POST OPERATIVE NAUSEA AND VOMITING, ITS CAUSES, AND THE WAY OF ITS PREVENTION AND TREATMENT

Surendra Maharjan1, Zhang Bing2

ABSTRACT

Postoperative nausea and vomiting is still occurring in one third of the patient undergoing surgery under general anaesthesia even after following the guidelines and using multi modal approach for its prevention. Lots of studies have been done for its prevention but very few studies are done for its treatment in Post anaesthetic care unit after the failure of prophylaxis. The purpose of this article is to know about the risk factor, incidence of nausea and vomiting after surgery, its mechanism, available medication (pharmacological and nonpharmacological), reducing risk factor, and mainly to know about the method of using the antiemetic medication in PACU after the failure of the prophylactic medication.

KEYWORDS
nausea, prophylaxis failure, rescue drugs, vomiting

Citation
Introduction

Postoperative nausea and vomiting is one of the most commonly experienced side effects of the general anaesthesia which can increase duration of the post anaesthetic care unit stay and leads to increase in duration of hospital stay and increase in financial expense. PONV is about 20% to 30% on the patient under general anaesthesia and is almost about 70-80% in the high-risk patient. Female gender, history of motion sickness or PONV, postoperative opioid use and non-smoking status are regarded as a major risk factor for PONV. Multiple guidelines are available to achieve the target of prevention of PONV. In ambulatory surgery, 0.1% to 0.2% patient get admitted due to PONV. PONV refers to the sensation of nausea and vomiting or retching for up to 24 hours post operation. Researchers have shown that patients are willing to pay more to get rid of PONV. Though multi modal treatment strategies with multiple antiemetic and nonpharmacological methods are being used to prevent PONV we still have an occurrence of PONV in PACU. Enhanced recovery after surgery (ERAS) is all about reduction of morbidity, decrease the hospital stay and recover fast. Thus prevention and treatment of PONV is also one of the many goals of the ERAS.

The main objective of this review is to gain knowledge about the cause of the nausea and vomiting that occurs in the patient who undergoes surgery under general anaesthesia and the ways of its reduction and prevention and what can be done in case of occurrence of Post-operative nausea vomiting. This article also enlightens us about the beneficial effect of the prevention of PONV on patient recovery and early discharge from hospital after undergoing surgery under general anaesthesia.

This review article included altogether 113 literatures. We searched online pubmed and medline for articles published till 2019 using keywords – post operative nausea and vomiting PONV prophylaxis, and rescue.

Pathophysiology of nausea and vomiting

Vomiting is triggered in the vomiting centre which comprises of the lateral reticular formation and nucleus tractussoliatarius of medulla which is inside the blood-brain barrier. The most important trigger zone for vomiting is CTZ (chemical trigger zone) which lies in the area postrema on the wall of the fourth ventricle and inside the blood-brain barrier. Opioids and volatile anaesthetic agents act on CTZ to trigger nausea and vomiting. Vestibular and gastrointestinal afferent send emetogenic stimuli to the vomiting centre and stimulate for nausea and vomiting. Input from higher cortical centres, the cerebellum, glosopharyngeal nerve stimulation and vagal stimulation can also induce the vomiting centre and cause nausea and vomiting. Vestibular system also contributes in the generation of nausea and vomiting via motion and vertigo. Figure 1.

<table>
<thead>
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<th>Risk factor</th>
<th>Points</th>
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<th>PONV risk %</th>
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<td>History of PONV /motion sickness</td>
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</tr>
<tr>
<td>Postoperative opioids</td>
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<td>4</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td>0-4</td>
<td></td>
<td>10-80</td>
</tr>
</tbody>
</table>

Simplified risk score in adults (Based on Apfel’s simplified risk score)
The risk factor of PONV can be either patient related, anaesthesia related or surgery related.

**Patient related**

**Gender**

Female gender suffers three times more PONV than the male. The high prevalence of PONV in female gender is believed to be caused by the fluctuation of female hormone during menstruation cycle. This relationship is limited to the adults only as there is no difference in PONV in children before puberty and elderly above eighty years. However many studies have failed to show the differences in PONV in different stages of the menstruation cycle. Some authors have shown that this gender difference in PONV is also seen in old age when hormones levels (gonadotropins) are same in both male and female.

**Smoking status**

Non-smokers have twice more incidence of PONV than the smokers. The exact mechanism of this not understood completely. However Apfel and colleagues have proposed that smoking cigarettes might have an effect in dopamine receptor but there isn't any extra pyramidal side effects seen in smokers to rely on their suggestion. Studies have shown that polycyclic aromatic hydrocarbons in the cigarette induces the cytochrome p450 enzymes which increases or fasten the metabolism of the emetogenic volatile anaesthetics and drugs which helps in reduction of PONV.

**Previous history of PONV and motion sickness**

Previous history of motion sickness or PONV increases the occurrence of PONV. There is three times more chance of occurring nausea and vomiting in general anesthesia in these patient.

**Age**

In younger children less than 3 years, the incidence of PONV is relatively low. In adult PONV decreases as the age increases. Paediatric patients have a more chances of having PONV(postoperative vomiting) than adults with school children having incidence of about 34-45%. Infants have lowest incidence with about 5 % of occurrence and preschool children have an incidence of about 20%. Adults younger than 50 years of age have more prone to PONV than those who are older than 50 years of age. The likelihood of PONV decreases by 13% for addition of each 10-yrs in age.

**Obesity**

More obese patients are at increased risk of PONV. It may be due to the adipose tissue which obese patient have more in comparison to the non-obese patient which can store more volatile anaesthetics which in return can aggravate PONV. Also Obese patient are more prone to suffer from gastrointestinal disease, liver disease, have larger gastric volume, and have increased incidence of gastric oesophageal reflux disease, these all factor can increase incidence of PONV. In addition, obese patient are difficult to mask ventilate which also causes more gastric gas extension and can lead to PONV. However recent researches have shown that obesity don’t have significant effect on PONV.

**Preoperative Anxiety**

Preoperative anxiety can increase the incidence of PONV. Pre-operative anxiety increases the stress hormones which delays the gastric emptying and increase the gastric volume and increase the probability of nausea and vomiting. When these stress hormones (epinephrine and nor epinephrine) are injected to the ventricles of the cats they have induced vomiting in the cats.

**Anaesthesia related**

**Inhalational anaesthetics**

Volatile anaesthetics causes early post-operative period (first 2-6 hours) PONV and there is no difference in incidence of PONV with the use of halothane isoflurane, enflurane, and sevoflurane. The incidence of PONV with sevoflurane and desflurane is also same. The occurrence of PONV with volatile anaesthetics depends upon the concentration and duration of use of volatile anaesthetics. Increase in the duration and concentration of volatile anaesthetics increases the incidence of PONV.

**Nitrous oxide (N2O)**

N2O can increase the incidence of PONV which has been shown by many studies in the past. Nitrous oxide stimulates nausea and vomiting mainly by following mechanisms-

1) Catecholamine release by stimulation of sympathetic nervous system.
2) Stimulation of vestibular system by changing middle ear pressure.
3) Abdominal extension caused by the exchange of nitrous oxide and nitrogen with the inhalation gas in abdomen went during mask ventilation.
4) Releasing endogenous opioid peptides and activating the area postrema of the brain.

However some studies have failed to show the significant role of nitrous oxide in PONV.

**Duration of anaesthesia**

Increase in the length of anaesthesia increases the occurrence of PONV. It has been shown that 30 minutes increase in time of surgery increases the risk of PONV by 59 %. It is because of use of more emetogenic drugs in long surgeries.

**Post-operative opioid use**

Opioids induces nausea and vomiting by activating CTZ. Opioids use is one of the major risk factor of PONV. Gregory W. Roberts have shown that reduction of opioid dose to half reduces the incidence of PONV by the 6%. The author also showed that there is a strong logarithmic dose –response relationship between postoperative opioid dose and PONV as well as PON (post-operative nausea). Patient controlled analgesia and epidural opioids were a marker for large
dose opioid use and was associated with POV in the 24-h postoperative period of 41% and 31% respectively, compared with 11% for other patients not using both of them. A woodhouse showed that duration of dose delivery of opioids with PCA also effect the PONV. The author administered PCA morphine over 5 min which was associated with a more increase in the intensity of retching and vomiting compared with patients receiving PCA morphine over 40 seconds. The author also showed that the patients receiving the dose more slowly experienced their emetic episodes later in the postoperative period as opposed to patients receiving a bolus who developed nausea and vomiting immediately postoperatively. There is no difference in the incidence of PONV with the use of different kinds of opioids.

**Surgery Related**

Sinclair, in his study along with Chung and Mezei had shown that patient undergoing breast surgery had about 41.5% incidence of PONV in early postoperative phase and 42.95% after 24 hours of operation. The author found 16% suffered from PONV those undergoing shoulder orthopaedic surgery. There was 22% who felt PONV in Ophthalmology department those undergoing strabismus surgery. The thyroid surgery, gynaecological surgery, orthopaedic knee and orthopaedic(other) surgery had also a significant number of PONV. In another study the authors found that PONV was highest in the women undergoing laparoscopic ovum retrieval procedures (54%), followed by laparoscopy (35%). In that study other surgeries like dental extractions, dilatation and curettage of the uterus, or knee arthroscopy had equal tendency of nausea and vomiting (16%,12%, and 22% respectively), they also reported high incidence of PONV after extracorporeal shock wave lithotripsy, head and neck surgery and stomach, duodenum and gall bladder operations. In paediatric patient strabismus surgery and tonsiloadenoidectomy surgery have highest incidence of PONV in comparison to the other surgeries. However Apfel CC, Kranke P, Eberhart LH did not find significant relation of surgical sight and PONV in their study.

**In Paediatrics**

In paediatric patient, nausea can’t be assessed so vomiting is the end point. POV(Post-operative vomiting) in children ranges from 33.2% to 80%. There is no difference in incidence of POV in male and female before puberty. Most of the risk factor are same for children as in adult but there is significant difference in some aspects. Strabismus surgery, age ≥3 years, positive history of POV in the children or PONV in their relatives(mother, father or siblings), surgery ≥ to 30 minutes are identified as independent risk factor for POV in children. Each risk factor is given 1 point. They carry 9%, 10%, 30%, 55% or 70% risk of POV respectively for 0,1,2,3, and 4 points as shown in table 2.

**PREVENTION OF PONV**

**Measures that can be taken to reduce the baseline risk factor**

**Regional anaesthesia**

Use of regional anaesthesia instead of general anaesthesia can reduce the PONV by 11 times. However hypotension induced by spinal anaesthesia can also cause PONV. The authors found 16% suffered from PONV those undergoing shoulder orthopaedic surgery. There was 22% who felt PONV in Ophthalmology department those undergoing strabismus surgery. The thyroid surgery, gynaecological surgery, orthopaedic knee and orthopaedic(other) surgery had also a significant number of PONV. In another study the authors found that PONV was highest in the women undergoing laparoscopic ovum retrieval procedures (54%), followed by laparoscopy (35%). In that study other surgeries like dental extractions, dilatation and curettage of the uterus, or knee arthroscopy had equal tendency of nausea and vomiting (16%,12%, and 22% respectively), they also reported high incidence of PONV after extracorporeal shock wave lithotripsy, head and neck surgery and stomach, duodenum and gall bladder operations. In paediatric patient strabismus surgery and tonsiloadenoidectomy surgery have highest incidence of PONV in comparison to the other surgeries. However Apfel CC, Kranke P, Eberhart LH did not find significant relation of surgical sight and PONV in their study.

**Avoidance of volatile anaesthesia**

Use of propofol instead of volatile agents for induction and maintenance of anaesthesia can decrease the incidence of early occurrence of PONV(0-6hours post-operative) by 19 percent. Apfel cc and friends showed in their randomized controlled study that volatile anesthetics significantly increased the incidence of early PONV (0-2hrs) which had a dose response relationship. G.kumar and friends had increased the incidence of early PONV(0-6hours post-operative) by 19 percent. Apfel cc and friends showed in their randomized controlled study that volatile anesthetics significantly increased the incidence of early PONV(0-6hours post-operative) by 19 percent. Apfel cc and friends showed in their randomized controlled study that volatile anesthetics significantly increased the incidence of early PONV(0-2hrs) which had a dose response relationship. In another study  the volatile anesthetics significantly increased the incidence of early PONV(0-6hours post-operative) by 19 percent. Apfel cc and friends showed in their randomized controlled study that volatile anesthetics significantly increased the incidence of early PONV(0-2hrs) which had a dose response relationship. G.kumar and friends had decreased the PONV significantly. Epidural anaesthesia has a lower incidence of nausea and vomiting post-operative than a general anaesthesia in a woman under going laparoscopic procedures.

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**Reduction perioperative opioid use**

Decreasing the use of opioids in traoperative and post operatively contributes to control PONV. A multimodal pain regimen can effectively reduce the perioperative opioid use. Multimodal pain management and reduction of opioid

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**Table 2: Risk factors of POV for children.**

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Points</th>
<th>Score</th>
<th>POV risk %</th>
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<tr>
<td>Surgery ≥ to 30 minutes</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Age ≥3 years</td>
<td>1</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>Strabismus surgery</td>
<td>1</td>
<td>3</td>
<td>55</td>
</tr>
<tr>
<td>History of POV or PONV in relatives</td>
<td>1</td>
<td>4</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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</table>

Based on original article by GAN et al.5
use and the side effect of opioid use including nausea and vomiting is one the main target of ERAS.  
Acetaminophen, NSAIDS (non-steroidal anti-inflammatory drugs), Regional anaesthetic technique (neuraxial or peripheral block), gabapentanoids, lidocaine, tramadol, N-methyl-D-aspartate antagonists (eg-ketamine, dextromethorphan, magnesium sulphate, methadone), alpha2 agonists (dexametomidine and clonidine) are some analgesic methods which can be used to reduce the consumption of opioids. However opioids have been a main stream of pain management since a long time, total omission of opioid use is a difficult task though its use can be decreased via multimodal pain management methods.

Management of pain and anxiety

Pain can also induce nausea and vomiting thus controlling pain adequately with multimodal pain management and effectively reduce the incidence of PONV. Preoperative anxiety can increase the incidence of PONV. Thus Preoperative anxiety reduction with benzodiazepines can also help in reduction of PONV.

Others

Some studies have shown that high dose neostigmine i.e > 2.5 mg can induce PONV. However meta analysis done by Cheng C-R, Sessler DI, Apfel CC did not find the relations of neostigmine use and PONV. BIS guided anaesthesia has shown decrease in the occurrence of post-operative nausea and vomiting and fast recovery due to avoidance of unnecessary use of emetogenic anaesthetic agent in larger amount.

Pharmacological intervention available for PONV

Currently available pharmacological drugs for PONV acts on one of the different receptors that trigger vomiting.

5-HT3 Receptor antagonist:

5-HT3 receptor antagonist are the most commonly used and effective antiemetic available for PONV. They are superior than the traditional antiemetics used for PONV. 5-HT3 receptors are found in central CT2 and peripheral vagus nerve terminals, stimulation of either of the receptors triggers the vomiting centre. Ondasetron, dolasetron, granisetron are commonly used selective SHT-3 receptor antagonist. Palonosetron is a new member in this group which can effectively reduce the PONV in single IV dose of 0.075 mg. 5-HT3 receptors bind and block peripheral and central emetogenic signals to the vomiting centre and prevent PONV. Most common side effect of SHT-3 receptor antagonists is headache followed by asthenia, constipation, diarrhoea, dizziness, insomnia, dyspepsia, decreased appetite, increased liver enzymes and abnormal vision. Studies have shown that 32 mg of ondansetron and 2.4mg/kg of dolasetron can significantly prolong the Qtc interval. However the incidence of torsade’s point and cardiac arrhythmias are very rare with the therapeutic doses. Palonosetron hasn’t shown tendency of prolonging Qtc interval.

Cholinergic receptor antagonist:

Atropine and scopolamine act centrally inhibiting muscarinic receptors in cerebral cortex and pons. Scopolamine has an antiemetic property in motion sickness and PONV. Transdermal formulation of scopolamine is associated with reduction of PONV both in early and late phase. The adverse effects of scopolamine includes inhibition of secretion of saliva causing dry mouth, also decreases sweat, decreases gastrointestinal secretion and motility. It also causes drowsines, dilates pupils, increases heart rate and urine retention. The most common adverse effect of scopolamine is visual disturbance which can last for 24-48 postoperative hours.

Dopamine receptor antagonist:

The most common and dopamine antagonist used for the prevention of PONV is metoclopramide. It has been used for the prevention of PONV since long time. It actson central dopaminergic receptors (D2 receptors), and central and peripheral 5-HT-3 receptors and on peripheral 5-HT-4 receptors. Since it blocks the central dopamine receptor extrapyramidal side effect can be its adverse effect however the antiemetic dose of the metoclopramide used most often is 10mg which does not show any extra pyramidal side effect, in addition there is no evidence of serious adverse reaction in chemotherapy where the dose of metoclopramide is very high. The most common adverse effect experienced are sedation and drowseness and headache but they are also clinically not significant. Droperidol is a butyrophenone, a centrally acting dopamine D2 antagonist having an antiemetic action with more pronounce effect in nausea than in vomiting and have a short lived action. Apfel cc and his colleagues have shown that the droperidol have comparable clinical efficacy on both nausea and vomiting. The adverse reaction of droperidol includes extrapyramidal symptoms like restlessness and abnormal movements, sedation and drowsiness which are dose dependant. Sedation and drowsiness is not seen in the dose 0.25-0.625mg. It might cause other adverse reaction like hypotension, anxiety, visual disturbance, night mares, oculogyric crisis, and urinary retention but they occur in very small number of patient and doesn’t have serious issues. However the FDA had issued “Black box ” warning regarding the use of Droperidol as it provokes the prolongation of Qtc interval and was reported to provoke serious cardiac arrhythmias. However 1.25mg or dose below it does transient prolongation of Qtc without any risk of torsade genic action. Haloperidol is a butyrophenone, another potent anti-dopaminergic agent which is most commonly used as antipsychotic and to control severe agitation. It is being used in treatment of cancer patient as antiemetic successfully for a long time. Haloperidol is effective in prevention of PONV in the dose from 0.5mg to 1 mg. The most common adverse reaction of haloperidol is extrapyramidal side effects, neuroleptic malignant syndrome, orthostatic hypotension, and electrocardiographic...
changes. QTC prolongation and torsade point can occur with haloperidol however it occurs more in psychiatric patient receiving 35 mg (IV, oral or IM) in 24 hours. It should be avoided in patient who have a risk factor for QTC interval prolongation such as the electrolyte disorder, congestive heart failure, cardiac hypertrophy, acute or chronic dysrhythmia, and patient taking tricyclic antidepressant and monoamine oxidase inhibitors.

Histamine receptor antagonist:
Vestibular system and nucleus tractus solitarius at the vomiting centre have a H1 receptor which can be blocked efficiently by antihistamines such as diphenhydramine, dimenhydrinate, cyclizine and promethazine for prevention of PONV. However the adverse reactions like drowsiness, urinary retention, dry mouth and blurred vision has been reported.

Dexamethasone:
Dexamethasone is a corticosteroid which has been successfully used for prevention of PONV. De Oliveira GS Jr and colleagues have shown the effectiveness of dexamethasone 4mg or 5mg similar to that of 8 mg or 10 mg in their study. The best prophylaxis of postoperative nausea and vomiting currently available is achieved by combining dexamethasone with a 5-HT3 receptor antagonist. However the exact mechanism of its antiemetic property is still not clear. Chiu-Ming Ho and colleagues have demonstrated the antiemetic action of dexamethasone in cat via activation of glucocorticoid receptors in bilateral NTS but not in area postrema, in the brain stem. Dexamethasone might prevent PONV via inhibiting prostaglandin synthesis, reducing serotonin activity and changing permeability of blood-brain barrier to plasma proteins. The anti-inflammatory action of dexamethasone which significantly decreased the production of IL-6 a potent pro-inflammatory cytokine produced by T cells and macrophage, may also have a role in prevention of PONV. The main adverse effect of dexamethasone is increase in blood sugar level and infection, however a single low dose of dexamethasone does not have a significant adverse effect.

NK1 antagonist (aprepitant):
Neurokinin-1 receptors are found in the gastrointestinal vagal afferent and nucleaeuctrasol matrices which can be activated by substance P and cause nausea and vomiting. Aprepitant is a new class of drug that can be used in post-operative nausea and vomiting which effectively blocks the NK-1 receptors. Aprepitant is a first neurokinin-1 antagonist that was approved for the use in post-operative nausea and vomiting. Aprepitant appears to be superior in prevention of vomiting in comparison to the ondansetron and other drugs of 5HT-3 antagonists class. Aprepitant appears to be superior in prevention of vomiting in comparison to the ondansetron and other drugs of 5HT-3 antagonists class.

Opioidantagonists:
Opioid induces the nausea and vomiting by acting on CTZ in area postrema of the medulla by mediating vomiting centre in the brainstem as shown by elimination of emetic effect of opioids on ablation of postrema. Gan T J and colleagues have illustrated that infusion of 0.25mg/kg/hr of the naloxone decreases the incidence of PONV as well as other side effects of morphine in PCA. Methylxaltrexone blocked the emetic action of opioids without altering the analgesic effect in animal studies. Opioids decreases the gastric motility and induces constipation which is also a factor for nausea and vomiting. Weese and colleagues demonstrated that use of alvimopan can reduce the postoperative ileus and PONV as well.

Ephedrine:
Ephedrine is a sympathomimetic drug which increases the mean arterial blood pressure via acting through sympathetic nervous system. E.Hagemann and colleagues have demonstrated that epinephrine 0.5 mg/kg IM given at the end of abdominal hysterectomy has significantly reduced PONV for the first 3h without presence of adverse drug reaction. D.M.Rotherberg and colleagues also concluded the efficacy of epinephrine 0.5mg/kg IM (intramuscular) without any sedative effect in comparison with the droperidol. The antiemetic action of epinephrine has been speculated because of its prevention of hypotension. Also, its action against the motion sickness is also thought to be the cause of its antiemetic property. However Hagemann and colleague were able to demonstrate that it has unique property of antiemetic besides prevention of hypotension induced by general or regional anaesthesia and motion sickness. Increase in heart rate and blood pressure are main concern of ephedrine however in low dose of 0.5 mg IM, this adverse effect does not seem to occur.

Propofol:
Propofol is a 2,6-diisopropylphenol; Diprivan, Astra Zeneca Pharmaceuticals, Wilmington, DE which has a very good response as the intravenous anaesthetic that helps to reduce the PONV. Propofol acts on presynaptic and postsynaptic gamma-aminobutyric acid type A (GABA (A)) receptors which are found throughout the central nervous system and are associated with fast neuronal inhibition. Many studies have established its antiemetic effect. TIVA (Total intravenous anaesthesia) using propofol as a continuous infusion compared with inhalational agents have a lower incidence of PONV. Borgeat and colleagues in their study demonstrated that propofol sub hypnentic doses i.e. 10 mg possesses direct antiemetic effect in the context of minor elective surgery and also the adverse effect was rare in that dose. Gan T.J and colleagues found that the plasma concentration required for the antiemetic action of the propofol is 343ng/ml which corresponds to the bolus dose of 10mg followed by 10mg/kg/min infusion.
Though the antiemetic mechanism of propofol is not clearly understood, there are various proposed mechanisms. Diflorio T proposed that propofol acts via dopaminergic receptor. Propofol may have suppressed various emetic centres like CTZ, vagal nuclei and other nausea and vomiting centres for its anti-emetic action. Also Collins and colleagues have demonstrated that propofol can reduce the synaptic transmission in the olfactory cortex which decreases the release of excitatory amino acids like aspartate and glutamate that can be related with antiemetic action of propofol. Gelb AW and colleagues have found that continuous propofol infusion of 333-417µg/kg /m for 6 hours can decreases the level of serotonin in postrema. However the cost of the TIVA with propofol is expensive compared to the inhalational agents, and continuous infusion of the propofol postoperatively requires monitoring which is only possible in PACU (post anaesthesia care unit), intensive care unit or similar kinds of unit.

Non pharmacological methods:
Acupuncture is effective in prevention of PONV. Acupoint PC6 is generally used for the prevention of PONV. It can be used with various methods like manual manipulation, electroacupuncture, acupressure, transcutaneous electrical acustimulation (TEAS), or transcutaneous electrical nerve stimulation and laser stimulation. Chinese P6 point is located at three finger breadth proximal to the proximal flexor palmar creases, between the tendons of the flexor carpi radialis and palmaris longus. Korean hand acupressure is a new kind of acupuncture that is different from the chinese acupuncture which includes K-K9 and K-D2 acupressure point that are located in palmar aspect of the middle phalanx of the fourth finger and dorsum of the lateral aspect of the distal phalanx of the index finger respectively. Schlagler A have demonstrated the efficacy of Korean hand acupressure in prevention of nausea and vomiting in both adult undergoing gynaecological laparoscopic surgery and children undergoing strabismus surgery.

Table 3: Antiemetic doses and timing for prevention of postoperative nausea and vomiting.

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<tr>
<th>Drug</th>
<th>Dose</th>
<th>Timing</th>
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<tbody>
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<td>Dexamethasone</td>
<td>4-5mg, IV</td>
<td>At induction</td>
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<tr>
<td>Dimenhydrinate</td>
<td>1mg/kg, IV</td>
<td></td>
</tr>
<tr>
<td>Dolasetron</td>
<td>12.5mg, IV</td>
<td>End of surgery; timing may not affect efficacy</td>
</tr>
<tr>
<td>Droperidol</td>
<td>0.625-1.25mg, IV</td>
<td>End of surgery</td>
</tr>
<tr>
<td>Ephedrine</td>
<td>0.5mg /kg , IM</td>
<td>End of surgery</td>
</tr>
<tr>
<td>Granisetron</td>
<td>0.35-1.5mg, IV</td>
<td>End of surgery</td>
</tr>
<tr>
<td>Haloperidol</td>
<td>0.5 - 2 mg, IM/IV</td>
<td>End of surgery</td>
</tr>
<tr>
<td>Prochlorperazine</td>
<td>5-10 mg, IM/IV</td>
<td>End of surgery</td>
</tr>
<tr>
<td>Promethazine</td>
<td>6.25-25 mg, IV</td>
<td>At induction</td>
</tr>
<tr>
<td>Ondasetron</td>
<td>4 mg, IV</td>
<td>End of surgery</td>
</tr>
<tr>
<td>Scopolamine</td>
<td>Transdermal patch</td>
<td>Prior evening or 4 h before surgery</td>
</tr>
<tr>
<td>Tropisetron</td>
<td>2 mg, IV</td>
<td>End of surgery</td>
</tr>
</tbody>
</table>

Based on the original article by Gan et al

Table 4: Antiemetic doses in children for postoperative vomiting prophylaxis

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
</tr>
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<tbody>
<tr>
<td>Dexamethasone</td>
<td>150 mcg/kg up to 5 mg</td>
</tr>
<tr>
<td>Dimenhydrinate</td>
<td>0.5mg /kg upto 25 mg</td>
</tr>
<tr>
<td>Dolasetron</td>
<td>350mcg /kg up to 12.5 mg</td>
</tr>
<tr>
<td>Droperidol</td>
<td>10-15mcg / kg up to 1.25 mg</td>
</tr>
<tr>
<td>Granisetron</td>
<td>40mcg/kg up to 0.6 mg</td>
</tr>
<tr>
<td>Ondasetron</td>
<td>50-100mcg/kg up to 4 mg</td>
</tr>
<tr>
<td>Tropisetron</td>
<td>0.1 mg /kg up to 2mg</td>
</tr>
</tbody>
</table>

Based on the original article by Gan et al

Table 5: Pharmacological combination therapy of PONV for Adults and children

<table>
<thead>
<tr>
<th>Adults</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Droperidol +dexamethasone</td>
<td>Ondasetron, 0.05mg/kg</td>
</tr>
<tr>
<td></td>
<td>+dexamethasone, 0.015 mg/kg</td>
</tr>
<tr>
<td>5HT-3 receptor antagonist+dexamethasone</td>
<td>Ondasetron,0.1mg/kg + droperidol, 0.015 mg/kg</td>
</tr>
<tr>
<td>5HT-3 receptor antagonist+droperidol</td>
<td>Tropisetron, 0.1mg/kg + dexamethasone, 0.5 mg/kg</td>
</tr>
<tr>
<td>5HT-3 receptor antagonists+dexamethasone +droperidol</td>
<td></td>
</tr>
</tbody>
</table>

Based on Society for Ambulatory Anaesthesia Guidelines for the Management of Postoperative Nausea and Vomiting.
Based on ASPAN’S Evidence-Based Clinical Practice Guideline for the Prevention and/or management of PONV/PDNV.10

### TABLE 6: Prophylaxis treatment of PONV Based on the patient’s level of Risk determined by Risk Factor Assessments.

<table>
<thead>
<tr>
<th>Level of risk</th>
<th>Low risk</th>
<th>Moderate risk</th>
<th>Severe risk</th>
<th>Very severe risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>% chance of PONV</td>
<td>10-20%</td>
<td>40%</td>
<td>60%</td>
<td>80%</td>
</tr>
<tr>
<td>Number of prophylactic intervention to consider</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3 or more</td>
</tr>
</tbody>
</table>

**Strategy for rescue therapy for PONV in PACU**

When prophylaxis with the antiemetic fails to prevent PONV, the antiemetic from different class should be used which has not been used for prophylaxis.10 There is no benefit of repeating the same antiemetic or antiemetic from same class within the 6 hrs of use of the antiemetic as a prophylaxis for established PONV.10 Low doses of 5HT-3 antagonists i.e. ondansetron, 1mg, dolasetron, 12.5mg, granisetron, 0.1 mg and Tropisetron, 0.5 mg can be used if no prophylaxis has been given for the treatment of established PONV.11 Promethazine, 6.25 to 25 mg IV is better than metoclopramide, 10 mg and droperidol, 0.625 mg in treatments for established PONV.10 Propofol, 20mg, can also be used for rescue therapy in patients in the PACU which is as effective as ondansetron.11 However, the antiemetic effect is of short time duration with low dose propofol.12 Isopropyl alcohol is not recommended for the treatment of established PONV. Readministraion of 5 HT-3 antagonist might be useful if administered after 6hrs of its administration as prophylaxis however long acting antiemetics like dexamethasone, TDS (transdermal scopolamine), apropitant, palonosetron are not recommended to readminister for control of established PONV.5

### DISCUSSIONS

As stated by Kapur PA in 1991 PONV is a big little problem and is still a problem. Patients undergoing surgery under general anaesthesia complains nausea and vomiting more troublesome than the pain and are willing to pay more amounts for its prevention and treatment.5 Female Gender, Non-smoking status, perioperative opioid use, h/o motion sickness and PONV has been regarded as the definite risk factor although length of surgery, types of surgery (Strabismus surgery, Intra abdominal, ENT, thyroid, breast, gynaecological, neurological surgery), inhalational anaesthesia, age, N2O, are also regarded as a risk factor contributing to PONV.2,12,14 Many guidelines are available for its prevention and reduction.1,5 Reduction of baseline factor by using regional anaesthesia, using propofol instead of inhalation for induction and maintenance, reduction of opioids use, use of multimodal pain management can reduce incidence of PONV.5 PONV is still occurring even after using multiple drugs for its prevention. Multimodal approach can be used for its prevention. Use of multiple drugs with different mechanism of action has shown better efficiency than the single drug for the prevention of PONV. Drugs should be used according to the risk factor to reduce its unnecessary use and prevent from its side effects. However both pharmacological and non-pharmacological method and risk reduction approach has failed to prevent it, as one third of the surgical patient still experiences PONV. Lots of studies has been done for its prophylaxis and prevention but very few studies has been done for the rescue drugs and its efficiency in PACU that can be used when PONV occurs even after using multimodal approach for the prevention of PONV. Researches needed to be done for the treatment of PONV that occurs in PACU even in the presence of prophylactic antiemetic, that might help the patient to get rid from the bad experience they have in PACU due to nausea and vomiting and help to discharge them early from PACU and ultimately from hospital. Rescue drugs should be used from different classes of drugs that has not been used for prophylaxis. Prevention and treatment of PONV effectively can help in cost reduction for the patient due to early discharge and also provide patient satisfaction after operation.

### CONCLUSION

Without prophylactic intervention, PONV will develop in about one third of patients (range, 10% to 80%) who undergo general anaesthesia without any prophylactic intervention. The effect of PONV includes late discharge from the PACU, prolonged hospital admission, increased chances of pulmonary aspiration, and significant postoperative discomfort. The ability to identify high-risk patients for prophylactic intervention can significantly improve the quality of patient care and satisfaction in the PACU.

Thus, depending upon the risk factor and chances of PONV, prophylaxis should be given with monotherapy or combination therapy. All prophylaxis in children at moderate or high risk for postoperative vomiting should include combination therapy using a 5-HT3 antagonist and a second drug from other class. Because the effects of interventions from different drug classes are additive, combining interventions has an additive effect in risk reduction.

When rescue therapy is required, the antiemetic should be chosen from a different therapeutic class than the drugs used for prophylaxis.

Though we tried to include all the available regimens pharmacological and non-pharmacological methods of prevention and treatment of PONV, we are not in position to suggest the ideal drug for the treatment of PONV.
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REFERENCES


CONFLICT OF INTEREST

I have no conflict of interest to declare.


