Prevention of Postoperative Nausea and Vomiting by Use of Rapid Sequence Intubation
A Hypothesis-Generating, Multicenter, Quality Improvement Project

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The use of rapid sequence intubation without prophylactic medication decreases postoperative nausea and vomiting (PONV) in high-risk patients to a rate of approximately 2%.

Abstract
The goal of this study was to decrease the incidence of PONV in high-risk patients with the use of rapid sequence intubation (RSI). A quality improvement study was undertaken at four different sites using an anesthesia care team model. RSI was used in 146 patients at high risk for PONV. No pharmacologic prophylaxis for PONV or limits were placed on the type of anesthesia or anesthesia medications.
Of the 146 patients in the study, two developed PONV. One patient experienced nausea, and the other had nausea and vomiting. Both responded well to rescue treatment, with no increase in time to discharge. There were no admissions or other issues related to PONV.

It appears the introduction of 100% oxygen or volatile anesthetics in the stomach may be the cause of PONV during the mask ventilation period. Avoidance of mask ventilation with positive pressure in an unconscious patient using RSI significantly decreases the occurrence of PONV, without the use of costly and potentially powerful systemic antiemetics.

Introduction

PONV is a significant anesthesia-associated event. The incidence of PONV in adult patients receiving anesthesia is estimated to be 20% to 50%, and even higher in high-risk patients.1-3 PONV causes great patient discomfort, delays discharge, increases costs from pharmacologic treatments, incurs wound complications, heightens anxiety, and presents potentially serious side effects caused by the administration of antiemetic medications.2-3 It has been found that many patients fear PONV as much as or more than the pain associated with surgery.4

Much attention has been given to hypothesized causes of PONV and optimizing its treatment, with little improvement in outcomes. The standard practice is now considered to include using high-dose antiemetics, avoiding certain anesthetics and risk-stratifying patients.2,3 Very little work has been done to actually define the physical causes of PONV. In a 1990 review, Watcha found that positive pressure ventilation (PPV) is associated with an increase in PONV; however, PPV was not implicated as the primary factor.2 Even with all of the advances in pharmacology and modification of anesthesia delivery, PONV continues to be a significant morbidity associated with anesthesia. Recently, some centers have reported reductions in the incidence of PONV and there may be certain providers who see less PONV, but there are few data to support this finding.5

Some patients experience PONV despite receiving therapy. There may be a variation in the likelihood of PONV based on the mode of delivery of the anesthetic. Patients who receive regional anesthesia, total intravenous anesthesia (TIVA) or sedation are less prone to PONV. Simple factors may have been overlooked. Many benign anesthetics have been implicated as causing PONV and their use, therefore, has been limited. These excellent techniques and anesthetics (e.g., nitrous oxide) that have relatively benign side effects have been replaced with very potent, centrally acting antiemetics, with limited success.

After discussion with colleagues who do RSI on most patients for general anesthesia, the observation was noted that there seemed to be less PONV in these cases. All practices that were thought to increase the risk for PONV, such as the exclusion of antiemetics and elimination of nitrous oxide, were not controlled.1,2 The only requirement that was maintained was an RSI and no antiemetic prophylaxis. Surprisingly, very few cases of PONV were noted in these RSI patients. The assumption was made that 100% oxygen or volatile anesthetics in the stomach may be causing acute gastritis, hence the PONV. This appeared to be the only common denominator. The data presented by Hovorka in 1990, that implicated inexperienced providers having a higher incidence of PONV, support this idea.5

The induction of anesthesia usually includes mask ventilation with 100% oxygen followed by securing the airway (Table 1). Mask ventilation is probably not needed in most patients, since the next step would be to secure the airway, if masking proved ineffective. However, this standard algorithm could be causing a significant morbidity—PONV. RSI is a safe method to induce general anesthesia. It bypasses the process of mask ventilating patients after induction and depends on adequate spontaneous ventilation.

The purpose of this study was to show that using RSI for the induction of anesthesia in high-risk patients without prophylaxis will significantly reduce the rate of PONV.

Methods

After exploring research options, a clinical case review was initiated since RSI is a standard of general anesthesia induction and treatment of PONV is addressed either prophylactically or in a rescue scenario.2 High-risk patients were selected from surgical schedules at two community teaching hospitals and two outpatient centers. A goal of 200 participating patients was chosen. The surgeons were not always informed of the induction method but no preoperative antiemetics were allowed (e.g., a scopolamine patch). However, some surgeons became suspicious as they actually noticed less PONV. All providers were instructed to use RSI with either succinylcholine or rocuronium for induction of general anesthesia. After

### Table 1. General Anesthesia Induction Techniques

<table>
<thead>
<tr>
<th>Traditional Induction</th>
<th>Rapid Sequence Intubation</th>
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<tbody>
<tr>
<td>Preoxygenate</td>
<td>Preoxygenate</td>
</tr>
<tr>
<td>Induction</td>
<td>Induction</td>
</tr>
<tr>
<td>PPV with 100% oxygen ± volatile anesthetics</td>
<td>Secure airway</td>
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<td>Secure airway</td>
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PPV, positive pressure ventilation
appropriate preoxygenation was achieved, the airway was immediately secured with a laryngeal mask (LM) airway or an endotracheal tube (ETT). Excessive positive pressure was avoided with use of the LM airway. Any cases in which the mask ventilation occurred prior to placement of a secured airway were excluded. No other restrictions were given, including the use of nitrous oxide, type of inhalation agent, type of muscle relaxant, use of muscle relaxant reversal, choice of narcotic or use of ketorolac, and extubation criteria. Any patients who were having a procedure that allowed blood to enter the stomach, including nasal fracture and reconstruction, or required preoperative prophylaxis for PONV, were excluded.

**High-Risk Characteristics for PONV**

Certain patient characteristics are known to identify patients at higher-than-normal risk for PONV:
- Women
- Age less than 50 years
- Laparoscopic procedures
- Previous occurrence of PONV
- Nonsmoking status
- History of motion sickness

All patients gave consent for general anesthesia, and were instructed to inform the staff if they felt sick or had pain in the postoperative period. No other variables were changed with the exception that all patients were not mask ventilated prior to securing the airway with the ETT or LM airway.

Evaluation for PONV was done immediately after extubation in the PACU and prior to discharge. In addition, all patients were asked about PONV during a postoperative day 1 follow-up call from the surgical centers. All patients who experienced PONV were immediately treated with 4 mg of IV ondansetron. Routine postoperative orders were altered to remove the PRN delivery of any antiemetics without practitioner approval. The deletion of the administration of routine antiemetics from postoperative orders allowed notification from the staff if the patient required rescue medication. Delayed discharge, transfer to a hospital facility, and readmission caused by PONV were also examined.

**Results**

The data were collected on site, during the PACU check and at the routine postoperative follow-up call, which ensured patient confidentiality was maintained. Both patients in whom PONV occurred received IV ondansetron for rescue with good results and minimal change to discharge. One patient experienced vomiting and the other was treated for severe nausea.

The results are clear: Among the 146 patients from four different surgical settings, there were only two cases of PONV without the administration of prophylaxis (Table 2). The data show a rate of PONV of 1.5% in high-risk patients.

Some practitioners were reluctant to take part in this trial because it goes against standard mask ventilation teaching and concern for PONV morbidity. Some practitioners agreed to attempt RSI but few trusted the lack of prophylaxis based on the overwhelming belief that all patients should be given a prophylactic antiemetic.

Traditionally, anesthesia providers have been trained—for reasons that are unclear to me—to start the induction of anesthesia, mask ventilate and then secure the airway. This appears to be the cause of PONV and may be doing more harm than good. The problem is that it is traditional to provide general anesthesia in this manner all over the world, despite the possibility that it may be causing the majority of PONV.

Anecdotally, there also seemed to be less drowsiness in these study patients, but this outcome was not measured in any way. This reduction may be related to avoidance of centrally acting antiemetics in these patients.

**Discussion**

This is a very small study, and a larger study with more controls needs to be conducted, but the data are convincing enough that this information is being released early for others to formally review and analyze. The author is limited in his practice to do further investigational research and so wishes to share these findings. There are many variables that may need to be kept constant, but this study shows a reduction in PONV. In addition, there are potential cost savings and a reduction in side effects that would have resulted from prophylaxis treatment for PONV.

What do we do with this information? First, more investigation needs to be done. An exhaustive review of the literature was absent for the cause of PONV. Animal studies (using 100% oxygen or volatile anesthetics in the stomach to evaluate gastritis) and human trials can further evaluate the use of RSI for patients prone to having PONV. RSI is used for high-risk airway failure.

| **Table 2. Outcomes in Study of Rapid Sequence Intubation** |
|---|---|---|---|---|---|
| Procedures | PONV | Rescue | Delayed Discharge | Transfer | Readmission |
| 146 | 2 | 2 | 0 | 0 | 0 |

PONV, postoperative nausea and vomiting
so why not use it on all patients if it reduces the rate of PONV? Decompressing the stomach is not the solution. I postulate that once the 100% oxygen has been exposed to the gastric lining, then the vomiting reflex is activated trying to expel a gas irritant. Alcohol and food illnesses can cause vomiting; oxygen in the stomach may be no different.

Have we made a huge mistake? Mask ventilation with high positive pressure on the esophagus will always put gas in the stomach as well as the lungs. Once paralyzed, the lower esophageal sphincter will relax prior to instrumentation of the airway, unless the airway is immediately secured. It is most likely this step that is allowing 100% oxygen to enter the stomach, creating an acute injury, and this may be the major cause of PONV.

With the addition of new medication that reverses the nondepolarizing muscle relaxants, it seems now is the time to reevaluate our standard induction techniques. All cases now can be done with a short-acting (succinylcholine) or intermediate-acting (rocuronium) muscle relaxant. Even very short cases can be performed using RSI.

If the reduction in PONV exists to the levels seen in this study, should we all change our practice to use RSI most of the time? RSI has always been a safe way to induce patients; if the airway is lost on induction, then the next step is to instrument the airway immediately. Spontaneous ventilation prior to induction is adequate for airway control and does not force oxygen into the stomach. Teaching this change may be more of an issue as it takes time to learn the techniques, but with the use of an LM airway, video laryngoscopes and other equipment, an airway can be secured in less than three minutes.

Many patients view PONV as important as or worse than pain postoperatively, so this is a very important topic to be addressed. Recent reviews call for further discussion of this topic. Little has changed in the outcome of PONV. The present study suggests that a new cause of PONV may have been identified and challenges the anesthesia community to evaluate this further.

### Suggested Further Research

With regard to toxicity, if the oxygen or volatile anesthetics are causing a toxic reaction in the gastric lining, an animal study would be indicated to look at post-exposure gastric irritation (gastritis). As for more studies, controlled trials should include higher numbers of patients and look at potential side effects from 100% RSI, post-discharge nausea and vomiting, and antiemetic sedation, and should eventually include a multicenter blinded evaluation.

### Additional Considerations

#### Cost Savings

There are potential direct and indirect cost savings associated with RSI for all patients. The direct savings would come from the elimination of all prophylactic use of PONV medications; these would be used only in rescue situations. The indirect cost savings would be patient costs to institutions, such as delayed discharge, medication side effects, additional equipment and readmissions. Many of the medications we use for PONV are not benign (Table 3). In fact, some of them are very potent medications that have major side effects, and we may need to give two or more to decrease PONV. Complications include heart rhythm problems, increased blood glucose and centrally acting side effects. Many of these drugs act on the central nervous system and affect neurochemicals.

The side effects listed are the most common. It is rare to see these side effects at the dose used for PONV but the list of potential side effects, including drowsiness and interaction with acetylcholinesterase inhibitors, emphasizes that it would be prudent to reduce their use as much as possible. Three of the most common PONV medications used in practice today cause drowsiness. This is exactly what we are trying to avoid by decreasing postanesthesia recovery time.

With over 45 million anesthetics administered in the United States each year (per the American Association of Nurse Anesthetists), reducing the amount of prophylaxis at a direct cost of only $1.00 per dose with dual therapy could represent a savings of tens of millions of dollars.

### Table 3. Common Medications for PONV

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<tr>
<th>Drug</th>
<th>Approximate Cost Per Dose to Institution, $</th>
<th>Side Effects</th>
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<tbody>
<tr>
<td>Dexamethasone</td>
<td>2.00</td>
<td>Arrhythmia, depression, emotional lability, increase in blood glucose</td>
</tr>
<tr>
<td>Metoclopramide</td>
<td>1.00</td>
<td>Anxiety, bradycardia, drowsiness, headache</td>
</tr>
<tr>
<td>Ondansetron</td>
<td>1.00</td>
<td>Dizziness, drowsiness, fatigue, headache, sedation</td>
</tr>
<tr>
<td>Scopolamine</td>
<td>25.00</td>
<td>Bradycardia, confusion, drowsiness, flushing, tachycardia</td>
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* Prices provided by hospital pharmacy staff.

* Dexamethasone and scopolamine also interact with acetylcholinesterase inhibitors (e.g., neostigmine).
Patient Satisfaction
If institutions can provide data that they have fewer occurrences of PONV, then patients will be more inclined to seek care at those centers. Even a reduction in the rate of PONV by 10% would be an achievement. The data suggest a reduction in the rate of PONV to almost zero is feasible.

Medical Education
As discussed above, the use of RSI in the majority of patients would lead to a need for major educational retraining. Many anesthesiologists hesitate to use succinylcholine, but it is a safe medication for RSI with minimal side effects.9 With the addition of nondepolarizing muscle relaxant reversal agents, these can be used for RSI as well.11 RSI is standard care for high-risk patients; it may need to become standard for nearly all patients.

References