Preoperative Risk Assessment to Guide Prophylaxis and Reduce the Incidence of Postoperative Nausea and Vomiting

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Purpose: *This article describes the implementation of a postoperative nausea and vomiting (PONV) risk prediction and prophylaxis protocol.*
Design: *This is a retrospective pre/post implementation quality improvement project.*
Methods: *This project used chart reviews to assess the impact of the implemented PONV assessment and prophylaxis in a sample population of adult females undergoing gynecologic surgical procedures.*
Findings: *The mean number of prophylactic antiemetics administered significantly increased during the postimplementation period from 3.64 (SD, 0.878) in the preimplementation period to 4.07 (SD, 1.021) in the postimplementation period (*$P < .001$*). The greatest increase in antiemetic administration occurred in the moderate-risk (risk score, 4) and the high-risk (risk score, 5 to 6) groups. The incidence of PONV decreased from 32.3% in the preimplementation period to 28.9% in the postimplementation period; however, this reduction did not meet statistical significance. Antiemetic administration compliance increased from 37% in the preimplementation group to 61% in the postimplementation group (*$P < .001$*).*
Conclusions: *The results of this project suggest that a risk-tailored approach to PONV prophylaxis using a risk assessment tool along with treatment recommendations is effective at reducing the incidence of PONV. The effectiveness of this approach is limited by the involvement of the anesthesia providers responsible for completing the assessments and administering PONV prophylaxis.*

Keywords: *postoperative nausea and vomiting, PONV, prevention and control, risk assessment, decision support techniques.*

THE ONSET OF NAUSEA OR VOMITING within the first 24 hours after surgical anesthesia, collectively termed postoperative nausea and vomiting (PONV), adversely impacts patient experience during the postoperative period and increases health care costs. Although the incidence of PONV has declined during the last 75 years, anesthesia providers and postanesthesia care unit

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(PACU) nurses continue to struggle with its prevention.[1] Among surgical inpatients, the incidence of nausea and vomiting is approximately 50% and 30%, respectively.[2] The risk of nausea and vomiting increases to 70% for inpatients assessed to have high risk for PONV.[2] In contrast, Apfel et al[3] reported a postdischarge PONV incidence of 37% among same-day surgical (SDS) patients. Although the reported incidence of PONV in SDS patients is lower than that of inpatients, Gan et al[2] suggested that the incidence rates of inpatient and SDS patients differ because of underreporting of PONV in the SDS patient population. The occurrence of PONV is multifactorial, involving anesthetic, surgical, and patient-specific triggers.[4] Effective antiemetic medications are available at relatively low cost.[2] This has given rise to the practice of administering PONV prophylaxis to all surgical patients.[5] The continued high incidence of PONV in spite of this prevention strategy has prompted a focus on PONV prophylaxis strategies that are specific to each patient rather than a general prophylaxis strategy for all patients.[2] This quality improvement project examined the impact of introducing a patient-tailored PONV prophylaxis strategy at an institution previously using a generalized strategy.

Review of Literature

Anesthesia care has improved significantly in quality and safety; however, PONV continues to be a significant problem for institutions and patients. For institutions, PONV impacts patient health outcomes and the cost of patient care.[6] Ganter et al[7] found a strong correlation between PONV and PACU length of stay. Patients who experienced PONV spent twice the amount of time in the PACU than those patients who did not. These delayed PACU discharges impede perioperative efficiency by hindering the flow of patients from the operating room to the PACU.[2] Beyond its impact on the PACU, postoperative vomiting increases the risk of pulmonary aspiration, suture dehiscence, esophageal rupture, subcutaneous emphysema, and pneumothorax, and it is a leading cause of unexpected hospital admissions.[3] For patients, PONV represents a significant source of distress even before undergoing surgery, and patients rank PONV as their most undesirable postoperative outcome.[8] Patients reported PONV as more undesirable than pain and shivering. Study participants reported that they were willing to pay $100 out of pocket for a medication that would prevent PONV.

Many of the causes of PONV are unavoidable; volatile anesthetics, nitrous oxide, and postoperative opioid analgesics cause PONV in a dose-dependent fashion.[2] Laparoscopic procedures, gynecologic surgeries, and cholecystectomies carry an increased risk for PONV.[2] Historically, the treatment of PONV has varied among institutions and providers. The selection of medications has been based on provider preference, price, and availability.[9] Until recently, the literature on PONV lacked a systematic attempt to quantify the combined impact of independent predictors of PONV.[4]

Anesthesia providers have effective antiemetic medications to manage PONV, yet these medications are not without risks for adverse effects. Without a consistent method of determining PONV risk, patients with the highest risk for PONV do not consistently receive an effective multimodal approach to PONV management. Conversely, antiemetic administration to patients with low PONV risk exposes those patients to rare but well-documented side effects.[2]

The most recent and comprehensive guidelines for the management of PONV are the Society for Ambulatory Anesthesiology's *Consensus Guidelines for the Management of Postoperative Nausea and Vomiting*.[2] These guidelines recommend managing PONV using risk-dependent strategies that base the administration of antiemetic prophylaxis on individual risk using a prediction model. According to Kappen et al,[10] several validated predictive models exist, but they have had little clinical impact because they have been poorly implemented. Spontaneous compliance by anesthesia providers to risk-dependent PONV prophylaxis guidelines is 40%, and it is suggested that poor adoption rates have resulted in administering multiple antiemetics to all patients, regardless of risk.[11] Although this practice is well intended, it is not evidence based.[10] Current best practice recommendations support the effectiveness of risk-dependent strategies. Their implementation in perioperative settings has shown great promise in reducing PONV, particularly in high-risk populations.[10]

A targeted approach for PONV management that aligns with the guidelines established by Gan et al[2] includes use of an assessment tool that objectively quantifies PONV risk and recommends prophylactic antiemetics based on the patient's individual risk for developing PONV. A systematic review by Gan et al[2] found that female gender, nonsmoking status, personal history of PONV, patients younger than 50 years, and postoperative opioid administration are strong independent indicators for PONV risk. In adult patients, Gan et al[2] described two risk assessment tools: the Apfel Simplified Risk Score for PONV[12] and the Apfel Simplified Risk Score for postdischarge nausea and vomiting (PDNV).[3] Apfel et al[3,12] validated each component of their assessment tools as independent predictors of PONV risk. They also evaluated and validated the effectiveness of each tool as a predictor of total PONV risk.[3,12] While recommending the use of these tools, Gan et al[2] noted that these tools are not completely predictive demonstrating sensitivity and specificity between 65% and 70%.[2]

The Apfel risk assessment tools assign each risk factor a point, and the cumulative number of points represents the patient's individual risk for PONV. Scores are divided into three categories: low risk (0-1 points), moderate risk (2 points), and high risk (3 or more points). The Apfel Simplified Risk Score for PONV[12] produces a score between zero and four. The corresponding risk for PONV is 10%, 20%, 40%, 60%, and 80%. The Apfel Simplified Risk Score for PDNV[3] produces a score between zero and five. The corresponding risk for PONV is 10%, 20%, 30%, 50%, 60%, and 80%. An additional algorithm links risk severity with treatment recommendations.[2] Treatment recommendations are based on a 26% reduction in PONV risk for each antiemetic administered.[10] Kappen et al[10] implemented a similar model that found that risk model–guided clinical decision making significantly increased the administration of antiemetic medications to patients identified as having the greatest risk of PONV. During the study period, there was an 8% reduction in the incidence of PONV between the preimplementation and postimplementation groups (odds ratio, 0.60; 95% confidence interval, 0.43-0.83). The greatest reduction in PONV occurred in patients determined to have the highest risk (OR, 0.45; 95% CI, 0.28-0.72).

The goal of this quality improvement project was to provide a more objective and targeted approach to assess a patient's risk for PONV and administer appropriate prophylaxis in adult gynecologic surgery patients at a community hospital in the southeast United States. The specific aims of this project were as follows:

Aim 1
: Increase the postimplementation number of antiemetics administered to patients in the moderate-risk and high-risk categories for PONV when compared with the preimplementation number of antiemetics administered.

Aim 2
: Decrease the postimplementation incidence of PONV in adult gynecologic surgery patients when compared with the preimplementation incidence of PONV.

Aim 3
: Achieve 50% anesthesia provider compliance to the PONV assessment and prophylaxis protocol during the postimplementation phase of the project.

Methods

This project implemented a PONV prophylaxis protocol that used an assessment tool to guide PONV prophylaxis that was tailored to each patient's risk of developing PONV. The tool used six independent predictors of PONV risk: general anesthesia, female gender, age younger than 50 years, nonsmoking status, history of PONV or motion sickness, and anticipated postoperative opioid administration. Each of the six predictors was assigned one point that resulted in cumulative PONV risk scores between zero and six. The points corresponded with increasing risk for PONV: 10%, 20%, 30%, 50%, 60%, and 80%. Total risk was capped at 80% resulting in risk scores 5 and 6, both indicating an 80% risk. Based on the risk score, the tool indicated the patient's risk, indicated the total number of antiemetics to be administered, and suggested a medication strategy. Anesthesia providers could adapt the medication strategy based on their total assessment of the patient. The providers could select any antiemetic combination with the stipulation that the number of medications administered matched the number indicated on the tool based on risk.

Furthermore, all medications administered must belong to different drug classes. All available antiemetics were listed on the tool grouped by their mechanism of action. The goal was to reduce the patient's risk for PONV below 20%. A risk reduction of 26% was used for each medication administered resulting in recommendations to administer between zero and five antiemetic medications. The assessment tool combined the antiemetic medication recommendations from the *Consensus Guidelines for the Management of Postoperative Nausea and Vomiting*[2] with the Apfel Simplified Risk Score for PONV[12] and the Apfel Simplified Risk Score for PDNV.[3] The intention was to produce an assessment tool that concisely presented current best practices.

Project implementation occurred in a community hospital that performed 1,160 gynecologic surgeries in fiscal year 2015 and was projected to perform 1,100 gynecologic surgeries in fiscal year 2016. Patients included in the sample were females who were 18 years of age or older undergoing gynecologic surgeries in the main operating rooms that received monitored anesthesia care, regional anesthesia, or general anesthesia. Patients were excluded for the following: pregnancy, admission to the intensive care unit after surgery, mechanical ventilation support overnight after surgery, and inability to communicate with staff in English. All patients meeting inclusion criteria during the data collection period, except those meeting exclusion criteria, were included in the project.

The project used a retrospective chart review, pre/post test design. Data were collected during 4 months with 2 months allotted for preimplementation and postimplementation groups. The preimplementation period included the collection of data regarding PONV prophylaxis trends and PONV incidence to establish a baseline to compare the effects of the risk-dependent PONV protocol. Postimplementation chart audits recorded PONV prophylaxis trends and PONV incidence. Anesthesia provider compliance to the protocol was assessed by chart audits of patients included in the postimplementation period to determine if antiemetics were administered per the protocol. The project's first author completed all data collection and chart reviews.

The anesthesia department employs 30 nurse anesthetists and 10 physician anesthetists. For this project, the term *anesthesia provider* refers to certified registered nurse anesthetists who were the primary providers of direct patient anesthesia care. Before entering the postimplementation phase, the first author provided education on the project and the protocol to nurse and physician anesthesia providers as well as to the PACU nursing staff. Education included formal presentations at staff meetings, informal in-services in the PACU and in anesthesia work areas, and electronic mails to all providers. The first author was onsite for the first 2 weeks of the postimplementation phase to provide direct one-on-one education to anesthesia providers providing anesthesia for gynecologic surgeries. Folders containing data collection worksheets were available in all operating rooms where gynecologic surgeries were performed. The folders included printed instructions. Reminder cards with contact information for the first author were placed in a visible location on the anesthesia machines.

The project asked anesthesia providers to initiate the new protocol by completing a data collection worksheet for each patient. The worksheet consisted of a copy of the protocol with space to document the patient's risk score and any PONV prophylactic therapies administered. This document asked providers to evaluate demographic data that related to the components of the risk assessment tool: gender, age, smoking status, history of PONV, and history of motion sickness. These data, however, were only documented on the worksheet as zero or one point depending on whether the patient did or did not have each risk predictor. Each worksheet had a randomly generated four-digit identification number that the provider entered as a Quick Note in the intraoperative section of the patient's electronic medical record (EMR). A retrospective chart review of the EMR repeated the risk assessment to assess compliance to the new protocol. The identification numbers allowed for matching of EMR with worksheets during the chart reviews. Data collected during chart reviews included components of the PONV risk assessment: age, gender, tobacco use, history of PONV, and surgical procedure.

Data regarding the incidence of patient-reported nausea, the incidence of vomiting, and the use of postoperative rescue antiemetics were also collected. Before this project, the institution did

not have a formal process for measuring the incidence of PONV. For the purposes of this project, patients were identified as having PONV if, within the first 24 hours after surgery, they reported nausea or vomiting to nursing staff or they received an antiemetic medication.

After institutional review board (IRB) evaluation, the project was designated *IRB Exempt* because the project did not meet the definition of research as described in the Code of Federal Regulations, and it satisfied the privacy rule also described in the Code of Federal Regulations. As an exempt project, informed consent was not required. Every effort was made to protect the private health information of patients. All data were deidentified during collection. Identification numbers were placed in intraoperative documentation that is not discoverable using the standard search features of the EMR. Printed data were stored in a locked cabinet in a secured administrative office at the hospital. Electronic data were stored behind a firewall on school of nursing servers at a local university. The servers are password protected and encrypted using at least 128-bit encryption. Access to the data was restricted to the first and last authors. All parties involved in the study were subjected to confidentiality agreements.

Analysis

Demographic data were compared using χ^2 tests for categorical and two-sample t tests for continuous variables to ensure groups were similar across comparison periods. To evaluate aim 1, a two-sample t test was conducted to compare the pre- and postimplementation number of antiemetics administered to patients in the moderate-risk and high-risk categories for PONV. To evaluate aim 2, a Fisher exact test was conducted to compare incidence of PONV in adult gynecologic surgery patients at pre- and postimplementation. To evaluate aim 3, descriptive statistics (N, %) were computed to determine anesthesia provider compliance to the PONV assessment and prophylaxis protocol. Statistical analysis used SPSS software (version 24; IBM, Chicago, IL).

Results

The project covered a 4-month period: 2 months for preimplementation and 2 months for postimplementation. During this time, 316 patients met inclusion criteria for the project. The samples for the preimplementation and postimplementation periods included 164 and 152 patients, respectively. The two samples did not differ significantly with regard to age, body mass index, American Society of Anesthesiologists' Physical Status Classification, surgical procedures, or PONV risk score distribution. Surgical time was longer in the postimplementation period than in the preimplementation period with the time reaching statistical significance. Demographic characteristics of the sample are summarized in Table 1.

Comparing the presence of the six risk factors used in the risk assessment tool, statistically significant differences were noted between the two samples in the number of patients anticipated to need postoperative opioids and in the number of patients who did not smoke. Excluding these variations, the presence of PONV risk factors was similar between the two samples. Table 2 summarizes the prevalence of the risk factors in the two samples.

Increasing the total number of prophylactic antiemetics administered in the moderate-risk and high-risk categories was the first aim of this project. The mean number of prophylactic antiemetics administered to these risk groups significantly increased during the postimplementation period from 3.64 (SD, 0.878) in the preimplementation period to 4.07 (SD, 1.021) in the postimplementation period ($t = 3.96$; $df = 298.9$; $P < .001$). The greatest increase in antiemetic administration occurred in the moderate-risk (risk score, 4) and the high-risk (risk score, 5-6) groups (Table 3). The number of patients with risk scores 4, 5, or 6 receiving fewer antiemetics than indicated for their risk score decreased in the postimplementation period (Table 4). The reduction in undertreated patients with a risk score of 5 was significant, decreasing from 87% in the preimplementation period to 55% in the postimplementation period ($\chi^2 = 18.5$; $df = 5$; $P = .002$). The administration of dexamethasone, diphenhydramine, and scopolamine significantly increased in the postimplementation period (Table 5).

The incidence of PONV (aim 2) decreased from 32.3% in the preimplementation period to 28.9% in the postimplementation period; however, this reduction did not meet statistical significance.

Table 1. Demographic Comparison (N = 316)

	Preimplementation, *n* = 164	Postimplementation, *n* = 152	*P*
Patient characteristics			
Age, y, mean (range)	40 (18-74)	42 (10-83)	NS
BMI, kg/m^2, mean (IQR)	31 (11)	31 (11)	NS
ASA class, *n* (%)			
I	26 (16)	23 (15)	NS
II	120 (73)	113 (74)	NS
III	17 (10)	16 (10)	NS
IV	1 (0.6)	0 (0)	NS
Procedural characteristics			
Surgical time, min, mean (IQR)	134 (128)	150 (120)	.037
Laparoscopic, *n* (%)	54 (33)	62 (41)	NS
Procedure, *n* (%)			
D&C	20 (12)	10 (7)	NS
Hysterectomy	54 (33)	54 (36)	NS
Hysteroscopy	22 (13)	23 (15)	NS
Myomectomy	10 (6)	12 (8)	NS
Oophorectomy	6 (4)	10 (7)	NS
Other GYN	52 (32)	43 (28)	NS
PONV risk score, *n* (%)			
1	0 (0)	1 (0.7)	NS
2	2 (1.2)	3 (2)	NS
3	21 (13)	28 (18)	NS
4	55 (34)	39 (26)	NS
5	72 (44)	67 (44)	NS
6	14 (9)	14 (9)	NS

NS, not significant; BMI, body mass index; IQR, interquartile range; ASA, American Society of Anesthesiologists; D&C, dilation and curettage; GYN, gynecologic; PONV, postoperative nausea and vomiting.

Table 6 isolates the incidence of PONV for each risk score. When isolated for risk score, the highest risk patients (risk score, 6) demonstrated a significant reduction in the incidence of PONV from 79% in the preimplementation period to 29% in the postimplementation period ($\chi^2 = 7.04$; $df = 1$; $P = .008$).

Among pre- and postimplementation groups, the incidence of PONV was significantly lower ($\chi^2 = 13.89$; $df = 1$; $P < .001$) for participants who received the appropriate number of antiemetics as indicated by PONV risk score (21%) in comparison to those who did not (40%) (Table 7). This reduced incidence of PONV is seen primarily among patients with higher risk scores of 5 and 6. The incidence of PONV among patients with a risk score of 5 significantly decreased from 46% to 23% when the patient received PONV prophylaxis in compliance with

Table 2. Risk Factor Prevalence by Project Period

	Preimplementation	Postimplementation	*P*
General anesthesia	111 (68)	108 (71)	NS
Age younger than 50 y	136 (83)	114 (75)	NS
Nonsmoker	139 (85)	140 (92)	.042
History of PONV	26 (16)	27 (18)	NS
Postoperative opioids	155 (95)	125 (82)	.001

NOTE. Data are presented as *n* (%) unless otherwise indicated.
NS, not significant; PONV, postoperative nausea and vomiting.

Table 3. Antiemetic Administration Stratified by Risk Score

PONV Risk Score	Number of Prophylactic Antiemetics					
	Preimplementation Period, *n* (%)					
	1	**2**	**3**	**4**	**5**	**6**
1	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
2	0 (0)	0 (0)	1 (50)	1 (50)	0 (0)	0 (0)
3	1 (5)	2 (10)	5 (24)	12 (57)	1 (5)	0 (0)
4	0 (0)	6 (11)	24 (44)	19 (35)	6 (11)	0 (0)
5	0 (0)	2 (3)	**28 (39)**	33 (46)	**8 (11)**	1 (1)
6	0 (0)	1 (7)	2 (14)	5 (36)	3 (21)	3 (21)
	Postimplementation Period, *n* (%)					
	1	**2**	**3**	**4**	**5**	**6**
1	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
2	0 (0)	0 (0)	1 (33)	2 (66)	0 (0)	0 (0)
3	1 (4)	3 (11)	4 (14)	16 (57)	3 (11)	1 (4)
4	0 (0)	1 (3)	13 (33)	14 (36)	11 (28)	0 (0)
5	0 (0)	2 (3)	**15 (22)**	20 (30)	**25 (37)**	4 (6)
6	0 (0)	1 (7)	3 (21)	0 (0)	8 (57)	2 (14)

PONV, postoperative nausea and vomiting.

Gray boxes indicate antiemetic administration below protocol recommendation. Bold font indicates changes between samples that reached statistical significance.

recommendations of the risk assessment tool ($\chi^2 = 6.17$; $df = 1$; $P = .013$). Likewise, the incidence of PONV among patients with a risk score of 6 significantly decreased from 75% to 38% when the patient received PONV prophylaxis in compliance with the recommendations of the risk assessment tool ($\chi^2 = 3.88$; $df = 1$; $P = .049$).

Assessment of the third aim of this project focused on two components of the project that required anesthesia providers to comply with the instructions given for participation in the project. The project examined anesthesia providers' compliance to the risk assessment tool's recommendations for number of antiemetics to be administered based on a patient's risk score. The project also assessed anesthesia providers' compliance to correct documentation of the assessment tool. There was a significant increase in compliance to antiemetic administration recommendations in the postimplementation sample. Antiemetic administration compliance increased from 37% in the preimplementation group to 61% in the postimplementation group ($\chi^2 = 18.17$; $df = 1$; $P < .001$). Table 8 presents antiemetic compliance stratified by PONV risk score. Of note, the antiemetic administration compliance significantly increased from 13% to

Table 4. Patients Given Fewer Antiemetics Than Recommended

PONV Risk Score	Preimplementation	Postimplementation	*P*
1	0 (0)	0 (0)	NA
2	0 (0)	0 (0)	NA
3	3 (14)	4 (14)	NS
4	30 (55)	14 (36)	NS
5	63 (88)	37 (55)	.002
6	8 (57)	4 (29)	NS

NOTE. Data are presented as *n* (%) unless otherwise indicated.

PONV, postoperative nausea and vomiting; NA, not available; NS, not significant.

Table 5. Antiemetics Administered to Patients

	Preimplementation	Postimplementation	*P*
Dexamethasone	128 (78)	134 (88)	.017
Diphenhydramine	56 (34)	70 (46)	.031
Metoclopramide	2 (1)	3 (2)	NS
Midazolam	162 (99)	147 (98)	NS
Ondansetron	159 (97)	146 (96)	NS
Promethazine	7 (4)	8 (5)	NS
Propofol infusion	53 (32)	52 (34)	NS
Scopolamine	34 (21)	59 (39)	< .001

NOTE. Data are presented as *n* (%) unless otherwise indicated.
NS, not significant.

45% in patients with a risk score of 5 ($\chi^2 = 17.9$; $df = 1$; $P < .001$); however, 55% of the patients with a risk score of 5 did not receive the correct number of antiemetics in the postimplementation period, indicating noncompliance. Assessing anesthesia providers' compliance to documentation instructions in the postimplementation period lacked a preimplementation counterpart for comparison. Anesthesia providers were asked to complete a PONV Risk Assessment Tool worksheet for each patient. The anesthesia provider then placed the completed worksheet in a designated area of the PACU. In addition, the anesthesia provider was instructed to make a note of the worksheet reference number in the electronic record to allow for matching of worksheets to patients during audits. Compliance to these instructions was 36%. Table 9 summarizes these compliance rates stratified by risk score.

Discussion

The goal of this project was to implement the recommendations of the *Consensus Guidelines for the Management of Postoperative Nausea and Vomiting*[2] in attempts to reduce the incidence of PONV. To accomplish this goal, the project used a risk assessment tool to guide anesthesia providers in assessing a patient's risk for PONV and administering an appropriate multimodal PONV prophylaxis. The use of a directive decision support tool to increase provider compliance and reduce the incidence of PONV is well documented in the literature.[10,13-18] These studies demonstrate absolute risk reductions between 8% and 35% for PONV. Kappen et al[19] argued that the ability to compare these studies is limited because of study design and study analysis. Despite this, there remains strong support for integrating this method of PONV assessment and management into routine practice. The results of this project reflect many of the same findings seen in the literature.

Gan et al[2] described current practice of PONV prophylaxis as liberal antiemetic administration. In general, patients are given one or two antiemetics regardless of their potential risk for developing PONV. This approach overtreats low-risk patients and undertreats high-risk patients. This project significantly increased antiemetic

Table 6. PONV Incidence by Risk Score

PONV Risk Score	Preimplementation	Postimplementation	*P*
1	0 (0)	0 (0)	NA
2	0 (0)	0 (0)	NA
3	2 (10)	4 (14)	NS
4	12 (22)	9 (23)	NS
5	28 (39)	27 (40)	NS
6	11 (79)	4 (29)	.008
Total	53 (32)	44 (29)	NS

NOTE. Data are presented as *n* (%) unless otherwise indicated.
PONV, postoperative nausea and vomiting; NA, not available; NS, not significant.

Table 7. PONV Incidence by Risk Score and Compliance

PONV Risk Score	Noncompliant	Compliant	*P*
1	0 (0)	0 (0)	NA
2	0 (0)	0 (0)	NA
3	2 (33)	4 (9)	NS
4	8 (18)	13 (26)	NS
5	46 (46)	9 (23)	.013
6	9 (75)	6 (38)	.049
Total	65 (40)	32 (21)	< .001

NOTE. Data are presented as *n* (%) unless otherwise indicated.
PONV, postoperative nausea and vomiting; NA, not available; NS, not significant.

administration. Anesthesia providers administered significantly more dexamethasone, diphenhydramine, and scopolamine (Table 5). The increase in antiemetic administration occurred predominantly in moderate-risk and high-risk patients; those with risk scores of 4, 5, and 6 (Table 3). This finding meets the goal to increase antiemetic administration to high-risk patients. Because of the nature of the sample population (Table 2), females undergoing gynecologic surgeries, there were disproportionately more high-risk patients than low-risk patients. A broader sample is needed to properly examine the impact on antiemetic administration to low-risk patients; however, the data suggest that the risk assessment tool improves compliance to the best practice recommendation of administering fewer antiemetics to low-risk patients and more antiemetics to high-risk patients. The incidence of patients receiving fewer antiemetics than indicated for their level of risk decreased in the postimplementation period, yet these rates continued to be alarmingly high. Although the incidence of undertreated patients with a risk score of 5 decreased from 88% to 55%, more than half of these high-risk patients did not receive the recommended PONV prophylaxis for their level of risk (Table 4). This appears to be related to provider compliance.

The incidence of PONV was reduced between preimplementation (32.3%) and postimplementation (28.9%) groups, although not with statistical significance. Given the pattern of the increase in antiemetics, this was unexpected. When stratified by risk score, the incidence of PONV appears to follow the trend seen in the number of patients receiving fewer than recommended antiemetics (Tables 4 and 6). Patients with a risk score of 5 represent both the highest incidence of PONV, 11% higher than any other risk group, and the highest incidence of antiemetic undertreatment. By contrast, the incidence of PONV significantly decreased from 79% to 29% in patients with the highest level of risk, risk score 6. The incidence of PONV directly mirrors the incidence of undertreatment for this population. In fact, four patients with a risk score of 6 received fewer than the recommended antiemetics in the postimplementation period. These four patients account for all the cases of PONV in this population. Simply, patients who received antiemetics according to their risk score did not experience PONV, whereas patients who did not receive antiemetics according to their risk score did experience PONV. These patients with a risk score of 6 offer a promising view of the true potential impact of the tool used in this

Table 8. Antiemetic Administration Compliance

PONV Risk Score	Preimplementation	Postimplementation	*P*
1	0 (0)	1 (100)	NA
2	2 (100)	3 (100)	NA
3	19 (91)	24 (86)	NS
4	25 (46)	25 (64)	NS
5	9 (13)	30 (45)	< .001
6	6 (43)	10 (71)	NS

NOTE. Data are presented as *n* (%) unless otherwise indicated.
PONV, postoperative nausea and vomiting; NA, not available; NS, not significant.

Table 9. Compliance to Tool Documentation, Postimplementation

PONV Risk Score	Noncompliant	Compliant
1	1 (100)	0 (0)
2	3 (100)	0 (0)
3	22 (79)	6 (21)
4	25 (64)	14 (36)
5	36 (54)	31 (46)
6	10 (71)	4 (29)
Total	97 (64)	55 (36)

NOTE. Data are presented as *n* (%) unless otherwise indicated.

PONV, postoperative nausea and vomiting.

project. These patients demonstrate that greater compliance to recommended PONV prophylaxis results in a significant reduction in the incidence of PONV. Furthermore, these patients demonstrate the profound impact this approach has on reducing PONV in the highest risk populations.

After noting these trends in PONV incidence, the project examined all patients based on compliance to risk scores rather than sample group. There was a statistically significant difference in the incidence of PONV: 21% in patients who received antiemetics according to the PONV Risk Assessment Tool and 40% in patients who did not receive antiemetics according to the tool. Essentially, the incidence of PONV among patients who received antiemetics according to the tool was half of the incidence of those who did not receive antiemetics according to the tool. This trend is also present in the comparative incidence of PONV in patients with risk scores of 5 and 6 with statistically significant reductions in PONV among patients who received antiemetics according to the PONV Risk Assessment Tool. Antiemetic administration according to the tool speaks to the sensitivity of its recommendations to target patients with the highest PONV risk.

Clearly, we cannot conclude that PONV incidence would have dropped to 20% if all patients had been compliant during the postimplementation period. It does, however, point to the strength of the risk assessment tool at effectively reducing PONV. The reported incidence of PONV in both the preimplementation and postimplementation samples is the result of the intermixing patients who did and did not receive antiemetics according to their risk score.

There is an 8% difference between the measured incidence of PONV in the postimplementation group and the group that received antiemetics according to their risk score. There are a number of possible explanations for this difference. Aside from being the result of a mixed sample, another possibility is that the PONV prediction model used may not have been sufficient to improve clinical practice. Although the risk assessment tool had a statistically significant impact on anesthesia providers, this impact may not have translated into a significant clinical impact. Given the statistically significant difference between PONV incidence in patients who did and did not receive antiemetics according to their risk score, it is likely that this 8% difference is the result of a mixed sample. This raises the question: why were there enough patients who did not receive antiemetics according to their risk score in the postimplementation sample to alter the incidence of PONV? The answer appears to be related to provider involvement.

The third aim of this project was to increase compliance of anesthesia providers to the guideline-based recommendations included in the risk assessment tool. According to Gan et al,[2] anesthesia provider compliance to best practice guidelines for PONV management is low and a contributing factor in the current incidence of PONV. Provider compliance to administration of the correct number of antiemetics increased from 37% in the preimplementation period to 61% in the postimplementation period. This change is statistically significant, but it does not appear to give a complete picture of provider involvement in the project. As discussed, large numbers of patients were undertreated based on the recommendations for their risk level. This was most notable in the patients with a risk score of 5. Even in the postimplementation period, only 45% of these patients were given the correct number of antiemetics (Tables 4 and 8). Equally concerning, only 36% of postimplementation anesthesia cases included all the required documentation (Table 9). This lack of documentation complicates project assessment. Documentation of provider involvement did not match the incidence of compliance to antiemetic administration.

A portion of this increased administration compliance could be the result of a Hawthorne effect. Some providers may have modified their usual antiemetic administration without using the tool for PONV risk assessment.

The effectiveness of a risk-tailored approach to PONV prophylaxis using a risk assessment tool along with treatment recommendations is limited by the involvement of the anesthesia providers responsible for performing the assessments and administering the PONV prophylaxis. Kappen et al[19] offered a potential means of overcoming low involvement by anesthesia providers. In their study, they successfully reduced the incidence of PONV at their institution by integrating their risk-tailored PONV prophylaxis protocol into their EMR. Anesthesia providers were presented with the patient's PONV risk, recommendations for prophylaxis, and a stoplight visual cue that changed colors as antiemetics were documented until an acceptable number of antiemetics had been administered.

Limitations and Recommendations

This project had several limitations that could serve as starting points for additional future projects. First, the sample included female patients undergoing gynecologic surgeries. Female gender is an independent indicator for PONV, and there is a relationship between PONV and gynecologic procedures. Expanding this project to a larger more diverse sample might provide additional insight into the impact of this protocol. Second, compliance remained a limiting factor for the success of this project. Additional projects may benefit from integrating this protocol into the EMR used in the operating room. Finally, the risk factors included in the assessment are objective measures with the exception of the risk factor anticipated postoperative opioid use. As previously discussed, postoperative opioid administration is a predictor of PONV; however, asking providers to anticipate the use of postoperative opioids introduces a subjective measure into the assessment. Pre-established responses to this variable based on the surgical procedure would remove the variability seen in the responses to this risk factor. Integrating the risk assessment into the EMR would allow for standardizing responses to this variable without adding complexity to the assessment.

Conclusion

The results of this project suggest that a risk-tailored approach to PONV prophylaxis using a risk assessment tool along with treatment recommendations is effective at reducing the incidence of PONV in an adult female population undergoing gynecologic surgeries. The issues with provider compliance to protocol highlight that challenges still remain before reaching the optimistic goal of PONV-free hospitals.

Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jopan.2018.02.007

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