Randomized Controlled Trial Evaluating the Use of Supplemental Oxygen Administered in the PACU to Decrease Postoperative Nausea and Vomiting

C Thorner, M Moss, R Baker

Abstract

Purpose: Postoperative nausea and vomiting (PONV) are common complications. The current study examines the effect of supplemental oxygen administered in the PACU on PONV, postoperative antiemetics, and length of stay.

Scope: This randomized controlled trial examined 169 adult patients undergoing outpatient surgery under general anesthesia.

Conclusions: Among patients with no history of PONV, those who received supplemental oxygen on arrival to the PACU had a lower incidence of PONV and antiemetic administration (8.9%) compared to patients who received standard care (22.8%), p=0.041. Administering oxygen in the PACU is a low-cost intervention to decrease the occurrence of PONV among low-risk patients.

Authors' Addresses: C Thorner, TriHealth, Bethesda North Hospital.
M Moss, TriHealth, Anderson Surgery Center.
R Baker, TriHealth Nursing Administration, Entrance 1B Education Center, 4750 Wesley Avenue, Cincinnati, Ohio, United States of America.
Email: Rachel_Baker2@trihealth.com

Introduction

Postoperative nausea and vomiting (PONV) are common complications for patients undergoing surgery with general anesthesia. It is estimated that approximately 25-30% of patients generally, and up to 79% of high-risk patients, experience PONV [1-7]. Patients who have one or more of the evidence-based predictors of postoperative nausea and vomiting are considered to be high risk of experiencing PONV. These evidence-based predictors include female sex, history of PONV or motion sickness, nonsmoking, and young age [8]. Postoperative nausea and vomiting can result in negative outcomes for the patient and the hospital. Preventing PONV can improve outcomes resulting improvements in patient satisfaction [3, 9], shorter lengths of stay in the post anesthesia care unit (PACU) [10, 11], decreases in unanticipated readmissions [12], and decreases in resource utilization and costs [10, 13].

Because of the multiple benefits of preventing PONV for the patient and hospital, it is critical that patients' PONV risk factors are assessed before surgery and used to guide PONV management during the surgical visit [8]. Anecdotally, nurses report that when they apply supplemental oxygen to patients in the PACU if they begin experiencing PONV, the nausea often is resolved and vomiting is prevented. A search of evidence to examine this anecdotal report found many studies that reported mixed results on the effect of intraoperative supplemental oxygen on occurrence of postoperative nausea and vomiting.

In a systematic review of ten randomized controlled trials comparing intraoperative 80% supplemental oxygen to 30-40% supplemental oxygen on the incidence of postoperative nausea and vomiting, Orthan-Sungar and colleagues [14] found that there was no significant difference in PONV related to the percent of supplemental oxygen. They concluded that the use of 80% supplemental oxygen is not an effective intervention to reduce risk of PONV. Several years later, Hovaguimian and colleagues [15] conducted a systematic review of 22 randomized controlled trials comparing high inspired oxygen fraction (FiO2) (80-100%) and normal FiO2 (30-40%). They reported a significant but weak effect of high FIO2 on nausea with a decrease from 24.8% of patients receiving normal FIO2 experiencing nausea to 19.5% of patients receiving high FIO2 experiencing nausea; risk ratio 0.79 (95% CI, 0.66-0.93). Finally, Fasquel and colleagues [16] conducted a systematic review of 23 studies comparing the use of high FIO2 to normal FIO2 among adult patients undergoing surgery with general anesthesia. They reported no significant decrease in PONV with intraoperative high FIO2.

In the time after these three reviews were conducted, there have been two studies published that have examined the impact of supplemental oxygen on incidence of PONV. Both of these studies examined only pediatric surgical patients. Izadi and colleagues [17] reported that pediatric patients undergoing tonsillectomy had significantly lower incidence of PONV in the first two hours surgery when high FIO2 was administered compared to normal FIO2. However, a study of pediatric patients undergoing strabismus surgery found no significant difference in PONV between patients who received high FIO2 compared to patients who received normal FIO2 [18].

The reviewed studies reported conflicting results on the impact of administering different rates of oxygen intraoperatively. Two systematic reviews found no impact of high FIO2 oxygen on incidence of PONV [14, 16] while the other systematic review found a significant decrease in risk of postoperative nausea among patients receiving high FIO2 [15]. Studies published since these reviews also found conflicting reports with one study finding a significant decrease in PONV when high FIO2 was administered [17] and one study reporting no significant difference in PONV [18]. Interestingly all these studies compared different rates of oxygen administered intraoperatively. To date, no studies have examined the impact of administering oxygen in the postoperative setting on PONV. And, no studies have compared the impact of postoperative oxygen administration and room air only with no oxygen administered on patient PONV.

The purpose of the study was to address these gaps in the literature and to determine if supplemental oxygen applied immediately upon arrival to PACU can significantly reduce occurrence of PONV in outpatient surgical patients receiving general anesthesia compared to not administering supplemental oxygen in the PACU. Specifically, the current study examines the impact of supplemental oxygen on occurrence of PONV in the PACU, antiemetic medication administration in the PACU, and length of stay in the PACU.

Methods

A block-randomized, non-blinded, controlled study was conducted in which patients were randomized either: (1) to receive 2L supplemental oxygen via nasal cannula administered on arrival to the PACU for 15 minutes and then weaned as tolerated by the patient, or (2) to receive standard care which involved remaining on room air and only receiving supplemental oxygen as needed to keep oxygen saturation levels greater than 92% or if patient began experiencing symptoms of PONV. Approval was obtained by the organization's Institutional Review Board (IRB) prior to beginning study procedures.

The study took place at a PACU with 19 postoperative recovery bays. The team members on this unit provide care for patients undergoing outpatient procedures including, cystoscopy, robotic procedures such as hernia repair and cholecystectomy, breast procedures including lumpectomy and mastectomy, orthopedic procedures such as laminectomy and anterior cervical discectomy and fusion, and gynecological surgeries including hysterectomy and dilation and curettage. There are approximately 30 surgeries performed in this setting each day, with approximately 15 surgeries being performed on an outpatient basis where the patient is discharged from the hospital following their recovery period.

Patients were eligible to participate in the study if they were 18 years old or older, were admitted for an outpatient surgical procedure performed under general anesthesia, had no underlying disease requiring oxygen, and were not administered an antiemetic agent or medication preoperatively, including application of a scopolamine patch. Preoperatively, a study team member met with potential participants, described the study, and answered any patient questions. If a patient was interested in participating in the study, informed consent was obtained.

Block randomization by PACU bay was used to assign patients to interventions. As patients come out of surgery, assignments to PACU bays were random. Approximately half of the PACU bays were designated "intervention" bays and signs were placed in these bays reminding the nurses that patients cared for in these bays were to receive 2L of oxygen via nasal cannula applied immediately upon arrival and for at least the first 15 minutes the patient was in the PACU. The other PACU bays were designated "control" bays and nurses in these bays followed standard practice that involved 2L of oxygen via nasal cannula only being applied if the patient's oxygen saturation fell below 92% or if the patient had complaints of nausea or vomited.

Every 1-2 weeks, manual chart reviews were performed on the charts of patients who signed the informed consent form. The study nurses confirmed that supplemental oxygen was administered for at least 15 minutes for patients in the intervention bays and documented whether oxygen was administered for patients in the control bays. From the chart review, the study nurses documented if the patient experienced PONV, if the patient received an antiemetic agent while in the PACU, and the patient's length of stay in the PACU. Finally, the study nurses obtained data on potentially confounding variables including type of surgery and if the patient had a history of PONV or motion sickness.

Results

A total of 248 patients were enrolled in the study. However, 42 patients who were scheduled for an outpatient surgical procedure were unexpectedly admitted to the hospital after surgery and therefore excluded from analysis. An additional 37 patients were removed from the analysis because they received an antiemetic agent or a scopolamine patch preoperatively. After these exclusions, 169 patients were included in the final analysis. Because of the random assignment to PACU bays and the multiple patients removed for exclusion criteria, the final number of patients in each group differed, with 69 patients in the intervention group receiving supplemental oxygen and 100 patients in the control group receiving standard care.

Just over half of the sample (55%) were female and 45% were male. Approximately 46% of procedures were laparoscopic or robotic. The most frequent surgeries included general surgical procedures (61.5%), gynecological procedures (16.6%), and urological procedures (9.5%). Most patients received intraoperative antiemetic agents with over 95% of patients receiving ondansetron 4mg. Only 3% of patients received no antiemetic agent intraoperatively. There was no significant difference in gender, whether the surgery was performed laparoscopically, the type of procedure, or type of antiemetic agent administered intraoperatively between the intervention and control groups.

After randomization, there was a significant difference between the two groups with a higher percent of patients in the intervention group having a previous history of PONV (34.8%) compared to the patients in the control group (21%), $p=0.046$. Because a history of PONV increases a patient's risk of subsequent PONV, this was a potential confounder and therefore, outcomes were analyzed separately for patients with a history of PONV and patients without a history of PONV. There were no other variables that significantly differed between the two groups (Table 1).

A Chi Square test was used to compare occurrence of PONV and occurrence of antiemetic agent administration in the PACU between patients in the two groups. A Mann-Whitney U test was used to compare length of stay in the PACU between the two groups. In all analyses, the level of significance was set at $\alpha=0.05$.

Among patients with no history of PONV, patients who received supplemental oxygen in the PACU experienced a significantly lower occurrence of PONV (8.9%) compared to patients who received standard care (22.8%), $p=0.041$. When examining patients with a history of PONV, there was no significant difference in occurrence of PONV between patients who received supplemental oxygen in the PACU (16.7%) and patients who received standard care (19%), $p=0.835$.

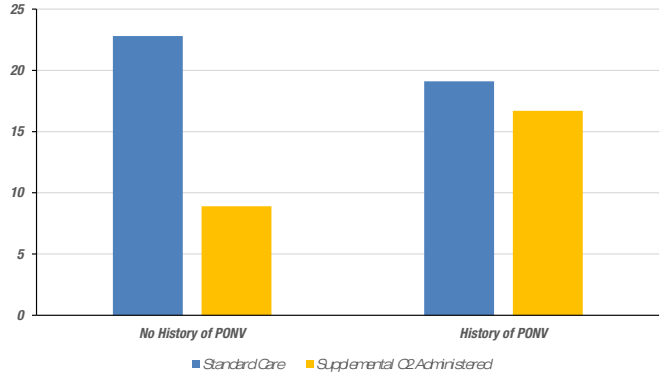
All patients who experienced PONV while in the PACU received an antiemetic agent. Therefore, the results when comparing antiemetic medication administration in the PACU between the groups were the same as the results when comparing PONV. Among patients with no history of PONV, a lower percentage of patients who received supplemental oxygen received an antiemetic agent in the PACU (8.9%) compared to patients who received standard care (22.8%), $p=0.041$. When examining patients with a history of PONV, there was no significant difference in occurrence of antiemetic medication administration in the PACU between patients who received supplemental oxygen (16.7%) and patients who received standard care (19%), $p=0.835$ (Figure 1).

When examining the length of stay in the PACU, no significant differences were found in either subgroup of patients. Among patients with no history of PONV, there was no significant difference in length of PACU stay between patients who received supplemental oxygen ($M=74.67$ min., $SD=28.14$) and patients who received standard care ($M=86.81$ min., $SD=48.34$), $p=0.348$. Similarly, among patients with a history of PONV, there was no significant difference in length of PACU stay between patients who received supplemental oxygen ($M=78.96$ min., $SD=22.40$) and patients who received standard care ($M=89.67$ min., $SD=51.65$), $p=0.891$.

Table 1 Sample Characteristics (n=169).

	Intervention Group (n=69)	Control Group (n=100)	*p*
Gender, n (%)			*p*=0.34
Female	28 (41%)	52 (52%)	
Male	41 (59%)	48 (48%)	
Laparoscopic/Robotic surgery, n (%)			*p*=0.23
Yes	28 (41%)	50 (50%)	
No	41 (59%)	50 (50%)	
Type of surgery, n (%)			*p*=0.40
General Surgery	43 (62.3%)	61 (61%)	
Gynecology	11 (15.9%)	17 (17%)	
Urology	8 (11.6%)	8 (8%)	
Ortho/Neuro	6 (8.7%)	8 (8%)	
Vascular	0 (0%)	3 (3%)	
Plastics	0 (0%)	3 (3%)	
Surgical Oncology	1 (1.4%)	0 (0%)	
Intraoperative antiemetic, n (%)			*p*=0.35
Zofran 4mg	64 (92.8%)	97 (97%)	
Decadron 4-10mg	61 (88.4%)	91 (91%)	
Pepcid 10-20mg	3 (4.3%)	4 (4%)	
Phenergan 6.25-12.5mg	1 (1.4%)	2 (2%)	
Benadryl 12.5mg	3 (4.3%)	0 (0%)	
Reglan 10mg	1 (1.4%)	1 (1%)	
None	3 (4.3%)	2 (2%)	
History of PONV, n (%)			*p*=0.046*
Yes	24 (34.8%)	21 (21%)	
No	45 (65.2%)	79 (79%)	

Figure 1 Percent of Patients who Experienced PONV and Received an Antiemetic in the PACU.



Discussion

Because of the multiple benefits of preventing PONV for the patient and hospital, it is critical that patients' PONV risk factors are assessed before surgery and used to guide PONV management [8]. Previous studies examining the use of intraoperative oxygen and its effects on PONV reported conflicting results. To date, this is the first study examining the administration of supplemental oxygen postoperatively to decrease the incidence of PONV and decrease the administration of antiemetic medication.

Limitations of this study include a relatively small sample size, especially considering the analyses were conducted on subgroups of the total sample. Future research should address the potential benefit of supplemental oxygen administered postoperatively in a larger group of patients. Additionally, the study was not blinded and patients who were aware they were not receiving the intervention may have been more sensitive to noticing postoperative nausea. Future research could compare supplemental oxygen provided postoperatively to patients who inhaled room air through a nasal cannula to decrease the potential for placebo effect.

In this study, there was no significant difference in incidence of PONV, antiemetic agent administration, or PACU length of stay among patients with a history of PONV. Patients with a previous history of PONV are at higher risk of subsequent episodes of PONV and may

benefit from more rigorous intervention. Since the current study found no benefit among the subgroup of patients with a history of PONV, additional research is needed regarding pharmacological and non-pharmacological interventions to decrease the incidence of PONV in these high-risk patients.

Interestingly, there was a significant decrease in incidence of PONV and administration of antiemetic medications in the PACU among patients with no history of PONV who received supplemental oxygen for the first 15 minutes in the PACU. This information can be useful when caring for patients in PACU who have no history of PONV or are experiencing their first surgery. Administration of 2L of oxygen via nasal cannulae in the PACU is a simple, non-pharmacological intervention that could reduce the incidence of PONV in this patient population.

Acknowledgements: The authors thank Becky Jones for her help with data collection, Kim Vossler for her help obtaining informed consent, and all the Bethesda North Hospital PACU staff nurses for their help with the study.

References

1. Apfel CC, Läärä E, Koivuranta K, et al. A simplified risk score for predicting postoperative nausea and vomiting: Conclusions from cross-validations between two centers. ***Anesthesiology*** 1999;**91(3)**:693-700.
2. Cohen MM, Duncan PG, DeBoer DP, Tweed A. The postoperative interview: Assessing risk factors for nausea and vomiting. ***Anesthesia and Analgesia*** 1994;**78(1)**:7-16.
3. Eberhart LHJ, Mauch M, Morin AM, et al. Impact of a multimodal anti-emetic prophylaxis on patient satisfaction in high-risk patients for postoperative nausea and vomiting. ***Anaesthesia*** 2002;**57(10)**:1022-7.
4. Maras G, Bulut H. Prevalence of nausea-vomiting and coping strategies in patients undergoing outpatient surgery. ***Journal of PeriAnesthesia Nursing*** 2021;**36**:487-91.
5. Tateosian V, Gan TJ. Another quest for the holy grail of abolishing post operative nausea and vomiting. ***Journal of Clinical Anesthesia*** 2017;**41**:58-9.
6. Watcha MF, White PF. Postoperative nausea and vomiting: Its etiology, treatment and prevention. ***Anesthesiology*** 1992;**77(1)**:162–84.
7. Amirshahi M, Behnamfar N, Badakhsh M, et al.Prevalence of postoperative nausea and vomiting: A systematic review and meta-analysis. ***Saudi Journal of Anaesthesia*** 2020;**14(1)**:48-56.
8. Gan TJ, Belani KG, Bergese S, et al. Fourth consensus guidelines for the management of postoperative nausea and vomiting. ***Anesthesia & Analgesia*** 2020;**131(2)**:411-48.
9. Habib AS, Chen Y-T, Taguchi A, et al. Postoperative nausea and vomiting following inpatient surgeries in a teaching hospital: A retrospective database analysis. ***Current Medical Research and Opinion*** 2006;**22(6)**:1093-9.
10. Ganter MT, Blumenthal S, Dubendorfer S, et al. The length of stay in the post-anaesthesia care unit correlates with pain intensity, nausea and vomiting on arrival. ***Perioperative Medicine*** 2014;**3(1)**:10.
11. Fortier J, Chung F, Su J. Unanticipated admission after ambulatory surgery – a prospective study. ***Canadian Journal of Anaesthesia*** 1998;**45(7)**:612-9.
12. Myles PS, Williams DL, Hendrata M, et al. Patient satisfaction after anaesthesia and surgery: Results of a prospective survey of 10,811 patients. ***British Journal of Anaesthesia*** 2000;**84(1)**:6-10.
13. Dzwonczyk R, Weaver TE, Puente EG, Bergese SD. Postoperative nausea and vomiting prophylaxis from an economic point of view. ***American Journal of Therapeutics*** 2012;**19(1)**:11-5.
14. Orthan-Sungur M, Kranke P, Sessler D, Apfel CC. Does supplemental oxygen reduce postoperative nausea and vomiting? A meta-analysis of randomized clinical trials. ***Anesthesia and Analgesia*** 2008;**106(6)**:1733-8.
15. Hovaguimian F, Lysakowiski C, Elia N, Tramer MR. Effect of intraoperative high inspired oxygen fraction on surgical site infection, postoperative nausea and vomiting, and pulmonary function: Systematic review and meta-analysis of randomized controlled trials. ***Anesthesiology*** 2013;**119(2)**:303-16.
16. Fasquel C, Huet O, Ozier Y, et alEffects of intraoperative high versus low inspiratory oxygen fraction (FiO2) on patient's outcome: A systematic review of evidence from the last 20 years. ***Anaesthesia Critical Care & Pain Medicine*** 2020;**39(6)**: 847-58.
17. Izadi P, Delavar P, Yarmohammadi ME, et al.Effect of supplemental oxygen 80% on post-tonsillectomy nausea and vomiting: A randomized controlled trial. ***European Archives of Oto-Rhino-Laryngology*** 2016;**273(5)**:1215-9.
18. Farsani DM, Naghibi K, Varposhti MR, et al. Comparing the effect of supplemental 80% and 40% oxygen on postoperative nausea and vomiting in the pediatrics undergoing strabismus surgery. ***Majallah-I Danishgah-I 'Ulum-I Pizishki-I Arak*** 2017;**20**:76-85.