly via increased circulating stress hormones [61]. These hormones have been shown to induce emesis when instilled into the ventricles of cats [43]. Infants and children who are anxious often swallow large volumes of air and anaesthetic gases during induction of anaesthesia. In combination

TABLE II. Surgical site as a determinant of PONV in adults [65] and children [71]. (\*High incidence secondary to narcotic administration)

Adults		Children	
Site	Incidence (%)	Site	Incidence (%)
Ovum retrieval	54	Cardiac catheterization	72*
Laparoscopy	35	Strabismus	76
Knee arthroscopy	22	Hernia, orchidopexy	54–58
Dental	16	Adenotonsillectomy	58
Dilatation and curettage	12	Plastic, penile, orthopaedics	37–49
		Removal of sutures	18

with the effect of nitrous oxide on the volume of gas within the gastrointestinal tract, this may contribute to the high incidence of PONV.

#### SURGICAL FACTORS

##### *Site of Surgery*

The relationship between the site of surgery and the incidence and severity of PONV is unclear. In two large studies, differences could not be detected in the incidence of PONV among a large variety of surgical sites [17, 47]. However, the difficulty of investigating such an effect is related to possible masking of a causal relationship by confounding variables (such as age, gender, premedication, anaesthetic and opioid administration). Nonetheless, there is increasing evidence that certain surgical sites may be associated with a greater frequency of, and in many instances, severity of PONV (table II): for example, intra-abdominal surgery (intestinal, gall bladder) has an incidence of 70% compared with 15% for abdominal wall surgery [13] with laparoscopic (gynaecological 40–77%) [5, 40, 41, 55] and ear surgery (47%) greater than head and neck surgery (25–33%) [80], and the smallest incidences reported after dental, dilatation and curettage (not involving evacuation of the uterus) [26] and peripheral and superficial extremity surgery [13, 60, 65, 79].

In children, the surgical case mix differs from that in adults (table II). The surgical site associated with the greatest incidence of PONV in children is strabismus surgery. Hernia, orchidopexy and adenotonsillectomy are associated with the next most frequent incidence, and peripheral minor surgery the least likely to lead to PONV [71]. It is likely that more than one mechanism mediates the responses that culminate in PONV. PONV after intra-abdominal surgery may result from stimulation of autonomic afferents (i.e. vagal or sympathetic) from the intestinal wall or peritoneum or a resultant ileus and after adenotonsillectomy from irritant effects of blood on the gastrointestinal tract.

##### *Adenotonsillectomy*

The incidence of PONV after adenotonsillectomy in children is 36–76% [35, 63, 69, 71, 87]. There are three causes for the high frequency of PONV after adenotonsillectomy: (1) irritant effect of blood on oesophagogastric chemoreceptors and nociceptors [15, 22, 75]; (2) irritation of trigeminal nerve

afferents during surgery [15]; and (3) postoperative opioid administration. To minimize the effect of the first mechanism of PONV, direct oral suctioning is used during surgery to supplement cautery for haemostasis. Postoperative management includes positioning the child head down in the lateral decubitus position. The second and third mechanisms are difficult to control, although non-steroidal anti-inflammatory drugs may be effective.

##### *Ocular surgery*

Ophthalmological surgery is associated with a high incidence of PONV [1, 10, 36, 50, 81]. However, PONV does not uniformly affect all types of ophthalmological surgery: the incidence after intraocular and non-squint non-intraocular surgery is approximately 50% that after strabismus surgery [9, 10]. This may be explained, in part, by the older age of the patients and the less stimulating nature of intraocular surgery (*vis a vis* the autonomic nervous system) compared with younger patients undergoing strabismus surgery [10]. The remainder of this discussion concentrates on strabismus surgery.

##### *Strabismus surgery*

Vomiting is the most frequent postoperative complication after strabismus surgery. The incidence of PONV ranges between 40% and 88% in children older than 2 yr of age [1, 9, 10, 14, 36, 39, 49–51, 81, 86, 88]. Age also affects the incidence of PONV after strabismus surgery (4–30 months, 28%; 3–18 yr, 57%) [86], although this is not supported by previous data [9]. PONV occurs rarely in the immediate post-anaesthetic period (i.e. the first 2 h after surgery) [72, 86]. In most instances, it begins after return to the ambulatory unit, during the journey home or at home 2–8 h after surgery. PONV may continue for up to 24 h after surgery.

*Aetiology.* The aetiology of vomiting after strabismus surgery is unclear. Several hypotheses have been proposed in an attempt to explain this phenomenon [9, 50, 81, 89]. These include traction on the extraocular muscles, distorted visual images, early ingestion of postoperative fluids and labyrinthine pathways. Manual traction on the extraocular muscles during surgery stimulates afferent neural pathways to the vomiting centre via the ciliary ganglion or labyrinthine pathway (oculogastric or oculo-emetic reflex). This resets the vomiting centre for emesis after emergence from anaesthesia. The second hypothesis invokes the effect of acute cor-

rection of the alignment of visual axes. The effect of a sudden change in axes might result in distortion of the visual images and PONV (optokinetic imbalance). To test this hypothesis, we covered the surgical eye in 60 children (who received no pharmacological prophylaxis for emesis) but found that this did not significantly decrease the incidence of PONV after strabismus surgery [Arellano and Lerman, unpublished data, 9]. The third hypothesis proposed to explain the incidence of PONV in these children is that of an emetic response to mandatory intake of clear fluids before discharge from hospital. Included in the discharge criteria for children after ambulatory surgery in most paediatric institutions at present is that the children ingest and tolerate clear fluids. Schreiner and co-workers reported that mandatory oral fluid intake after strabismus surgery was associated with a four-fold greater incidence of PONV in the ambulatory unit and a 50% prolongation of hospital stay compared with a group of children in whom fluid intake was elective [72]. Unfortunately, the authors did not provide data on the incidence of PONV *after* discharge from hospital for each of the two strabismus groups. In another study of fluid intake after surgery, parents were asked to withhold fluids 4–6 h or longer depending on the age of the child [86]. PONV was delayed until after discharge from hospital in 90% of those who vomited, although the incidence of PONV overall was similar to that reported previously (57%) [86]. However, the significance of the latter report is limited by the fact that parents were informed that early oral fluid intake may cause vomiting and that a control group was not included. The fourth hypothesis relates to the effects of changes in head position or motion on PONV. If sudden changes in head position or motion sickness initiates vestibular afferents to the vomiting centre, this could result in PONV [86]. Based on these studies, it would appear that traction on the extraocular muscles resets the vomiting centre such that emesis occurs after the first or second oral intake. Delaying the injection of clear fluids has no effect on the incidence of emesis, but clears the ambulatory unit and transfers the site of PONV from the day-case unit to home, or the journey to home.

*Additional factors implicated in strabismus surgery.* Several factors have been shown to increase the incidence of vomiting after strabismus surgery. Anterior displacement of the inferior oblique muscle is associated with a significantly greater incidence of PONV than is surgery involving other extraocular muscles [89]. This observation is consistent with the hypothesis that the probability of PONV increases as traction on the extraocular muscle increases. Thus less accessible muscles (such as the inferior oblique), are more likely to result in PONV after surgery.

Several other factors have been implicated in the high incidence of PONV after strabismus repair. Vomiting occurs more frequently after strabismus surgery in children > 3 yr of age than it does in infants and children < 3 yr of age [72, 86, 89]. Administration of oral fluids to children on recovery from strabismus surgery increases the incidence of postoperative vomiting compared with children who

drink only when they request fluids [72, 86]. In a large retrospective study, repeat surgery was associated with an increase in the incidence of vomiting after strabismus surgery [89], although previous studies have not supported this finding.

*Factors not responsible.* Several studies have demonstrated that the incidence of postoperative emesis does not correlate with the number of extraocular muscles repaired [50, 75]. The incidence of vomiting was found to be independent of the following factors: type of ventilation (spontaneous compared with controlled ventilation), acupuncture (when applied after induction of anaesthesia) [88], i.v. lignocaine [18], covering the surgical eye (optokinetic effect), gender [89], opioids (codeine) [50, 89], duration of anaesthesia [89] and the surgeon [89].

*Therapy.* The type of surgery associated most often with PONV in paediatric anaesthesia is strabismus surgery. Although the morbidity after PONV and the risk of readmission after PONV are small, PONV is one of the most common causes of unanticipated hospital admission in the day-case paediatric surgical population [66, 67]. This is one cause of PONV that merits consideration for therapy, if not prophylaxis.

Abramowitz and co-workers first demonstrated that droperidol 0.075 mg kg<sup>-1</sup> given i.v. at the end of surgery significantly decreased the incidence of PONV after strabismus surgery [1]. Subsequently, we demonstrated that droperidol 0.075 mg kg<sup>-1</sup> decreased the incidence of PONV (24 h follow-up) from 60% to 25% [50]. This dose of droperidol, however, was associated with a 4–6 h recovery period. In an attempt to discharge children earlier, we investigated smaller doses of droperidol (0.025 and 0.050 mg kg<sup>-1</sup>) [28]. These doses were not as effective in attenuating PONV as 0.075 mg kg<sup>-1</sup> but more importantly, did not shorten the recovery period. Several other therapeutic interventions have been investigated recently. I.v. metoclopramide 0.15 and 0.25 mg kg<sup>-1</sup> [14, 51], dixyrazine 0.25 mg kg<sup>-1</sup> [49] and transdermal hyoscine [32, 39] have been used successfully in children to decrease the incidence of PONV after strabismus surgery and, in most instances, without extending the recovery period. I.v. lignocaine has had variable effect on the incidence of PONV after strabismus surgery in children [18, 81]. The effect of the new i.v. induction agent propofol, on the incidence of PONV has recently been reported [82]. Induction of anaesthesia with propofol 3.0 mg kg<sup>-1</sup> i.v. and maintenance with propofol reduced the incidence of PONV after strabismus surgery by 50%.

#### *Gastric suction*

There are conflicting reports on the effectiveness of gastric suction in reducing the incidence, severity or both, of PONV [22, 23, 53, 74]. Gastric distention and an increased likelihood of PONV result from inadvertent inflation during manual ventilation of the lungs via a mask with or without gastric stasis after upper abdominal surgery. This may be attenuated by gastric suction [62]. On the other hand, Palazzo and Strunin [62] suggested that gastric

suction would not attenuate opioid-induced PONV. The incidence of PONV in adult females is reportedly greater after their lungs are ventilated by inexperienced anaesthetists compared with more experienced anaesthetists [42]. Gastric suctioning has also been shown to be of no additional benefit when used to supplement an alfentanil anaesthetic in which droperidol was administered [37]. Several investigators recommend that if a gastric tube is used, it should be inserted after induction of anaesthesia and removed before emergence to minimize pharyngeal stimulation [62]. Early removal is suggested to preclude pharyngeal-induced PONV and has been proposed as a possible mechanism of gastric tube-induced vomiting. Recent evidence suggests that gastric evacuation may be particularly effective after laparoscopic gynaecological surgery [53]. However, a gastric tube that is curled or kinked in the stomach or passed into the duodenum may not only not prevent vomiting, but may stimulate retching and vomiting until it is withdrawn.

#### *Mask ventilation*

Manual ventilation by mask may result in gastric or intestinal inflation, or both. The mechanism by which mask ventilation causes PONV is likely a direct result of forcing gas into the gastrointestinal tract and distending the stomach and bowels. Experience of the anaesthetist may be an important determinant of the magnitude of the effect of mask ventilation on PONV [40]. Previous studies suggested that mask anaesthesia was associated with a greater incidence of PONV than anaesthesia in patients in whom the trachea was intubated [8, 22].

#### *Gynaecological surgery*

The incidence of PONV after gynaecological surgery depends on the type of surgery. Laparoscopy for diagnostic and therapeutic purposes is associated with a 36–60% (median value 50%) incidence of PONV [2, 5, 38, 41, 52, 57, 65]. Although the mechanism of PONV after laparoscopy is unclear, several investigators have apparently decreased the incidence of PONV to 13–33% by avoiding the use of nitrous oxide and fentanyl [2, 57, 73]. Nitrous oxide may contribute to the incidence of PONV during laparoscopy by expanding intestinal and peritoneal gas (primarily carbon dioxide) volumes. Laparoscopy for ovum retrieval and therapeutic abortion (55%) [54, 65], major gynaecological surgery (58%) and hysterectomy (65–77%) [40, 55] are associated with a high incidence of PONV. In contrast, dilation and curettage does not usually cause a high incidence of PONV—incidence of 25–36% [34, 44, 56]. The mechanism of PONV after uterine and gynaecological surgery is unclear. Packing the uterus and pelvic pain have been implicated as possible mechanisms [64].

#### *Other Factors*

##### *Duration of surgery*

Bellville, Bross and Howland reported an almost three-fold greater incidence of PONV after surgery in parallel with an increase in the duration of surgery

[8]. An increased incidence and severity of PONV has been associated with surgery of increasing duration by several investigators [12, 13, 17, 26, 27, 29, 71, 74]. In contrast, duration of surgery was not a significant factor in several studies [34, 47]. The possible relationship between duration of anaesthesia or surgery and the incidence of PONV is not easily explained. Increased effects of premedication, anaesthetics, including nitrous oxide, prolonged fasting and increased pain may contribute to the increased incidence of PONV in these patients.

##### *Surgical position*

The position of the patient during surgery has been implicated in the genesis of PONV. However, Gold found no effect in women undergoing gynaecological surgery [34]. The effect of this factor on the incidence of PONV has not been fully elucidated.

##### *ENT surgery*

The incidence of PONV after ear surgery ranges from 38 to 48% [69, 72, 80]. The type of ENT surgery that is often associated with PONV includes bat ear and middle ear surgery (cholesteatoma, tympanic membrane and ossicular surgery). There is little literature on the incidences of PONV with each of these types of surgery. Although not firmly established, PONV after bat ear surgery may be the result of reflex stimulation through the auriculo-temporal branch of the facial nerve [80]. In contrast, PONV after middle ear surgery may arise from increased middle ear pressure secondary to nitrous oxide or direct labyrinthine pathways [58, 77]. Further studies are required to clarify the extent of the PONV and its pathogenesis.

##### *Pain*

Andersen and Krohg noted that while abdominal surgery resulted in pain, the pain itself was associated with postoperative nausea. Paradoxically, the authors found that opioids did not increase the frequency of nausea, but actually relieved it [3]. It is my impression that in spite of this study, pain-induced nausea occurs infrequently, and that parental opioids are associated with more nausea and vomiting than they relieve.

##### *Post-anaesthetic fluid intake*

PONV has been observed to occur soon after the first fluid intake after emergence from anaesthesia [10]. This has been the subject of discussion for over 30 years [10, 17, 70]. Despite the apparent relationship between post-anaesthetic fluid intake and PONV, many institutions have standing orders that require that patients tolerate clear fluids before they are eligible for discharge from hospital, particularly after day-case surgery. Several authors have suggested that if fluids are withheld after strabismus surgery, adenotonsillectomy and ophthalmic surgery in children, then PONV may be delayed until after discharge from hospital, but even more importantly, the incidence of PONV may be reduced by 50% [72, 86]. In a recent study of postoperative fluid tolerance in children, fluid intake was offered electively only when the children were thirsty and

hungry and they requested fluids. This resulted in a smaller incidence of PONV before discharge from hospital and earlier discharge from hospital but did not decrease the overall incidence of PONV [72, 86]. That is, many of the children vomited during transport home or at home within 24 h of surgery. The readmission rate for children who were discharged without having ingested fluids was small (0–0.06%) and not a cause for concern [72, 86]. When a similar approach was applied to a study of children and adults who were recovering from ophthalmic surgery, the incidence of PONV after fluids were withheld for at least 4 h did not differ significantly from those who had fluids shortly after surgery [10]. However, the latter study may have been limited by too brief a period of postoperative fluid restriction. Nonetheless, if these preliminary data are substantiated by additional studies, oral fluids may no longer be a mandatory prerequisite for suitability of discharge from hospital and may facilitate earlier discharge from hospital. Whether withholding post-anaesthetic fluids attenuates the incidence of PONV remains to be established.

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