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Interventions to Reduce Postoperative Nausea and Vomiting

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Abstract

Postoperative nausea and vomiting (PONV) is a significant complication that affects surgical patients due to the use of anesthesia and opioid pain medications. This literature review examines contributing factors, pathophysiological pathways, and effectiveness of pharmacological and non-pharmacological interventions used to decrease the incidence of PONV in surgical patients. A systematic search using Google Scholar and CINAHL was used to select 12 peer-reviewed articles to identify common themes to reduce PONV. Findings of this literature review reveal that both pharmacological and non-pharmacological interventions help reduce PONV; however, no specific combination of interventions is found to eliminate it completely.

Keywords: Postoperative Nausea and Vomiting, PONV, Anesthesia, Risk Factors, Pharmacological Interventions, Non-Pharmacological Interventions

Literature Review: Interventions to Reduce Postoperative Nausea and Vomiting

The occurrence of postoperative nausea and vomiting (PONV) is a significant and negative outcome from anesthesia that can lead to adverse outcomes in surgical patients. PONV is described as the sensation of nausea or the act of vomiting within the first 24 hours following surgery, which is considered the postoperative period (Avinash et al., 2023; Veiga-Gil et al., 2017). About 30% of surgical patients without risk factors experience PONV, and roughly 80% of patients with high-risk factors experience PONV (Marsh et al., 2022). Adverse outcomes related to PONV can be physical, emotional, or financial. This phenomenon can negatively impact surgical outcomes in patients and interventions to decrease the incidence is crucial to investigate.

Negative physical outcomes related to PONV include increased risk of dehydration, wound dehiscence, electrolyte imbalances, and aspiration (22). PONV can also cause emotional distress and negatively impact patients' outlook on recovery from surgery (Marsh et al., 2022). Severe PONV may also lead to unplanned hospital admissions and longer stays, thereby increasing healthcare costs (Pankiv et al., 2024). The impact PONV has on surgical patients also delays postoperative recovery, including mobility milestones, thereby increasing the risk of postoperative complications (Marsh et al., 2022). Reviewing how PONV occurs and what interventions can help reduce the incidence of PONV is vital for surgical patients and perioperative settings. The purpose of this literature review is to understand the effects of anesthesia, the pathophysiology of PONV, and its risk factors, thereby allowing the evaluation of current and potential interventions to reduce the prevalence of PONV.

Postoperative Nausea and Vomiting (PONV)

Anesthesia

Surgical procedures are performed daily worldwide. Patients undergoing surgery need different types of anesthesia to remain comfortable and sedated during the procedure. To investigate the effectiveness of interventions for preventing PONV in patients, it is important to understand anesthesia and its contributing role it plays in PONV among surgical patients. PONV occurs in surgical patients depending on the use of anesthetic agents in combination with pain medication. The use of anesthesia is crucial for reducing pain and discomfort in surgical patients, and each case is unique, requiring a tailored approach. Various methods of anesthesia include general anesthesia with inhalation gases, total intravenous anesthesia (TIVA), regional anesthesia, and monitored anesthesia care (MAC) (Lee, 2017). The choice of anesthesia for sedation during surgery and pain management during or after the operation has a significant impact on PONV (Marsh et al., 2022).

The article written by Lee (2017) reviews the types of anesthesia used and the impact on ambulatory surgery. Ambulatory surgery, also known as day surgery, is a procedure that allows patients to return home on the same day. According to Lee (2017), ambulatory surgery is the most widely practiced form of surgery, accounting for approximately 65-70% of all surgical cases in the United States. Lee (2017) reviews and explains the different types of anesthesia used that impact efficient patient discharge and the effects of PONV in ambulatory surgery patients. Lee (2017) concluded that selecting an appropriate type of anesthesia, depending on the patient's status, combined with the administration of prophylactic multimodal antiemetic medication, can improve patient outcomes. This article supports the understanding of how anesthesia administration impacts PONV and leads to investigating interventions to minimize PONV in surgical patients.

General Anesthesia Related to PONV

Certain surgical cases require general anesthesia, which involves the use of volatile inhalation agents and combinations of medications to provide patients with comfort during surgery. This method of anesthesia raises a patient's risk of PONV to 20-50%, even without considering individual risk factors for PONV that will be discussed later. The use of opioid pain medications for pain control in patients also increases the risk of PONV. According to Khanna et al. (2022), the duration and length of surgery requiring general anesthesia, especially with various inhalation gases,

directly affect the occurrence of PONV. The length and type of anesthesia used are also reported by Khanna et al. (2022), who reviewed multiple inhalation agents and their impact on PONV within the first 2 to 6 hours after surgery. Ünülü et al. (2018) also discuss that the use of inhalation gas is a primary contributor to PONV within two hours after the operation. It is recommended that early use of non-opioid pain medication and prophylactic antiemetic medication in the preoperative period can also benefit surgical patients and reduce PONV.

Lee's (2017) article argues that the type of anesthesia gas used cannot be solely responsible for PONV; instead, the duration of surgery is a key factor. This may be linked to the amount of narcotic pain medications given for patient comfort, which isn't fully discussed here. This research opens the door for future studies on how the duration and type of anesthesia, along with tracking opioid pain medication during anesthesia, can influence the occurrence of PONV. Limitations of this article include the fact that multiple medications are administered during anesthesia, making it difficult to identify which specific medication or inhalation gas is responsible for PONV. The study also does not specify which non-opioid medications should be considered for pain management during surgical cases requiring general anesthesia.

Pathophysiology

Pathways of PONV

Understanding the pathophysiology of PONV is crucial for understanding how both pharmacological and non-pharmacological interventions work, as well as why they may fail. The pathophysiology and discussion of medication or alternative therapies are explored through articles written by Veiga-Gil et al. (2017) and Stociea et al. (2015). These articles explain how different neurotransmitters and brain areas contribute to PONV and how specific medications or therapies affect the brain. The pathways for nausea and vomiting, and the receptors that mediate them, influence the effectiveness of pharmacological and non-pharmacological interventions.

Veiga-Gil et al. (2017) claim that the pathophysiology of nausea and vomiting remains incompletely understood. Nausea is a sensation, and vomiting is the physical act of expelling material from the stomach through the mouth. Veiga-Gil et al. (2017) explain that nausea is associated with cortical structures of the brain, whereas vomiting is associated with pathways originating from the medulla oblongata. Stociea et al. (2015) explain that the vestibular nuclei (VNU), area postrema (AP), nucleus solitary tract (NST), and vagal afferent fibers related to the gastrointestinal tract are responsible for the perception of nausea. These areas of the brain that perceive the feeling of nausea have output pathways through the brainstem to create the vomiting reflex.

These specific areas and pathways have their own neuronal groups. The region most vulnerable to toxins crossing the blood-brain barrier (BBB) is in the AP. According to Stociea et al. (2015), the capillaries in this part of the brain are not surrounded by protective glial cells, such as astrocytes. Veiga-Gil et al. (2017) confirms the findings of Stociea et al. (2015), stating that this area lacks a BBB, and its chemoreceptors are vulnerable and play a key role in drug-induced emesis. Different research by Lee (2017) and Khanna et al. (2022) discusses that opioid pain medications are commonly administered during surgery with anesthesia to promote patient comfort. These drugs circulate throughout the body and bind to specific mu receptors. The AP contains multiple chemoreceptors, and since this area is unprotected, drugs, metabolites, and anesthetics can cross the BBB. Additionally, this brain region releases neurotransmitters in response to toxins and metabolites that cross into it, including serotonin, dopamine, acetylcholine, histamine, and neurokinin-1. The release of these neurotransmitters then influences various pathways involved in the vomiting reflex.

According to both Stociea et al. (2015) and Veiga-Gil et al. (2017), the roles of the various brain pathways involved in the sensation of nausea remain unclear. The conclusions of both articles suggest that further research is needed to understand the sensation of nausea. Both authors explain that the existing vomiting pathways are essential to understand, particularly in relation to the different neurotransmitters and receptors involved, which can benefit from medication prophylaxis or pharmacological interventions. Certain medications target specific chemoreceptors of the vomiting reflex system. Stociea et al. (2015) and Veiga-Gil et al. (2017) suggest that using risk scores to identify patients with high-risk conditions who are more likely to experience nausea and vomiting is beneficial. This indicates that the use of prophylactic antiemetic medications and the application of standardized risk tools can help surgical patients choose interventions.

Risk Factors

Understanding the pathophysiology of PONV influences different interventions, as does understanding risk factors that increase its prevalence. As previously mentioned, about 30% of surgical patients without risk factors experience PONV, while roughly 80% of those with high-risk factors do (Ünülü & Kaya, 2018). All articles reviewed in this literature review discuss consistent risk factors that raise the likelihood of PONV in surgical patients. The consistent risk factors include female sex, non-smoking status, a history of PONV and/or motion sickness, and the use of opioid pain medication postoperatively. Other literature suggests that age, genetics, anxiety, hormones, alcohol consumption, and pain can also contribute to PONV, but these themes were not considered consistent risk factors in any of the other literature or found on scoring systems. These uncommon risk factors are compelling and add complexity to understanding nausea. They warrant further research due to the complexity of nausea pathways, which are not yet fully understood, as previously mentioned.

Risk Scoring Systems

Identifying risk factors and assigning them values is crucial for evaluating the effectiveness of both pharmacological and non-pharmacological interventions in reducing PONV. Risks can be assessed through risk stratification using evidence-based scoring systems, such as the Apfel score. According to Avinash et al. (2023), each risk factor is assigned a score of 1 point. The total high score is 4, with low risk considered as 0-1, moderate as 2, and high risk as 3-4. Anesthesiologists and nurses can utilize this scoring system in the preoperative setting to determine whether prophylactic pharmacological or non-pharmacological interventions are necessary.

Although the Apfel scoring system is not mandated in preoperative settings, it can be a valuable tool for guiding interventions when used consistently. Studies supporting the motion to make the Apfel scoring system a preoperative standard include those by Avinash et al. (2023), Dewinter et al. (2017), and Stephenson et al. (2017). Avinash et al. (2023) conducted a small randomized controlled trial to determine whether consistently using the Apfel scoring system decreased the incidence of PONV by intervening with antiemetic therapies. The study concluded that medication prophylaxis for all patients, as determined by the scoring system, proved less costly overall. A limitation of this study was its small sample size of 70 patients, which should be further investigated with a larger sample to demonstrate consistency.

Other studies by Dewinter et al. (2017) and Stephenson et al. (2017) also reviewed the impact of the Apfel scoring system on PONV reduction. Dewinter et al. (2017) conducted audits within an institution to determine whether a simplified scoring system would be more user-friendly for staff in identifying high-risk patients. The study reviewed adult day-surgery patients undergoing general anesthesia from 1 hour after surgery to 24 hours after surgery and the incidence of PONV. The study concluded that a simplified algorithm to identify high-risk patients resulted in significantly fewer cases of PONV and improved staff compliance with the algorithm. This study indicates that simplified process improvement for identification can lead to better patient outcomes if the medication and intervention algorithm is followed. This study paves the way for future studies at other institutions to assess whether this approach can be used to identify effective interventions in high-risk patients.

Stephenson et al. (2021) conducted a cohort study on the use of preoperative risk stratification and adherence to standardized antiemetic protocols, which was like that of Dewinter et al. (2017). The study was conducted over 12 months in a hospital in India. The study's flaws included the predominantly male sample (69%), despite female sex being a recognized high-risk factor. The study, however, corroborates that using the Apfel risk score in conjunction with multimodal prophylactic therapy decreased the incidence of PONV (Stephenson et al., 2021). Overall, the reviewed literature supports the use of scoring systems in preoperative settings to establish early prophylaxis for high-risk patients using pharmacological and non-pharmacological interventions.

Pharmacological Interventions

Using scoring systems to identify high-risk patients helps healthcare workers determine potential interventions. Pharmacological options include various antiemetic medications that can be used to prevent or treat PONV. These medications are classified differently and target different chemoreceptors in the body. Commonly used medicines for prophylaxis mentioned in the literature review include ondansetron, a serotonin receptor antagonist (5-HT3); droperidol, a dopamine antagonist; dexamethasone, a corticosteroid; scopolamine patch, a muscarinic cholinergic antagonist; and aprepitant, a neurokinin receptor antagonist. Almost every study included in this literature review references the use of preventative medication or a multimodal medication approach. The listed medication classes are common themes through the literature, though different medicines within each class are referenced and various combinations of medications are referenced.

Serotonin Receptor Antagonists (5-HT3)

The most mentioned and used pharmacological intervention throughout the literature to reduce PONV is 5-HT3 receptor antagonists, especially ondansetron. This medication blocks 5-HT3 receptors in the AP and other vomiting center pathways. This medication is safe in multiple patient populations, including women and pediatric patients, and is cost-effective. However, this medication should be given with caution in patients with cardiac conditions who have a prolonged QT on their electrocardiogram. Ondansetron can prolong QTc intervals, decrease heart rate, and increase the risk of arrhythmias. The use of a 5-HT3 antagonist is supported in multiple articles and is referenced as the primary medication to give to patients receiving anesthesia and opioid medications.

The literature by Chen and Chang (2022) and Pankiv et al. (2024) discusses how administering a 5-HT3 antagonist rather than a placebo improves patient outcomes. Chen and Chang (2022) also explored other 5-HT3 antagonist medications in their study and found that ramosetron, another 5-HT3 antagonist, was more effective. However, this study was limited to patients undergoing a specific type of surgery, craniotomy. The meta-analysis did, however, support that combination therapy with other antiemetic medications such as dexamethasone (corticoid) and droperidol (dopamine antagonist) should be further explored to support future clinical guidelines.

A systematic review by Pankiv et al. (2024) focused on preventing PONV in pediatric patients using 5-HT3 antagonists. Just as Chen and Chang (2022) concluded, Pankiv et al. (2024) stated that the use of 5-HT3 antagonists versus placebo reduces PONV. Both analyses found that when 5-HT3 medications are used alongside other drugs, the incidence of PONV decreases. The limitation of this study is that it concentrates on pediatric patient populations and suggests that corticosteroids, such as dexamethasone, may be a better option for pediatric surgical patients. This patient population focus is particular to pediatric patients only. Pankiv et al. (2024) also note that the use of alternative therapies, such as acupressure combined with medication, warrants further research for PONV interventions.

Corticosteroid

The administration of corticoids, specifically dexamethasone, in combination with other antiemetics, such as ondansetron, has been shown in meta-analyses and systematic reviews of randomized controlled trials to reduce the incidence of PONV in high-risk patients. The mechanism of this medication is not entirely understood, but theories that it can inhibit prostaglandin synthesis, reduce 5-HT3 release from the GI tract, and alter BBB permeability have been proposed. Veiga-Gil et al. (2017) argue that this medication enhances the effects of other antiemetics and provides longer antiemetic coverage for up to 72 hours. Because the mechanism of action is not fully understood, this medication should be studied further to determine whether, when given alone, it can reduce PONV. A suggestion for further investigation could be randomized controlled trials of monotherapy with dexamethasone or other corticosteroids to assess the effects or prevalence of PONV.

Dopamine Antagonist

Dopamine antagonist medications, such as droperidol, are mentioned in different literature. This type of medication is most effective with opioid-induced PONV and should be considered for prophylaxis. The medication works by blocking dopamine receptors in the AP. The medication does appear to have side effects that can affect cardiac rhythms, extrapyramidal effects, and has the potential to cause anxiety and restlessness in patients. This medication, in combination with other medications, should be considered as part of multimodal pharmacological interventions.

Other Pharmacological Interventions

Other major pharmacological interventions discussed in the literature include muscarinic cholinergic antagonists, such as the transdermal scopolamine patch, and neurokinin receptor antagonists, such as aprepitant. As previously mentioned, a history of motion sickness is considered a high-risk factor for PONV. Scopolamine patches, best known for preventing motion sickness, help reduce the incidence of PONV when used in combination with other prophylactic antiemetic medications. Neurokinin receptor antagonists, such as aprepitant, are another pharmacological intervention considered adequate for PONV. These medications suppress the vomiting reflex that stems from the NST. These medications were not fully explained or referenced in detail in the literature but are mentioned as options for use in multidrug

therapy for PONV prevention.

Other medications mentioned in the literature, with no common themes, that may reduce PONV include midazolam and propofol. These medications are commonly used for TIVA anesthesia, which can be considered less nausea-provoking for patients. Midazolam is a benzodiazepine that is widely used for sedation and anxiety. Echeverria-Villalobos et al. (2022) suggest that preoperative anxiety can contribute to PONV. This medication should be researched further to see if, in combination with other medicines, it can decrease preoperative anxiety as well as PONV. Though each article reviewed addressed these medication classifications, no repetitive combinations of medications were presented. Future studies involving randomized controlled trials with specific pharmacological interventions should be conducted to determine whether a particular medication combination is more effective than another in high-risk patients.

Non-pharmacological Interventions for PONV

Medication therapy for PONV reduction has been reviewed and suggests that combination pharmacology can assist in the reduction of PONV. The literature also supports the use of non-pharmacological interventions. Common non-pharmacological interventions suggested in the literature include aromatherapy, acupressure, and other sensory therapies. As discussed previously, anxiety is thought to be a contributing risk factor in PONV but has not been fully researched. Guided imagery and music therapy are suggested non-pharmacological interventions for PONV. Small randomized studies reviewed by Stoicea et al. (2015) suggest that when patients perform guided imagery and music therapy techniques, they can achieve muscle relaxation and a lower requirement for opioid pain medication during anesthesia. The limitations of the studies reviewed included small sample sizes and a focus on specific surgeries. The future analysis of relaxation and anxiety-reducing interventions should be studied in larger sample sizes and with a variety of surgical procedures.

Acupressure

Anxiety as a risk factor is also discussed by Ünülü et al. (2018), stating that anxiety levels are correlated with comfort levels. Comfort levels and anxiety levels are evaluated in a randomized controlled study that explores the impact of using acupressure or acupuncture in gynecological surgery patients. According to Ünülü et al. (2018) and Stoicea et al. (2015), acupressure at the Neiguan point (P6) on the bilateral distal wrist sites can help reduce PONV. Ünülü et al. (2018) explain that placing acupressure on the P6 area sends signals to the brainstem via the vagus nerve, causing a reduction of muscle contraction in the gastric tract. Stoicea et al. (2015) confirm the findings of Ünülü et al. (2018), also noting that stimulation of this point increases β-endorphin release, which in turn alters serotonin release. This helps reduce anxiety and can decrease the prevalence of PONV in patients by 20%. The limitations of these studies include small sample sizes and on gynecological surgery cases.

Aromatherapy

The use of aromatherapy as an intervention for PONV is also a common theme in the literature by Marsh et al. (2018) and Stoicea et al. (2015). Aromatherapy involves inhaling essential oils to promote an individual's well-being. It can help reduce anxiety and has no side effects compared to antiemetic medications. Marsh et al. (2018) conducted a retrospective cohort study of the use of a specific brand of essential oils, Post-Ease, containing lavender, peppermint, ginger, and lemon oils, to assist with PONV. The study notes a small sample size and emphasizes the need for staff education on proper use of the product. Overall, it suggests that using essential oils for PONV is safe, cost-effective, and complementary to other treatments. Stoicea et al. (2015) also mention that aromatherapy can support pharmacological interventions.

Limitations of Current Research and Directions for Future Research

The type of anesthesia used for surgical patients is a contributing factor to PONV. In hopes of reducing the incidence of PONV, the use of antiemetic drugs for PONV is a necessary intervention. The literature lacks a specification of the most effective medication combinations to decrease the occurrence of PONV. This suggests that future research or literature review should focus on specific combinations of medications that are most effective in preventing PONV. Other gaps within the literature included the small sample sizes of randomized controlled studies and specific surgeries. The research also lacks an explanation of the types of opioid pain medications used within the trials that directly play a role in PONV. Suggestion for future research can be randomized controlled studies that focus on specific anesthetic gas use, opioid medications used for pain control throughout and after surgery during recovery room stays, and options for non-opioid pain medications that can be administered in place of opioid pain medication. This should be researched to see if specific combinations of anesthesia and medications impact high-risk patients.

Conclusion

Each article for this literature review referenced common themes or relevant information on risk factors, anesthesia effects, and pharmacological interventions or non-pharmacological interventions impact on PONV. Overall, the themes within the literature review suggest that identifying high-risk patients and using combinations of medications in conjunction with non-pharmacological interventions can help reduce the risk of PONV in surgical patients. This can decrease further adverse outcomes in surgical patients, and future research on specific combinations should be explored. Though the literature and studies contained different sample sizes, medications used, and types of surgeries, it is confirmed that the use and length of anesthetics and opioid pain medication directly influence PONV. Patients with high-risk factors should be identified using a standardized scoring system to provide prophylaxis and guide anesthetic agent selection for surgery. Non-pharmacological interventions can be used alone or in combination with pharmacological interventions to help reduce the prevalence of PONV. Overall, the goal of reducing PONV with pharmacological and non-pharmacological interventions is essential to decrease adverse outcomes in surgical patients and plays an important role in surgical patient recovery [1-12].

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