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Sustaining reductions in postoperative nausea and vomiting after evidence-based practice initiative: A success story

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Abstract

Background: Postoperative nausea and vomiting (PONV) remains a significant problem in the surgical population. Many researchers have demonstrated significant reductions in institutional PONV when risk screening and antiemetic prophylaxis protocols are implemented. These protocols have not been universally adopted. Our adoption and implementation led to significant reductions in PONV. The challenge is to sustain these reductions over time.
Methods: A retrospective cohort chart review of consecutive surgical patients (n = 1002) during the period encompassing October through November of 2016, the sustainability group (G16). Descriptive statistics were used to compare G16 with the implementation group (G14) in regard to demographic data, and Z-score and Chi-square (x^2) statistics were utilized to determine levels of significance. Correlations were calculated to determine levels of compliance to the protocol and the incidence of PONV.
Results: A significant (P = 0.0007) reduction in PONV incidence was identified as 8.5% (85/1002) in G16 compared to 13.4% (134/997) achieved in G14. Overall compliance with the targeted prophylaxis protocol was 87.2% (G16, 874/1002), a significant (P = 0.0001) improvement compared to 79% (G14, 788/997). A 61.1% (11/18) incidence of PONV in laparoscopic gastric bypass patients was identified in the G16 group.
Conclusions: Initial reductions in PONV were not only sustained but significantly improved. Preoperative risk assessment for PONV, risk stratification, and fidelity to anti-emetic prophylaxis protocols reduce the incidence of PONV in the post-anesthesia care unit. High-risk patients require three or more interventions to obtain acceptable reductions in PONV. Laparoscopic gastric bypass patients remain a high risk group requiring aggressive multimodal prophylaxis beyond their Apfel simplified risk score.

KEY WORDS: Antiemetics; evidence based practice; patient satisfaction; postoperative nausea and vomiting.

Riassunto

Introduzione: La nausea ed il vomito post-operatorio rappresentano un problema rilevante nei pazienti chirurgici. È stata dimostrata da molti ricercatori una significativa riduzione del vomito e della nausea post-operatoria quando vengono attuati i protocolli della profilassi anti-emetica e lo screening del rischio. Questi protocolli non sono adottati universalmente. L'uso appropriato ha mostrato una riduzione significativa della nausea e del vomito post-operatorio. La sfida è quella di mantenere questa riduzione nel tempo.
Metodi: Uno studio di coorte retrospettivo basato sulla revisione delle cartelle cliniche di pazienti chirurgici (*n* = 1002), durante il periodo compreso tra Ottobre e Novembre 2016, il cosiddetto gruppo di sostenibilità (G16). Statistiche descrittive sono state usate per confrontare i dati anagrafici del gruppo G16 con quelli del gruppo di attuazione (G14), i punteggi Z ed il Test del Chi quadrato vennero adottati per determinare i livelli di significatività. Le correzioni sono state calcolate per determinare i livelli di aderenza al protocollo e l'incidenza del VNPO.
Risultati: Una significativa (*P* = 0.0007) riduzione nell'incidenza del VNPO è stata identificata con un livello pari all'8.5% (85/1002) nel G16 rispetto al 13.4% (134/997) raggiunto nel gruppo G14. L'aderenza complessiva al protocollo mirato di profilassi è stato pari all'87,2% (G16, 874/1002), con un significativo (*P* = 0.0001) miglioramento rispetto al 79% (G14, 788/997). Un'incidenza del 61.1% (11/18) di VNPO nei pazienti con bypass gastrico laparoscopico è stata identificata nel gruppo G16.
Conclusioni: La riduzione iniziale del vomito e nausea post-operatoria è stata non solo mantenuta ma anche incrementata. La stratificazione del rischio e l'adesione ai protocolli di profilassi anti-emetica riduce l'incidenza del vomito e della nausea post-operatoria nelle unità di terapia intensiva post-operatoria. I pazienti sottoposti a chirurgia gastrica laparoscopica sono un gruppo ad alto rischio che richiede una profilassi aggressiva con diverse modalità indipendentemente dall'Apfel risk score.

TAKE-HOME MESSAGE

Implement preoperative risk scoring and targeted prophylaxis based upon risk to decrease institutional incidence of PONV. Treat LGB patients as high risk regardless of risk score.

Competing interests - none declared.

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INTRODUCTION

Research studies and reviews related to postoperative nausea and vomiting (PONV) routinely begin with comments related to incidence (30% in general and up to 80% in a subset of patients) [1, 2], associated complications (surgical site hemorrhage, dehiscence, dehydration, electrolyte imbalance, aspiration, pneumothorax and esophageal rupture) [3], increased costs (related to prolonged recovery, increased length of stay and increased staffing demands) [4], and patient dissatisfaction (fear of vomiting more than pain) [5]. In 2016, there were more than 200 articles published with PONV in the title or keyword list demonstrating a continued concern and interest in this topic. Published commentaries have envisaged PONV free facilities and whether all of the answers have been provided to the question, 'What can be done?' [6, 7]. The afore mentioned publications reported incidences of PONV ranging from 11.9% to 57% [8, 9]. These values fall quite short of the vision of a PONV free surgical environment, and even the lower end of the range merely approaches Gan's recommended goal of 10% (personal e-mail, 2014). The conclusion enumerated by these data is that there is still significant work to be done. We present a two-year sustainability study of an evidence-based approach in addressing an unacceptable high incidence (estimated over 50%) of PONV in the post-anesthesia care unit (PACU). This approach consisted of implementing a protocol encompassing, a combination of two interventions. First, preoperative risk screening (utilizing the *Apfel Simplified Risk Score*) was implemented for all patients presenting for surgery. Next, the protocol used prophylaxis based upon risk stratification [10–12]. The current Society of Ambulatory Anesthesia (SAMBA) recommendations contain risk assessment (stratification) and antiemetic prophylaxis for patients of moderate (2 risk factors) to high risk (3-4 risk factors) for PONV. The recommendation appears to be predicated upon the medication costs and numbers needed to treat (NNT). Although this approach will most definitely reduce the incidence of PONV, the question remains, 'What is the acceptable incidence of PONV?' The *Apfel Simplified Risk Score* (female, non-smoker, history of motion sickness/PONV and planned administration of opioids) is accompanied with and expected incidence of PONV (without prophylaxis) based upon the number of risk factors (0 = 10%, 1 = 20%, 2 = 30%, 3 = 60%, and 4 = 80%) [13]. Administration of a single antiemetic intervention results in a relative risk reduction of approximately 26% [14]. Therefore, prophylaxis for the moderate to high risk surgical patients would result in an estimated incidence greater than 20%. Two antiemetics would reduce the expected incidence of PONV in the moderate to 22% whereas three antiemetics would produce an expected incidence of 24 and 32% in the high-risk group (3-4 risk factors). Implementation science has identified several concepts associated with sustainment of program implementation but the key concept is 'fit' [15]. As we looked to the SAMBA recommendations, we recognized that many anesthesia providers routinely provided antiemetic prophylaxis to all patients receiving general anesthesia (GA). Therefore, introducing a protocol which encouraged a 'wait and see' approach to low-risk patients would not fit. Since the initial aim was to increase antiemetic prophylaxis, any degree of variance from the idea of planned intervention would have discouraged the use of antiemetics, which would subsequently prove detrimental to the protocol success. Maximum 'buy-in' on the part of the anesthesia staff required adopting and 'enhanced' SAMBA recommendation approach. Each category of risk would receive an antiemetic prophylactically, thereby changing the binary decision from that of 'administer or wait and see' to 'administer' and then adding the question, 'How many antiemetics should be administered?' A three-level, targeted antiemetic prophylaxis approach was instituted. Low-risk patients would receive at least one antiemetic, moderate risk patients would receive at least two antiemetics and high-risk patients would receive at least three antiemetics. The simplicity and non-prescrip-

tive nature resulted in significant reductions in PONV incidence, as previously published [8].

METHODS

Ethical approval was obtained from the local Institutional Review Board (IRB) (IRBnet ID: 969386-1), who granted consent exempt status. A retrospective cohort chart review of consecutive surgical patients (n = 1002) during the period encompassing October through November 2016. The retrospective design was chosen in an attempt to diminish the Hawthorn effect that was anticipated with a replication of the pilot's prospective design. Data in this sustainability cohort is identified as G16. This time period approximated the original interventional time period of mid-September through November 2014 when the protocol was piloted. This original implementation cohort is identified as G14. Inclusion criteria (G16) consisted of adult (> 17 years) surgical patients originating from an in or out-patient status undergoing GA for elective and emergent surgery, with an admission to the post-anesthesia care unit (PACU). Exclusion criteria consisted of need for mechanical ventilation and non-communicative status. The G14 patients (n = 997) met the same exclusion criteria although the inclusion criteria differed in that all patient were same day arrivals for elective surgery. The goals of this study were to first determine if the previous reductions in incidences of PONV were sustained and then to determine the current level of compliance to the implemented protocol. The protocol consisted of a step-wise administration of antiemetics based upon risk stratification: Low-risk (0-1 risk factor) patients were to receive at least one antiemetic; Moderate risk (2 risk factors) patients were to receive at least two antiemetics; and high-risk patients were to receive at least three antiemetics. The choices available to the anesthesia providers were: ondansetron, dexamethasone, haloperidol, transdermal scopolamine patch, diphenhydramine, intramuscular ephedrine and total intravenous anesthesia (TIVA) utilizing Propofol. Statistical analyses were conducted using the statistical software IBM SPSS 19.0.1 (IBM, Armonk, New York) and Microsoft Excel 2016 (Redmond, WA). Descriptive statistics were used for demographic data, Z-score and Chi-square (x^2) statistics were utilized. Correlations were calculated for compliance to the protocol and incidence of PONV using Phi Cramer's V.

RESULTS

The overall incidence of PONV decreased from 13.4% (G14) to 8.5% (G16) (P = 0.0007), while the compliance rate increased from 79% (G14) to 87.2% (G16) (P < 0.0001) (see Table 1). There were significantly more males and fewer females in the G16 group as compared to the G14 group (P = 0.02). The G16 cohort consisted of significantly more Apfel risk score 2 patients and significantly fewer Apfel risk score 4 patients (P = 0.005, P = 0.001, respectively), which can be explained by the gender disparity as males can never be risk-assessed above Apfel risk score 3 and routinely score Apfel risk score 2. Despite these differences, decreases were noted in the moderate and severe risk categories although none reached statistical significance. Table 1 also depicts the incidence of PONV by Apfel category. There were no reported complications related to antiemetic use in either the G14 or G16 groups. Differences were identified between G14 and G16 in regard to surgical service. G16 differed from G14 in the following aspects: 1) more general surgery patients, 2) significantly more orthopedic patients (P = 0.001), and 3) more thoracic patients (P = 0.011). G16 further differed from G14 in that it contained: 1) significantly fewer gynecology patients (P = 0.001), 2) fewer genitourinary patients (P = 0.001), and 3) fewer otolaryngology patients (P = 0.028). Compliance to the antiemetic prophylactic protocol by Apfel risk score is depicted in Table 2. Significant increases in compliance were noted in Apfel risk score 1 patients (81.4% to 97.1%) and Apfel 2 patients (77.7% to 93.2%) (both with p values < 0.0001). An increase in compliance of 7% (85.1%) was noted in the Apfel risk score 4 patients (P = 0.08). A 4.1%

(75.7%) decrease in compliance was noted in the Apfel risk score 3 patients (P = 0.207). The overall number of patients experiencing PONV in the G14 cohort, who did not receive compliant prophylaxis, was 38 (3.81%) whereas in the G16 cohort the number was 20 (2%) (P = 0.021), a significant decrease (see Table 3). This demonstrates that even in those non-compliant cases, the G16 cohort's incidence of PONV was significantly lower than the G14 cohort. A review of these small numbers of non-compliant cases is reviewed in Table 3. There is no significant difference in non-compliance between the two groups when measured by Apfel category. When examining the actual shortfall in interventions, the mean, median and modes of the shortfall in numbers of interventions is practically identical in both groups. Of concern was the degree to which levels of compliance differed between genders, as can be seen in Table 4. In the G14 group, the non-compliance rate for males was 14.4%, while for females the non-compliance rate was 26% (P = 0.00004). This same phenomenon was seen in the G16 group, a non-compliance rate of 5% for males and 18.9% for females (P < 0.00001). The rates of non-compliance for males dropped significantly from G14 to G16 (P = 0.00001) and as well for females (P = 0.006). There was no significant difference in compliance when broken down by service line. To ascertain whether the Hawthorn effect was relevant, we compared both compliance and incidence of PONV (G16) between the first 38% of the data and the remaining 62%. During the initial sampling, anesthesia providers were not aware data were being collected. During the collection of the remaining 62% of the data, anesthesia providers became aware of the ongoing audit. Compliance was 87% and 87.4% respectively (P = 0.873) while the incidence of PONV was 9.4% and 7.9% respectively (P = 0.435). These figures demonstrate the lack of effect on outcomes based on knowledge of the audit. Laparoscopic gastric bypass (LGB) patients experienced a greater than average incidence of PONV in the G16 group (61.1%, 11/18); regrettably, the data were unavailable for the G14 group. These data were abstracted after anecdotal impressions of increased PONV incidences were noted during the middle of the second week of the collection period. PONV calculations were conducted from that period forward. LGB patients represented 14.5% (11/76) of patients experiencing PONV. The researchers collected data pertaining to PONV (G16) during both the PACU stay and continuing through to 24 hours postoperatively. An additional 38 patients experienced PONV after discharge from the PACU resulting in an overall 12.3% (123/1002) PONV incidence in the initial 24 hour period. This incidence is 1.1% less than the incidence of PONV identified in the G14 cohort during the PACU period (13.4%). In patients experiencing PONV after discharge from the PACU, the most common narrative note was 'nausea upon arrival' followed closely by 'out of bed walking…' and thirdly, following administration of oral or parenteral opioids. Future follow up studies will include this change as a matter of course.

Table 1. Demographic background for the G14 (n = 997) and G16 (n = 1002).

G16				**G14**			
	n	**%**	**CFD**	*N*	**%**	**CFD**	*P*
Gender	997	100	-	1002	100	-	-
Male	383	38.4	38.4	439	43.8	43.8	0.02*
Female	614	61.6	100	563	56.2	100	0.02*
PONV	997	100	-	1002	100	-	
Yes	134	13.4	13.4	85	8.5	8.5	0.0007*

No	863	86.4	100	917	91.5	100	
Apfel Simplified Risk Score	997	100	-	1002	100	-	-
0	4	0.4	0.4	1	0.1	0.1	0.16
1	161	16.1	16.5	138	13.8	13.9	0.16
2	373	37.4	53.9	440	43.9	57.8	0.005*
3	304	30.5	84.4	329	32.8	90.6	0.212
4	155	15.5	100	94	9.4	100	0.001*
Surgical Service	997	100	-	1002	100	-	-
General	280	28.1	28.1	322	32.1	32.1	0.057
Gynecologic	171	17.2	45.3	117	11.7	43.8	0.001*
Orthopedic	53	5.3	50.6	115	11.5	55.3	0.001*
Genitourinary	175	17.6	68.2	121	12.1	67.4	0.001*
Otorhinolaryngology	90	9.0	77.2	63	6.3	73.7	0.028*
Plastics	34	3.4	80.6	39	3.9	77.6	0.338
Vascular	60	6.0	86.6	60	6.0	83.6	0.398
Thoracic	48	4.8	91.4	77	7.7	91.3	0.011*
Neurosurgical	86	8.6	100	88	8.7	100	0.393
n = number of subjects, * statistical significance $P < 0.05$, CFD = cumulative frequency distribution							

Table 2. Compliance with Protocols by Category and Overall Groups.

Apfel Category	**G14**			**G16**			**Significance Difference within Category (P values)**
	n	**Compliant (*n*)**	**Compliant (%)**	***n***	**Compliant (*n*)**	**Compliant (%)**	
0	4	4	100.0	1	1	100.0	-
1	161	131	81.4	138	134	97.1	< 0.0001*
2	373	290	77.7	440	410	93.2	< 0.0001*
3	304	242	79.6	329	249	75.7	0.207
4	155	121	78.1	94	80	85.1	0.08
Total or Mean	997	788	79.0	1002	874	87.2	< 0.0001*
n = number of subjects, * statistical significance $P < 0.05$							

Table 3. Noncompliance rates by Apfel Score and outcome.

Apfel Score	G14		G16		Significance Difference % of Cases (P values)
	PONV+ (*n*)	PONV+ (%)	PONV+ (*n*)	PONV+ (%)	
2	8	21.1%	3	15%	0.340
3	21	55.3%	13	65%	0.309
4	9	23.7%	4	20%	0.378
Total	38	100%	20	100%	
Overall PONV and Noncompliance	G14 *n* = 997		G16 *n* = 1002		Significance Difference % of Cases (p values)
	38	3.81%	20	2.00%	0.021*

PONV = postoperative nausea and vomiting, + presence of PONV, * statistical significance $P < 0.05$, *n* = number in group

Table 4. Comparison of Noncompliance by Group and Gender.

Group	G14				G16			
Gender	Male (*n = 382*)		Female (*n = 614*)		Male (*n = 440*)		Female (*n = 562*)	
Intervention Shortfall*	-1	-2	-1	-2	-1	-2	-1	-2
Apfel								
1	1	0	0	0	3	0	1	0
2	40	3	19	1	13	1	15	1
3	12	2	88	23	5	0	68	7
4	0	0	28	2	0	0	13	1
Totals	53	5	135	26	21	1	97	9
Percent of category of noncompliance	91.4%	8.6%	83.9%	16.1%	95.5%	4.5%	91.5%	8.5%
Noncompliance Rate by Shortfall	13.9%	1.3%	22.0%	4.2%	4.8%	0.2%	17.3%	1.6%
Noncompliance Rate by Gender	14.4%		26%		5.0%		18.9%	
Total Noncompliance rate	22.0%				12.8%			

Significance Levels	
Male vs Female Percent noncompliance G14 ONLY	$P = 0.00004$†
Male vs Female Percent noncompliance G16 ONLY	$P < 0.00001$†
Male Compliance G14 vs Male Compliance G 16	$P = 0.00001$†
Female Compliance G14 vs Female Compliance G 16	$P = 0.0059$†

Intervention shortfall* = Number of interventions given - number of interventions in protocol
†- indicates statistical significance $P < 0.05$, *n* = number in group†- indicates statistical significance $P < 0.05$, *n* = number in group

Table 5. Overall PONV incidence and percentage by category and groups.

Apfel Category	G14			G16			Significance Difference within Category (P values)
	PONV+ (*n*)	% within category	% overall	PONV+ (*n*)	% within category	% overall	
0	0	0.0%	0.0%	0	0.0%	0.0%	-
1	8	5.0%	0.8%	8	5.8%	0.8%	0.389
2	38	10.2%	3.8%	23	5.2%	2.3%	0.290
3	49	16.1%	4.9%	41	12.5%	4.1%	0.346
4	39	25.2%	3.9%	13	13.8%	1.3%	0.063
Total	134	-	13.4%	85	-	8.5%	0.0007*
Group *N*	997			1002			

N = number in group, *n* = number in category, * statistical significance $P < 0.05$

DISCUSSION

Beyond the theories of implementation and sustainability frameworks (Diffusion of Innovation, [16] Re-Aim, [17] and Dynamic Sustainability [18]) we present a real-world example of EBP implementation, integration and sustainment. Several authors have presented dramatic reductions in PONV incidence from baseline within a research framework [19–21]. Rusch et al. (2010) were able to reduce PONV incidence below 10%, although there is no mention of sustainability of these improvements in the literature [21]. Kumar et al. (2012) noted a return to baseline incidence of PONV when compliance is low [22]. It is important to remember that implementation of EBP differs substantially from conducting randomized control trials (RCTs) [23]. In implementing an EBP plan, the importance of homogeneity of the RCT is replaced by heterogeneity. Although the data collection periods were similar in regard to time of year, several statistical differences were noted in the composition of G14 and G16 (see Table 1). Pierre et al. (2004), presented reductions in PONV to 14.3 – 15.5%, which are higher than the 8.5 – 13.4% presented here [10]. This difference may be explained by their focus on moderate and high-risk categories. The estimated risk for PONV is 10 – 20% in the low-risk category (0 – 1 risk factor). Table 5 depicts an incidence of 0 – 5.8% in our low-risk category. The differences between our two cohorts represent further integration of the EBP process over the two year period. The pilot implementation (G14) was a 'slice' of the surgical population (same day admission for elective surgery). This was an intentional effort to start small with the implementation plan and then grow the process after the EBP initiative proved its utility and value. [8]. The sustainability data (G16) reflects the results of integrating risk screening into the in-patient population, the creation of a forcing function in the electronic medical record (EMR) and the automatic population of risk factors into the anesthesia preoperative evaluation forms. Furthermore, development and implementation of a targeted prophylaxis icon in the EMR acts as a reminder to the anesthesia provider while in the operating suite. Kooij et al. (2010) found that implementation of decision support within the intraoperative electronic record significantly improved adherence to guideline implementation [24]. Each improvement was a stepwise development which added risk screening and targeted prophylaxis to a larger and more diverse surgical patient population. For instance, the marked increase in orthopedic patients (see Table 1) demonstrates the inclusion of emergent, non-scheduled patients

into the process. Drilling down and exploring inherent PONV risk stratification, (see Table 5) one can identify that incidences of PONV in the moderate (2 risk factors) and high (3 – 4 risk factors) risk patients decrease between G14 and G16 which demonstrates sustainability through reductions in within category incidence. These results support the findings of an overall statistically significant reduction in PONV incidence between the two cohorts despite the composition differences since the comparisons are between risk factor groups regardless of gender or surgical service. The best of protocols are only moderately effective when fidelity is not maintained [25]. Despite extensive evidence, fidelity to PONV guidelines is lacking. White et al. (2008) and Brampton et al. (2013) reported compliance rates from 52 – 67% [26, 27]. Table 2 depicts compliance rates of 79% (G14) and 87.2% (G16). Kapoor et al. (2008) reported an inverse relationship between compliance relative to the complexity of the risk screening tool and complexity of antiemetic protocols [28]. For this reason, the Apfel simplified risk scoring method and a 'Do Something for everyone' protocol was adopted. The 'enhanced' SAMBA targeted prophylactic protocol requires antiemetic prophylaxis at every risk category and is non-prescriptive. The non-prescriptive approach does not dictate which antiemetic agents are to be used but requires the anesthesia provider to tailor the intervention to each individual patient. Hodge et al. (2016) found that sustainment of EBP implementation (for at least three years) were more likely to have supervisory support and peer 'buy-in' and realization of sustained levels of improvement [29]. We believe that the non-prescriptive and all-inclusive approaches were key in obtaining peer 'buy-in'. The gender disparity related to protocol fidelity is troublesome. With increased compliance between G14 and G16, the increase in gender disparity related to non-compliance was unexpected. Since males are more likely to be risk stratified as moderate risk (2 risk factors) and women as high risk (3 – 4 risk factors) the males routinely require one fewer antiemetic per protocol. We surmise that anesthesia providers administer dexamethasone and ondansetron for all genders and may neglect the third antiemetic in female patients at a greater rate due to distraction, timing or lack of 'buy-in' to the protocol. Our area with the greatest opportunity for improvement is the laparoscopic gastric bypass (LGB) population. A 61.1% incidence of PONV is quite concerning. Bataille et al. (2016) reported incidences ranging from 45 – 54% with bimodal prophylaxis utilizing ondansetron and dexamethasone in conjunction with either total intravenous general anesthesia (TIVA) or inhaled general anesthesia (GA) with sevoflurane [30]. Despite multimodal (triple) prophylaxis, Ziemann-Gimmel et al. (2014) reported a 37.3% incidence of PONV but were able to decrease their incidence to 20% with an opioid-free TIVA with propofol, ketamine and dexmedetomidine [31]. Our findings confirm that the incidence of PONV in the LGB population is predicated upon surgery specific risk to a greater extent than inherent patient specific risk factors. This identifies the need for aggressive prophylaxis without regard to the Apfel simplified risk score as well as further research efforts to investigate the most efficacious antiemetic prophylaxis protocols and anesthesia techniques.

Limitations

The two groups were not randomized or matched but rather convenience, consecutive cohorts. The primary outcome metric was PONV during the patients' PACU stay. Post PACU narrative data obtained in the G16 cohort had no comparison. The retrospective nature of the review may have led to incomplete data abstraction since it relied upon interpretation of numerous providers' narrative notes, accurate completion of electronic checklists and documentation of antiemetic administration within the EMR.

CONCLUSIONS

Initial reductions in PONV were not only sustained but significantly improved. Preoperative risk assessment for PONV, risk stratifi-

cation, and fidelity to anti-emetic prophylaxis protocols reduce the incidence of PONV in the PACU. High-risk patients require three or more interventions to obtain acceptable reductions in PONV. Women are more likely to receive non-compliant prophylaxis as compared to men. Laparoscopic gastric bypass patients remain a high-risk group requiring aggressive multimodal prophylaxis beyond their calculated Apfel simplified risk score.

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