INCREASING UTILIZATION OF THE APFEL SCORING SYSTEM IN HIGH-RISK PATIENTS

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Dedication and Acknowledgments

To my amazing husband, Christopher Neal Jr.; I had to spend many days and nights away from home. No matter the physical distance, our love never waned. As crazy as it was for me to pursue a second doctoral degree, you were proud of me for "bettering myself." You never gave me a hard time for missing holidays and family events or falling asleep before 7:30 p.m. I cannot thank you enough for being so selfless and supportive while I pursued my dreams. I dedicate this project to you and look forward to our "better" life together.

Abstract

Background: Postoperative nausea and vomiting (PONV) is a side effect following an anesthetic event that impacts 30-80% of patients undergoing general anesthesia (Flood et al., 2021). Patients who are female, have a history of PONV or motion sickness, are non-smokers, and are predicted to require postoperative opioids have increased incidences of PONV. Postoperative nausea and vomiting can lead to aspiration, wound dehiscence, and dehydration. **Purpose:** This project aimed to reduce the incidence of PONV in female patients undergoing gynecological surgery. **Methods:** This quality improvement project was completed following the Plan-Do-Study-Act model. An educational intervention on the Apfel scoring system was provided to Certified Registered Nurse Anesthetists (CRNAs). Pre- and post-intervention chart reviews compared PONV risk factors, Apfel Scores, prophylactic antiemetic utilization, and postoperative antiemetic administration. A post-intervention survey was used to evaluate CRNA knowledge and confidence. **Results:** The number of patients who received the appropriate number of prophylactic antiemetics based on their calculated Apfel score decreased from 56% to 50% ($z = -0.713$, $p = .11$). The frequency of patients requiring a postoperative antiemetic due to PONV decreased from 37% to 34% ($z = -0.746$, $p = .08$). **Recommendations and Conclusion:** There was no statistical change in the number of patients who received the appropriate number of antiemetics based on their calculated Apfel score or the administration of postoperative antiemetics in the post-anesthesia care unit (PACU). Future projects should explore barriers to clinical application of the Apfel scoring system among CRNAs.

Key Words: Postoperative nausea and vomiting, Apfel scoring system, PONV gynecological surgery, PONV management

Background and Significance

Postoperative nausea and vomiting (PONV) is an undesired side effect following an anesthetic event. Postoperative nausea and vomiting is defined as the experience of nausea or vomiting within 24-48 hours following a surgical procedure that requires anesthesia (Flood et al., 2021). PONV can be further divided into two categories: early PONV, which occurs within 24 hours following emergence, and late PONV, which occurs 24-72 hours following an anesthetic event (Flood et al., 2021). The occurrence of PONV among all patients undergoing general anesthesia is 30-40% and 70-80% among patients with identified risk factors (Flood et al., 2021). Risk factors that increase the incidence of PONV include female gender, history of PONV or motion sickness, non-smoker, and the anticipated use of postoperative opioids (Apfel et al., 1999; Apfel et al., 2012). Anesthesia contributes to PONV through the administration of volatile anesthetics, postoperative opioids, and nitrous oxide (Flood et al., 2021). Postoperative nausea and vomiting can lead to various problems, such as worsened dehydration, electrolyte imbalances, prolonged time spent in the PACU, aspiration, bleeding, airway compromise, hospital admittance, and wound dehiscence (Flood et al., 2021). Nurse anesthetists can help mitigate PONV and its associated problems by administering multimodal antiemetics prophylactically (Flood et al., 2021)

The incidence of PONV can be reduced using evidence-based screening tools (Dewinter et al., 2018; Nagase et al., 2022; Sherif et al., 2015; Tabrizi et al., 2019). Screening tools work by quantifying a patient's risk for PONV. The scores taken from the screening tools are then used to guide clinicians on the number of antiemetics to administer. Current evidence-based practice recommends the use of a PONV screening tool, such as the Apfel scoring system, to improve the identification and management of high-risk patients (Gan et al., 2020; Nagase et al., 2022; Stephenson et al., 2021).

Purpose

The purpose of this project was to reduce the incidence of PONV in female patients undergoing gynecological surgery under general anesthesia. The specific aims of the project were as follows:

- To improve utilization and adherence of the Apfel scoring system for PONV prophylaxis.
- To reduce the need for postoperative antiemetics in the PACU by female patients undergoing gynecological surgery.
- To improve the number of prophylactic antiemetics administered by the CRNA based on a patient's calculated Apfel score.
- To promote the administration of ondansetron within the final two hours of surgery.
- To promote the administration of dexamethasone during the induction of anesthesia.
- To increase the utilization of total and combined intravenous anesthetics in accordance with the patient's calculated Apfel score.

Review of Current Evidence

Search Strategies:

CINAHL, PubMed, and ProQuest databases were utilized using the following search terms: "Apfel scoring system," "Apfel score gynecological surgery," "Apfel validation," "rescue antiemetics," "ondansetron timing," "dexamethasone nausea vomiting," "Propofol antiemetic," "Propofol nausea," "total intravenous anesthetic (TIVA) vs. combined intravenous anesthetic (CIVA)," "Koivuranta scoring system," "PONV management," "PONV risk factors," "nausea and vomiting gynecological surgery," and "postoperative nausea and vomiting". The date range was 2017-2023. A total of 1,028 articles were obtained. Duplicate articles, articles not published in English, and articles not specific to the project population and topic were excluded. Seventeen articles met the inclusion criteria. An additional 25 articles were obtained through citation mining for a total of 42 articles.

Nausea and Vomiting

Nausea is the subjective sensation of having the urge to vomit, while vomiting is a physical event (Zhong et al., 2021). Nausea and vomiting are a series of physiological events controlled by the chemoreceptor trigger zone (CRTZ), also known as the vomiting center (Flood et al., 2021). The CRTZ is located in the brain, on the floor of the fourth ventricle, outside the blood-brain barrier. Because the CRTZ is situated outside this natural barrier, hormones and harmful substances can easily be detected (Flood et al., 2021). Many neurotransmitters interact with the CRTZ, such as acetylcholine, dopamine, histamine, substance P, and serotonin (Flood et al., 2021). Once the CRTZ detects a chemical stimulus, nausea can be induced. The induction of nausea can further signal motor neurons through cranial nerves V, VII, IX, X, and XII to contract the ileum, jejunum, and diaphragm to compress the stomach, resulting in the expulsion of its contents, also known as vomiting (Flood et al., 2021). Antiemetics interact with neurotransmitters and the CRTZ to prevent or treat PONV. Categories of antiemetics include: 5-HT3 antagonists, anticholinergics, antihistamines, benzodiazepines, cannabinoids, corticosteroids, dopamine antagonists, and neurokinin-1 antagonists (Flood et al., 2021).

Risk Factors

There are patient characteristics and surgical contributions that can promote an episode of emesis following the administration of anesthesia. Patient characteristics include being a woman, being a nonsmoker, and having a prior history of motion sickness or PONV (Apfel et al., 1999, 2012; Stadler et al., 2003; Zheng et al., 2020). The increased incidence of PONV in women is not fully understood, but some researchers have noted the influence of estrogen and progesterone on the CRTZ (Apfel et al., 2012; Vahabi et al., 2015). It is thought that estrogen and progesterone act on the CRTZ in a manner that influences the occurrence of PONV, explaining why pre-menopausal women are more likely to experience PONV than post-menopausal women (Apfel et al., 2012; Vahabi et al., 2015).

The type of surgical procedure, type and duration of anesthesia, and use of opioid medications can also contribute to the incidence of PONV (Flood et al., 2021). Gynecological, orthopedic, and abdominal surgeries incur the highest rate of PONV (Son & Yoon, 2018; Stadler et al., 2003). Surgical procedures lasting longer than 60 minutes or the administration of general anesthesia for greater than 100 minutes also increase the likelihood of PONV (Apfel et al., 2012; Son & Yoon, 2018; Stadler et al., 2003). Volatile gases are commonly known to promote PONV (Flood et al., 2012; Son & Yoon, 2018). Of the three common volatile gases currently used in anesthesia, desflurane has the highest incidence of PONV, followed by isoflurane, then sevoflurane (Son & Yoon, 2018). Intraoperative opioid use has been shown to minimally contribute to PONV, while postoperative opioid use exacerbates PONV (Apfel et al., 2012; Roberts et al., 2005; Stadler et al., 2003).

PONV Scoring Systems

Apfel Scoring System

The Apfel scoring system was developed by Christian Apfel. The scoring tool gives patients one point for each of the following PONV risk factors: female gender, nonsmoker, anticipated postoperative opioid use, and prior PONV or motion sickness (Apfel et al., 1999).

The total score can range from zero points to a maximum of four points. The total Apfel score correlates with the probability of a patient experiencing PONV (Apfel et al., 2002; Eberhart et al., 2000). An Apfel score of zero, one, two, three, or four correlates with a PONV incidence rate of 10%, 21%, 39%, 61%, and 79%, respectively (Apfel et al., 1999). Sherif et al. (2015) were able to reproduce these incidence rates, concluding that Apfel scores of zero, one, two, three, and four had a PONV incidence rate of 8.3%, 25.5%, 37.8%, 64.6%, and 83.3% respectively.

Practice consensus guidelines published by the American Society for Enhanced Recovery (ASER) recommend that the number of risk factors should guide the number of prophylactic antiemetics administered to the patient (Gan et al., 2020). These guidelines recommend the administration of two prophylactic antiemetics in adult patients with one or two risk factors and three to four prophylactic antiemetics in adult patients with three or more PONV risk factors (Gan et al., 2020). The combined administration of a 5-HT3 antagonist and dexamethasone is deemed the cornerstone of antiemetic prophylaxis and recommended as the initial prophylactic antiemetics to administer (Gan et al., 2020; Som et al., 2016). In the Som et al. (2016) meta-analysis, combining a 5-HT3 antagonist and dexamethasone reduced the need for post-operative rescue antiemetics (odds ratio 0.21, 99% CI 0.10–0.46).

Following the implementation of the Apfel scoring system, two studies reported a statistically significant reduction in PONV (Nagase et al., 2022; Tabrizi et al., 2019); one study reported a statistically insignificant reduction in PONV (Moore et al., 2021); and one study found no change in PONV (Choy et al., 2022). In the Nagase et al. (2022) study, the incidence of PONV decreased from 44.6% to 34.1%. In the study by Tabrizi et al. (2019), the incidence of PONV decreased from 21.1% to 9.5%. Although both studies utilized the Apfel scoring system and had reductions in the incidence of PONV, the antiemetics prophylactically utilized varied, the number of prophylactic antiemetics administered varied, and the Apfel score threshold for treatment varied (Nagase et al., 2022; Tabrizi et al., 2019). Moore et al. (2021) reported a reduction in PONV following two educational sessions over an 8-month period. The incidence of PONV decreased from 34.7% to 26.5% and was determined to be clinically significant but statistically insignificant (Moore et al., 2021). The insignificant decrease in PONV was in addition to significantly improved provider adherence from baseline data to the first educational session data (OR=2.31, 95% CI=1.33-4.04) (Moore et al., 2021). Provider adherence insignificantly decreased between the first and final educational sessions (P=.17, OR=0.71, 95% CI=0.42-1.19) (Moore et al., 2021). Choy et al. (2022) found that PONV rates in the pre-intervention group (19.6%) and post-intervention group (22.9%) did not statistically differ despite there being an Apfel scoring system utilization rate of 89.6% post-intervention. Unlike Nagase et al. (2022) and Tabrizi et al. (2019), Choy et al. (2022) and Moore et al. (2021) administered antiemetics per the ASER recommendations.

Other Scoring Systems

Koivuranta, Sinclair, Palazzo & Evans are also PONV scoring systems (Thomas et al., 2002). The Koivuranta scoring system awards points to five PONV risk factors: female gender, history of motion sickness or PONV, nonsmoker, postoperative opioid use, and length of surgery > 60 minutes (Koivuranta et al., 1997). The Sinclair scoring system awards points to six PONV risk factors: sex, smoker, previous PONV history, duration of surgery (in 30-minute increments), general anesthetic, and gynecological non-dilation and curettage procedure (Sinclair et al., 1999; Thomas et al., 2002). Lastly, the Palazzo & Evans scoring system awards points to five PONV risk factors: postoperative opioids, previous PONV history, sex, history of motion sickness, and the relationship between sex and PONV (Thomas et al., 2002).

Eberhart et al. (2000) concluded that the Apfel, Koivuranta, and Palazzo & Evans scoring systems predicted PONV (any severity) with the same accuracy (area under the curve (AUC) 0.70, 0.71, and 0.68, respectively) (Eberhart et al., 2000). Eberhart et al. (2000) concluded the Koivuranta ($p = 0.002$) and Apfel ($p = 0.005$) scoring systems were significantly better than the Palazzo & Evans scoring system in predicting postoperative vomiting. In a study conducted by Apfel et al. (2002), the accuracy and precision between the PONV scoring systems were reported as similar (AUC 0.68 (Apfel), 0.66 (Koivuranta); 0.66 (Sinclair), and 0.63(Palazzo)) (Apfel et al., 2002). Eberhart et al. (2000) and Apfel et al. (2002) concluded that the four scoring systems were equally accurate and precise and recommended that clinicians use the subjectively easier scoring system.

Antiemetics

Ondansetron

Ondansetron is a 5-HT3 antagonist with a half-life of three to four hours (Flood et al., 2021). The timing of ondansetron administration does not affect PONV incidence in surgical procedures lasting less than two hours (Al-Saad, 2013; Chakraborty & Sinha, 2016; Cruz et al., 2008; Sun et al., 1997; Tang et al., 1998). In surgical procedures lasting more than two hours, ondansetron administered within 30 minutes of the completion of surgery reduced the incidence of PONV from 30% to 20% (Cruz et al., 2008).

Dexamethasone

Dexamethasone can be prophylactically administered in doses of four, five, eight, and ten milligrams, with each dose being equivalent in efficacy (De Oliveira et al., 2013). For optimal efficacy, dexamethasone should be administered at induction (Gan et al., 2020; Wang et al., 2000). Wang et al. (2000) reported that patients who received dexamethasone before induction experienced lower incidences of PONV (15%) when compared to patients who received dexamethasone at the end of anesthesia (45%) and patients who received a placebo (53%).

Propofol

Total intravenous anesthetic (TIVA) is an anesthetic technique in which propofol is used as the anesthetic instead of a volatile gas (Hoornstra, 2022). A combined intravenous anesthetic technique (CIVA) uses propofol and a volatile gas together for the purpose of anesthesia (Hoornstra, 2022). In patients who received the volatile anesthetic sevoflurane without a prophylactic antiemetic, 38% did not experience PONV (Kawano et al., 2016). Seventy-one percent of patients who received propofol only and seventy-six percent of patients who received a combination of propofol and sevoflurane did not have PONV (Kawano et al., 2016). Other studies have found no statistically significant difference in PONV rates when a TIVA or CIVA was used (Wolf et al., 2021). Hoornstra (2022) reported that TIVA and CIVA techniques did not reduce the incidence of PONV in surgeries of less than two hours.

Theoretical Model

The Awareness-to-Adherence Model describes the cognitive and behavioral steps a provider must take to comply with guidelines (Pathman et al., 1996). The Awareness-to-Adherence Model consists of four components: awareness, agreement, adoption, and adherence (Pathman et al., 1996). The model states that dissemination of information through publication alone is not enough to change clinical practice (Pathman et al., 1996). The provider must first be made aware of the evidence-based practice recommendation, intellectually agree with the recommendation, clinically integrate the guideline into practice, and regularly adhere to the guideline (Pathman et al., 1996). Adherence is achieved when providers apply care in accordance with the guidelines in over 90% of their applicable patient population (Pathman et al., 1996).

The Awareness-to-Adherence Model was ideal for this project because the project site did not utilize the Apfel scoring system or any PONV screening tool. The CRNAs could not express familiarity with the Apfel scoring system or similar screening tools. The project site did not have a policy that standardized antiemetic administration. Because of the unfamiliarity with PONV screening tools and the Apfel scoring system, there was an opportunity to bring awareness to the CRNAs. Awareness would be made through an evidence-based educational intervention. It was anticipated that the CRNAs would adopt and agree to utilize the Apfel scoring system. Adoption and agreement would be determined through an observable decrease in postoperative antiemetic administration. Adherence would be determined by an increase in the administration of prophylactic antiemetics based on the patient's Apfel score in at least 90% of the patients.

Translational Framework

Plan

This evidence-based project utilized the Plan-Do-Study-Act model. The team for the evidence-based project consisted of the primary investigator (PI), the project team leader, a statistician, and the site's chief CRNA. The project was reviewed and declared exempt by the Institutional Review Board (IRB) at the University of North Carolina Greensboro and the facility site.

Population

The first population for this project was adult female patients undergoing gynecological surgery under general anesthesia. Patients were included if they were female, aged 18 years and older, and required an endotracheal tube or a laryngeal mask airway during surgery. Patients were excluded if they were pregnant or not biologically female.

The second population evaluated was CRNAs employed at the clinical site during project implementation. Certified registered nurse anesthetists were included if they were present on the day and time of the educational intervention and agreed to participate.

Setting

This project was conducted at a large level III facility in urban North Carolina. The facility provided many surgical services, including vascular, gynecological, trauma, cardiac, neurological, obstetrics, pediatrics, general, urological, and orthopedic. In addition, the facility had 19 operating rooms, offered inpatient and same-day surgeries, and staffed over 70 CRNAs.

Do- Project Implementation

Intervention

In the anesthesia breakroom, a 20-minute evidence-based educational session on PONV and the Apfel scoring system was implemented on a weekday in July 2023. The educational intervention occurred on a rolling basis to reach the greatest number of CRNAs as they moved in and out of the breakroom. Upon entering the breakroom, CRNAs were invited to participate. Consent was implied if the CRNA agreed to participate. During the session, the PI utilized an

8x11 Apfel scoring system cognitive aid (Appendix A) and educational notes (Appendix B). The 8x11 Apfel scoring system cognitive aid was given to participants as a 2x3 badge buddy.

Instruments

The charts were reviewed using a data collection sheet created by the PI for the purpose of the project (Appendix C). The PI created the Apfel scoring system survey for the purpose of the project and was administered through Survey Monkey (Appendix D).

Data Collection

Pre- and post-intervention chart reviews were conducted using the chart review tool. The pre-intervention chart review was conducted over the 30 days preceding the educational intervention. Post-intervention chart reviews were conducted during the 30 days after the educational intervention. Data collected included patient age, sex, PONV/motion sickness history, postoperative opioid use, smoking status, duration of surgery, antiemetics administered, anesthetic type, and timing of ondansetron and dexamethasone administration. Postoperative antiemetics were recorded if they were administered in the PACU. Dexamethasone administration was counted if it was administered within 15 minutes of endotracheal tube or laryngeal mask airway placement. No patient-identifying information was collected. The data collected from the chart reviews were entered into a password-protected Microsoft Excel file.

On the 30th day following the educational intervention, the CRNAs were emailed an Apfel scoring system survey via Survey Monkey. The survey contained eight Likert-style questions on CRNA confidence with utilizing and calculating an Apfel score, CRNA utilization of the Apfel scoring system in clinical practice, and antiemetic administration in accordance with the evidence-based Apfel recommendations. All CRNA survey responses were anonymous and stored in a password-protected Microsoft Excel file.

All email addresses and auditing tools were stored in the PI's locked file cabinet and will be destroyed after three years. The password-protected Microsoft Excel files and Apfel scoring system surveys were stored on the PI's password-protected laptop and will be permanently deleted after three years.

Study

Data Analysis

The data collected from pre- and post-intervention patient chart reviews were compared using quantitative and qualitative statistics. Simple descriptive statistics were used to compare PONV risk factors, duration of surgical procedure, calculated Apfel score, perioperative antiemetic administration, antiemetic administration in relation to the Apfel score, timing of ondansetron and dexamethasone administration, and TIVA/CIVA use. An Independent two-tailed T-test was used to compare the statistical significance of the calculated Apfel scores between the groups. A test of proportions was used to determine the statistical significance of the total number of antiemetics received based on the calculated Apfel score and the incidence of postoperative antiemetic administration. Statistical significance was set at five percent ($p < 0.05$).

The data extracted from the Apfel scoring system survey was analyzed using a frequency chart. For evaluation purposes, "agree" and "strongly agree" were viewed as positive responses to the educational intervention. Answers such as "disagree" and "strongly disagree" were viewed as negative responses to the intervention. The response "neither agree nor disagree" was viewed as neither positive nor negative.

Results

Patient Chart Review. A total of 235 patient charts were reviewed. Thirty-two charts (23 pre-intervention, 9 post-intervention) failed to meet the inclusion criteria and were excluded from the review. Ninety-eight charts were included in the baseline chart review and one-hundred-five in the post-intervention chart review. The mean age of patients in the pre-intervention group was 47.3 years (range 24-82 years) and 44.6 years (range 18-83) in the post-intervention group. The mean calculated Apfel score was 2.6 (range 1-4) for the pre-intervention group and 2.5 (range 1-4) for the post-intervention group. An independent t-test demonstrated that the calculated Apfel Scores for both groups were statistically similar $t(201) = 0.75$, $p < 0.05$. Refer to Table 1 for group demographics.

Table 1

Group Demographics

	Pre-Intervention		Post-Intervention	
	n	*%*	*n*	*%*
Age (average)	47.3		44.6	
Nonsmoker	77	79	87	83
Anticipated Postoperative Opioid Use	69	70	68	65
PONV/Motion Sickness History	6	6	3	3
Average Apfel Score	2.6		2.5	
Average Length of Surgery (hours)	1.0		1.1	
Average number of antiemetics administered	2.0		2.0	
Calculated Apfel Score				
1	3	3	6	6
2	41	42	42	40
3	50	51	56	53
4	4	4	1	1
Received the appropriate # of antiemetics based on the calculated Apfel score	55	56	53	50
Required a postoperative antiemetic	36	37	36	34

In the pre-intervention group, 56% of patients received the recommended number of prophylactic antiemetics based on their calculated Apfel score. In the post-intervention group, 50% of patients received the recommended number of prophylactic antiemetics based on their calculated Apfel score. When accounting for the difference in group sizes, there was no statistical difference in prophylactic antiemetic utilization based on the calculated Apfel score ($z = -0.713$, $p = .11$). Table 2 describes the selection and frequency of administered perioperative antiemetics.

Table 2

Perioperative Antiemetic Administration

	Pre-Intervention		Post-Intervention	
	n	%	*n*	%
Preoperative				
Scopolamine	5	5	11	10
Intraoperative				
Ondansetron	95	97	98	93
Dexamethasone	93	95	99	94
Diphenhydramine	3	3	3	3
Propofol infusion [a]	2	2	0	0
None	1	1	3	3
Postoperative				
Amisulpride	32	33	24	23
Ondansetron	4	4	8	8
Promethazine	2	2	0	0
Metoclopramide	0	0	1	1
Compazine	0	0	1	1
None	62	63	71	66

Note.
[a] Includes TIVAs and CIVAs

Ninety-six percent of patients in the pre-intervention group received ondansetron within two hours of surgery completion. In the post-intervention group, 91% of patients received ondansetron within two hours of surgery completion. Ondansetron was not administered intraoperatively in 3% of patients in the pre-intervention group and 6% in the post-intervention group. Dexamethasone was administered at induction to 92% of patients in the pre-intervention group and 97% in the post-intervention group. Dexamethasone was not administered to 4% of patients in the pre-intervention group or 3% in the post-intervention group. Two percent of the patients in the pre-intervention group received a CIVA technique, while one percent received a TIVA. The post-intervention group did not utilize a CIVA or TIVA.

Thirty-six patients in the pre-intervention group (37%) and thirty-six in the post-intervention group (34%) required a postoperative antiemetic while in the PACU. When accounting for the difference in group sizes, there was no statistical difference in postoperative antiemetic administration rates (z = -0.746, p = .08). Refer to Table 3 for the characteristics of the patients who required an antiemetic post-operatively.

Table 3

Characteristics of Postoperative Antiemetic Recipients

	Pre-Intervention		Post-Intervention	
	n	*%*	*n*	*%*
Patients requiring a postoperative antiemetic	36	37	36	34
Nonsmoker	24	67	26	72
Anticipated Postoperative Opioid Use	31	86	25	69
PONV/Motion Sickness History	4	11	2	6
Average Apfel Score				
Mean	2.75		2.6	
Mode	3		3	
Apfel Score				
1	1	1	1	1
2	10	10	13	13
3	22	61	20	56
4	3	3	0	0
Total Antiemetics used [a]	2.0		2.2	
Did receive an appropriate number of antiemetics per Apfel score [b]	15	42	18	50

[a] Indicates the average
[b] Indicates "yes" responses.

Apfel Scoring System Survey. A total of 16 CRNAs attended the educational session. Three CRNAs completed the Apfel scoring system survey. Three respondents agreed to utilizing the Apfel scoring system in clinical practice and calculating an Apfel score on patients undergoing general anesthesia. Three participants agreed or strongly agreed with being confident in calculating an Apfel score for patients receiving general anesthesia. Two respondents agreed or strongly agreed with being confident in utilizing the Apfel scoring system in clinical practice, while one was neutral. Three respondents strongly agreed to administering ondansetron within two hours of the completion of surgery. Three respondents agreed or strongly agreed to administering dexamethasone during induction. Three respondents agreed to administering antiemetics according to the patient's Apfel score. Two respondents agreed to administering antiemetics according to the Apfel scoring system's recommendations while one was neutral.

Identify barriers to success. Only three out of sixteen CRNAs completed the Apfel scoring system survey. Low survey response rates were a barrier to this project and prevented the generalizability of the results. Low response rates also limited the ability to evaluate any improvement in the utilization and adherence of the Apfel scoring system for PONV prophylaxis. Possible reasons for low response rates include a lack of interest, the inclusion of contract CRNAs, and disseminating the survey through work emails.

Identify strengths to overcome the barriers. In response to the low Apfel scoring system survey results, the deadline to submit a response was extended by one week. The CRNAs were also emailed reminders to complete the survey. Despite the extension and reminders, survey participation did not improve.

Discussion

The purpose of this quality improvement project was to reduce the incidence of PONV in female patients undergoing gynecologic surgery under general anesthesia. The first aim was to improve utilization and adherence to the Apfel scoring system for PONV prophylaxis. Due to limitations in the electronic charting system, utilization of the Apfel scoring system was captured through the Apfel scoring system survey. Given the lack of a baseline survey and a postintervention response rate of 19%, it cannot be determined if there was increased utilization of the Apfel scoring system.

The second aim looked to reduce the need for postoperative antiemetics in the PACU by female patients undergoing gynecological surgery. The need for postoperative antiemetics decreased from 37% to 34%. This decrease was determined to be statistically insignificant when accounting for group size. This aim was determined to be unsuccessful.

The third aim was to improve the number of prophylactic antiemetics administered by the CRNAs based on the patient's calculated Apfel score. Patients who received the appropriate number of antiemetics based on their calculated Apfel score decreased from 56% to 50%. This decrease was determined to be clinically insignificant when accounting for group size. Because there was no statistical increase in the number of patients who received the appropriate number of antiemetics based on their calculated Apfel score, this aim was determined to be unsuccessful.

The fourth and fifth aims sought to promote the administration of ondansetron within the final two hours of surgery and the administration of dexamethasone during the induction of anesthesia. Ondansetron administration within the final two hours of surgery decreased from 96% to 91%. Dexamethasone administration during induction increased from 92% to 97%. Since both aims had results above 90%, this indicates CRNA adherence per the awareness-to-adherence model. Therefore, this aim is viewed as successful.

The sixth aim sought to increase the utilization of total and combined intravenous anesthetics in accordance with the patient's calculated Apfel score. Combined intravenous anesthesia decreased from 2% to 0%, and TIVA utilization decreased from 1% to 0%. This aim was determined to be unsuccessful because there was no increase in CIVA or TIVA utilization.

Following the awareness-to-adherence model, the CRNAs were made aware of the practice guidelines and clinical recommendations. Patients who received the appropriate number of antiemetics based on their calculated Apfel score decreased from 56% to 50%, signifying the CRNAs may not have agreed with the practice recommendations. Agreement would have been reflected as a statistically significant increase in the administration of the appropriate number of antiemetics based on the Apfel score. Agreement with the guidelines would have led to adoption and adherence. Adherence would have been reflected as a 90% administration rate of the appropriate number of prophylactic antiemetics based on the calculated Apfel score (Pathman et al., 1996). Progression through the awareness-to-adherence model likely stopped at agreement.

Responses from the Apfel scoring system survey did indicate comfort with utilizing the Apfel scoring system and clinical application of the Apfel scoring system. This could suggest that the Apfel scoring system was well-received by some of the CRNAs. Unfortunately, a response rate of 19% does not allow for the generalizability of the results.

The PI subjectively chose the Apfel scoring system. The Apfel, Koivuranta, Sinclair, and Palazzo & Evans scoring systems were all determined to be similar in accuracy and precision (Apfel et al., 2002; Eberhart et al., 2000). Therefore, the Apfel scoring system was chosen based on the availability of more research studies, unrestricted access to its use, and it being the most commonly used scoring system at nearby facilities. Although Nagase et al. (2022) and Tabrizi et al. (2019) reported decreases in PONV, Choy et al. (2022) reported a statistically insignificant increase. The Apfel scoring system was used in all three studies, but the administration of antiemetics according to the Apfel score was different. This could indicate that standardization through identifying and managing high-risk patients decreases PONV rates. The type of scoring system and how to treat each score may not matter as much as consistently identifying high-risk patients and prophylactically treating those patients. Choy et al. (2022) likely did not have successful results due to 33 out of 63 anesthesia providers viewing the Apfel scoring system educational presentation. Since nearly half of the providers did not view the presentation, it is possible that those providers were not standardizing their care, which allowed high-risk patients to go undetected and undertreated (Choy et al., 2022).

Limitations and Recommendations for Future Practice.

Preoperative anesthesia notes inconsistently mentioned if postoperative opioid use was anticipated. Other risk factors such as gender, smoking status, and history of PONV or motion sickness were routinely documented. Anesthesiologists (who were excluded from the educational session) performed the preoperative assessments and wrote the preoperative notes. The implementation site frequently utilized transabdominal plane blocks for pain control. The CRNAs' views on anticipated postoperative opioid use following a transabdominal plane block were not assessed, and therefore, it is unclear if this impacted the calculated Apfel scores. Future studies should evaluate how CRNAs calculate anticipated postoperative opioid use in the setting of transabdominal plane blocks.

Anticipating postoperative opioid use is a subjective metric of the Apfel scoring system. Choy et al. (2022) theorized that the subjectivity of anticipating postoperative opioid use likely led to the underscoring and undertreatment of some patients. This likely led to the increase in PONV rates from 19.6% to 22.9%. Future studies should discuss methods to objectively answer if postoperative opioid use is anticipated.

The data collected in this study was dependent upon accurate charting. There were occasions when antiemetics were not documented intraoperatively, and there was no way to determine whether this was intentional or unintentional. Future research should consider adding an antiemetic exemption option to electronic charting records.

The Apfel scores calculated by the CRNA were not documented. The facility did not require the documentation of an Apfel score, and there was no dedicated section in the chart to document an Apfel score. Therefore, there is no way to know what Apfel score the CRNA calculated. There is also no way to know if any differences occurred between the CRNAs' and PI's calculated Apfel score. Future researchers should consider methods of capturing the CRNA's calculated Apfel score.

This project did not evaluate the CRNAs' perceived barriers. Not evaluating perceived barriers limits insight into why the Apfel scoring system may not have been utilized and what issues may have arisen with its utilization. Future studies should incorporate open-ended questions in post-intervention surveys.

The postintervention chart review was not limited to the charts of the CRNAs who participated in the educational intervention. This created the possibility that the participating CRNAs translated the evidence into clinical practice, but the data was skewed from the charts of the CRNAs who did not participate in the educational session. Future research should consider educational methods that can reach all staffed CRNAs.

Act

The Act portion is where the decision is made to adopt, adapt, or abandon the quality improvement project (American Medical Association (AMA), 2023). Adoption involves exiting the PDSA cycle and implementing the project on a larger scale (AMA, 2023). Adaption involves restarting the PDSA cycle and refining the current process in the next planning phase if the plan meets or surpasses the desired results (AMA, 2023). Lastly, abandonment is recommended if the plan did not work or the project would be better suited under different circumstances (AMA, 2023). Abandonment would involve discontinuing the plan and completely restarting the PDSA cycle with a new QI attempt (AMA, 2023).

Since the number of patients who received the appropriate number of antiemetics based on their calculated Apfel score decreased from 56% to 50% and the need for postoperative antiemetics in the PACU decreased from 37% to 34%, the recommendation to restart the project was made. An overhaul of the current plan is needed. Changes in the new PDSA cycle should address the ability to objectively identify PONV risk factors and ways to increase CRNA participation and adherence.

Conclusion

In conclusion, there was no statistical change in the number of patients who received the appropriate number of antiemetics based on their calculated Apfel score or the administration of postoperative antiemetics in the PACU. Implementing solutions to reduce PONV rates by standardizing the identification and management of high-risk patients should be an important objective. Misidentifying high-risk patients can lead to PONV, which can cause postoperative complications and a negative experience for patients. Implementing the Apfel screening tool is a feasible and practical way to standardize PONV management since it consists of only four questions. However, in order to promote consistency, more clarification may be needed on how to anticipate a patient's postoperative opioid needs objectively.

The results of this study will be emailed to the chief CRNA of the host facility and presented at the university's Poster Day event. Given the lack of change in PONV rates and rescue antiemetic utilization, adopting the Apfel scoring system will not be recommended. Instead, it is recommended that the host facility assess staff perception and systemic barriers to implementing a PONV screening tool. The CRNAs may also need to consider other PONV screening tools.

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Appendix A

Apfel Score	PONV Incidence	Recommended Interventions	
0	10%	None	
1	21%		
2	39%	1-2 antiemetics	• 5-HT3 antagonists (Ondansetron given within 2 hours of surgery completion) • Corticosteroids (Dexamethasone at induction)
3-4	61%	3 or more antiemetics	• Anticholinergics (Atropine, Scopolamine) • Antihistamines (Diphenhydramine, Promethazine) • Dopamine antagonists (Amisulpride, Haloperidol, Metoclopramide) • Neurokinin-1 antagonists (Aprepitant) • Non-barbiturate sedative (Propofol TIVA or background infusion)
4	79%		

Apfel Risk Factors
(+1 point each)

- Female
- Non-smoker
- Postop opioids
- History PONV or motion sickness

Appendix B

Educational Notes

- Postoperative nausea and vomiting is the experience of nausea or vomiting within 72 hours of receiving anesthesia (Flood et al., 2021, p. 707).
- The occurrence of PONV among all patients undergoing general anesthesia is 30-40% and 70-80% in patients with identified risk factors (Flood et al., 2021, p. 707).
- Patient risk factors that increase the incidence of PONV include female gender, history of PONV/motion sickness, younger age, and non-smoking status (Apfel et al., 1999, 2012).
- Anesthetic risk factors for PONV (Flood et al., 2021, p. 707).
    - Volatile anesthetic use
    - Duration of anesthesia
    - Postoperative opioid use
    - Nitrous oxide use
- Complications from PONV (Flood et al., 2021, p. 707).
    - worsened dehydration
    - electrolyte imbalances
    - prolonged time spent in the post-anesthesia care unit
    - aspiration
    - bleeding
    - airway compromise
    - hospital admittance
    - wound dehiscence

Afpel scoring system efficacy

- Created in 1999 by Christian Apfel, MD
- Further validated by several studies throughout the last two decades in a broad range of surgical patients (general, ENT, gynecology, ortho, etc.)
- The Apfel score consists of four risk factors (female, non-smoker, postop opioids, history PONV/motion sickness.
- Koivuranta score contain Apfel's four risk factors plus surgery > 60 minutes
- In a study comparing the Apfel score and Koivuranta score, the Apfel score had a higher specificity and was more accurate in the PONV prediction score (Gunawan et al., 2020)
- PONV is reduced by 10% by using the Apfel scoring system. (Gan et al., 2020; Nagase et al., 2022; Sigaut et al., 2010; Tabrizi et al., 2019).

Apfel score components

- First start under "Apfel Risk Factors"
- The score card has four risk factors listed
    - Female

  - Non-smoker
  - Postop opioids
  - History PONV/motion sickness
- If any of the factors apply to the patient, then one point is awarded
- Once the points are totaled, the clinician then finds the corresponding score on the chart, in the left column titled “Apfel score”. The score will have an adjoining column to the right titled “PONV Incidence” which gives a percentage on how likely a patient is to experience PONV.
- In the adjoining column to the far right titled “recommended interventions”, the recommended number of antiemetics to administer and antiemetic examples are given.
- A total score of:
  - 0-1: requires no antiemetics
  - 2: requires 1-2 antiemetics
  - 3-4: requires 3 or more antiemetics
- The primary antiemetics (5-HT3 receptor antagonist and corticosteroid) should be considered first
- Either ondansetron or dexamethasone can be given or both can be given

Ondansetron administration timing

- Depends on the length of surgery
- Half life of Ondansetron is 3-4 hours
  - For surgeries ≤ 2 hours, it is okay to give ondansetron upfront
  - For surgeries >2 hours, giving ondansetron within the last 30 mins is ideal

Background propofol infusion vs TIVA

- Both are equally effective at preventing PONV
  - (Hoornstra, 2022; Kawano et al., 2016; Wolf et al., 2021).

Appendix C

Chart Review Tool

Patient age ________

Add 1 point for each description met by the patient	
Female gender	
Nonsmoker	
Postoperative use of opioids	
Previous PONV or Motion sickness	
Total Score	

Surgery length ______

How many antiemetics were used? _____

Preop:

____ Amisulpride
____ Aprepitant
____ Atropine
____ Dexamethasone
____ Diphenhydramine
____ Haloperidol
____ Metoclopramide
____ Ondansetron
____ Promethazine
____ Propofol (TIVA/CIVA)
____Scopolamine
____ other:

Intraop:

____ Amisulpride
____ Aprepitant
____ Atropine
____ Dexamethasone
____ Diphenhydramine
____ Haloperidol
____ Metoclopramide
____ Ondansetron
____ Promethazine
____ Propofol (TIVA/CIVA)
____Scopolamine
____ other:

PACU:

____ Amisulpride
____ Aprepitant
____ Atropine
____ Dexamethasone
____ Diphenhydramine
____ Haloperidol
____ Metoclopramide
____ Ondansetron
____ Promethazine
____ Propofol (TIVA/CIVA)
____Scopolamine
____ other:

Was the number of antiemetics administered appropriate for the Apfel score? Yes No

If ondansetron was given, was it administered within 2 hours of the end of surgery? Yes No N/A

If dexamethasone was given, was it administered at induction? Yes No N/A

Was a total intravenous anesthetic used? Yes No

Was a background propofol infusion (CIVA) used? Yes No

Did the patient require an antiemetic in the PACU? Yes No

Appendix D

Apfel Scoring System Survey

Please check the box that most appropriately answers the question

	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
1. I utilize the Apfel scoring system in clinical practice					
2. I calculate an Apfel score on my patients undergoing general anesthesia					
3. I am confident in calculating an Apfel score for patients receiving general anesthesia					
4. I am confident with utilizing the Apfel scoring system in clinical practice					
5. I administer ondansetron within two hours of the completion of surgery					
6. I administer dexamethasone during induction					
7. I administer antiemetics in accordance to the patient's Apfel score					
8. I administer antiemetics in accordance to the Apfel scoring system's recommendations					