Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Goiter shrinkage; occasionally goiter develops if hypothyroidism occurs	Snoring, hoarseness, neck pain	Ask pt to vocalize "e"; examine airway, neck	Check CXR (PA, lateral), lateral neck films; if needed, CT scan of neck
CV		Assess CV response to Rx		Rhythm strip or full ECG if CV system is involved by either Hx or PE
GI	Rare hepatotoxicity			SGPT, SGOT
HEME	Mild anemia, thrombocytopenia; agranulocytosis as toxic reaction to propylthiouracil or methimazole (0.05–0.12% of pts)	Hx of sore throat or fever often heralds agranulocytosis	Skin/mucous membranes for infection/petechiae; purpura if at risk	CBC with plt count; differential leukocyte count
DERM		Rare depigmentation of hair		
MS		Pain/stiffness in joints (rare side effect)		
GU	Placenta: Crosses placental barrier and is excreted in breast milk			
CNS		Headache, paresthesia are rare side effects. Shaking, anxiety, emotional instability are signs that hyperthyroidism not yet controlled.	Reflex speed, tremor, nervousness, mental status	
ENDO	Need to assess if euthyroid	Refer to all other systems, especially reflex speed, tremor, heat intolerance, weight loss, fatigue, weakness, anorexia, increased appetite	Reflex speed; HR	Free T_4 level if unable to assess if euthyroid by Hx, PE

Key References: Farling PA: Thyroid disease, *Br J Anaesth* 85(1):15–28, 2000; Nayak B, Burman K: Thyrotoxicosis and thyroid storm, *Endocrinol Metab Clin North Am* 35(4):663–686, 2006; Ross DS: Antithyroid drugs. In Cooper DS, Mulder JE, editors: Waltham, MA, 2015, UpToDate. www.uptodate.com/contents/antithyroid-drugs-beyond-the-basics (Accessed 07.07.2016).

Perioperative Implications/Possible Drug Interactions

Preoperative Concerns
- Assess euthyroid state (see Assessment Points table).
- Fairly certain sign that remission may have occurred is decrease in size of goiter.

Induction/Maintenance
- No interactions known

Adjuvants/Regional Anesthesia/Reversal
- No interactions known

Postoperative Concerns
- Resumption not necessary if surgery to correct hyperthyroidism was successful.
- Be careful with pts who have Hx of liver disease and who are pregnant or breastfeeding.
- Short half-life makes resumption in nonthyroid surgery necessary ASAP, or give medication IV.

Anticipated Problems/Concerns
- Assess for hyperthyroidism, agranulocytosis, and liver dysfunction.

Proton Pump Inhibitors

Benjamin T. Cobb | Norman Randolph | Mark S. Weiss

Uses
- PPIs are used for the prevention and treatment of ulcers in the stomach, esophagus, or duodenum that are caused or exacerbated by stomach acids.
- People in USA receive approximately 21 million prescriptions annually.
- Worldwide, $13.6 billion worth of PPIs are consumed annually.
- PPIs are administered for the treatment of dysphagia, peptic and duodenal ulcer disease, gastroesophageal reflux, Barrett esophagus, Zollinger-Ellison syndrome, ulcers caused by NSAIDs, and eosinophilic esophagitis. PPIs are also used in the treatment of ulcers caused by *Helicobacter pylori*.

Perioperative Risks
- N/V, diarrhea, flatulence, abdominal pain.
- Interstitial nephritis and rhabdomyolysis.
- Possible mildly exaggerated effects of thiopental and/or other potent vasodilators.
- Inhibit CYP450 liver enzymes: (1) Drugs such as clopidogrel (Plavix) cannot be metabolized to active form and (2) PPIs increase free carvedilol levels.
- Displace protein-bound drugs (e.g., warfarin, sulfonylureas, thiopental, methotrexate).

Overview/Pharmacology
- Administered in an inactive (lipophilic) form in which they can enter the target cell. The acid environment in the cell protonates the drug and converts it into the activated form that binds to the proton pump.
- Metabolized by the liver, excreted by kidney and colon.
- Inhibit the cytochrome P450 system, causing variation in other medication effects.
- Displace protein-bound drugs, thus increasing their effects.

Drug Class/Mechanism of Action/Usual Dose
- PPIs suppress gastric acid production by binding to H+/K+ ATPase (i.e., the proton pump) in gastric parietal cells, causing long lasting suppression of acid secretion. The proton pump is at the terminal stage of acid production, and PPIs are up to 99% effective in decreasing gastric acid content as well as increasing the gastric pH.
- Omeprazole 20–40 mg PO for chronic GI symptoms
- Pantoprazole 40–80 mg IV q12–24h for acute GERD and GI bleeding
- Alternatives: antacids, sucralfate, tricyclic antidepressants, H_2-receptor antagonists, other PPIs (esomeprazole, lansoprazole), endoscopic interventions, and surgical interventions

Assessment Points

System	Effect	Assessment by Hx	PE	Test
RESP	URI, cough, asthma		Tachypnea, diminished breath sounds	ABG, CXR
GI	Abdominal pain, diarrhea	N/V, diarrhea	Compensatory tachypnea, abdominal tenderness	Endoscopy, upper GI series, KUB, ABG
ENDO	Hyperglycemia, hypercholesterolemia			Glucose, lipid panel
HEME	Anemia, thrombocytopenia	Dyspnea, bleeding, bruising	Hematomata, petechiae	CBC, bleeding time
HEPAT	Hepatocellular damage	Nausea, emesis, anorexia	Hepatomegaly, jaundice	AST, ALT, alk phos, PT/INR, PTT
Toxicity				
CV	Angina pectoris, arrhythmia, decreased magnesium levels	Chest pain	Hypotension, dyspnea	ECG/lyte panels
DERM	Rash	Pruritus, excoriations	Acneiform, erythematous, pruritic, or eczematoid lesions	
RENAL	Interstitial nephritis, pyelonephritis	Oliguria, anuria, hematuria	Edema, rales, pruritis	BUN/Cr, UA, CXR
CNS	Headache, tinnitus, drowsiness, dizziness		Sweating, confusion, convulsions	

Key References: Esomeprazole strontium (esomeprazole strontium)—drug summary. PDR.net. <http://www.pdr.net/drug-summary/Esomeprazole-Strontium-esomeprazole-strontium-3332.2474>, 2016 (Accessed 07.07.16); Gouda BB, Lydon AM, Badhe A, et al.: A comparison of the effects of ranitidine and omeprazole on volume and pH of gastric contents in elective surgical patients, *Eur J Anaesthesiol* 21(4):260–264, 2004.

Perioperative Implications

- Relatively few in the periop period.
- May cause acute renal injury.

Possible Drug Interactions

- May displace protein-bound drugs (e.g., warfarin [Coumadin], diazepam [Valium], sulfonylureas, thiopental [Pentothal], methotrexate, phenytoin [Dilantin]), increasing concentration in the blood and thus augmenting their effects.
- Inhibition of CYP450 liver enzymes. For example, the action of clopidogrel (Plavix) is inhibited by blocking conversion to its active form.
- May decrease the absorption of ketoconazole, decreasing its effectiveness.

Anticipated Problems/Concerns

- Increased risk of *Clostridium difficile* infection.
- May increase risk of myocardial infarction.
- Increased risk of osteoporosis with prolonged use, leading to hip, wrist, or spine fractures; use caution in performing RA.
- Hypomagnesemia may present as tetany, seizures, and cardiac arrhythmias.
- Decreased acid production with prolonged use may decrease the absorption of vitamin B_{12}.

Pseudoephedrine

Lori B. Heller | Lee A. Fleisher

Uses

- An OTC sympathomimetic commonly used as a nasal decongestant or for opening obstructed eustachian ostia.
- Used in the symptomatic treatment of reactive airway disease; however, appears to be ineffective as a bronchodilator.
- Also used for treatment of ejaculatory dysfunction and as a starting material for illicit drug manufacturing.
- Abuse and addiction to OTC stimulants does occur, particularly in those with eating disorders or erratic work hours, such as truck drivers. Associated with myocardial injury and withdrawal symptoms in this setting.

Perioperative Risks

- Concern about the coadministration of other sympathomimetic agents because of the possibility of additive effects and increased toxicity.
- Pressor effects of pseudoephedrine are more pronounced in:
  - Hypertensive pts
  - Pts taking β-adrenergic blocking drugs
  - Pts taking SNRIs
- May increase heart irritability
- MAO inhibitors, by increasing the quantity of NE, potentiate pseudoephedrine's indirect pressor effects; infrequently, a hypertensive crisis may result.
- May also reduce the antihypertensive effects of reserpine and methyldopa.

Overview/Pharmacology

- Acts directly on α- and, to a lesser degree, β-adrenergic receptors. Has an indirect effect by releasing NE from its storage sites.
- α-adrenergic effects result from inhibition of the production of cAMP by inhibiting the enzyme adenylyl cyclase, whereas β-adrenergic effects result from stimulation of adenylyl cyclase activity.
- Acts directly on α-receptors in the mucosa of the respiratory tract, producing vasoconstriction; this shrinks mucous membranes, thus reducing edema and congestion.
- May relax bronchial smooth muscle by stimulating β-adrenergic receptors, but this effect is not consistent.
- Readily and completely absorbed; elimination is predominantly renal and pH-dependent.

Drug Class/Dose

- Direct and indirect sympathomimetic
- Half-life is 6 h for standard preparation and 12 h for extended-release form.
- Adults and children ≥12 y of age: 60 mg q4–6h with a maximum dosage of 240 mg/d.
- Children 6–11 y of age: 30 mg q4–6h with a maximum dosage of 120 mg/d.
- Children 2–5 y of age: 15 mg q4–6h with maximum dosage of 60 mg/d.
- Children <2 of age: No USA FDA-approved dosing.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	Htn, dysrhythmias, cardiac irritability	Palpitations	BP/HR	ECG
HEENT	Mucosal vasoconstriction Reduction of volume of nasal mucosa Drainage of sinus secretions, opening of obstructed ostia	Nasal congestion Head stuffiness	Absence of hyperemia of nasal mucosa	
NEURO	Nervousness, excitability, restlessness, dizziness, weakness, insomnia, headaches, drowsiness		Tremors, anxiousness	
GU/RENAL	Urinary retention	Difficulty voiding, emptying bladder completely	Tachycardia, Htn	Bladder US, postvoid residuals
GI	N/V		Abdominal tenderness	

Key References: Kanfer I, Dowse R, Vuma V: Pharmacokinetics of oral decongestants, *Pharmacotherapy* 13(6 Pt 2):116S–128S, 1993; Werler MM: Teratogen update: pseudoephedrine, *Birth Defects Res A Clin Mol Teratol* 76(6):445–452, 2006.