Postoperative Nausea and Vomiting Reduction using the Apfel Screening and Treatment Tool

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Abstract

Problem & Purpose: Postoperative nausea and vomiting is a complication that predisposes patients to numerous adverse events including dehydration, electrolyte disturbances, aspiration, and rehospitalization. The evidence-based Apfel risk tool can predict postoperative nausea and vomiting in high-risk patients and can guide anesthesia providers to administer prophylactic treatment. Screening patients undergoing high-risk surgical procedures is not routinely implemented at a university hospital which has resulted in elevated postoperative nausea and vomiting incident rates, approximately 3.4-5% when compared with the medical system's average. This quality improvement project aims to implement the Modified Apfel risk tool to screen and prophylactically treat adult patients undergoing elective ear, nose, and throat surgeries at a university hospital. *Methods:* Adult patients scheduled for elective ear, nose, and throat cases were screened using the Modified Apfel tool and were treated based on their Apfel score. Compliance on screening patients using the tool and adherence to the prophylactic treatment guideline were collected daily. Additionally, data on patients who required antiemetic rescue treatment within 24 hours postoperatively was also collected daily. Run charts were used to analyze all data. *Results:* Fifteen weeks of data were collected and analyzed for 329 patients. A total of 135 patients (41%) were screened for postoperative nausea and vomiting with the Modified Apfel tool, 105 (78%) received treatment based on their score, and 124 patients did not receive rescue antiemetic treatment during the recovery period (92%). Overall, the implementation of the Modified Apfel tool guided anesthesia providers to administer prophylactic PONV treatment to ENT patients based on their Apfel score, thus reducing PONV in the recovery period. *Conclusions:* Although 100% provider compliance of screening patients with the risk tool was not achieved, the findings suggest that the implementation of the Modified

Apfel tool and treatment guideline may decrease the use of rescue antiemetics in the recovery period. Therefore, utilizing the Apfel tool and treatment guideline to improve postoperative nausea and vomiting rates are feasible interventions that could be implemented in the clinical setting.

Postoperative Nausea and Vomiting (PONV) is an adverse complication that predominantly affects patients during the first 24-48 hours after being exposed to anesthesia. PONV predisposes patients to dehydration, electrolyte disturbances, aspiration, esophageal rupture, bleeding, and rehospitalization. The prevalence of PONV is estimated to be approximately 30% in the general surgical population and as high as 80% in high-risk populations (Apfel et al., 2012; Amirshani et al., 2020). PONV is a multifactorial phenomenon, the most common causes include, female gender, young age, non-smoker, history of previous PONV, and history of motion sickness (Apfel et al., 2012). Other factors such as laparoscopic cases, breast-related surgeries, ear, nose, and throat (ENT) surgeries, length of surgery, and use of inhalation anesthetics have also been implicated to cause PONV (Gan et al., 2020).

To effectively decrease the incidence of PONV, early screening with evidence-based tools has proven to improve patient outcomes. Specifically, the Apfel risk assessment tool has shown to be effective at reducing the rate of PONV at an institutional level and can be used to guide anesthetists to provide prophylactic treatment to patients who obtain a score of three or higher (Gan et al., 2020). Screening adult patients for PONV was not routinely done at a large university hospital, see Figure 3. As a consequence, the PONV incident rates at this institution have consistently been 3.5-5% more than the medical system's average, which indicated a strong need for change. The purpose of this project was to implement the Modified Apfel tool and prophylactically treat adult ENT patients to reduce the incidence of PONV and rescue antiemetic use in the recovery period.

Literature Review

This evidence review was conducted to evaluate the body of evidence regarding the assessment of risk and effective management of PONV. Melnyk and Fineout-Overholt levels of

evidence were utilized to grade the studies, see Tables 1 and 2. The quality of the studies were evaluated utilizing the Newhouse rating scale, see Table 3. The literature review includes three systematic reviews and two descriptive studies. The review discusses the quantification of the independent predictors for PONV followed by a description and comparison of the most commonly used PONV risk models available to anesthesia providers. The review will conclude with a description of the most effective pharmacological interventions for PONV.

Apfel et al. (2012) conducted a systematic review (SR) and meta-analysis to quantify the independent predictors that predispose patients to PONV (Level I study, quality A). The researchers analyzed randomized controlled trials (RCTs) and epidemiological observational studies with at least 500 adult patients enrolled. Overall, 22 studies that reported data for 96,154 patients were included in the final analysis. The researchers conducted a quantitative analysis of each risk factor that was previously identified in the literature to cause PONV. The analysis resulted in the identification of the strongest patient-specific PONV predictors such as being female gender, previous history of PONV or motion sickness, non-smokers, and young patients, leading to the creation of the Apfel tool. On the other hand, Gecit & Ozbayir (2020) (Level IV study, quality C) and Gunawan et al. (2020) (level VI, quality C) explored the most commonly used PONV risk models. The study by Gecit & Ozbayir (2020) had a 242 sample and was conducted in the surgical clinic of a university hospital. The authors examined the effectiveness of the Apfel and the Koivurant scoring systems at early detecting patients at high risk for PONV. The study found that both tools proved to be effective at early detecting patients at high risk for PONV. On the contrary, the study by Gunawan et al. (2020) compared the sensitivity and specificity of three different PONV scores: Apfel, Koivuranta, and Sinclair scoring systems (level VI, quality C). The researchers assessed patients for PONV for 24 hours and compared the

three tools. The primary objective was to determine the gold standard tool in predicting PONV. The authors found that the Apfel tool was the most accurate to predict PONV and should be used in the clinical setting to screen patients. The aforementioned studies have multiple differences, but a major distinction was the quality of the evidence and sample sizes. However, all three studies recommended screening patients for PONV using the Apfel tool.

The most effective pharmacological interventions for PONV are described by Teshome et al. (2020), Singh et al. (2016), and Gan et al. (2020). The study by Teshome et al. (2020) is a SR (Level I, quality B) that included 32 studies in the final analysis. The study yielded a PONV treatment guideline to manage PONV with medications such as Serotonin (5-HT3) receptor antagonists, dexamethasone, metoclopramide, and propofol which can be utilized by anesthesia providers to prophylactically treat patients at risk for PONV. Similarly, Gan et al. (2020), (Level I, quality A) created a practice guideline with numerous antiemetics to help providers select the most effective antiemetics to treat PONV. On the other hand, Singh et al. (2016) focused specifically on a single drug by comparing Aprepitant's efficacy against conventional antiemetics (Level I, quality B study). The researchers found that Aprepitant is effective alone or in combination with other medications. The major difference among the studies previously mentioned is that Singh et al. (2016) focused on a specific drug whereas, in the other studies, a guideline was created with different antiemetics that providers can use to treat PONV. In conclusion, the evidence supports the use of the Apfel tool to screen patients for PONV to subsequently provide prophylactic treatment with effective medications thus, supporting the practice change at the clinical site.

Theoretical Framework

As shown in Figure 1, The Theory of Unpleasant Symptoms (TOUS) was selected to understand the practice problem of PONV. The theory is composed of three main concepts: the symptoms felt by the individual, the factors that influence the symptoms, and the consequences that result from the symptoms (Lenz et al., 1997). The TOUS is relevant to PONV as the theory not only incorporates the symptoms felt by patients but also incorporates other factors that influence the patients' responses. Because PONV is multifactorial, the theory was used to assess how PONV factors interact with each other to subsequently identify an evidence-based intervention that can be implemented by providers in the clinical setting to prevent PONV. Ultimately, the goals were to decrease PONV, optimize the patients' recovery, and decrease PONV rescue treatment.

The Framework of Complex Innovation implementation (see Figure 2), was used to guide the implementation of this QI project. This framework theorizes that successful innovation implementation requires management support (Helfrich et al., 2007). The institution recognized that screening patients for PONV with the Modified Apfel tool was essential and the project was supported by stakeholders. The framework also states that innovations in healthcare areas are complex and multiple individuals must work together (Helfrich et al., 2007). Several stakeholders, including anesthesia providers, the clinical site representative (CSR), and administrative individuals collaborated to implement this initiative. As a result, the contribution of these key members amplified the feasibility of the project. Ultimately, achieving the project goals of screening and prophylactically treating patients at high risk for PONV.

Methods

The project targeted adult patients 18 years and older throughout the perioperative period undergoing elective ENT surgeries at an acute-care research facility. Patient exclusion criteria

included being pregnant, undergoing emergency cases, American Society of Anesthesiologists (ASA) class of 4-6, and patients less than 17 years old. Staff inclusion criteria included providers providing direct anesthesia care such as certified nurse anesthetists (CRNAs), anesthesiologists, and anesthetist assistants (AAs). Excluded providers were Student Registered Nurse Anesthetists (SRNAs), medical students, and anesthesia interns. To ensure vulnerable individuals such as non-English speakers' needs were met, extra time was allotted to provide English interpretation in their language by utilizing the hospital language services.

Prior to implementation, a team of anesthesia providers was mobilized to identify goals, the population of interest, and a timeline. The team consisted of the project leader (PL), the project sponsor chief anesthesiologist, internal change champions (CC), and a nurse anesthetist who served as the CSR. Following approval from the clinical site, all barriers and facilitators were evaluated and addressed accordingly. Before implementation, education was provided to anesthetists using the Apfel educational brief (see Appendix A) and education was tracked using the educational tool (see Appendix B). Furthermore, the PL displayed the Apfel tool in all the operating rooms to remind anesthetists to document the score in the electronic health record (EHR). Additional reminders were sent weekly before the project went live.

Three critical goals were used to ensure the success of the project. First, screening patients for PONV with the risk tool was tracked daily via chart audits using the Compliance and Treatment Tracking Tool (Appendix C). Anesthetists who screened patients with the tool were instructed to document the score in the EHR. To increase compliance, weekly reminders were conducted by the project sponsor during staff meetings. Additionally, the tool and treatment guideline were posted in all the operating rooms. Second, the goal of prophylactic treatment administration was also monitored via chart audits. Emails were sent to staff to promote positive

reinforcement, increase compliance, and continue adherence. Additionally, the educational brief was constantly sent throughout the project's implementation phase to re-educate anesthesia providers. CCs were utilized throughout the implementation phase to verbally remind providers to adhere to the project's protocol. Finally, assessing whether patients required rescue antiemetic treatment within 24 hours in the recovery area was tracked by electronic audits. The project's progress was shared weekly via email and by displaying the progress in common areas to help increase compliance.

Several actions were employed by the PL to protect patient privacy. For instance, The Health Insurance Portability and Accountability Act (HIPAA) regulations were followed throughout the project's length. Data confidentiality was protected by storing all project data in a password-protected computer that was only accessible by the PL. Additionally, data collected with identifiers was later de-identified. After the project concluded, all recorded and collected data were destroyed. Collected data and the results of the project were analyzed via run charts. Three-run charts were created to display provider adherence (see Figure 4), prophylactic antiemetic treatment (see Figure 5), and the percentage of patients who did not receive rescue anti-emetics within 24 hours in the recovery period (see Figure 6).

Results

All anesthesia providers at the project site including anesthesiologists, CRNAs, and AAs were included in the educational brief email. A total of 47 out of 97 anesthesia providers (47%) verbalized they understood the educational brief provided by the PL. A total of 329 ENT patients were included in the study, of which 135 patients (41%) were screened with the Modified Apfel tool. Out of these 135 patients, a total of 105 (78 %) received PONV treatment based on their risk score. Additionally, all 329 patients were assessed by the PL for PONV occurrence within

24 hours and it was found that 124 (92%) patients who were screened with the tool did not receive rescue antiemetics, whereas 11 patients (8%) required treatment despite being screened and medicated. On the contrary, 27 patients (14%) out of 194 who were not screened for PONV experienced either nausea or vomiting resulting in the need to administer rescue antiemetic treatment to mitigate the negative effects of PONV. In the first run chart (Figure 4) there is a shift present indicating that adherence to screening patients for PONV improved throughout the project. Overall, the implementation of the Modified Apfel tool guided anesthesia providers to administer prophylactic PONV treatment to ENT patients based on their Apfel score, thus reducing PONV in the recovery period. In the second run chart (Figure 5), a run is present which signifies that a statistical change occurred because the goal of provider compliance at treating patients with PONV prophylactic treatment achieved 100% compliance in different weeks throughout the implementation phase. Finally, the third run chart (Figure 6) does not demonstrate runs, shifts, or trends. Nevertheless, the goal to reduce antiemetic use in patients who were screened and subsequently treated by anesthesia providers was reached multiple times throughout the project's implementation phase.

The implementation of this QI project faced a few barriers. A major barrier was staff turnover as providing education and reinforcing staff compliance with new staff was not always feasible. Also, the limited number of anesthesia providers might have created a greater workload causing the staff to have insufficient time to screen patients with the tool. Nevertheless, the assistance of leadership support from the chief anesthesiologist, the use of internal champions, the CSR, and data utilization served as important facilitators that contributed to the project's success.

Discussion

This QI project supports the feasibility of implementing the Modified Apfel tool to identify patients at high risk for PONV and provide prophylactic treatment based on the risk score obtained. The use of the Modified Apfel tool and treatment guideline by anesthesia providers at this organization resulted in the early identification of patients at high risk for PONV, thus decreasing the need for providers to administer rescue antiemetic treatment in the recovery period. The utilization of risk scores such as the Apfel tool to early detect patients at high risk for PONV is consistent with the literature (Apfel et al.,2012; Gunawan et al. 2020; Gecit & Ozbayir, 2020). The latter studies concluded that patients undergoing surgical procedures should be evaluated for risk factors known to cause PONV and should be categorized as either low or high risk using the Apfel risk tool. Additionally, Teshome et al. (2020), Gan et al. (2020), & Singh et al. (2016) reported that antiemetics such as aprepitant, dexamethasone, scopolamine, and ondansetron are effective antiemetics that can be utilized to medicate patients at high risk for PONV. Despite the project concluding with a favorable outcome, the project's goals were challenging to attain.

Live and in-person educational sessions were not possible affecting the providers' educational goal as only 47 out of 97 providers received education. Provider compliance in screening patients for PONV was not consistently achieved as provider adherence improved from baseline but declined towards the last three weeks of the project. This decline may be attributed to the project's sponsor being absent during the last staff meetings where staff were reminded to screen patients with the tool. Furthermore, high staff turnover, especially during the second wave of the Coronavirus Disease 2019 (COVID-19) pandemic in this organization may have significantly impacted the project's results. In particular, the hospital's use of agency-

employed supplemental staff and CRNAs working as locum tenens providers resulted in the inability of the PL to fully achieve the educational goal. Moreover, charting of the Apfel score may have been time-consuming for some providers as the score had to be charted in the EHR increasing the time spent manually charting, thus affecting compliance.

Furthermore, 78% of ENT patients who were screened for PONV received prophylactic treatment based on their scores. Treatment compliance similarly varied throughout the project, but significantly improved from baseline. Likewise, treatment compliance was affected during week 13 due to the reasons aforementioned. Although the goals of 100% compliance of screening patients for PONV and prophylactic treatment administration were not achieved towards the end of the project, 100% of patients starting week 13 still did not require rescue antiemetic treatment (Figure 6). A possible cause may have been the cancelation of long elective cases and the initiation of short ambulatory cases due to the COVID-19 pandemic. The literature shows that the effect of high-risk agents on PONV is dose-dependent (Gan et al., 2020). Therefore, the short ENT cases may have affected the results as these cases required minimal exposure to high-risk agents such as volatile anesthetists, nitrous oxide, and opioids. Moreover, about half of the surgical cases reviewed by the PL had short durations lasting from 30 minutes to two hours, possibly leading to patients not requiring antiemetics during the recovery phase.

The type of anesthesia selected for the surgical procedure may have also affected the risk of PONV. For instance, some surgical procedures may only require the use of a propofol infusion to maintain anesthesia. The use of total intravenous anesthesia with propofol has previously been described in the literature to decrease PONV as opposed to using previously mentioned high-risk inhaled anesthetic agents (Gan et al., 2020).

The inability to reach all anesthesia providers to provide interactive educational sessions due to COVID-19 physical distancing measures was a project limitation. Ongoing educational interactive sessions that involve face-to-face interaction, are a major recommendation for future studies.

Conclusion

The implementation of the Modified Apfel tool and treatment guideline to identify patients at high risk for PONV to subsequently provide prophylactic treatment was a feasible intervention at this institution. Providers were able to identify and treat patients at risk for PONV, which led to patients requiring less rescue antiemetics during the recovery period. Therefore, it would be beneficial for patients undergoing ENT procedures and the hospital to continue to implement this practice change to decrease PONV's occurrence. Major benefits to using the tool include, improving the patient experience throughout the perioperative period, minimizing the usage of antiemetics, minimizing post-anesthesia care unit (PACU) discharge delays, and avoiding unanticipated admissions after ambulatory surgery.

The implementation of this QI project had a major positive impact on the organization's PONV policy. Before the institution of this project, the organization had a PONV policy in place that did not require providers to quantify PONV risk factors nor document the patients' PONV scores. However, with the completion of this project, the organization's PONV policy was strengthened as anesthesia providers were required to quantify the patients' risk factors, document the score obtained, and provide evidence-based treatment.

In regards to sustainability, several factors could be addressed to sustain the project. For instance, incorporating the Modified Apfel tool into the EHR may improve staff compliance as feedback from providers suggested that this measure can potentially decrease the time that is

spent manually charting a PONV score in the patients' chart. To address this issue, the anesthesia team could work with the IT department to add the tool to the EHR and build in a prompt to remind providers to chart the score. Finally, as previously mentioned, COVID-19 restrictions prevented the use of interactive educational sessions affecting provider compliance in screening patients with the tool. To improve staff compliance, incorporating multiple educational sessions during staff meetings could be a possible measure to educate all the existing anesthesia providers and locum tenens CRNAs. Also, modifying the PONV policy to make mandatory the charting of the PONV score in the EHR system, can potentially improve sustainability. In conclusion, the outcome of this QI project suggests that the implementation of the Apfel tool and treatment guideline are feasible interventions that can be incorporated to other surgical populations to abate PONV.

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Singh, P. M., Borle, A., Rewari, V., Makkar, J. K., Trikha, A., Sinha, A. C., & Goudra, B. (2016). Aprepitant for postoperative nausea and vomiting: A systematic review and meta-analysis. *Postgraduate Medical Journal*, *92*(1084), 87–98. https://doi-org.proxy-hs.researchport.umd.edu/10.1136/postgradmedj-2015-133515

Table 1

Evidence Review Table

Citation: Gecit, S., & Ozbayir, T. (2020). Evaluation of preoperative risk assessment and postoperative nausea and vomiting: Importance for nurses. *Journal of Perianesthesia Nursing: Official Journal of the American Society of PeriAnesthesia Nurses, 35*(6), 625–629. https://doi-org.proxy-hs.researchport.umd.edu/10.1016/j.jopan.2020.04.006					Level VI
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this study was to "assess the importance of preoperative risk assessment for Postoperative Nausea and Vomiting (PONV) and the significance for nurses."	Descriptive	Sampling Technique: Convenience Eligible: 18-year-old volunteer patients undergoing surgical procedures, cognizant, American Society of Anesthesiologist (ASA) classification I & II. Accepted: 242 patients undergoing surgical procedures. Excluded: 61 patients were excluded due to refusal, ASA class III and IV, and being unconscious during the first 24 hours postoperatively. Control: Not applicable-descriptive study Intervention: 242 patients were assessed with the PONV risk assessment	Intervention Patients undergoing surgical procedures were evaluated preoperatively and postoperatively using patient evaluation forms that included the Apfel and Koivuranta risk assessment scores to early detect and prevent PONV Protocol Patients fasted for 6 to 10 hours and no premedication was provided to patients undergoing surgery. Patients were assessed using the patient information form and the patient evaluation form. Both forms were completed preoperatively and postoperatively.	DV: Incidence of PONV after undergoing surgical procedures Measurement tool (reliability), time, procedure: The risk for PONV was measured with the Apfel and the Koivuranta nausea vomiting risk scores. The Apfel risk tool is divided into three categories: low risk, medium risk, and high risk. Patients with scoring results between 0 and 1 points were found to be at low risk, patients with 2 points were at moderate risk, and patients with 3 to 4 points were at high risk for PONV. The Koivuranta included scores of 0 to 5. If 0, 1, 2, 3, 4, or 5 risk factors were present, the	Statistical Procedures(s) and Results: 45.9% of the patients were found to have nausea and 23.6% suffered vomiting. The Kruskal-Wallis test was performed to evaluate the relationship between the Apfel risk score and PONV, the results showed that there was a statistically significant difference between the use of the Apfel risk score and PONV (p=.000). Kruskal-Wallis for Koivuranta risk score and PONV showed that there was a statistically significant difference (p=0.000). The authors concluded that the implementation of Apfel or Koivuranta risk scores can early detect and prevent PONV.

		tools. Power analysis: Not stated Group Homogeneity: No comparison group		incident of PONV was 17%, 18%, 42%, 54%, 74%, and 87%.	
Citation: Gunawan, M. Y., Utariani, A., Maulydia, M., & Veterini, A. S. (2020). Sensitivity and specificity comparison between Apfel, Koivuranta, and Sinclair score as PONV predictor in post general anesthesia patient. *Qanun Medika - Medical Journal Faculty of Medicine Muhammadiyah Surabaya*, *4*(1), 69. http://dx.doi.org/10.30651/jqm.v4i1.2826					Level VI
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results

The purpose of this study was to "compare the sensitivity and specificity scores of the Apfel, Koivuranta, and Sinclair as predictors of PONV in adult patients after being under general anesthesia (GA)."	Observational descriptive-Cross-sectional study	Sampling Technique Patients who met the criteria were selected as the study's subject with random sampling. Eligible Patients undergoing elective operations receiving GA. Inclusion Criteria- Patients 17 – 65 years old; ASA I & II undergoing elective surgery under GA with isoflurane inhalation. Accepted 100 patients, 53 males, and 47 females. Excluded Patients receiving antiemetic drugs throughout the perioperative period, patient with high intracranial pressure, pregnant patients, patients receiving Total Intra-Venous Anesthesia (TIVA) procedure; and patients who refused to participate in the study. Control N/A Intervention 100 patients were assessed with the	Intervention Protocol Study subjects were assessed using three types of PONV predictor scores: Apfel, Kovuiranta, and Sinclair risk tools. Subjects then were assessed for 24 hours postoperatively. PONV was classified if vomiting, nausea and retching occurred in 24 hours. Protocol Subjects had 8 hours of NPO status before the surgery and were anesthetized with isoflurane and oxygen for the surgical procedure.	Dependent Variable: To identify which of the three risk tools had the best specificity and sensitivity that can be utilized to screen patients receiving GA. Measure Not identified	Statistical Results The prevalence of PONV after GA in elective surgery was 26%. Data collected were analyzed with SPSS software. Descriptive data valued with frequency, average, and standard deviation. Analytic data was analyzed to find the specificity sensitivity for the risk scores. Area Under the Curve (AUC) and Receiver Operating Characteristics (ROC) were used to measure the accuracy of each PONV risk score. Apfel score sensitivity- 79.5%, specificity- 45.9% AUC -0.701 p value= <0.001 Koivuranta sensitivity- 96.2%, specificity- 27%, AUC -0.6. p value= 0.023 Sinclair Sensitivity- 73.1%, Specificity- 48.6%, AUC- 0.619 p value= 0.051 Conclusion The researchers concluded that it is recommended to use the Apfel score as it is more accurate to predict PONV.

		PONV risk tools. Power analysis-none Group Homogeneity: Not applicable to the study			
Citation: Singh, P. M., Borle, A., Rewari, V., Makkar, J. K., Trikha, A., Sinha, A. C., & Goudra, B. (2016). Aprepitant for postoperative nausea and vomiting: A systematic review and meta-analysis. *Postgraduate Medical Journal*, *92*(1084), 87–98. https://doi-org.proxy-hs.researchport.umd.edu/10.1136/postgradmedj-2015-133515					Level I
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this meta-analysis was" to evaluate aprepitant efficacy against other conventional antiemetics at treating PONV."	Systematic review-meta-analysis	Search strategy Databases explored, Medline, Embase, Science Citation Index expanded, Cochrane Central Register of Controlled Trials, Clinical Trials Registry, Scopus and meta register of controlled trials published up to 25 April 2015. The medical subject heading terms 'Aprepitant for postoperative nausea vomiting', 'Aprepitant compared with 5-HT3 antagonists for PONV', 'NK-1 vs 5-HT3 for PONV' and 'Comparison of Aprepitant for PONV' were searched. Eligible Studies Prospective randomized controlled trials	Control Use of conventional antiemetics (i.e 5-HT3 antagonist, dexamethasone) Intervention Use of antiemetics in the perioperative period, especially, Aprepitant. Protocol Not applicable	Dependent Variable Researchers chose studies with the following outcomes: a) Incidence of vomiting on postoperative day (POD) 1 (primary outcome) or POD 2. b) Incidence of use of rescue antiemetic on POD1 & POD 2 C. Incidence of patients with no nausea and no vomiting/ retching POD 1 & POD 2. Measure: The number of vomiting	Level of measurement Meta-analysis performed with fixed effect and random effect modeling The I2 statistic was completed to assess variation across studies. Values of I2 <40% were considered non-significant, values of 40–60% were considered to represent moderate heterogeneity and values of 60–90% were considered as high heterogeneity. Studies with heterogeneity values <40%, fixed and random effects results were used. The results were expressed as Mantel–Haenszel pooled OR with 95% CI. And $p<0.05$ was considered statistically significant Outcome Data Retrieval 454 articles were retrieved and duplicates were removed and ultimately 15 trials that measured or reported the primary outcome were chosen for the final analysis. Analysis

		comparing aprepitant (in doses of 125 mg, 80 mg and 40 mg as adjuvant or primary antiemetic) with conventionally used antiemetics during the postoperative period in the adult population (age ≥18 years), published either as full articles or meeting abstracts (in peer-reviewed journals), were considered. Excluded Studies with desired variable missing, n=6, studies with incomplete data, n=2. Included n=15 Prospective randomized controlled trials, single centre or Multicentre. Prisma Included detailed decision-making criteria for retaining/omitting studies from the SR Power analysis Not applicable		and nausea episodes POD 1/POD 2	For the primary outcome: incidence of vomiting and efficacy of various doses of aprepitant: Vomiting episodes occurred in 9.7% in the aprepitant patients vs 21.9% in the control groups. The OR for vomiting in the aprepitant group was 0.48 (95% CI 0.34 to 0.67) on POD1 and 0.54 (95% CI 0.40 to 0.72) on POD2. Conclusion Aprepitant alone or in combination with other medications led to the reduction of PONV for POD 1 and POD2. Patients who received aprepitant had a lower cumulative incidence of vomiting with more patients being free of nausea and emesis. A single oral dose of 80 mg can be safely and effectively used with a sustained anti-vomiting effect. SR Bias Risk: Low. Quality assessment for bias in the included studies was carried out in accordance with other published meta-analyses and the guidelines laid down by the Cochrane Collaboration by another independent researcher.
Citation: Teshome, D., Fenta, E., & Hailu, S. (2020). Preoperative prevention and postoperative management of nausea and vomiting in resource limited setting: A systematic review and guideline. *International Journal of Surgery Open*, *27*, 10–17. https://doi.org/10.1016/j.ijso.2020.10.002					Level I
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results

The purpose of this systematic review and guideline was "to improve patients' satisfaction by reducing the prevalence of PONV and its complication in patients undergoing elective surgeries. "	Systematic review	Search Strategy Literature was searched using PubMed/PMC, Google Scholar, and Cochrane library. Key terms used were PONV, antiemetics, and prophylaxis. Excluded Non-English & non-surgical studies were excluded (total n=15). Included Five, systematic reviews with meta-analysis, one guideline, and 4 meta-analysis of randomized control trials (RCTs), three literature reviews, three multicenter RCTs, thirteen single-center RCTs, and two cross-sectional studies. Prisma Included detailing decision-making criteria for retaining/omitting studies from the SR. Power analysis Not applicable to SR	Control Controls varied between studies included in the systematic review. For example, 5HT3 antagonists vs dexamethasone, TIVA using propofol vs inhalation anesthesia. Intervention Interventions in the studies in the SR mainly focused on PONV prevention and multimodal treatment. For instance, preemptive low-dose dexamethasone to reduce postoperative emesis and pain after total knee replacement. Other interventions included the assessment of ondansetron and metoclopramide. Protocol Not applicable to SR critique	Dependent Variable PONV Measure PONV occurrence within 24- 72 hours post-surgery.	Level of Measurement: Nominal Outcome Data Retrieval Researchers collected data for PONV treatment from all the studies selected. Analysis: none completed Conclusion Patients undergoing surgical procedures should be evaluated for the risk factors known to cause PONV and should be categorized as either low or high risk for PONV using the Apfel risk tool. Multimodal treatment should be given based on the guideline created for PONV management. SR Bias Risk: Based on the methodology described the risk for bias is low. Results and suggestions were consistent with the literature review discussed in the study.

Citation: Gan, T. J., Belani, K. G., Bergese, S., Chung, F., Diemunsch, P., Habib, A. S., Jin, Z., Kovac, A. L., Meyer, T. A., Urman, R. D., Apfel, C. C., Ayad, S., Beagley, L., Candiotti, K., Englesakis, M., Hedrick, T. L., Kranke, P., Lee, S., Lipman, D., … Philip, B. K. (2020). Fourth consensus guidelines for the management of postoperative Nausea and Vomiting. Anesthesia and Analgesia, 131(2), 411–448. https://doi-org.proxy-hs.researchport.umd.edu/10.1213/ANE.0000000000004833					Level I
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"The current guideline was developed to provide perioperative practitioners with a comprehensive and up-to-date, evidence-based guidance on the risk stratification, prevention, and treatment of PONV in both adults and children. The guideline also provides guidance on the management of PONV within enhanced recovery pathways."	Evidence-based comprehensive guidelines based on systematic reviews of RCTs published up through September 2019	Search Strategy A literature search was conducted using the Cochrane Methodological Expectations of Cochrane and PRISMA guidelines from January 2011 to February 2019. The databases included in the search were Ovid MEDLINE, Ovid MEDLINE, Epub Ahead of Print and In-Process & Other Non-Indexed Citations, Embase Classic+Embase, Cochrane Central Register of Controlled Trials, and Cochrane Database of Systematic Reviews. The MeSH terms consisted of multiple combinations of key terms that included: "PONV + algorithms", "PONV + Combination use of anti-emetics", "PONV + Enhanced Recovery After Surgery (ERAS)", "PONV +	Control The controls varied between the systematic reviews and dependent on the aspect of PONV. Some studies examined the effects of anticholinergics such as transdermal scopolamine efficacy versus placebo. Other studies focused on dexamethasone alone and dexamethasone in combination with ondansetron. Also, some studies had control groups with ondansetron versus aprepitant, while others compared aprepitant versus various other antiemetics and placebo. Intervention The guideline included studies with different interventions. For instance, some studies focused on the use of an objective risk assessment tool such as Apfel or Koivuranta	Dependent Variable Researchers included articles with the primary outcome of PONV incidence 24 hours after surgery. Measure The measurement tools used to evaluate the outcomes varied in the studies that were included in the development of the guideline. The majority of studies evaluated PONV as the presence of nausea and/or vomiting 24 hours after surgery.	Statistical Procedures (s) and Results: No statistical procedures were completed. Analysis: The quality and grading of the evidence were assessed based on the ASA Task Force on Acute Pain management practice guideline. Results: Guideline 1: Identify patients' risk for PONV. These risk factors include female sex, a history of PONV and/or motion sickness, non-smoking status, and young age. Surgery-related factors are related to the surgical procedure. For instance, laparoscopic, bariatric, gynecological surgery, and Cholecystectomy procedures have a high risk for PONV. Anesthesia-related risks of PONV include the use of volatile anesthetics, nitrous oxide, and postoperative opioids. Guideline 2: Reduce baseline risk for PONV. This includes minimizing the use of perioperative opioids and substitute with multimodal analgesic regimens, use regional anesthesia, have preferential use of propofol infusions as the main anesthetic agent, avoid volatile

		Risk", "PONV + Prophylaxis", "PONV + Neurokinin Antagonists or Serotonin 5HT3 Antagonists", and "PONV + Prophylaxis + Children." The researchers then summarized and presented at the consensus meeting. Following the review of the presented evidence, the panel was then asked to reach an agreement on the evidence analysis and grade the quality of the gathered evidence, as well as determine its clinical relevance. If an accord could not be reached, the majority's perspective was presented. If an agreement continued to still not be met, it was noted in the guideline. Eligible studies: (n=>9000) Criteria for eligibility included adult subjects over 18 years old and English language studies. Excluded Studies that involved subjects less than 18	scoring system to identify the risk of PONV and PDNV (post-discharge nausea & vomiting)—in percentage—for patients undergoing general anesthesia. Other studies had interventions with neurokinin, serotonin/5HT3 antagonist, and anticholinergics for PONV prevention. Intervention fidelity (describe the protocol): Not applicable to SR.		anesthetics, and adequately hydrate patients undergoing same-day surgery. Guideline 3: Administer PONV prophylaxis using 2 interventions in adults at risk for PONV. This includes the recommendation to use multimodal prophylaxis in patients with one or more risk factors. For example, Aprepitant 40 mg by mouth (PO) at induction, dexamethasone 4-8 mg intravenous (IV) at induction, droperidol 0.625 mg IV at the end of the surgery, haloperidol 0.5 to <2 mg (no timing recommended), ondansetron 4 mg IV at the end of the surgery, scopolamine transdermal patch the prior evening or 2 hours before surgery. Guideline 4: Administer prophylactic antiemetic therapy to children at increased risk for POV/ PONV and use a combination as adults. Guideline 5. Provide antiemetic treatment to patients with PONV who did not receive prophylaxis or when prophylaxis failed. PONV prophylaxis has failed, patients should receive antiemetic treatment from a different pharmacological class to the PONV prophylaxis. Guideline 6. Ensure general multimodal PONV prevention and timely rescue treatment is

		years old (except for pediatric antiemetic prophylaxis and treatment). Included RCTs (without meta-analysis) and observational, comparative studies were included in this evidence-based guideline with a publication date range from January 2011 to February 2019. No details were noted as to the number of published studies that were legitimately accepted to develop the fourth edition practice guidelines. PRISMA Diagram not included, but the article stated that the searching process followed the PRISMA guidelines. Power analysis Not applicable Group Homogeneity: N/A			implemented in the clinical setting Guideline 7: Administer multimodal prophylactic antiemetics in Enhanced Recovery Pathways (ERAS). Administer multimodal prophylactic antiemetics in ERAS. Conclusion: The updated PONV guidelines were created to provide comprehensive evidence-based clinical recommendations on PONV management. Prevention should be considered an essential feature of anesthesia which can be accomplished using risk assessment tools such as the Apfel risk score which represents an an objective approach to predict the incidence of PONV, with sensitivity and specificity of between 65% and 70%, Also, the guideline identified many drugs that can effectively provide prophylaxis and treatment for PONV. For instance, patients can Prophylactically be treated with transdermal scopolamine patch in the preoperative unit or the night before surgery as the patch is an effective measure for PONV prophylaxis in PACU and for 24 hours after surgery. SR Bias Risk: The risk for bias is low as studies were selected based on the Cochrane Handbook for systematic reviews of interventions.

Citation: Apfel, C. C., Heidrich, F. M., Jukar-Rao, S., Jalota, L., & Cakmakkaya, O. S. (2012). Evidence-based analysis of risk factors for postoperative nausea and vomiting. *British Journal of Anesthesia, 109*(5), 742-753. https:// doi:10.1093/bja/aes276					Level I
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
The purpose of this study was "to determine the highest risk factors that predispose patients to PONV by conducting a systematic review of the existing evidence."	Systematic review with meta-analysis	**Search Strategy:** A systematic literature search was conducted involving Pubmed, EMBASE and Cochrane databases. MESH terms included '(post-operative or surgical procedures, operative or anesthesia or postanesthesia). References list of included studies were manually searched for other relevant sources. Three independent investigators performed the systematic evaluation of the included studies. **Eligible studies**: (n=409) 409 eligible sources of data were considered. **Excluded studies**: (n=387) Studies that were not epidemiological observational or RCTs, contained <500 patients, patients under 15 years of age and studies not using multivariate logistic regression analysis to identify	**Control:** Most studies included were observational studies with no control, however one RCT investigated the use of total IV anesthesia as compared to the control variable of anesthetic gas and the effects of PONV occurrence. Another RCT studied different antiemetic medication combinations, and another had the control group of patients receiving nitrous oxide anesthesia compared to the intervention group of nitrous-free anesthesia. **Intervention:** Studies that were included performed multivariate logistic regression analysis to identify independent predictors of PONV. **Intervention fidelity** (describe the protocol): N/A	**DV**: The primary outcomes were to identify the independent predictors of PONV. Studies included in this meta-analysis investigated the primary endpoint of PONV which was defined as the unpleasant sensation with the urge to vomit. Vomiting (defined as the expulsion of gastric content) incidence 24 hours after surgery. **Measurement tool (reliability), time, procedure**: Studies used odds ratio or corresponding regression coefficients to determine the relationship between patient, anesthesia or surgery related risk factors and incidence of PONV that occurs within 24 hours after surgery.	**Statistical Procedures(s) and Results:** Odds ratio analysis and respective regression coefficients were performed to quantify the strength of each identified factor in predicting PONV. **Analysis:** The study found that female gender was the strongest predictor for PONV ($p < 0.001$; OR (95% CI 2.57)), followed by a history of PONV and/or motion sickness ($p < 0.001$; OR (95% CI 1.82)), being a non-smoker ($p < 0.001$; OR (95% CI 1.77)), and younger age ($p < 0.001$; OR (95% CI 0.88 per decade)). The anesthesia-related factors include the use of volatile anesthetics ($p < 0.001$; OR (95% CI 1.82)), which was the strongest predictor under this category, followed by the duration of anesthesia ($p < 0.001$; OR (95% CI 1.46)), postoperative opioid use ($p < 0.001$; OR (95% CI 1.39)), and the use of nitrous oxide ($p=0.02$; OR (95% CI 1.45)).

		independent risk factors for PONV. **Included studies**: 22 studies including RCTs and observational studies that reported data on a total of 95,154 patients. These studies all had a sample size with a minimum of 500 patients and reported adjusted odds ratio or regression coefficients of predictive PONV factors.			Under surgery-related factors, only three were statistically significant: cholecystectomy was the highest predictor (p <0.001; OR (95% CI 1.90)), followed by laparoscopic procedures (p = 0.01; OR (95% CI 1.37)), and gynecologic surgeries (p = 0.03; OR (95% CI 1.24)). **Conclusion**: This rigorous systematic review indicates that patient related risk factors are a high predictor of PONV and objective assessment tools like the Apfel score should be done in clinical practice to risk stratify PONV in patients undergoing surgery. **SR Bias Risk:** To prevent the risk of bias, the researchers included only studies with greater than 500 patients as large studies provide the most reliable data with a high level of evidence.

Table 2

Rating System for Hierarchy of Evidence

Level of Evidence	Type of Evidence
I (1)	Evidence from systematic review, meta-analysis of randomized controlled trails (RCTs), or practice-guidelines based on systematic review of RCTs.
II (2)	Evidence obtained from well-designed RCT and/or reports of expert committees.
III (3)	Evidence obtained from well-designed controlled trials without randomization.
IV (4)	Evidence from well-designed case-control and cohort studies
V (5)	Evidence from systematic reviews of descriptive and qualitative study
VI (6)	Evidence from a single descriptive or qualitative study
VII (7)	Evidence from the opinion of authorities

Table 3

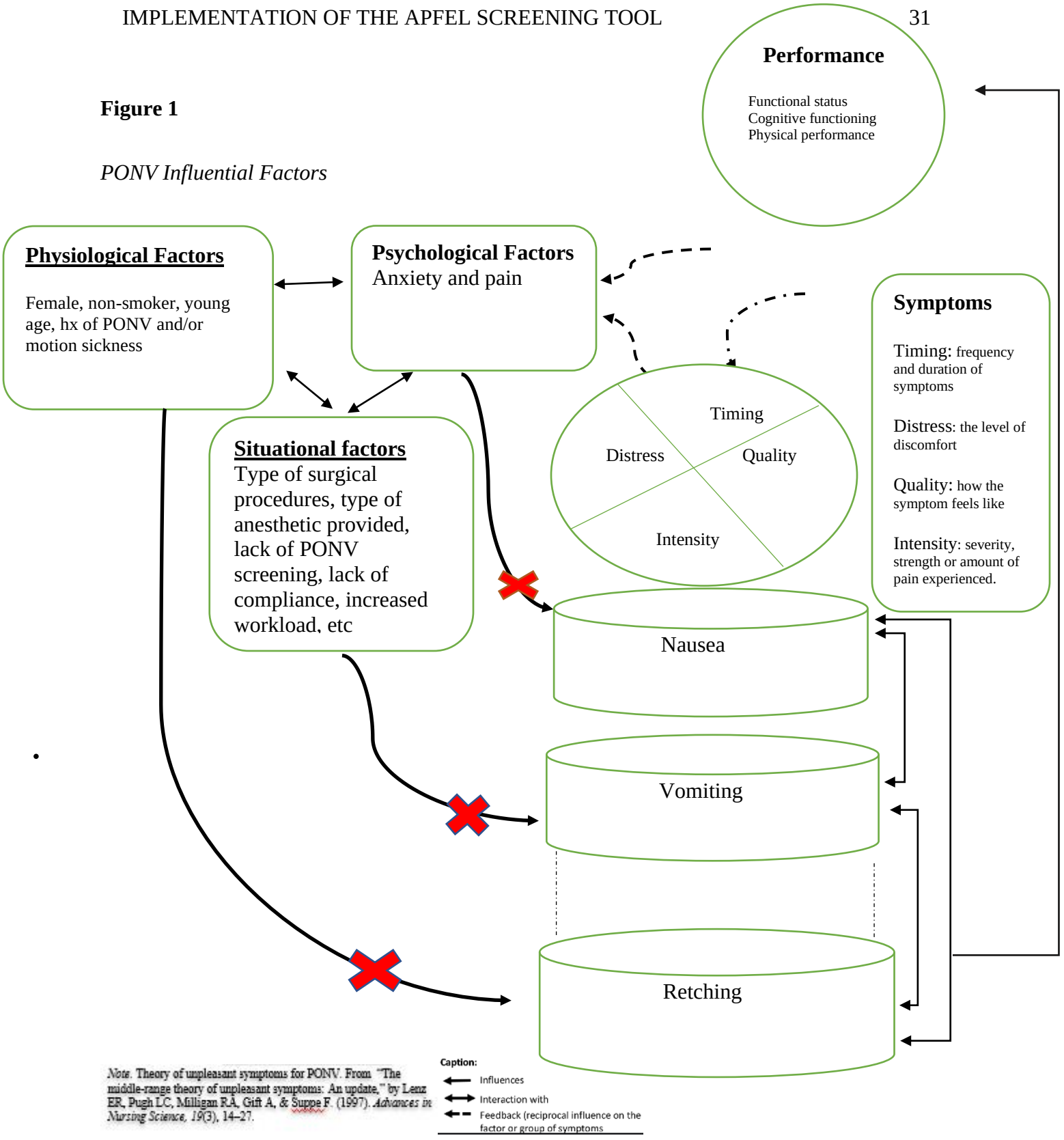
Synthesis Evidence

Evidence Based Practice Question (PICO): Can the implementation of the Apfel scoring tool for adult patients undergoing ear, nose, and throat surgery detect and guide PONV treatment using ondansetron, dexamethasone, aprepitant, and scolopamine, compared to not using a screening tool improve PONV rates at Georgetown University Hospital?	
Summary of Findings	**Overall Quality**
Singh et al. (2016) analyzed studies with patients at high risk for PONV per their Apfel risk score and aprepitant's efficacy. The researchers found that aprepitant can effectively lower the incidence of vomiting in the postoperative period with the therapeutic benefit extending into the second postoperative day compared to conventional antiemetics.	B, evidence obtained predominantly from RCTs. All the trials included in the SR found aprepitant efficacious for extended postoperative periods. Reasonably systematic and appropriate search conducted; reasonably consistent results with sufficient numbers of well-defined studies.
Teshome et al. (2020) concluded that patients undergoing surgical procedures should be screened for PONV risks using the Apfel risk score. Prevention and management should be instituted based on the risk score obtained. Guideline created by researchers can be used as a guide to treat PONV.	B, SR included evidence from meta-analysis of RCTs and guidelines, multicenter RCTs, literature reviews, single center RCTs, and cross-sectional studies. Based on the evidence found, the researchers created a PONV prophylaxis guideline that was consistent with the literature. There is high certainty that patients can benefit from multimodal treatment for PONV.
Apfel et al., (2012) concluded that the strongest predictors for PONV involve patient-related, anesthesia-related, and surgery related factors. The researchers found that the most reliable independent predictors of PONV were female gender, history of PONV or motion sickness, non-smoker, younger age, duration of anesthesia with volatile anesthetics, and postoperative opioids. In conclusion, a logical choice such as the Apfel risk score should be implemented for an objective PONV risk assessment in daily clinical practice.	A, this study evaluated large higher-level studies. The search criteria were well defined, and the selection of the evidence had meticulous enrollment criteria including studies with large sample sizes. This was a Landmark study that allowed the creation of the Apfel scoring system. The results of this study were consistent and the recommendations were clear.
Gan et al., (2020) developed a comprehensive guideline for the perioperative management of PONV in adult and pediatric patients. The guidelines can guide clinicians for PONV prevention through determining a risk assessment, achieving baseline risk prevention, and being proactive with pharmacoprophylaxis. The guideline also included evidence on newer medications that can help to treat PONV.	A, these evidence-based comprehensive guidelines are based on the most current evidence and it was reviewed by an international, multidisciplinary panel of experts who are knowledgeable in the PONV phenomenon. The PONV guidelines had consistent data and the recommendations were clear.

VI	**2**	Gecit & Ozbayir (2020) found that the early use of the Apfel risk score in clinical practice is considered to contribute to the early detection and prevention of PONV. Gunawan et al. (2020) compared three different risk scores and researchers found that the best predictive risk score was the Apfel risk tool as it was more accurate and had simpler determination variables.	C, there was a lack of randomization, and no control was utilized. Power analysis was vague to contextualize the adequacy of the sample size. Results were consistent and compatible with the literature. C, small sample affecting generalizability, data analyzed appropriately, there was no control group to assess comparison, lack of randomization, no statistical power was reported. Results were consistent with the literature. The recommendation was made to reproduce the same study with a larger sample to produce more valid results to determine the best PONV predictor score.

Figure 1

PONV Influential Factors



Note. Theory of unpleasant symptoms for PONV. From "The middle-range theory of unpleasant symptoms: An update," by Lenz ER, Pugh LC, Milligan RA, Gift A, & Suppe F. (1997). *Advances in Nursing Science, 19*(3), 14–27.

Figure 2

Conceptual Framework of Complex Innovation Implementation

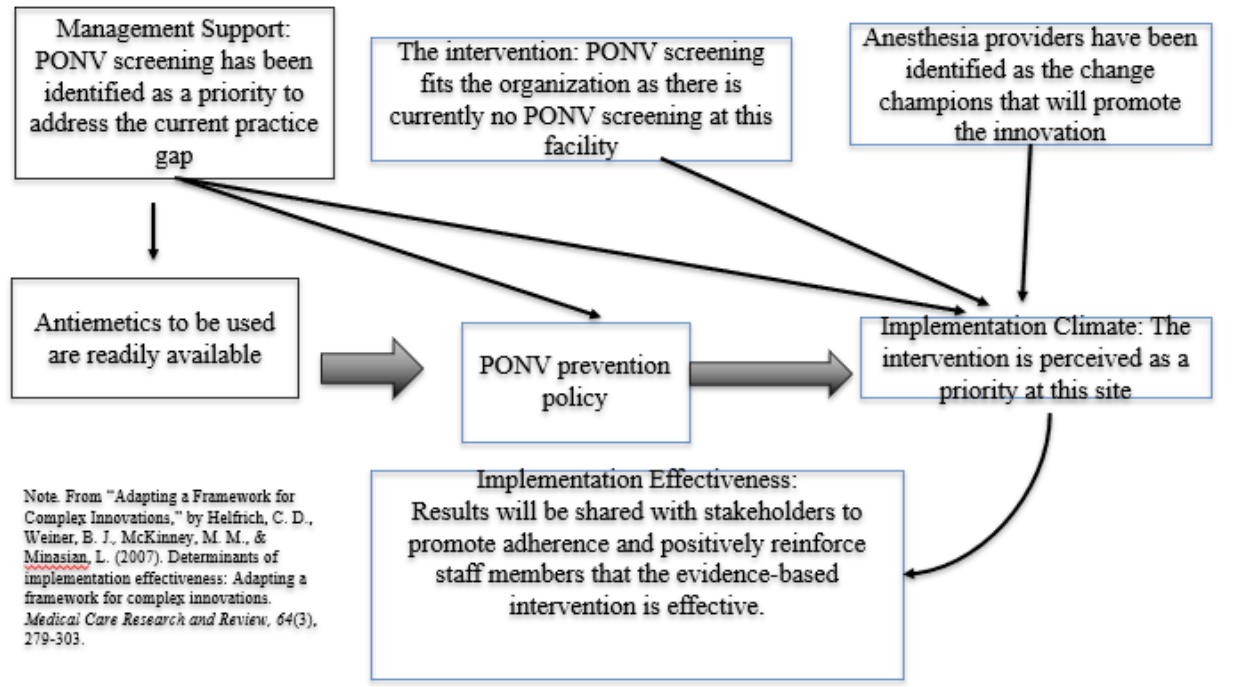


Figure 3

Current Process Map

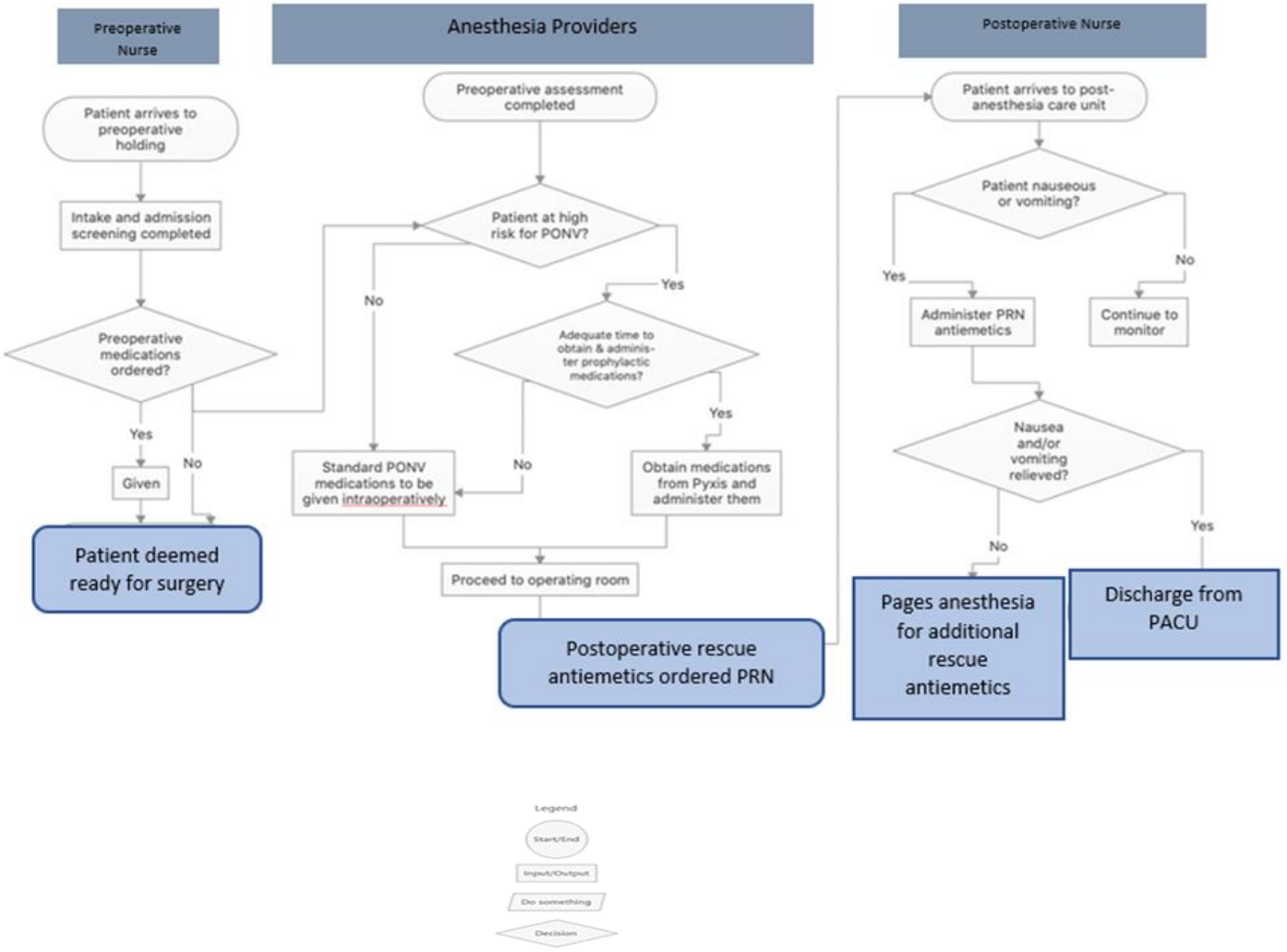


Figure 4

Patient Screening

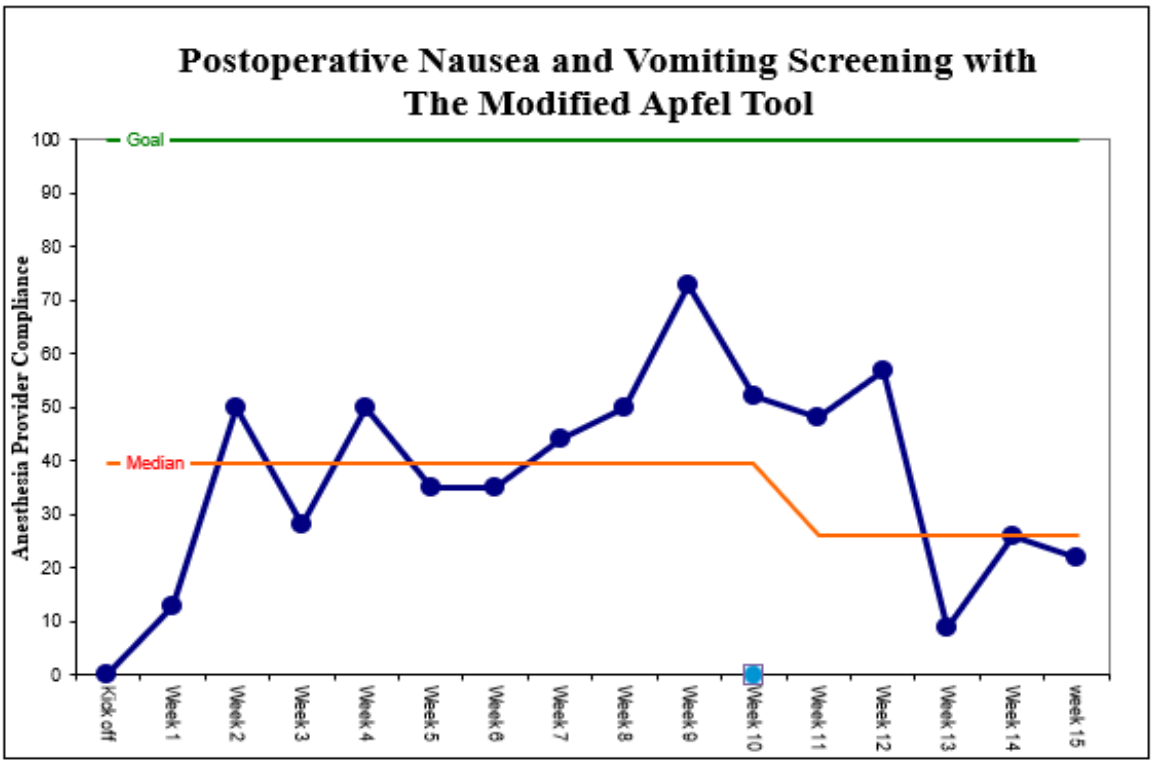


Figure 5

Prophylactic Treatment Administration

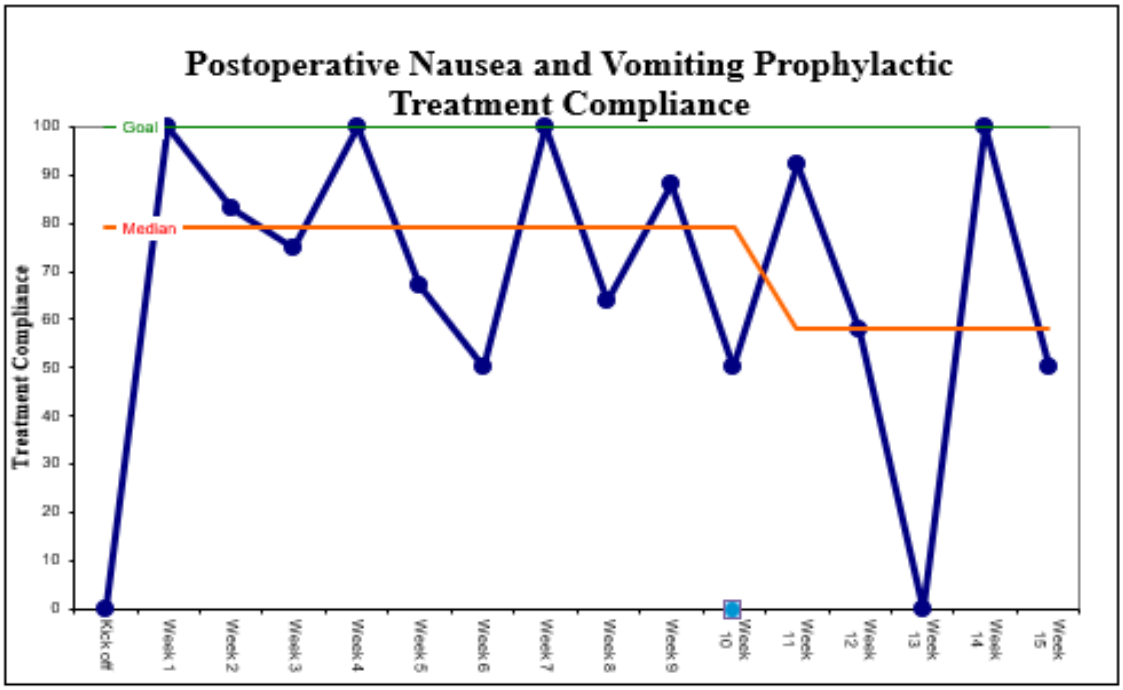
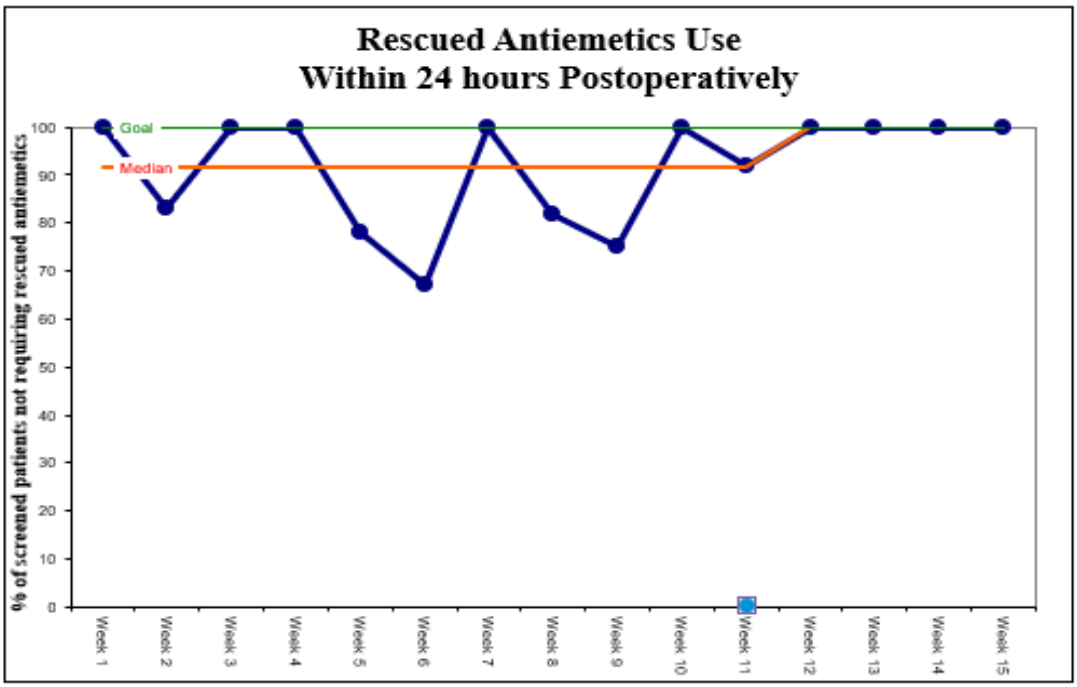


Figure 6

Patients Not Requiring Anti-emetics



Appendix A
Education Brief: University of Maryland DNP Project, SRNA Class of 2022
Subject: **PONV Prevention**
Type: Quality Improvement Project
For: Anesthesia Providers

- **Who**: APCs – CRNAs, CAAs, Anesthesia Residents, and solo Anesthesiologists will be responsible for screening, treatment, & documentation.
- **What**: Modified Apfel Screening Tool and Prophylactic Treatment Guideline (See Tables 1 & 2 below)
- **When**: Starting September 7th, 2021, please use the modified tool to screen all ***Adult Elective Surgery Patients*** preoperatively & document the score anytime during the case.
- **Where**: Document the PONV risk score as a free-text note within the anesthetic record. For example, simply write "PONV score 3." (**This is our key data-point, and we need this score to be documented).** Document your prophylactic medications as you normally would in the EHR.
- **Why**: Help us decrease the PONV rates at MGUH & Improve patient outcomes by adhering to the current MMGA PONV guidelines

Table 1. **Modified Apfel Screening Tool**

Risk Factor Assessed (1 point each)	**Points**
Female Gender	
Non-smoker	
History of PONV and/or motion sickness	
Volatile Anesthetics	
High-Risk Surgery (laparoscopic, bariatric, GYN, cholecystectomy)	
Risk score = sum of points (0-5)	

Table 2. **PONV Prophylactic Treatment Guideline according to Modified Apfel Score****

Risk Score	**Minimum number of Antiemetics recommended**	**Treatment Recommendations**
0-1	2	Dexamethasone + ondansetron
2	3	Droperidol + dexamethasone + ondansetron
3	4	Scopolamine + droperidol + dexamethasone + ondansetron
4	5	Aprepitant + scopolamine + droperidol + dexamethasone + ondansetron
5	6	Propofol infusion + Aprepitant + scopolamine + droperidol + dexamethasone + ondansetron

** Please use your own clinical judgement to determine if medications are appropriate and/or contraindicated for your specific patient.

Example: A 36-year-old female presents for lumbar spinal surgery. She has a history of motion sickness, is a current every-day smoker, and will receive volatile anesthetics.

- PONV score: 3 (documented within a free-text note)
- Suggested prophylactic treatment: Droperidol, Dexamethasone, & Ondansetron

Appendix B

Apfel Education Tool	
De-identified anesthesia provider	Received education? 1=yes, 0=no

Appendix C
Treatment and Compliance Tool

DOS	De-identified Patient ID	Apfel Screen Completed? 1= Yes 0=No	Apfel Score	Anesthesia Provider Code	Compliance with treatment according to score? 1=yes, 0=no	Received antiemetic by PACU RN within 24 hours postoperatively? 1=yes, 0=no	Adverse effects of PONV treatment? 1=yes, 0=no