Journal of Radiology Nursing 38 (2019) 177–182

Contents lists available at ScienceDirect

Journal of Radiology Nursing

journal homepage: www.sciencedirect.com/journal/journal-of-radiology-nursing

Periprocedural Considerations for the Prevention and Treatment of Nausea and Vomiting

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Keywords:
Postoperative nausea and vomiting
Nausea and procedures
Clinical practice guidelines on prevention of PONV
Pharmacology for emesis

A B S T R A C T

Procedures and the sedation required to complete them are triggers to nausea and vomiting. Nausea and vomiting are uncomfortable complications of care. These complications lead to increased length of the procedure and recovery time, which increases cost per case. Furthermore, experiencing nausea and vomiting is a factor in patient dissatisfaction of care. Postprocedural nausea and vomiting may bring about aspiration, increased intracranial pressure, or bleeding. This article outlines the clinical practice recommendations associated with diminishing the rate of complication in the perianesthesia settings in acute and outpatient care. Current research, pharmacology, and alterative interventions are also incorporated into this discussion.

Introduction

Many variables impact the choice of medications when procedural sedation is required. Creating the optimal procedural sedation prescription is becoming a more intricate process as length of diagnostic and interventional radiology cases expands exponentially. This variable of increasingly lengthy cases requires the use of longer acting anesthetic and sedation medications. The individuality of the patient is another high impact variable within the procedural sedation equation. The higher the American Association of Anesthesia (ASA) classification, the higher the acuity of the patient. Given this combination of sicker patients and longer procedural sedation times makes nausea and vomiting complications more prevalent. Minimizing these complications becomes an increasingly important care outcome (Werthman, 2019) for interventional radiology procedures as well as operative procedures (Practice guidelines for moderate procedural sedation and analgesia, 2018).

Postoperative nausea and vomiting (PONV) has an enormous impact on the patient experience and attendant patient satisfaction scoring (Practice guidelines for moderate procedural sedation and analgesia, 2018; ASPAN's EBP Clinical Guideline for the prevention and management of PONV/PDNV, 2006). In addition, it can inflate the cost of care due to increased recovery time, use of expensive rescue medications, or longer time spent in acute care. Clinicians sometimes consider nausea and vomiting an expected, though self-limiting consequence of pain and sedation medications. Postprocedural nausea and vomiting may minimally delay discharge. Nausea and vomiting may, however, set in motion life-threatening complications. Some, specific to radiology, are aspiration, triggering retroperitoneal bleeds, bleeding at procedure site, airway compromise, increased sedation and analgesia requirements, and increased intracranial pressure (Smith & Ruth-Sahad, 2016). The published rate found in retrospective reviews on the incidence of PONV is 30% (American Society of PeriAnesthesia Nurses PONV/PDNV Strategic Work Team, 2006) of adults undergoing anesthesia and sedation care. This statistical incidence of PONV has been documented across multiple decades. PONV incidence is higher in pediatric patients (Gan, 2006). Decreasing the incidence of PONV has been a quality indicator for anesthesia care within the operating room as part of the enhanced recovery after surgery (ERAS) initiative (Tateosian et al., 2018). Despite this focus, the current incidence of PONV appears static at 30% overall (Apfelbaum et al., 2013). In addition, guidelines from multiple professional organizations receive only sporadic incorporation. A current review of electronic medical records with built-in algorithms for published PONV prevention guidelines found that prophylaxis compliance was low (Gillman et al., 2019). The incidence of PONV remains around 30% for all operative patients and 80% for those at highest risk (Wibel et al., 2017).

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https://doi.org/10.1016/j.jradnu.2019.05.004
1546-0843/$36.00/

The operational definition used in this article is that of the American Association of Perianesthesia Nurses (2006) published in their evidence-based clinical guideline. This document states that postoperative nausea and vomiting is defined as any nausea or vomiting that occurs within 24 hours of surgery. The logical assumption is that any beneficial interventions, tools, and medications used in perianesthesia and perioperative areas will also be helpful for patients receiving procedural sedation within the radiology arena. The scope of information provided gives a synopsis of the physiology, risk factors, risk assessment tools, clinical practice guidelines, medications, and alternative therapies that provide beneficial options for use in the procedural area. An example of a prudent nurse choosing to implement these interventions is also included in a concluding case study.

Synopsis of the Physiology: Multifactorial Pathways for Nausea and Vomiting

Unpleasant and undesirable are some of the expressions patients use to describe nausea and vomiting (Collins, 2013). Nausea is a feeling and is therefore subjective (Thomas et al., 2019). Nausea may or may not accompany vomiting (Denham & Gallagher, 2018). There is no specific anatomical site associated with nausea. Patients describe nausea as a type of altered sensory state or state of being (Collins, 2011). It may therefore be part of the brain's limbic system. Nausea is at times associated with the preejection phase of vomiting. Vomiting is a muscle response of the gastrointestinal tract, triggered by parasympathetic response to a stimulus. Vomiting is a protective reflex that can be mechanically stimulated by direct activation of the cranial nerves pharyngeal (IX) and vagus (X). These work in concert to coordinate the gag reflex (Denham & Gallagher, 2018).

There are multiple receptor sites within the brain specific to vomiting. These are found in two anatomical locations, the chemoreceptor trigger zone (CTZ) center and the medulla. Each can initiate a vomiting response (see Figure 1). The five senses—eyes, ears, touch (pain), taste, and smell—can trigger a vomiting response when a noxious stimulus is encountered (Denholm & Gallagher, 2018). The most common sensory trigger is vestibular (ear, cranial nerve VIII) as demonstrated by motion sickness. Additional triggers are ingestion of toxic materials into the gut, gastrointestinal obstruction, circulating toxins that cross the blood-brain barrier, and direct stimulation of the central nervous system by medications such as chemotherapy. The neurotransmitters used in the CTZ and medulla to initiate the vomiting process are muscarinic (M_1) part of the parasympathetic system, dopaminergic (D_2), histaminergic (H_1), serotonin, and neurokinin NK_1 (Denholm & Gallagher, 2018). Owing to the multiple pathways for triggering vomiting, it is difficult to have one medication that will block all receptor sites that elicit vomiting.

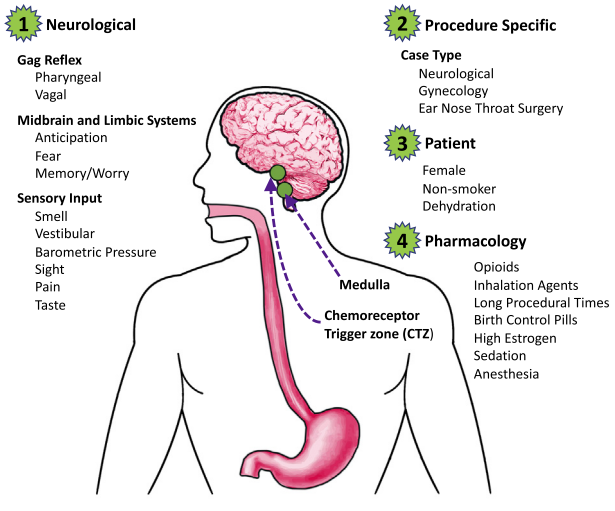

Figure 1. Factors that may elicit vomiting.

Risk Factors and Risk Assessment Tools

Risk factors can be grouped into three categories. The first are patient linked. Patient variables in adults that have the greatest impact are female gender, nonsmoker, dehydration, and history of motion sickness (Apfel et al., 1999). In pediatric patients, the variables include family history of PON, strabismus surgery, duration of anesthesia greater than 45 minutes, and use of postoperative opioids (Eberhart, et al., 2004). The second set of risk factors is dosage of the sedation agent, pain medications, especially use of opioids, and time of sedation or analgesia. The final variable is the procedure site. Gynecology organs, neurovascular, and oral and ENT surgeries and procedures possess the highest risk of associated nausea and vomiting. The most powerful predictors of this patient complaint have been placed in two different preoperative, easily incorporated, screening tools. Highest risk patients require treatment preprocedure to prevent PONV (American Society of PeriAnesthesia Nurses PONV/PDNV Strategic Work Team, 2006). Two of these tools are Apfel et al. (1999) risk assessment for adults and Eberhart et al. (2004) tool for pediatric assessment. These tools divide patients into low-, moderate-, and high-risk categories. Depending on risk level, the provider can initiate the decision tree for interventions incorporating single or multimodal therapies (Dewinter et al., 2018; Melloul et al.,2016; Nelson, et al., 2017).

Clinical Practice Guidelines—Decision Trees

Several organizations have published evidence-based guidelines. These guidelines are summarized in Table 1 with the associated references. There are no published radiology-specific guidelines the authors could discover in a comprehensive literature review specific to nausea and vomiting. However, these gastrointestinal complaints have been extensively studied by the surgical, anesthesia, and perianesthesia nursing disciplines. The common thread in all these guidelines is identification of those patients at highest risk (Gan, 2006). Once identified, these patients must receive early intravenous hydration and preemptive antiemetic dosing (Gan, et al., 2014; Munsterman & Strauss, 2018; Nelson, et al., 2019). High-risk patients should be identified by use of a standardized tool. An individualized plan of care should be carefully developed before sedation or analgesia. If a procedure within a particular service line has an increased risk of vomiting, such as gynecology procedures, like uterine fibroid embolization, a specific protocol for PONV prevention should be established. Aggressive intravenous hydration is a key aspect of PONV prevention protocols (Jewer et al., 2019). If rescue medications are indicated, then medications are recommended in a step-by-step multimodal approach (Gan et al., 2014). Each individual area of radiology must evaluate the baseline incidence of postprocedure nausea and vomiting. They must then develop an action plan to address the needs of the service line and of those patients at highest risk of nausea and vomiting.

There are several Cochrane Systematic Reviews relevant to PONV. These are summarized in Table 2 (Carlisle &Stevenson, 2017; Hines et al., 2018; Jewer, et al., 2019; Lee et al., 2015; Weibel, et al., 2017). They are key documents for radiology area stakeholders to review before development of protocols for care, pertinent to PONV prevention.

Table 1
Selected highlights of clinical practice guidelines

Clinical practice guideline	Professional society	Selected recommendations	Unique aspects	Last update
Clinical Practice Guideline for the prevention and/or management of PONV/PDNV (American Society of PeriAnesthesia Nurses PONV/PDNV Strategic Work Team, 2006)	American Association of PeriAnesthesia Nurses (ASPAN)	Stratify level of risk of PONV from history and prior surgical experience Use PONV prophylaxis with one to two interventions in adults at moderate risk	One of the first guidelines to encourage use of alternative techniques with pharmacology The decision trees are easy to follow and incorporate into the electronic medical record	2006
Consensus Guidelines for the Management of Postoperative Nausea and Vomiting (Gan et al., 2014)	Society for Ambulatory Anesthesia (SAMBA)	Reduce baseline risk factors for PONV by using adequate hydration, minimize interoperative and postoperative opioids use, propofol for induction, use regional anesthesia when feasible Use multimodal therapy for the patient with high risk for PONV Ensure treatment is implemented throughout ambulatory surgery area	More specific data to the care of pediatric patients An excellent diagram that illustrates the optimal treatment for the different levels of risk	2014
An Updated Report from the American Society Anesthesiologists on Postoperative Care (Apfelbaum et al., 2013)	American Society of Anesthesiologists Taskforce on Postoperative Care (ASA)	Provides a comprehensive review of six different medication classifications and the randomized control trials	Guidelines are comprehensive and address multiple anesthesia quality measures	2013
Enhanced Recovery after Surgery (Melloul,et al., 2016; Nelson,et al.,2017)	Enhanced Recovery after Surgery Society	There is an overall emphasis on short NPO times and stresses importance of intravenous hydration as prophylaxis	Recommendations are specific to different surgical case types and cover all aspects of perioperative care	2006–2019 Annual release of recommendations that are case specific

Hydration and Drugs for Nausea and Vomiting

The ERAS initiative emphasizes the importance of limiting the length of nothing by mouth (NPO) status and giving presurgical fluid boluses to optimize fluid balance (Nelson, et al., 2017). There is research supporting a decrease in PONV and hemodynamic complications after surgery using these interventions. ERAS clinical recommendations for multiple surgical case types report adequate hydration diminishes the incidence of PONV in gastrointestinal surgeries (Jewer, et al., 2019).

There are five primary medication classifications of antiemetics. The most commonly used and recommended classification for prophylaxis is a serotonin antagonist that works in the CTZ center. The two medications most commonly used in this classification are ondansetron and granisetron. This medication class provides optimal benefit when given preprocedure (Tateosian et al., 2018). If a patient is considered moderate or high risk, this medication is incorporated into the standard order set in many facilities. When someone is considered high or highest risk, a second pharmacological agent is used. The classification that is most commonly administered and recommended after procedure are dopamine antagonists such as promethazine or prochlorperazine (American Society of PeriAnesthesia Nurses PONV/PDNV Strategic Work Team, 2006). If a patient has a history of excessive PONV, it is vital to identify which drug classifications have been most effective in emetic rescue. A listing of drugs specific to antiemetic classifications is listed in Table 3.

Alternate Therapies: Aromatherapy and Acupressure

Alternate therapies are incorporated as PONV treatment strategies in some institutions. These treatments are often inexpensive and noninvasive (Hines, et al., 2018). They are often recommended as adjuncts, or in combination with traditional pharmacological therapies. There are few randomized controlled trials offering high-quality evidence for clinical adoption (Lee et al., 2015). In addition, patient satisfaction is often increased when alternative therapies are part of the treatment plan (Collins, 2013). Patients are often asked to discontinue their oral herbal supplements before surgery and procedures. This is due to possible drug interactions and potential impact on blood hemostasis during the surgery or procedure (Apfelbaum et al., 2013).

Table 2
Cochrane systematic reviews for protocol development

Title of cochrane systematic review	Plain language summary: key results
Supplemental Perioperative Intravenous Crystalloid for PONV Date published: 2019 (Jewer et al., 2019)	High probability that additional intravenous fluids diminish PONV.
Drugs for PONV after General Anesthesia Date published: 2017 (Weibel, et al., 2017)	Six tables were created to summarize the randomized control trials to specific medications. Levels of evidence were ranked according to the rigor of the study.
Aromatherapy and PONV Date published: 2018 (Hines et al., 2018)	Few adverse effects but research was not able to determine high efficacy of this intervention.
Stimulation of P_6 Point in PONV Date published: 2015 (Lee et al., 2015)	"Further high-quality research on combinations of PC6 acupoint stimulation and antiemetics are needed to reduce uncertainties about this effect on PONV. Overall, the side effects related to PC6 acupoint stimulation were minor, transient, and self-limiting (e.g., skin irritation, blistering, redness, and pain) in 14 studies. To prevent PONV, the effect of PC6 acupoint stimulation is comparable to antiemetics."[22]

Table 3
Selected pharmacological antiemetic agents

Generic name of antiemetic	Drug classification	Mechanism of action
Aprepitant*	Neurokinin-1 receptor blockers	Selective high-affinity antagonist of human substance P/neurokinin 1 (NK1) receptors.
Fosaprepitant*	Neurokinin-1 receptor blockers	Selective high-affinity antagonist of human substance P/neurokinin 1 (NK1) receptors.
Rolapitant*	Neurokinin-1 receptor blockers	Selective high-affinity antagonist of human substance P/neurokinin 1 (NK1) receptors.
Dexamethasone	Steroid	Interaction with the neurotransmitter serotonin, and receptor proteins tachykinin NK1 and NK2, alpha-adrenaline suppresses anticipatory nausea
Methylprednisolone	Steroid	Decreases the sensory tract in the medulla named the solitary nucleus
Dimenhydrinate	Antihistamine	Inhibits the H_1 receptors in the vestibular system
Meclizine HCl	Antihistamine	Inhibits the H_1 receptors in the vestibular system
Promethazine	Antihistamine	Inhibits the H_1 receptors in the vestibular system
Scopolamine	Anticholinergic agent	Competitive inhibitor of the parasympathetic nervous system
Dolasetron	5-hydroxytryptamine antagonists	Inhibits serotonin receptors. 5-HT3 receptors are located on the nerve terminals of the vagus in the periphery and centrally in the chemoreceptor trigger zone (CTZ) of the area postrema.
Granisetron	5-hydroxytryptamine antagonists	Inhibits serotonin receptors
Ondansetron	5-hydroxytryptamine antagonists	Inhibits serotonin receptors
Tropisetron	5-hydroxytryptamine antagonists	Inhibits serotonin receptors
Droperidol	Neuroleptic with sedative properties	Blocks dopamine receptors in the chemoreceptor trigger zone (CTZ)
Metoclopramide	Dopamine blocker in CNS	Antagonism of the D_2 receptors in the CTZ
All medication information obtained from Vallerand and Sanoski (2019). *Davis drug guide 16th edition*. Philadelphia, PA: F.A. Davis.	Prokinetic	

* These medications are FDA approved for chemotherapy-induced nausea and vomiting and may be helpful with PONV.

Aromatherapy advocates the use of essential oils with PONV to diminish sensations of nausea and reduce the incidence of vomiting. Aromas that have been studied are isopropyl alcohol, fennel, peppermint, and ginger (Hines, et al., 2018). The mechanism of action for how inhaled aromas impact PONV is related to intake of the scent. The olfactory system then connects to the limbic system, which is involved with emotion and memory. In addition, the olfactory sense has a feedback loop to the hypothalamus which has neural connections to the CTZ (Denholm & Gallagher, 2018). Laboratory testing of persons who inhale these oils finds no traces of the substance in blood work (Hines, et al., 2018).

The most researched herbal product for postoperative nausea and vomiting is ginger (Hines, et al., 2018). Ginger has historically been recommended in eastern medicine for nausea with pregnancy, migraine headache, and gastrointestinal (GI) complaints of diarrhea and dyspepsia (Lee & Shin, 2017). Ginger may be ingested, inhaled as an oil, or massaged into the skin. Most studies use the oral form of ginger which most anesthesiologists do not recommend before procedure (ASA, 2018; Soltani et al., 2018). Ginger's antiemetic properties act within the GI system to promote gastric tone and emptying (Asay et al., 2018). Ginger also decreases the release of serotonin associated with GI irritation (Lee & Shin, 2017). The level of evidence for the use of ginger as aromatherapy is found in small population studies leading to low generalizability (Stallings-Welden et al., 2018).

Nurses in the emergency department and the postanesthesia recovery areas report that using isopropyl alcohol aroma can abort a nausea and vomiting episode (Lindblad & Ting, 2018). However, the evidence is currently only supported by eight studies of moderate statistical power (Hines et al., 2018). The Cochrane review (2018) noted that rapid short-term relief and reduced need for rescue emetics was noted in several of the more robust studies. Aromatherapy is contraindicated in patients with sinus obstruction or loss of olfactory sense.

Acupressure

Acupressure on the P_6 pericardial channel is also an alternative therapy used with PONV either as a single intervention or as an adjunct to pharmacology (Oh & Kim, 2017). The anatomical point of the Nei Guan (P6) is found approximately three finger breadths below the wrist on the inner forearm between the two tendons. Acupressure can be accomplished invasively with needles and is called acupuncture. Acupressure can also be performed manually by the nurse or patient. There are also disposable acupuncture devices, as well as multiple use Velcro wristband devices that attach to the wrist at the P_6 channel (White, et al., 2012). These wristbands have great appeal to those who suffer from motion sickness and yet need to travel. Some patients will bring their wristbands to the hospital owing to their success with motion sickness as a single therapy. There has been no difference found in PONV outcomes between acupuncture and acupressure. The outcomes are comparable to treatment with the standard antiemetic regimen (Lee et al., 2015).

Case Study: Using Some Best Practices in Radiology

To illustrate some examples of best practices in radiology nursing, a case study is presented at the conclusion of this article. This case study is based on clinical experience. It is a story blended from multiple patients and is not linked to any one patient or case. No data have been extracted from an electronic medical record.

A 30-year-old female was referred to the radiologic clinic for uterine fibroid embolization. Over the last 5 years, the patient sought care repeatedly for abdominal fullness and girth, menorrhagia, pain, persistent fatigue, and lower pelvic pressure with urinary frequency. The patient's symptoms are worse during menses. She rates her pain 9/10 during menses and 4/10 the rest of the time. A conservative treatment course was followed, and the patient received hormonal medications and analgesics in addition to iron supplementation for anemia, which provided temporary resolution of the symptoms. Recently, her symptoms have intensified, and she reports syncopal episodes and dyspnea. Her baseline vital signs are as follows: BP 106/78, HR 105, RR 22, O_2 saturation 96% on room air. Patient weight was 78 kg. Labs: hemoglobin 8 g/dL, hematocrit 27%, platelets 150,000 mm^3, creatinine 0.9 mg/dL, BUN 14 mg/dL. ASA classification was 2 because of anemia and the

Mallampati score was 1. She took an oral dose of alprazolam 0.5 mg 1 hour before the MRI. The contrast-enhanced MRI was performed, and a diagnosis of uterine fibroids was confirmed. She experienced a profound sense of nausea after administration of contrast during the diagnostic MRI procedure and vomited after discharge home.

A preprocedural assessment was performed before the uterine fibroid embolization and documented in the procedural sedation patient record by the nurse and radiologist. The ASA classification and Mallampati score remained unchanged. A thorough review of the patient's medical and surgical history before the procedure was completed and included the patient profile, baseline observations, allergies, infectious status, preprocedural risk assessment, blood analysis results, including anticoagulant status. The patient denied any allergies, does not smoke or drink alcoholic beverages. She had remained NPO since midnight and was scheduled as a first case at 7 am. Her history was positive for PONV after laparoscopy 8 years ago and after a vaginal hysteroscopy 5 years ago. The Apfel simplified risk score was used to assess the patient's risk of developing PONV. According to Apfel's simplified risk scores, the patient has a moderate risk for PONV based on three risk factors: nonsmoking status, female gender, and a history of PONV.

Owing to moderate risk of PONV (two to three risk factors), recommended interventions called for a multimodal approach (ASA, 2018). Procedural sedation plan included an antiemetic, smaller doses of the opioids, and acupressure. The radiologist decided to administer ondansetron, a selective 5-HT3 antagonist at the beginning of the procedure for prophylaxis, and to perform acupressure via a device during the procedure. The rescue antiemetic chosen for standby was promethazine due to the patient's positive response in prior episodes of nausea and vomiting. Midazolam, propofol, and fentanyl were the procedural pharmacology agents to be used. Before the procedure, the nurse inserted a 20 G intravenous (IV) catheter into a large vein in the patient's arm and a urinary catheter into her bladder. An intravenous solution of 0.9% NaCl (normal saline) was started at the 175 ml/hour to promote hydration (Munsterman & Strauss, 2018). A prophylactic antibiotic was administered as well. Preprocedural ASA classification was 2 and the Mallampati score was 1.

Before initiating procedural sedation, the nurse connected the patient to the monitoring equipment. The patient's blood pressure, respirations, heart rate, heart rhythm, and end-tidal CO_2 were monitored, with baseline measurements recorded. A P_6 wrist compression device was placed on the right wrist. The nurse administered 4 mg of ondansetron in the patients IV 15 minutes before the procedure and before placing the patient on the radiology table. After positioning, skin prep, and draping, a timeout was called. The timeout process occurred with all team members participating. The patient was informed that the procedure was to begin and that medications would be administered for prevention of her discomfort, pain, nausea, and vomiting. Midazolam 2 mg IV was administered along with starting an infusion of propofol at a rate of 4 mcg/kg/minute. Fentanyl 25 mcg IV was administered before femoral sticks. Before accessing the groin, Ramsey sedation score was 3 and all cardiac and respiratory monitoring values maintained at 10% of baseline.

After infiltration of the area with lidocaine, the radiologist inserted the sheaths. Bilateral common femoral arteries were accessed with fluoroscopic guidance. Next, the flush catheter was advanced into the abdominal aorta and a pelvic angiogram was performed to identify the appropriate uterine artery and other arteries feeding the fibroids. After the appropriate uterine arteries were identified, the radiologist injected small polyvinyl alcohol particles (about the size of a grain of rice) into the uterine arteries to reduce the blood supply to the fibroids (de Bruijn, et al., 2016). Because of multiple areas of fibroid growth, case duration was four and one-and-half hours (Gupta et al., 2014). The midazolam, fentanyl, and propofol were titrated based on patient's vital signs, sedation level, and level of discomfort. Promethazine 12.5 mg IV was administered at the conclusion of the case due to the patient reporting nausea. Cardiac rhythm was normal sinus to sinus tachycardia. Her blood pressure range was 110–130 systolic and 60 to 70 diastolic. Her respirations and capnography readings remained within 35–45 mmHg with normal, square-shaped waveforms. In the postprocedural assessment, the client followed commands and responded appropriately to questions. She remained in postprocedure recovery for 2 hours without any episodes of PONV. She was discharged home after meeting the required Aldrete score, ability to void after catheter removal, and the vital sign discharge standing orders criteria. She asked to take the disposable wrist compression device with her so that she would not have motion sickness on the car ride home.

Conclusion

PONV prevention and quick rescue is an essential concern when procedural sedation is used. Pinpointing optimal intervention requires conversation between patient and providers at multiple points in the procedural processes. This article provides background regarding where to find the tools, and evidence-based resources for nurses to positively impact patient care when procedural sedation is used. Radiology nurses could spearhead the development of protocols and standing order sets that may lead to PONV reduction. Nurses, collaborating with their interventional team, are uniquely suited to bring needed changes in patient care, relevant to PONV.

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