Chapter 21

Nausea, Vomiting, and Upper Gastrointestinal Tract Motility Disorders

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KEY TERMS AND DEFINITIONS

Antiemetic—a preparation or medication that relieves nausea and vomiting.

Chemoreceptor trigger zone (CTZ)—the neural center for emesis, located in the brain.

Emesis—the medical term for vomiting.

Gastroparesis—condition that delays or stops stomach emptying, resulting in nausea, vomiting, bloating, discomfort, and weight loss. Usually the result of nerve damage, but may also be related to other medical conditions.

Motion sickness—the uncomfortable dizziness, nausea, and vomiting that people experience when their sense of balance and equilibrium is disturbed by constant motion.

Nausea—the feeling of needing to vomit.

Vestibular—related to the structures of the ear, which are linked to the maintenance of balance and perception of spatial positioning.

Vomiting—the forcible ejection of the contents of the stomach through the mouth (also called emesis).

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LEARNING OBJECTIVES

After completing this chapter, you should be able to

1. Define the following:
   - Antiemetic
   - Chemoreceptor trigger zone
   - Emesis
   - Gastroparesis
   - Motion sickness
   - Nausea
   - Vestibular
   - Vomiting
2. Identify the causes and risk factors for developing nausea/vomiting and gastroparesis.
3. List the most common signs and symptoms of nausea/vomiting and gastroparesis.
4. Describe nonpharmacologic therapies for nausea and vomiting.
5. Explain the pharmacotherapeutic effects of antacids, histamine$_2$-receptor antagonists, anticholinergics, antihistamines, dopamine antagonists, cannabinoids, corticosteroids, benzodiazepines, serotonin antagonists, and neurokinin$_1$-receptor antagonists and list their most common side effects and major drug interactions.
6. State the brand and generic names of the most widely used antiemetic and promotility medications, along with their routes of administration, dosage forms, and available doses.
7. Recognize common regimens for the treatment of nausea, vomiting, and gastroparesis.

Nausea and vomiting (N/V) usually present in a fairly straightforward manner. **Nausea** is defined as the feeling of needing to vomit, while **vomiting** is defined as the ejection of gastric contents. While the definitions of N/V are simple, the conditions have a variety of causes. Nausea and vomiting can be self-limiting or they can signal a more complex medical problem. This chapter will focus on the treatment of N/V, including both nonpharmacological and pharmacological therapies.

NAUSEA, VOMITING, AND GASTROPARESIS

Pathophysiology

The process of **emesis** can be divided into three stages: nausea, retching, and vomiting. Nausea is the feeling of needing to vomit. It can be accompanied by pallor (paleness), tachycardia (increased heart rate), sweating, and salivation. Retching is the labored movement of the chest and abdominal muscles that occurs before vomiting. Vomiting is the forceful ejection of the gastric contents through the mouth. Regurgitation is a more passive process, where the stomach contents move up the gastrointestinal (GI) tract into the mouth.[1]

Nausea and vomiting (N/V) are triggered by impulses sent from the vomiting center in the medulla of the brain. The vomiting center can be stimulated by impulses sent from the cerebral cortex, **vestibular** system (considered later in this chapter), the **chemoreceptor trigger zone (CTZ)**, or from the GI tract or pharynx. Neuroreceptor transmitters are located in the vomiting center. They include cholinergic, histaminic, dopaminergic, opiate, serotonin, neurokinin, and benzodiazepine receptors. Stimulation of these receptors can lead to emesis. Therefore, medications that block these receptors are helpful in the treatment of N/V.

CASE STUDY

Mr. Bill Jones, a regular customer, comes into the pharmacy and says that he has been experiencing some N/V since early this morning. He called his doctor's office and was told to try to manage his symptoms with over-the-counter (OTC) products. If the N/V do not resolve by tomorrow, the doctor would like to see him.

Causes of Nausea and Vomiting

There can be many different causes of N/V. GI diseases, as well as other types of disorders (including cardiovascular, infectious, neurologic, or metabolic diseases), can cause N/V. Certain medications (particularly medications associated with the treatment of cancer), as well as conditions

TABLE 21-1. Causes of Nausea and Vomiting[1,2]

Gastrointestinal	Neurologic	Therapy-Induced
Obstruction disorders	Vestibular disorders	Chemotherapy
Constipation	Migraines	Antibiotic
Gastroparesis	Increased intracranial pressure	Radiation therapy
Nonulcer dyspepsia	Depression	Opiates
Irritable bowel syndrome	Psychiatric illness	Oral contraceptives
Pancreatitis	Anticipatory	Digoxin
Peptic ulcer disease	Bulimia and anorexia nervosa	Operative procedures
Gastroenteritis		Oral hypoglycemics
Cardiac		**Endocrine/Metabolic**
Acute myocardial infarction		Pregnancy
Congestive heart failure		Renal disease
		Diabetes

such as pregnancy, postoperative states, **motion sickness**, and motility disorders, can also cause N/V. See **Table 21-1** for a more complete list of causes of N/V.

Clinical Presentation

Patients may present with mild or more severe symptoms. Simple N/V are usually mild and self-limiting and only require symptom management. Complex N/V can be more severe and not easily relieved with **antiemetic** medications. Complex N/V tend to be caused by more difficult-to-manage disease states (for example, chemotherapy or diabetic **gastroparesis**). These patients may become dehydrated and develop electrolyte imbalances and weight loss.

TREATMENT

The desired treatment outcome for all patients is the relief of N/V and prevention of any more serious adverse effects, such as dehydration, malnourishment, and electrolyte imbalances. Treatment can consist of nonpharmacological therapy and/or pharmacological therapy.

Nonpharmacological Therapy

Nonpharmacological therapy can include dietary measures, acupuncture, or acupressure, as well as relaxation and self-hypnosis techniques. Dietary approaches to N/V are frequently recommended for pregnant patients. These include eating frequent, small meals, avoiding spicy or fatty foods, eating crackers before arising in the morning, taking small sips of carbonated beverages or fruit juices when nauseated, and eating high-protein snacks. Acupressure and acupuncture are based on the theory that bodily functions are controlled by certain points on the body, and the P6 (neiguan or pericardium) point is used by acupuncturists to treat N/V. This is the same point stimulated by acupressure wristbands, which have been used with nausea and vomiting of pregnancy (NVP), postoperative nausea and vomiting (PONV), and motion sickness.[1,2]

Nonpharmacological therapy can be used with or without pharmacological treatment to avoid or reduce unwanted adverse effects from the medications used in the treatment of N/V. Patients who are pregnant may not wish to use medications due to concerns about possible teratogenic effects (related to or causing malformation of the embryo or fetus).

CASE?

What are some nonpharmacological methods that can be recommended for Mr. Jones's N/V?

Pharmacologic Therapy

A variety of prescription and OTC medications are used to treat N/V, and many classes of medications can be used as antiemetics. The causes, frequency, and severity of the

patient's N/V help to determine which medication and route of administration is most appropriate for an individual. (See **Medication Table 21-1**; Medication Tables are located at the end of the chapter).

Antacids

Antacids work locally in the stomach to neutralize gastric acid. They are available without a prescription, so they are often used as a first-line therapy for acute or occasional N/V. They are especially effective for N/V associated with heartburn. Magnesium hydroxide, aluminum hydroxide, and calcium carbonate are the most common antacid ingredients. Side effects associated with infrequent use of these preparations are mild and tend to be limited to diarrhea with magnesium products and constipation with aluminum or calcium products.

Histamine$_2$-receptor antagonists

Like antacids, histamine$_2$ (H_2)-receptor antagonists also act locally in the stomach to reduce the amount of acid secreted from gastric parietal cells. These products (ranitidine, famotidine, cimetidine, nizatidine) are all also available without a prescription. They are effective for N/V associated with heartburn or gastroesophageal reflux disease (GERD). These products are typically safe for occasional use. As noted in Chapter 20, however, cimetidine has quite a few drug interactions and would not be a good first choice for a patient already taking multiple medications.

In April 2020, the U.S. Food and Drug Administration (FDA) asked all manufacturers of ranitidine to remove products containing it from public shelves. In its investigation leading to the removal, the FDA found the contaminant *N*-nitrosodimethylamine (NDMA) in certain lots and discovered it may accumulate when stored improperly. Currently, ranitidine is not available in prescription or over-the-counter formulations in the United States. Following that action, voluntary recalls of certain lots of nizatidine have occurred as well. As of this writing, there is no evidence of trace NDMA in famotidine or cimetidine.[3,4]

Anticholinergics

Scopolamine is a commonly used anticholinergic for motion sickness. It blocks muscarinic receptors (see Chapter 4) found in the vomiting center and vestibular system and prevents N/V associated with motion sickness. It is available as a transdermal patch that can be applied and left on for up to 72 hours. This makes it an effective treatment for patients who cannot take oral medications or patients who need constant therapy (for example, patients traveling on cruise ships). Adverse effects seen with anticholinergic medications include dry mouth, drowsiness, blurred vision, and urinary retention.

Antihistamines

Medications that block histamine (H_1) receptors in the vestibular center are called antihistamines. These medications act similarly to anticholinergic medications and are effective for the treatment and prevention of motion sickness and vertigo (the sensation of rotation of oneself or one's surroundings while actually still). There are quite a few antihistamines and many are available OTC, which makes it easy for patients to self-treat. Dimenhydrinate, diphenhydramine, and meclizine are available without a prescription, while hydroxyzine requires a prescription. Adverse effects for this class of medications are very similar to those of the anticholinergic medications and include dry mouth, drowsiness, blurred vision, and urinary retention.

CASE?

What classes of medications are available OTC that Mr. Jones could try to help relieve his N/V?

PRACTICE POINT

Meclizine is available both OTC and Rx. It tends to cause less drowsiness than dimenhydrinate or diphenhydramine for most patients. The OTC products include Bonine and Travel-Ease.

Dopamine Antagonists

Phenothiazines are often used in the treatment of N/V. They block the dopaminergic receptors in the CTZ, causing a decrease in N/V. Available products include promethazine, prochlorperazine, and chlorpromazine (a medication discussed in Chapter 7 as an antipsychotic). They are available as oral tablets and liquids, rectal suppositories, and injections. This makes them convenient to use in a variety of patients and situations. They are available as generic products and are relatively inexpensive. Phenothiazines can be used for motion sickness, vertigo, gastritis, NVP, PONV, and chemotherapy-induced nausea and vomiting (CINV). Side effects seen with this class of medications include sedation,

orthostatic hypotension, and extrapyramidal symptoms. (Extrapyramidal symptom effects are involuntary movement disorders that can be permanent.)

ALERT!

LOOK-ALIKE/SOUND-ALIKE—Hydroxyzine (an antihistamine) can be easily confused with hydralazine, which is used for the treatment of high blood pressure.

PRACTICE POINT

Promethazine gel can be compounded for application to the skin as a transdermal preparation.[5] This dosage form can be used when patients are unable to take oral medications and do not wish to use a suppository.

CASE?

Mr. Jones returns to the pharmacy the next day. His doctor has given him a prescription for promethazine. The prescription says "promethazine 25 mg one every 4–6 hours as needed." What is wrong with this prescription?

Benzamides

Metoclopramide and trimethobenzamide are considered benzamides. They block the dopamine receptors in the CTZ and act in the GI tract, where they promote gastric motility. Metoclopramide is available in solid and liquid oral dosage forms, as well as an injection. It has been used for the treatment of gastroparesis (discussed extensively later in this chapter) since it stimulates the movement of food through the gut. It is also useful in the treatment of PONV and CINV. Metoclopramide has a black-box warning for having the possibility to cause tardive dyskinesia, which is an often-irreversible movement disorder, and should not be used for more than 12 weeks. Side effects include drowsiness, fatigue, dystonic reactions, and diarrhea.[6] Trimethobenzamide is available as a capsule and an injection. It can be used for simple N/V and PONV. Its side effects are also drowsiness and fatigue.

ALERT!

All patients receiving metoclopramide must be provided a medication guide with their prescriptions.

Butyrophenones

Butyrophenones include haloperidol (also used as an antipsychotic and discussed in Chapter 7) and droperidol. They block dopamine in the CTZ to decrease N/V. They are not used very frequently in the treatment of N/V. Droperidol has a black box warning stating that it can cause life-threatening arrhythmias in certain patients. Besides arrhythmias, these medications can cause sedation, agitation, restlessness, and extrapyramidal symptoms as well.

Cannabinoid

Dronabinol is a drug used to prevent and treat refractory CINV. It is available as oral formulations, and its exact mechanism of action is unknown. Some of the common adverse effects seen when using cannabinoids are drowsiness, euphoria, hypotension, ataxia, impaired vision, and dizziness.

PRACTICE POINT

The cannabinoids used to treat N/V are synthetic products but are chemically related to the principal active ingredient in marijuana. They are, thus, controlled substances and must be handled according to the regulations of the Drug Enforcement Agency and the State Board of Pharmacy.

Corticosteroids

Corticosteroids (discussed extensively in Chapter 9) can be used alone or in combination with other products to treat N/V, and are especially useful for CINV or radiation-induced N/V. The most commonly used corticosteroid for these indications is dexamethasone. It can be given orally or intravenously, and adverse effects (diabetes, cataracts, reduction in bone mineral density) typically seen with long-term use are not usually encountered with short-term treatment of

N/V. Some adverse effects that may be seen with short-term use are GI upset, insomnia, increased energy, and hyperglycemia (increased blood sugar). Corticosteroids are thought to reduce or prevent N/V by releasing serotonin, decreasing the permeability of the blood–brain-barrier, and reducing inflammation.[1]

Benzodiazepines

Lorazepam, discussed in Chapter 7, is often used to prevent and treat CINV. It is thought to be effective by preventing messages from the cerebral cortex and limbic system from reaching the vomiting center in the brainstem. Common side effects seen when using lorazepam are sedation and amnesia, although patients receiving it should also be monitored for respiratory depression.

Serotonin Antagonists

Chemotherapeutic and anesthetic agents cause the release of serotonin from cells in the intestinal mucosa, which can trigger N/V by stimulating the visceral vagal nerve fibers and the CTZ, where there is an abundance of serotonin receptors known as 5-hydroxytryptamine$_3$ (5-HT$_3$) receptors. Selective 5-hydroxytryptamine (5-HT, serotonin) antagonists are used in the prevention and treatment of CINV and PONV, and they work by blocking the 5-HT$_3$ receptors. The 5-HT$_3$ receptor antagonists include dolasetron, granisetron, ondansetron, and palonosetron, and they are available in both oral and injectable dosage forms. These agents are generally very well tolerated; however, some adverse effects that may be seen include headache, GI upset, asthenia, dizziness, and somnolence. It is important to note that these agents can also cause asymptomatic electrocardiograph changes, which reflect alterations in cardiac rhythms, and proper precautionary measures should be taken.

CASE?

Mr. Jones comes back to your pharmacy several months later. He has been diagnosed with colon cancer and will have a course of chemotherapy. His doctor told him this type of chemotherapy would make him very nauseated. The doctor gave Mr. Jones a prescription for ondansetron. Mr. Jones puts the prescription on hold but doesn't want to fill it until he sees how the chemo makes him feel. Should Mr. Jones have his prescription for ondansetron filled before he takes the first dose of chemo or wait until later? Why?

PRACTICE POINT

Some oral serotonin antagonists (especially ondansetron) are sometimes prescribed for severe or refractory NVP as an off-label use.

Neurokinin$_1$-Receptor Antagonists

Neurokinin$_1$ (NK$_1$) receptors are involved in CINV due to their presence in the GI tract and CTZ. Aprepitant was the first NK$_1$-receptor antagonist and is effective in the prevention of acute and delayed CINV. It is available as an oral capsule, suspension, and as an intravenous (IV) preparation and is used in combination with a 5-HT$_3$ antagonist and a corticosteroid. Rolapitant is another NK$_1$-receptor antagonist available in the United States as an oral tablet and is also used in combination with serotonin antagonists. Possible adverse effects seen with neurokinin$_1$-receptor antagonist use include fatigue, neutropenia (reduced white blood count), and hiccups.

PRACTICE POINT

While both the oral and IV forms of aprepitant have the same brand name (Emend), the IV form has a different generic name, fosaprepitant dimeglumine. Fosaprepitant dimeglumine is converted in the body to aprepitant.

ALERT!

Pharmacy technicians preparing fosaprepitant dimeglumine for IV infusion must take special care to read the included directions for mixing, as it is incompatible with many common solutions and requires gentle handling (no shaking).

Over-the-Counter Therapy

OTC therapies can be used as a first-line therapy by patients seeking reprieve from their N/V symptoms. They may also be very useful for patients who cannot be seen by a physician immediately but want to try a pharmacologic agent for their

ailments. While OTC medications are often the first choice for many patients with these symptoms, some patients should not be treated with them and must be referred to their primary care provider or an emergency department for further evaluation. These patients include those with severe right upper quadrant pain (just below the ribs); N/V with fever or diarrhea; severe abdominal pain in the middle or right lower quadrant; patients with a diagnosis of glaucoma, benign prostatic hypertrophy, chronic bronchitis, emphysema, or asthma; patients who are pregnant or breastfeeding; or patients with blood in their vomitus.[2]

There are many different agents available OTC for N/V symptoms. Antacids, anticholinergics, and antihistamines are drug classes used for N/V and all have products that are available OTC. Please see earlier sections for further discussion of these drug classes.

Bismuth Products

Bismuth subsalicylate is available without a prescription and is used to treat N/V associated with overindulgence in food and drink. It is also used to treat indigestion, heartburn, and gas complaints and may cause fecal discoloration (grayish black). It is available as a liquid, chewable tablet, or caplet. Products with bismuth subsalicylate are recommended only for adults.

Phosphorated Carbohydrate Solution

Phosphorated carbohydrate solution is available OTC and contains fructose, dextrose, and phosphoric acid. The solution is used in patients with nausea associated with intestinal influenza and also for food or drink indiscretions. This solution acts to relieve N/V by decreasing smooth muscle contraction in the GI tract and also by delaying gastric emptying. Due to the high sugar content of this preparation, patients should be counseled to avoid this product if they have diabetes. Also, if the patient's symptoms do not improve after the maximum stated dose or time, the patient should be referred for further evaluation.[2]

ALERT!

Administering acetylsalicylic acid or salicylates to children or teenagers who have a viral illness like the flu or chickenpox can cause a rare but serious illness called Reye's syndrome. Because viral illness is so hard to identify, especially in its early stages, children (especially children with fever) should never be given salicylate-containing medications. Salicylates include products such as Pepto-Bismol and Kaopectate, as well as aspirin.

Complementary Therapies

Pyridoxine (vitamin B_6) is available without a prescription and is often used in NVP. It is water soluble and has been used successfully since the 1940s. The exact mechanism of action is unknown. While side effects are rare, as the dose of pyridoxine increases, so does the risk of peripheral sensory neuropathic disturbances. Inhibited prolactin secretion has also been noted at extremely high doses.

Pyridoxine has also been used in combination with doxylamine. While the two drugs were originally in a combination product together, due to the possibility of teratogenicity, the combined drug was pulled from shelves in 1983. It is important to understand that no evidence of teratogenicity has been found. Both products are available OTC and are recommended by many obstetricians for their pregnant patients with NVP.

Ginger (*Zingiber officinale*), which does not cause central nervous system depression like other OTC medications, has been used to relieve NVP, PONV, and motion sickness. It is thought that ginger works directly at the digestive tract to reduce nausea. Two other natural products are also commonly used in the United States. Chamomile (*Matricaria recutita*) and peppermint oil (*Mentha piperita*) are both thought to have antispasmodic properties. Both are labeled GRAS (Generally Recognized as Safe by the FDA) in the United States.[7,8]

CHEMOTHERAPY-INDUCED NAUSEA AND VOMITING

CINV can be divided into three categories: acute, delayed, and anticipatory. Acute CINV occurs within 24 hours after receiving chemotherapy, while delayed CINV occurs more than 24 hours after the therapy. Anticipatory N/V happens before the chemotherapy dose in some patients who have experienced acute or delayed N/V previously. Risk factors for an increased chance of CINV include previous experience of CINV, female gender, low chronic alcohol ingestion, younger age, history of motion sickness, or nausea and vomiting during pregnancy.[1] Chemotherapeutic agents are classified according to their emetogenicity (tendency to induce vomiting). Knowing which agent is to be used and which category (lowest, low, moderate, high, or highest) it is in is the most important factor considered by clinicians when choosing an agent to prevent CINV.[1,2]

POSTOPERATIVE NAUSEA AND VOMITING

While not all patients experience N/V following surgical procedures, it can be very uncomfortable for those who do. It can also require that the patient be admitted to the hospital or prolong a hospital stay. Those patients who may experience PONV can be identified through risk factors that have already been established. History of PONV or motion sickness, female gender, nonsmoker, use of volatile anesthetics (halothane, enflurane, isoflurane, sevoflurane, and desflurane), use of opioids for pain control, and duration and type of surgery may all increase the risk of PONV to the patient. Clinicians try to decrease or eliminate as many risk factors as possible for their patients.

Several different drugs have been identified to help prevent PONV. Droperidol or a serotonin antagonist is effective in many high-risk patients. Other drugs that may be used include dexamethasone (given prior to undergoing anesthesia), anticholinergics, or antihistamines. Combinations of drugs may also be needed to achieve the best result.[1]

NAUSEA AND VOMITING OF PREGNANCY

Any woman of childbearing age who presents with N/V should be evaluated for pregnancy because pregnancy is the most common endocrinologic cause of N/V.[7] A majority of pregnant women will experience nausea and/or vomiting at some point during the pregnancy, most notably during the first trimester. When choosing a therapeutic agent for this population, teratogenic potential should be of primary concern. Nonpharmacologic alternatives, such as behavioral, dietary, and physical modifications, should be considered before pharmacologic therapy is initiated. Drugs that have been used and are considered to be safe during pregnancy include pyridoxine, doxylamine, promethazine, metoclopramide, and trimethobenzamide. Risks versus benefits must be weighed in all situations.

MOTION SICKNESS AND VESTIBULAR DISTURBANCES

Disorders of the vestibular system in the inner ear can be the cause of N/V in some patients. Infection, injury, neoplasm, and motion can all cause vestibular disturbances, which in turn, can result in dizziness, vertigo, and N/V. Some patients may experience motion sickness while riding in cars, trains, or boats. In patients who know that they are susceptible to this ill feeling, precautionary measures should be taken to minimize or avoid the exposure if possible, ensure adequate ventilation, and try to take part in distracting activities. It is recommended that patients take medication to control the N/V before it occurs to allow for adequate absorption of the oral therapy. Anticholinergics and antihistamines are usually the drugs of choice. However, if vomiting has already ensued and absorption of the oral medication is unpredictable, a scopolamine patch may be the best therapy.

MOTILITY DISORDERS

Gastroparesis, or delayed gastric emptying, can present in some patients as nausea, vomiting, bloating, constipation, or diarrhea. It is commonly seen in poorly controlled diabetic patients who have autonomic neuropathy. Under normal circumstances, the muscles in the stomach force food through the digestive tract. However, in patients with gastroparesis, those muscles do not function appropriately and food is not pushed through the stomach into the intestines properly.

Fortunately for sufferers of gastroparesis, there are drugs, termed promotility agents, available to help this condition by speeding the clearance of food and acid from the esophagus and stomach. Metoclopramide is effective for this disorder, but it also has side effects that may be intolerable to some patients (see the earlier discussion of dopamine antagonists) and it should not be used long term. Erythromycin, an antibiotic, has actions on receptors in the stomach to increase motility. Patients may develop a tolerance to this medication and would then need to be switched to a different agent. Also, erythromycin has several drug interactions, which must all be considered when the drug is prescribed or dispensed. The lower GI tract is also subject to motility disorders. These are covered in Chapter 22.

SUMMARY

There are many classes of medication that can be used to treat nausea and vomiting (N/V). It is important to first determine the cause of a patient's N/V before treatment is recommended or prescribed. Patients who are pregnant may wish to try nonpharmacological measures first. Patients who are experiencing simple N/V from gastritis or another self-limiting illness will probably benefit from nonpharmacological or over-the-counter (OTC) products initially. Patients who

are traveling and have problems with motion sickness have both OTC products, such as diphenhydramine and meclizine, and prescription options, such as scopolamine patches, available. There are also many options for patients with more severe causes of N/V, such as chemotherapy-induced nausea and vomiting (CINV) or postoperative nausea and vomiting (PONV). These patients will need a prescription product. The medication selected should be chosen based on patient-specific characteristics. It is often necessary to try several options before finding one that works best for each patient.

REFERENCES

1. Wilhem S, Lepari M. Nausea and vomiting. In: Chisholm-Burns MA, Wells BG, Schwinghammer TL, et al., eds. *Pharmacotherapy: Principles and Practice*. New York, NY: McGraw-Hill; 2019:329-338.
2. Welch AC. In: Krinsky DL, Ferreri SP, Hemstreet B, et al., eds. *Handbook of Nonprescription Drugs: An Interactive Approach to Self-Care*. 19th ed. Washington, DC: American Pharmacists Association; 2017:335-354.
3. Questions and answers: NDMA impurities in ranitidine (commonly known as Zantac). Food and Drug Administration Website. https://www.fda.gov/drugs/drug-safety-and-availability/questions-and-answers-ndma-impurities-ranitidine-commonly-known-zantac. Accessed January 27, 2020.
4. FDA requests removal of all ranitidine products (Zantac) from the market [news release]. Washington, DC: U.S. Food and Drug Administration; April 1, 2020. https://www.fda.gov/news-events/press-announcements/fda-requests-removal-all-ranitidine-products-zantac-market. Accessed April 15, 2021.
5. Loyd VA Jr. Promethazine HCl 50 mg/mL in PLO gel. *Int J Pharm Compound*. 2001;5(1):51.
6. Lexicomp®. Hudson, OH: Wolters Kluwer Clinical Drug Information; 2021. http://online.lexi.com. Accessed April 15, 2021.
7. Murphy PA. Alternative therapies for nausea and vomiting of pregnancy. *Obstet Gynecol*. 1998;91:149-155.
8. Niebyl JR, Goodwin TM. Overview of nausea and vomiting in pregnancy with an emphasis on vitamins and ginger. *Am J Obstet Gynecol*. 2002:S253-S255.

REVIEW QUESTIONS

1. Discuss nonpharmacological therapies for nausea and vomiting and which patients can most benefit from this type of therapy.
2. List and discuss treatment options for patients who suffer from nausea associated with motion sickness.
3. What is the best way to manage motion sickness and vestibular disturbances?
4. What is PONV, who is at risk of experiencing it, and how can it be managed?
5. Discuss the development and treatment of gastroparesis.

MEDICATION TABLE

MEDICATION TABLE 21-1. Pharmacologic Treatment of Nausea and Vomiting[6,a]

CLASS Generic Name (pronunciation)	Brand Name	Route	Forms	Dose	Rx/OTC
Antacids (also see Chapter 20 Medication Tables)					
Magnesium hydroxide (mag NEE zhum) (hye DROX ide)	Various products	Oral	Liquid	5–15 mL up to 4 times/day as needed	OTC
Aluminum hydroxide (a LOO mi num) (hye DROX ide)	Various products	Oral	Liquid	10 mL 5–6 times daily after meals and at bedtime as needed	OTC
Calcium carbonate (KAL see um) (KAR bon ate)	Various products	Oral	Tablet, liquid	1–4 tablets as symptoms occur; 10–15 mL q 2–4 hr as needed	OTC
H_2-Receptor Antagonists (also see Chapter 20 Medication Tables)					
Cimetidine (sye MET i deen)	Tagamet HB	Oral	Tablet, liquid	200 mg up to twice daily as needed	OTC
Famotidine (fa MOE ti deen)	Pepcid AC	Oral	Tablet, liquid	10–20 mg up to twice daily as needed taken 10–60 min before meals	OTC
Nizatidine (ni ZA ti deen)	Axid AR	Oral	Tablet, solution	150 mg up to twice daily as needed	OTC
Proton Pump Inhibitors (also see Chapter 20 Medication Tables)					
Dexlansoprazole (dex lan SOE pra zole)	Dexilant	Oral	Tablet	30 mg once daily	Rx
Esomeprazole (es oh ME pray zol)	Nexium	Oral	Tablet	20 mg once daily as needed	OTC
Lansoprazole (lan SOE pra zole)	Prevacid	Oral	Tablet	15 or 30 mg once daily as needed	OTC
Omeprazole (oh ME pray zol)	Prilosec	Oral	Tablet	20 mg once daily as needed	OTC
Pantoprazole (pan TOE pra zole)	Protonix	Oral	Tablet	20–40 mg once daily as needed	Rx
Rabeprazole (ra BE pray zole)	AcipHex	Oral	Tablet	20 mg once daily as needed	Rx
Anticholinergics					
Scopolamine (skoe POL a meen)	Transderm Scop	Transdermal	Patch	1 mg q 72 hr as needed	Rx
Antihistamines					
Dimenhydrinate (dye men HYE dri nate)	Dramamine	Oral, IV, IM	Tablet, injection	Oral: 50–100 mg q 4–6 hr as needed; IM, IV: 50 mg q 4 hrs	OTC

Continued next page

MEDICATION TABLE 21-1. Pharmacologic Treatment of Nausea and Vomiting[6,a] *(Continued)*

CLASS Generic Name (pronunciation)	Brand Name	Route	Forms	Dose	Rx/OTC
Diphenhydramine (dye fen HYE dra meen)	Benadryl	Oral, IV, IM	Tablet, capsule, liquid, injection	Oral: 25 mg q 4–6 hr or 50 mg q 6–8 hr as needed; IM, IV: 10–50 mg q 6 hr as needed	OTC
Hydroxyzine (hye DROX i zeen)	Vistaril	Oral	Tablet, liquid	25–50 mg q 6 hr as needed	Rx
Meclizine (MEK li zeen)	Bonine, Antivert, Dramamine Less Drowsy	Oral	Tablet	25–50 mg 1 hr before travel or 25–100 mg daily in divided doses	OTC
Phenothiazines					
Chlorpromazine (klor PROE ma zeen)	Thorazine	Oral, IV, IM	Tablet, injection	Oral: 10–25 mg q 4–8 hr as needed; IM, IV: 10–25 mg q 3–4 hr as needed	Rx
Prochlorperazine (proe klor PER a zeen)	Compazine, Compro	Oral, rectal, IV, IM	Tablet, suppository, injection	Oral: 5–10 mg 3–4 times daily as needed; rectal: 25 mg twice daily as needed; IM: 5–10 mg q 3–4 hr as needed; IV: 2.5–10 mg q 3–4 hr as needed	Rx
Promethazine (proe METH a zeen)	Phenergan	Oral, rectal, trans-dermal, IV, IM	Tablet, liquid, suppository, injection	12.5–25 mg q 4–6 hr as needed	Rx
Butyrophenones					
Droperidol (droe PER i dole)	Inapsine	IV, IM	Injection	0.625–1.5 mg after surgery	Rx
Haloperidol (ha loe PER i dole)	Haldol	Oral, IM, IV	Tablet, injection	0.5–1 mg q 6 hrs as needed for CINV; 0.5–2 mg as a single dose at end of surgery for PONV	Rx
Benzamides					
Metoclopramide (met oh KLOE pra mide)	Reglan	Oral, IM, IV	Tablet, liquid, injection	N/V: IV or oral; IV, 10 or 20 mg as a single dose; oral, 10 mg as a single dose and may repeat after 4–6 hr if needed CINV: oral 10 mg before chemotherapy or 10 mg q 6 hr as needed; can also be used 10–20 mg four times/day on post-chemotherapy days 2–4 and can be given in combination with dexamethasone; delayed CINV: 0.5 mg/kg or 20 mg q 6 hr as needed, 2–4 days	Rx

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MEDICATION TABLE 21-1. Pharmacologic Treatment of Nausea and Vomiting[6,a] *(Continued)*

CLASS Generic Name (pronunciation)	Brand Name	Route	Forms	Dose	Rx/OTC
Trimethobenzamide (trye meth oh BEN za mide)	Tigan	Oral, IM	Capsule, injection	Oral: 300 mg 3–4 times daily; IM: 200 mg 3–4 times daily	Rx
Corticosteroids					
Dexamethasone (dex a METH a sone)	Decadron	Oral, IM, IV	Tablet, injection	Can be given with NK_1-receptor antagonist and serotonin-receptor antagonist with or without olanzapine; 10 mg prior to chemotherapy; 12 or 20 mg oral or IV, depending on specific NK_1 antagonist used; on post-chemotherapy days, can be given 8 mg once or twice daily on days 2–4, depending on which agents dexamethasone was administered with	Rx
Cannabinoids					
Dronabinol (droe NAB i nol)	Marinol, Syndros	Oral	Capsule	Capsule: 5 mg/m^2 before chemotherapy, then q 2–4 hr as needed for a total of 4–6 doses/day; increase dose in increments of 2.1 mg/m^2 based on response (max 12.6 mg/m^2 dose); solution: 4.2 mg/m^2 then q 2–4 hr as needed for a total of 4–6 doses/day; increase dose in increments of 2.1 mg/m^2 based on response (max 15 mg/m^2 dose)	Rx-CIII
Benzodiazepines					
Lorazepam (lor A ze pam)	Ativan	Oral, IV	Tablet, injection	0.5–2 mg q 4–6 hr as needed	Rx-CIV
Serotonin Antagonists					
Dolasetron (dol A se tron)	Anzemet	Oral, IV	Tablet, injection	100 mg orally within 2 hr before chemotherapy; may be used with dexamethasone, an NK_1-receptor antagonist, and olanzapine	Rx

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MEDICATION TABLE 21-1. Pharmacologic Treatment of Nausea and Vomiting[6,a] *(Continued)*

CLASS Generic Name (pronunciation)	Brand Name	Route	Forms	Dose	Rx/OTC
Granisetron (gra NI se tron)	Sancuso, Sustol	IV, oral, transdermal	Injection, tablet, oral liquid, transdermal patch	IV: 10 mg within 30 min before chemotherapy; PO: 1 mg twice daily or 2 mg daily 1 hr before chemotherapy; SUBQ: 10 mg 30 min prior to chemotherapy in combination with dexamethasone or an NK_1-receptor antagonist; transdermal: apply 24–48 hr before chemotherapy; remove no sooner than 24 hr after chemotherapy; may be worn up to 7 days	Rx
Ondansetron (on DAN se tron)	Zofran	IV, oral	Injection, tablet, liquid	Postop N/V: 4 mg IV or 8 mg PO Chemo: 8 mg or 0.15 mg/kg IV or 8 mg BID × 2 doses; schedule and dosing varies depending on chemo regimen.	Rx
Palonosetron (pal oh NOE se tron)	Aloxi	IV	Injection	0.25 mg IV 30 min prior to chemo	Rx
Neurokinin$_1$ Antagonist					
Aprepitant (ap RE pi tant)	Emend	Oral	Capsule	130 mg IV 30 min prior to chemotherapy in combination with a serotonin antagonist and dexamethasone OR 125 mg capsule or 3 mg/kg suspension (max 125 mg/dose) 1 hr prior to chemotherapy, followed by 80 mg once daily for 2 days, in combination with serotonin antagonist and dexamethasone	Rx
Fosaprepitant dimeglumine (fos ap RE pi tant di ME gloo meen)	Emend	IV	Injection	150 mg 30 min prior to chemotherapy, given in combination with serotonin antagonist and dexamethasone	Rx
Rolapitant (roe LA pi tant)	Varubi	Oral	Tablet	180 mg 2 hr prior to chemotherapy in combination with dexamethasone, with or without serotonin antagonist	Rx

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MEDICATION TABLE 21-1. Pharmacologic Treatment of Nausea and Vomiting[6,a] *(Continued)*

CLASS Generic Name (pronunciation)	Brand Name	Route	Forms	Dose	Rx/OTC
Miscellaneous Agents					
Bismuth subsalicylate (biz muth) (sub sa LIS i late)	Pepto-Bismol, various additional products containing bismuth	Oral	Caplet, liquid, suspension	524 mg q 30–60 min or 1,050 mg q 60 min for up to 2 days (maximum 4,200 mg/24 hr)	OTC
Phosphorated carbohydrate solution	Emetrol	Oral	Liquid	15–30 mL; repeat dose q 15 min until distress subsides; not to be administered over more than 1 hr (5 doses)	OTC
Pyridoxine (peer i DOX een)	Aminoxin, Pyri-500	IM, IV, oral	Capsule, injection solution, liquid, tablet, sustained-release tablet	10–25 mg PO daily 3–4 times daily, alone or in combination with doxylamine	OTC
Erythromycin (er ith roe MYE sin)	Erythrocin, EryPEd, E.E.S., Ery-Tab, others	Oral, IV	Capsule, granules for suspension, injection, powder for suspension, tablet	250–500 mg 3 times daily before meals; 3 mg/kg every 8 hr	Rx

IM = intramuscular; IV = intravenous; OTC = over the counter; PO = orally; Rx = prescription; SUBQ = subcutaneous.
*C-IV = schedule IV controlled substance.
*According to the FDA, schedule IV describes drugs, substances, or chemicals that are defined as drugs with a low potential for abuse and low risk of dependence.
[a]Pronunciations have been adapted with permission from USP Dictionary of USAN and International Drug Names (USP Dictionary) © 2022.