Preventing Postoperative Nausea and Vomiting During an Ondansetron Shortage

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Postoperative nausea and vomiting (PONV) degrades patient experience and increases healthcare costs. Estimates of PONV range from 10% to 80%. The Apfel Simplified Score is an evidence-based instrument for determining individual risk of PONV. Scoring enables anesthesia providers to match antiemetic strategies with the calculated risk of PONV. Data were collected across 3 times. After the Apfel scoring system was automated into the electronic medical record, providers were more likely to increase PONV prophylaxis for patients at highest risk and reduce prophylaxis for patients at lowest risk. Rates of PONV remained similar at baseline (34.7%) and in the early postimplementation period (38.8%); a modest reduction was observed in the final period (26.5%). Intravenous ondansetron, the most common antiemetic at baseline, was not available in the early postimplementation period, which may partially explain the initial increase in PONV. While ondansetron was unavailable, providers began using 3 other antiemetics, a practice that persisted once intravenous ondansetron returned. The Apfel score is an evidence-based tool that providers can use to reduce the risk of PONV. This electronic tool and the reminder cards have been shared across the US Military Health System, fostering an organizational culture that values targeted prophylaxis for PONV.

Keywords: Acupuncture, medication shortage, PONV, postoperative nausea and vomiting.

Postoperative nausea and vomiting (PONV) represents a substantial physical and financial burden to patients and healthcare systems. In the US Military Health System, patients with PONV stay longer and consume more services immediately after surgery than those without PONV. As many as 1 in 3 patients experience PONV, but this unacceptably high rate can be reduced by matching prophylaxis to expected risk.

Widely used in research, the Apfel Simplified Score is a validated tool to evaluate risk of PONV. Using 4 independent risk factors—female sex, nonsmoking status, history of PONV or motion sickness, and postoperative opioid use—the score is easy for providers to remember and calculate at the bedside. Each of these risk factors adds 20% risk of PONV, with the baseline risk never less than 10%; 0, 1, 2, 3, and 4 factors correspond to 10%, 20%, 40%, 60%, and 80% risk, respectively. Notably, the maximum predictable risk is 80%. Each preventive treatment can reduce the risk of PONV by approximately 26%. Targeting high-risk patients with preventive measures also avoids medication overuse. Considering the high frequency of medication shortages in modern practice, using the right medication for the right patient is increasingly important.

Results of previous investigations have demonstrated that providers will change their antiemetic prophylaxis strategy after receiving education on the Apfel score. Therefore, the use of educational sessions to instruct healthcare personnel on the correct use of the Apfel Simplified Score is important when implementing this practice change. The electronic medical record (EMR) is a readily accessible medium to encourage the use of the Apfel score, and EMR-based reminders have been shown to increase adherence to PONV prophylaxis guidelines. Such reminders should be enduring, since adherence to guidelines and PONV rates return to preimplementation levels when these tools are withdrawn.

The addition of an enduring PONV scoring tool and training of providers to include evidence when making clinical decisions will benefit the military healthcare system and the patients it serves. Training staff is expected to produce measurable effects at the facility level, in terms of PONV risk reduction and staff adherence to guidelines for PONV prevention. Military staff frequently relocate, so these interventions should be compatible for use at any military location to provide for true sustainment. We hypothesized that implementing the Apfel scoring system would result in the reduction of PONV for patients at Naval Hospital Jacksonville in Florida and simultaneously improve medication practices as providers adhere to the guidelines for PONV prevention.
Methods
Postoperative nausea and vomiting are an identified clinical problem, and education sessions are an imperative aspect of effecting practice change. Formal provider training sessions on the correct use of the Apfel Simplified Score occurred in-person for postanesthesia care unit (PACU) nurses and anesthesia practitioners. These sessions took place in a classroom setting at the Naval Hospital Jacksonville over 1 hour. In this training, the local problem of PONV was described, and the following project interventions were introduced: an EMR-based PONV risk scoring tool and a PONV algorithm reminder card (Figure 1). A video-based demonstration showed anesthesia providers how to use the algorithm for PONV prophylaxis. Written knowledge assessments for attendees were conducted before and after each presentation to measure how well the information was captured by the attendees. Recovery room nurses were trained separately and were instructed to request PONV risk determination during postanesthesia handoffs. The training gave attendees the knowledge required to use the project interventions, which were developed and fully implemented on the project start day, after training was complete.

• Interventions Provided at Initial Rollout. The EMR-based risk scoring tool was integrated into all preanesthetic assessments and allowed for the assignment of low, moderate, or high risk of PONV. Low risk was defined as an Apfel score of 0 to 1, medium risk was defined as an Apfel score of 2, and high risk was defined as an Apfel score of 3 or greater. These scores correspond to the number of antiemetic interventions a patient should receive. Reminder cards were distributed to anesthesia providers to match a patient’s calculated risk with the appropriate prophylaxis, and cards were affixed to each anesthesia machine and preoperative terminal. Interventions were selected based on existing guidelines for PONV management. In an effort to induce a sustainable practice change, these cards included medications that were routinely available and regularly stocked by the hospital pharmacy.

• Preimplementation Risk Factor Scoring. Postoperative nausea and vomiting was defined as nausea or vomiting experienced by patient while in the recovery room and was scored as an all or none entity. In cases in which PONV was present, the length and severity of nausea and vomiting were not separately measured. To measure the effectiveness of training, the project team performed a retrospective chart review to collect data from surgical cases that occurred before training, a period referred to as baseline. For each baseline case, an observed Apfel score was assigned using the following criteria: anticipated postoperative opioids administered in the recovery room, patient history of PONV or motion sickness drawn from the preoperative assessment, female sex, and nonsmoking status. Notably, the practice of predicting opioid use in the recovery room had not yet started, so practitioners were asked to provide opioid use estimates for their own past cases retroactively. In these cases, the anesthesia provider was also responsible for writing the postoperative PACU orders, so this individual would be the person most capable of predicting whether opioid medications would be ordered. These estimates were based on limited information about the case: age, gender, type of surgery, and type of anesthesia. Cases were assigned an estimate only when the original anesthesia practitioner was available to comment and denied knowledge of any postoperative opioids administered.

• Data Collection. Cases were collected from the 5 highest-volume surgical services at the facility: orthopedics, gynecology, general surgery, urology, and otolaryngology. In these 5 surgical services, additional inclusion criteria were applied to nonemergent cases undergoing general anesthesia. Only patients aged 18 to 89 years and scoring between 1 and 3 on the ASA physical classification system were included. Cases were excluded if they were outside the 5 highest-volume surgical services, were emergencies, used exclusively regional anesthesia or monitored anesthesia care, were in pregnant women, or indicated the presence of nausea on the preanesthetic evaluation.

Data were collected over 3 periods: baseline (phase 0), early phase (phase 1), and final phase (phase 2). Baseline data included cases occurring before provider training took place. Baseline data collection was conducted until 30 records per surgical service were collected, working backward from the project start date, before training. The early phase of data collection included cases occurring after training, and data collection continued until 30 records per surgical service were obtained, approximately 4 months after the initial provider training and project start date. Following baseline and early-phase data collection and preliminary analysis, a follow-up provider train-
ing was held to update attendees on the project’s status. A knowledge assessment was administered before and after this training, and initial results were presented to providers at this time. Following the provider update, final-phase data collection began until another 30 records per service were collected, approximately 8 months after the project start date.

Provider adherence was determined by reviewing the antiemetic medications administered in each case, for which each patient had been categorized as having low, moderate, or high risk of PONV according to his or her Apfel score, and then classifying each case as “adherent” or “not adherent” with the evidence-based recommendations that were introduced during training. Appropriately treated patients were those who were given the recommended number of antiemetics corresponding to their Apfel score.

Rates of PONV were derived from recovery room nursing records. The incidence of PONV was described as the presence or absence of PONV in the recovery room. Patients needed only to report a single occurrence of nausea or vomiting to experience PONV; the duration and severity of symptoms were not further considered.

Secondary data included the administration of prophylactic antiemetic interventions, including haloperidol, promethazine, aprepitant, scopolamine, total intravenous (IV) anesthesia, ondansetron, dexamethasone, and acupressure. In accordance with the guidelines, the number of interventions is based on risk, with low-risk patients receiving no interventions and high-risk patients receiving 3 or more (see Figure 1). These interventions were considered of equal efficacy for the treatment of nausea and vomiting, and their administration was determined solely by the provider. Other data points included risk factors within the Apfel score. These data were used to make between-group comparisons.

**Statistical Analysis.** The following primary outcomes were measured: provider adherence to the guidelines (categories: adherence and nonadherence) and incidence of PONV (categories: presence or absence). Data were further categorized by phase to include baseline, early, and final subsets. Significance for categorical data was determined using $\chi^2$ tests. An $\alpha$ value of .05 was considered significant, suggesting an association between the categorical variables

<table>
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<tr>
<th>Phase</th>
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<th>Guidelines not followed, %</th>
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**Table 1.** Provider Adherence to Guidelines Across Project Phases 0 to 2

*Phase 0 = preintervention baseline; phase 1 = early phase (approximately first 4 months after intervention); phase 2, final phase (approximately months 4-8 after intervention).*
measured. Odds ratios (ORs) with confidence intervals were used to further measure the strength of association. The project was deemed exempt by the Navy Medicine East institutional review board designee. Analysis was performed with the Statistical Package for the Social Sciences (SPSS) version 22.0 for Mac (IBM Corp).

**Results**

- **Provider Adherence.** Chi-squared tests were used to determine association between provider adherence and the 3 phases of data collection. A significant association was found between the baseline and early phases (P=.002). Provider adherence significantly improved between these 2 phases (OR=2.31, 95% CI=1.33-4.04). Provider adherence was sustained in the final phase, with a nonsignificant decrease in adherence between the early and final phases (P=.17, OR=0.71, 95% CI=0.42-1.19).

- **Rates of Postoperative Nausea and Vomiting.** Most patients scored in Apfel categories 1 to 3 (Table 1). Patients with higher Apfel scores experienced higher rates of PONV in the recovery room (Figure 2). The incidence of PONV was 34.7% at baseline, 38.8% in the early phase, and 26.5% in the final phase. There were no significant differences in PONV rates between the baseline and final phase (P=.31, OR=1.18, 95% CI=0.59-2.33) or between the early and final phase (P=.13, OR=1.60, 95% CI=0.84-3.07). In appropriately treated patients, rates of PONV were lower in the final phase compared with the early phase (P=.044, OR=2.13, 95% CI=0.95-4.85). Furthermore, following the initial training, the proportion of appropriately medicated patients increased; 47% of baseline cases, 67% of early cases, and 59% of final cases were appropriately medicated (P=.006).

- **Antiemetic Interventions.** There were 9 interventions tracked across each phase: haloperidol, promethazine, aprepitant, scopolamine, total IV anesthesia, IV ondansetron, oral ondansetron, dexamethasone, and acupressure, and all were used except acupressure (Figure 3). Ondansetron and dexamethasone were the most commonly administered antiemetics across all periods. Intravenous ondansetron and IV dexamethasone were the only interventions regularly administered in the baseline group. Intravenous ondansetron was unavailable for entire time captured by the early phase, because of a nationwide shortage that persisted for several months. An equipotent dose of oral ondansetron (8 mg) had been listed as an alternative to IV ondansetron (4 mg) for both the early and final phases. During the final phase, IV ondansetron became available again but was not administered as frequently as it had been in the baseline group. Oral ondansetron was listed only as a substitute for IV ondansetron, and no patients received a combination of oral and IV ondansetron.

![Figure 3. Number of Antiemetics Administered in Each Phase](image)

**Table 2. Mean Number of Antiemetics Administered During Each Phase**

<table>
<thead>
<tr>
<th>PONV risk</th>
<th>Phase 0</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
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<td>Low (Apfel score 0-1)</td>
<td>1.5</td>
<td>0.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Moderate (Apfel score 2)</td>
<td>1.5</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>High (Apfel score ≥3)</td>
<td>1.9</td>
<td>1.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Patients with 0 or 1 risk factors, which translates to a 0 or 1 Apfel score, are at lowest risk of PONV. The guidelines suggest these patients may receive no antiemetics. Antiemetic prophylaxis for these patients decreased overall (Table 2; Figures 4-6). Low-risk patients received the greatest mean quantity of antiemetic interventions at baseline (1.5), the fewest during the early phase (0.5), with a near return to baseline in the final phase (1.4).

Patients with 2 risk factors, and given an Apfel score of 2, are at moderate risk of PONV. The guidelines suggest these patients should receive 1 to 2 antiemetics, and across phases, most study participants did. At baseline, moderate-risk patients received an average of 1.5 antiemetics. In the early and final phases, these patients received slightly less, an average of 1.2 antiemetics. Patients at moderate risk of PONV were more likely to receive 2 antiemetics at baseline and 1 antiemetic in either the early or final phase (see Table 2; Figures 4-6).

Patients with 3 or more risk factors are at the highest risk of PONV, and the guidelines indicate these patients should receive 3 or more antiemetics. However, at baseline, none of the patients with an Apfel score of 3 received 3 or more antiemetics, and they received a mean of only 1.9 antiemetics (see Figure 4). In the early phase, nearly one-third of high-risk patients received 3 or more antiemetics (see Figure 5). By the final phase, antiemetic prophylaxis for these patients had increased to an average of 2.0 antiemetics (see Table 2), but nearly half of these high-risk patients had received 3 or more antiemetics (see Figure 6).
Discussion
The Apfel score is useful for predicting the risk of PONV, and when prophylaxis guidelines are followed, rates of PONV tend to decrease. This project made the guidelines and the risk factor scoring readily available and demonstrated that provider adherence to the guidelines increased after implementation. A reduction of PONV incidence was seen when comparing baseline with the final phase, a clinically significant finding that did not reach statistical significance. The multiple points of reference to the Apfel tool may have improved the practitioners’ willingness to integrate the tool into their treatment plans.

Since PONV is known to increase facility costs, prevention of PONV correspondingly results in less expense for the hospital. Permanent integration of the Apfel tool into the EMR should predictably reduce facility costs through this mechanism. This project demonstrated that these combined points of reference contributed to appropriate provider adherence, but it is unknown if the card or the EMR-based tool was independently effective in achieving this goal. Future projects may look to examine the utility of a reminder card with or without an EMR-based tool. Also of note, providers were taught to use their own preoperative estimation of whether the patient would require postoperative opioid use, as part of a commonly employed predictive scoring system recommended by current guidelines.

The accuracy of personal predictions on whether opioids will be used is a valid consideration. As part of the training given to providers, expected length of surgery was suggested as a consideration when making these predictions. Longer surgeries are associated with more opioid use, but this factor is not considered an independent substitute for the opioid prediction within the Apfel score. It is unknown to what extent this suggestion may have influenced provider estimations. Despite this observation, the Apfel score continues to be a valid preoperative screening tool for estimating the risk of PONV.

A common hurdle for providers and hospitals is the uncertain availability of effective antiemetics. A nationwide ondansetron shortage coincided with the beginning of the early phase, immediately after implementation, which clearly affected the administration of antiemetics during this time. Ondansetron was available again during the final phase. Dexamethasone was intermittently available during the final phase, but present for most operative cases collected during this period. Small lapses in availability may have created data artifacts regarding prescribing habits.

In the baseline group, before the EMR-based risk scoring tool was integrated into all preanesthetic assessments, prophylaxis was often administered for patients at lowest risk of PONV (Apfel categories 0-1). Following training and the commencement of automatic risk calculation, providers were more likely to match calculated risk with the recommendations, such as no prophylaxis for patients at lowest risk (see Table 1).

Most patients included in this project were at moderate risk of PONV, and across all phases, these patients most often received 1 to 2 antiemetics. At baseline, most of these moderate risk patients received 2 antiemetics, but in the early and final phases, most received only 1 antiemetic. This may be attributable to the ondansetron shortage that occurred during the early phase. It is conceivable that some providers would prefer to give less medication rather than introduce a new medication during a shortage, especially when still within the recommended range of 1 to 2 antiemetics.

Perhaps of greatest clinical significance, there was an increase in the use of other antiemetics during the early
phase, including haloperidol, promethazine, aprepitant, and scopolamine. These medications were not used at all at baseline. The guidelines introduced these medications as additional strategies to prevent PONV, and provided a useful algorithm to follow when medication shortages inevitably occur. In the final phase, providers continued this trend by choosing a variety of antiemetic strategies from the list, even after IV ondansetron had returned. Thus, the practice of giving 2 antiemetics regardless of risk changed to reflect a more targeted risk reduction strategy, and this effect was sustained at 8 months.

As an evidence-based practice improvement initiative, this project was successful in its endeavor to change practitioner habits related to PONV prophylaxis at Naval Hospital Jacksonville. As such it can serve as a model for other facilities to follow to implement similar initiatives. This project included instances of PONV that occurred immediately following surgery, in the PACU. Many patients experience PONV within 24 hours of surgery and would not be captured here. Patients at highest risk of PONV were seldom included in the analysis. No patients in the highest category, Apfel 4, were included in baseline or the early phases, as no such records met inclusion criteria during the period of data collection. Following a normal distribution curve, with the fewest patients in categories 0 and 4, a much larger sample size would be needed to examine the impact on patients with either the lowest or the highest risk of PONV.

Conclusion
The Apfel score was successfully implemented into the EMR, resulting in significantly increased provider adherence, but only a slight decrease in PONV. This project and its associated tools have been shared throughout the Military Health System. Since the next generation of military EMR has the capability to determine the risk of PONV, there is an opportunity for systemwide sustainment. During the next several years the EMR is implemented, this project will serve as an introductory springboard to ensuring patients are given effective PONV prevention. As these findings have been shared with operational military medical personnel, patients in deployed or isolated settings are expected to experience the same high level of care in PONV prevention as their counterparts in the continental United States.

REFERENCES

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