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Bezoars: From Mystical Charms to Medical and Nutritional Management

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Bezoars are retained concretions of undigested foreign material that accumulate and coalesce within the gastrointestinal tract, most commonly in the stomach. Originally described in the stomach of ruminant animals such as goats, antelopes, and llamas, for centuries, bezoars were ascribed mystical and medicinal powers and considered invaluable possessions. Although the occurrence of bezoar formation has been well documented in humans, the diagnosis, management and treatment remains a difficult task for patients and healthcare professionals. Patients are often asymptomatic or display symptoms indistinguishable from other gastrointestinal disorders resulting in delayed diagnosis and potential life-threatening complications. Individuals may also present with considerable weight loss and compromised nutritional status due to early satiety and recurrent vomiting. Recognition of high-risk individuals and subtle clinical clues may assist in early diagnosis and prompt medical attention. Furthermore, understanding the pathophysiology of bezoar formation along with predisposing risk factors may aid in preventing recurrence.

INTRODUCTION

Bezoars are retained concretions of indigestible foreign material that accumulate and conglomerate in the gastrointestinal tract, most commonly in the stomach. Bezoars can be composed of virtually any substance including food, hair, medications, and chewing gum. Although they are most commonly found in the stomach, bezoars may occur anywhere from the esophagus to the rectum. Depending on a patient's course, they may lose a considerable amount of weight due to early satiety and recurrent vomiting. Bezoars have been described in patients with normal gastrointestinal anatomy and physiology, however the majority of gastric bezoars occur as a complication of previous

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Table 1
Bezoar Classification

Phytobezoar	Composed of nondigestible food particles found in fruit and vegetables (cellulose, hemicellulose, lignin)
Trichobezoar	Hair bezoar. Associated with young females and/or patients with psychiatric illnesses who ingest hair, carpet, rope, string, etc.
Lactobezoar	Compact mass of undigested milk concretions traditionally described in pre-term neonates on highly concentrated formula
Pharmacobezoar	Conglomeration of medications or medication vehicles (extended release products, bulk-forming laxatives)
Others	
• Trichophytobezoar	Mixture of hair, fruit, and vegetable fibers
• Diospyrobezoar	Persimmons
• Dead ascaris	Worm bezoars

gastric surgery or altered gastrointestinal motility in which there is a loss of normal peristaltic activity, compromised pyloric function, or reduced gastric acidity. Understanding the pathophysiology of bezoar formation and recognizing high-risk individuals are critical elements in the diagnosis, management, and prevention of gastrointestinal bezoars.

HISTORY

For centuries, bezoars have been described in the stomach and intestines of humans and ruminants including certain goats, sheep, deer, llamas, and antelopes. The original bezoars came from the stomach of goats found in the mountains of Western Persia (1). They were introduced to Europe from the Middle East sometime during the 11th century and remained popular there as medicinal remedies until the eighteenth century. They have been ascribed mystical powers and employed as medical therapies as early as 1000 B.C. (2). Considered a panacea for a variety of physical ailments, they have been used to treat poisons such as arsenic, venomous bites, epilepsy, dysentery, and the plague. The term bezoar comes from either the Persian "pahnzehr" or the Arabic "badzehr," both of which mean counter-poison or antidote (1,2). Bezoars were considered valuable possessions in the Middle Ages and were commonly set in gold and decorated with jewelry, given the name "bezoar stone." Today, bezoars are recognized as a potentially serious medical problem in patients with compromised gastric anatomy and/or gastrointestinal motility.

CLASSIFICATION

Bezoars can be classified into four types based on their origin and components: phytobezoars, trichobezoars, lactobezoars, and pharmacobezoars (medication bezoars) (3) (Table 1). Understanding the classification system may provide further insight into treatment options and prevention of recurrence.

Phytobezoars are the most common type of bezoars today. They are composed of food material nondigestible by humans including cellulose, hemicellulose, lignin, and fruit tannins (leucoanthocyanins and catechins) (4,5). These nondigestible materials are found in foods such as celery, pumpkins, grape skins, prunes, raisins, and most notably persimmons. Bezoars resulting from ingestion of persimmons have been commonly described and referred to as diospyrobezoars. In high concentrations, fruit tannins may form a coagulum upon exposure to an acidic environment initiating the formation of a phytobezoar (6).

Trichobezoars are the classically described "hair bezoar" occurring most frequently in children and young adult females. Usually observed in individuals with psychiatric disorders, trichobezoars result from ingesting large quantities of hair, carpet fibers, rope, string, or clothing (7). The hair fibers become entangled in the gastric folds and resist peristalsis. Undigested fat and mucus may become trapped in the fibers

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and ferment leading to a putrid odor. Gastric acid denatures the hair proteins and blackens the bezoar regardless of the intrinsic color. Trichobezoars are usually confined to the stomach; however, occasionally they have a "tail" which extends through the pylorus and into the proximal small intestine. There have been reported cases of trichobezoars extending throughout the entire length of the small intestine, known as the "Rapunzel syndrome" (8,9).

Lactobezoars are a compact mass of undigested milk concretions located within the gastrointestinal tract. These bezoars have been traditionally associated with pre-term infants fed a highly concentrated formula within the first weeks of life (10). Poor neonatal gastric motility, dehydration, concentrated formulas, and milk products such as casein have been attributed to the formation of lactobezoars (11). However, a recent study suggests that the etiology is likely multifactorial and examples may be seen in a wide range of patients (up to three years of age) who consume breast milk, commercial infant formulas, and cow's milk (12). Nevertheless, the preferred initial treatment for lactobezoars involves intravenous hydration and temporary cessation of enteral feedings.

Pharmacobezoars are conglomerates of medications or medication vehicles in the gastrointestinal tract of individuals at risk for bezoar formation. Several medications have been implicated in causing bezoars including cholestyramine, sucralfate, nifedipine, enteric-coated aspirin and antacids such as aluminum hydroxide (13). The majority of case reports describing pharmacobezoars have involved extended-release products such as nifedipine or verapamil (14,15). The tablet coating is composed of cellulose acetate; an indigestible semi-permeable casing that allows a continuous, controlled release of medication over a 24-hour period. However, in patients with altered gastrointestinal anatomy or motility, accumulation of these shell casings may lead to pharmacobezoar formation. Bulk forming laxatives such as perdium and psyllium have also been implicated in bezoar formation (15-18). The bulk-forming nature of these products in conjunction with an underlying GI abnormality is the proposed mechanism for bezoar formation. The manner through which medications initiate bezoar formation depends on the medication involved and underlying gastrointestinal abnormalities.

Although gastrointestinal bezoars are traditionally classified into these four types, other types of bezoars have been described including trichophytobezoars (a mixture of hair, fruit and vegetable fibers), diospyrobezoars (persimmons), worm bezoars (dead ascaris) and an unusual case of a toilet paper bezoar described in a young girl (19). The components of the bezoar often dictate the therapies necessary for removal and prevention of recurrence.

SYMPTOMS

Many patients with bezoars are asymptomatic or present with vague symptoms indistinguishable from other gastrointestinal disorders. One of the most common presenting symptoms is a vague feeling of epigastric discomfort that is present in as many as 80% of patients with bezoars (20). Other symptoms include abdominal bloating, nausea and vomiting, early satiety, post-prandial fullness, halitosis, anorexia, dysphagia and weight loss (3). The presenting symptoms may provide some insight into the anatomic location of the bezoar. Esophageal bezoars often present with signs and symptoms of dysphagia, odynophagia, reflux and retrosternal pain. Bezoars located in the stomach may result in abdominal pain, nausea and vomiting, gastric ulcerations from pressure necrosis and subsequent gastrointestinal bleeding as well as gastric outlet obstruction. Small bowel bezoars usually present with signs and symptoms of partial or complete intestinal obstruction or perforation requiring surgical intervention. Although the sequelae from gastrointestinal bezoars may be serious and potentially life threatening, most patients present with only vague symptoms indistinguishable from other gastrointestinal disorders. In evaluating for a potential bezoar, it is important to understand predisposing risk factors while obtaining a clinical history.

PREDISPOSING RISK FACTORS

Although bezoar formation may occur in individuals with normal gastrointestinal anatomy and physiology, patients with altered gastrointestinal anatomy and/or motility are at increased risk for developing bezoars (Table 2). For example, patients with a partial gastrec-

tomy secondary to peptic ulcer disease have a higher risk for bezoar formation due to compromised pyloric function. Furthermore, vagotomies resulting from a partial gastrectomy can impair gastrointestinal motility thus further increasing the risk for concretions developing in the stomach. A 5%–12% incidence of bezoar formation has been reported in the postgastrectomy state (21). In patients with diabetes mellitus complicated by gastroparesis, there is an increased risk for bezoar formation, especially those on a high fiber diet. Bezoar formation has also been described in patients with coexistent illnesses affecting gastrointestinal motility such as Guillain-Barre syndrome, myotonic dystrophy, and hypothyroidism (3). Other medical conditions associated with increased risk for bezoar development include cystic fibrosis, intrahepatic cholestasis, and renal failure. Edentulous patients with poor mastication of food particles may also be at greater risk for bezoar development, especially if coexisting risk factors as described above are also present. In addition, patients with psychiatric illnesses are at an increased risk for bezoar formation due to possible ingestion of hair and medications (22). Recognizing the clinical symptoms in association with predisposing risk factors may enhance clinical suspicion leading to prompt diagnosis, treatment, and avoidance of potential complications.

Table 2
Predisposing Risk Factors for Bezoar Formation

Gastric Surgery
- Partial gastrectomy
- Vagotomy

Neurologic
- Guillain Barre
- Miltonic Dystrophy

Endocrine
- Diabetes mellitus (gastroparesis)
- Hypothyroidism

Others
- Cystic fibrosis
- Intrahepatic cholestasis
- Renal failure
- Psychiatric illness

DIAGNOSIS

Physical examination has limited utility in diagnosing bezoars. Occasionally, a palpable mass may be appreciated on abdominal exam or halitosis recognized from the putrefying material within the stomach. However, these findings are nonspecific and often difficult to discern. In patients with trichobezoars, patches of alopecia may be recognized in individuals with psychiatric conditions such as trichotillomania (23).

Plain abdominal radiographs may demonstrate a filling defect outlined by gas or dilated bowel along with evidence for obstruction. Barium studies may reveal filling defects as the contrast material coating the bezoar infiltrates the interstices of the concretion producing a characteristic mottled or streaked appearance. Although barium studies may assist in the diagnosis, unfortunately, the barium may also interfere with other diagnostic and therapeutic interventions such as endoscopy or surgery by impeding visualization of the bezoar and gastrointestinal mucosa. Abdominal computed tomography has proven useful in the diagnosis and evaluation for potential complications such as intestinal obstruction or perforation (24).

Endoscopy has been demonstrated to be the diagnostic technique of choice for bezoars located in the esophagus or stomach. When compared to barium studies, the barium swallow identifies only 25% of the bezoars found endoscopically (25). Moreover, endoscopy has the advantage of potentially offering therapeutic intervention, especially when dealing with phytobezoars. Endoscopically, the phytobezoar will usually be visualized as a dark brown or green ball of amorphous material located in the fundus or antrum of the stomach. (Figure 1). The trichobezoar may appear black secondary to the enzymatic and acid oxidation of the hair material (Figure 2).

TREATMENT

The ultimate goal of treatment is removal of the bezoar and prevention of recurrence. Current management consists of surgical extraction or endoscopic fragmen-

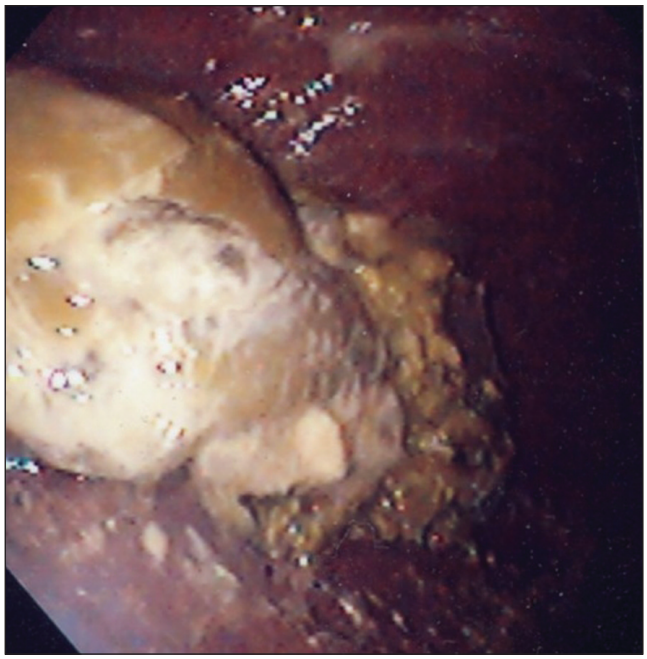

Figure 1. Endoscopic findings of a phytobezoar.

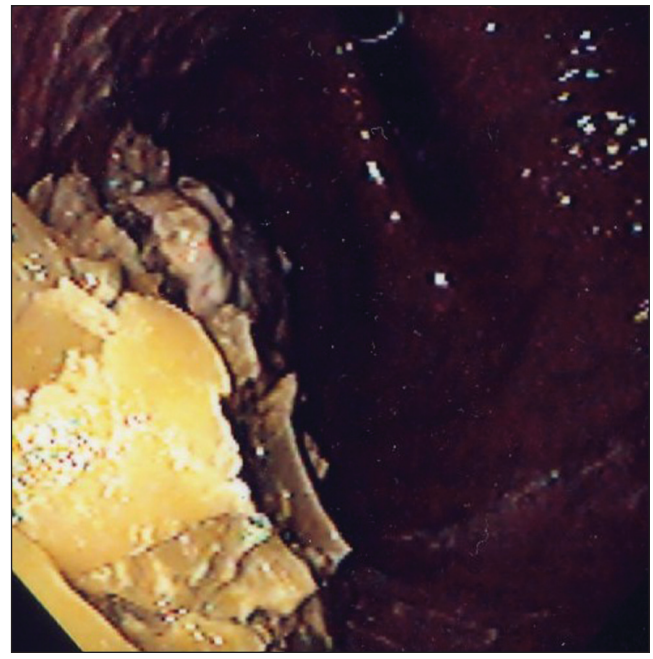

Figure 2. Endoscopic findings of a trichobezoar.

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tation, dissolution with enzymatic therapy consisting of proteolytic or cellulase enzymes, gastric lavage, dietary modifications and prokinetic agents (26,27). The choice of therapy is largely dependent on the type of bezoar present and the presence of underlying risk factors such as delayed gastric emptying, psychiatric illness, and medications prone to bezoar formation.

Most authors would agree that trichobezoars require operative removal. The twisted strands of hair can develop a wire-like consistency resulting in pressure necrosis and subsequent perforation (23). Other complications include gastric outlet obstruction, small intestinal obstruction, ulceration, pancreatitis and bleeding. Medical therapy is usually unsuccessful and may potentially prove hazardous by delaying immediate removal. Although endoscopic techniques for removal of trichobezoars have been successful, failure of removal should prompt a surgical evaluation.

Phytobezoars are composed of fruit and vegetable fibers that can be enzymatically degraded by proteolytic and cellulase enzymes. Medical therapies for the management of gastric phytobezoars are shown in Table 3. Papain, a proteolytic enzyme from the carica papaya plant, has been used for the treatment of phytobezoars with varied success rates (0%–100%) (28,29). Although the mechanism of action remains unknown, it is thought to cleave protein linkages within the phytobezoar. Adverse reactions have been reported including gastric ulceration (30), esophageal perforation (31), and hypernatremia (32). Although these complications following papain therapy are seldom reported, cautionary discretion is raised due to lack of controlled clinical trials. Earlier studies with papain therapy were conducted with Papase tablets, which are no longer available in the United States. An available alternative source of papain is Adolph's Meat Tenderizer, which is mixed with a clear liquid and administered orally or with gastric lavage (2–4 teaspoonfuls dissolved in 200mL of water) (32). The hypernatremia associated with papain use is believed to be secondary to the high sodium chloride concentration in Adolph's Meat Tenderizer **(Note: 1 teaspoon = 1680 mg (73 mEq) sodium in the "unseasoned" original; customer service: 800/328-7248).** A salt free preparation may help to reduce this untoward side effect.

An alternative enzymatic therapy, which has become more widely accepted, is cellulase, an enzyme

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Table 3
Medical Management of Gastric Phytobezoars

Cellulase	3-5 g dissolved in 300-500 mL of water and administered po for 2-5 days
Papain (Adolph's Meat Tenderizer)	1–2 teaspoon/s in 250 mL of water po TID for 2-5 days
Acetycysteine	15 mL diluted in 50 mL NaCl 0.9% administered via nasogastric lavage TID for 2 days
Metoclopramide	10 mg liquid, po with each meal and at night
Coca-Cola Nasogastric lavage	3 Liters of Coca-Cola administered via nasogastric lavage over 12 hours

that cleaves the leucoanthocyanidin-hemicellulose-cellulose bonds, resulting in dissolution of the phytobezoar (33). In the limited studies reported, cellulase has a success rate of 100% on therapy ranging from 2 to 7 days with no reported adverse side effects (33-36). The tablet form, gastroenterase, is no longer available in the U.S.; however the powder form is available and has shown similar success rates. Cellulase (3–5 grams) dissolved in 300–500 mL of water and administered orally for 2–5 days has proven successful by some investigators (36). Patients initially assumed the left lateral recumbent position for 20–30 minutes as they drank the solution, and assumed a supine position for 30 minutes after ingesting the solution. The impressive success rates and lack of adverse events with cellulase treatment makes this an attractive medical therapy for the management of phytobezoars.

Patients with delayed gastric emptying may benefit from long-term therapy with prokinetic agents such as metoclopramide for the management and prevention of gastric bezoars (37). Although no studies have been reported, other prokinetic agents such as erythromycin or domperidone may be efficacious given their effect on gastrointestinal motility. However, future studies are necessary to confirm the potential efficacy of these medications.

Lavage therapy to mechanically fragment and dissolve gastric bezoars has been reported to be effective. A single case of treatment of a phytobezoar with gastric lavage followed by instillation of acetylcysteine was successful with no reported side effects (38). Recently, Coca-Cola nasogastric lavage was reported to be effective in five consecutive patients with large gastric bezoars (39). Continuous gastric lavage with 3 L of Coca-Cola over a 12-hour period showed complete dissolution of the phytobezoars without adverse side effects. Furthermore, patients were advised to drink two glasses of Coca-Cola every other day after discharge and no bezoar recurrence was observed after 3-15 months. An acidic environment is important in the digestion of fiber. Coca-Cola contains carbonic and phosphoric acid and has a pH of 2.6 (40), which is similar to the pH of 1–2 in normal gastric secretions. Therefore, the authors suggest that Coca-Cola acidifies the gastric contents and liberates carbon dioxide in the stomach resulting in the disintegration of phytobezoars. Other cola beverages, such as Diet Coca-Cola, a sugar free product, may be equally effective and offer an alternative for patients with diabetes mellitus. Coca-Cola gastric lavage represents a potentially safe, cheap and effective treatment for the dissolution of gastric bezoars **(Note: 3 L of Coca-Cola contains ~ 1240 calories or 318 g of CHO).** Further studies of Coca-Cola lavage in a large, controlled trial is necessary to confirm the efficacy of this treatment modality.

Endoscopic therapy focuses on mechanical disruption using instruments such as tripod forceps (41), polypectomy snares (42), water piks (43), neodymium yttrium aluminum garate (Nd:YAG) laser (44), and bezotriptors, or bezotomes (45). Electrohydraulic lithotripsy, a well-established method for treating urinary and hepatobiliary stones, has also been successful in the endoscopic management of gastric phytobezoars (46). Surgical extraction is indicated if medical therapy has failed and/or endoscopic removal is unsuccessful. Although endoscopic removal of large, hard bezoars (i.e. trichobezoars, diospyrobezoars) has been

reported (45), operative removal is often required. Follow up studies (i.e. endoscopy or radiographic imaging) to confirm dissolution of the bezoar may be considered on a case-by-case basis depending on recurrent symptoms or complications.

NUTRITION

Identifying high-risk individuals and recognizing nutritional elements contributing to the formation of bezoars are critical components to preventing the recurrence of bezoars. Patients should be instructed to avoid a high fiber diet especially citrus fruits and raw vegetables (47). Certain medications known to precipitate bezoar formation should also be avoided (see Table 4). Eliminating bulk laxatives such as perdium and psyllium in high-risk individuals (i.e. partial gastrectomy or patients with gastroparesis) is an important point that may be overlooked by healthcare professionals. In the acute setting, treatment with an adequate liquid diet ranging from one to two weeks in addition to medications may assist in dissolution of the bezoar and prevention of recurrence (see Appendix A, B and C for liquid suggestions, commercial products and recipes). If a liquid diet is required for greater than one week, consider nutritional counseling with a registered dietitian to ensure nutritional adequacy especially in a patient with nutritional compromise at presentation. A liquid or chewable vitamin/mineral supplement may also be beneficial if nutrient deficiencies are present. To find a registered dietitian, try calling a local hospital. After reaching the clinical nutrition department, ask for references for outpatient counseling. Although dietary discretion is an important component in the management of bezoars, dietary therapy alone is rarely successful and often requires additional interventions such as medications or mechanical disruption with endoscopy.

Table 4
Foods and Medications Implicated in Bezoar Formation

Fruits	*Bulk forming laxatives*
Apples, Oranges	Perdiem
Persimmons	Psyllium
Figs, berries	
Grape skins, Coconuts	
Vegetables	*Extended Release Products*
Green beans, legumes	Nifedipine
Potato peels	Verapamil
Brussel sprouts, sauerkraut	
Celery	
Vitamins and Natural Products	*Other medications*
Ascorbic acid	Aluminum hydroxide
Ferrous sulfate	Cholestyramine
Lecithin	ECASA
	Sucralfate

SUMMARY

Although the prevalence of bezoars in humans is low, the potential for complications in untreated patients remains high emphasizing the importance of early diagnosis and treatment along with prevention of recurrence. Recognition of high-risk individuals and subtle clinical findings by knowledgeable healthcare professionals may prompt early investigation and prevention of potential life-threatening sequelae. Avoiding certain medications and advising dietary discretion in patients with altered gastrointestinal anatomy and/or motility may also aid in the prevention of bezoar formation. ■

References

1. Williams, RS. The fascinating history of bezoars. *Med J Aust,* 1986;145(11-12):613-614.
2. Andrus CH, Ponsky JL. Bezoars. classification, pathophysiology, and treatment. *Am J Gastroenterol,* 1988;83(5):476-478.
3. Pfau P, Ginsberg G. Foreign Bodies and Bezoars. In Feldman: *Sleisenger and Fordtran's Gastrointestinal and Liver Diseases,* 7th edition. 2002:395-397.
4. Holloway WD, Lee SP, Nicholson GI. The composition and dissolution of phytobezoars. *Arch Pathol Lab Med,* 1980;104:159-161.
5. Matsuo T, Ito S. The chemical structure of kaki-tannin from immature fruit of the persimmon. *Agric Biol Chem,* 1978; 126:421- 424.
6. Izumi S, Isida K, Iwamoto M. The mechanism of the formation of phytobezoars, with special reference to the persimmon ball. *Jpn J Med Biochem,* 1933;2:21-35.
7. Phillips MR, Zaheer S, Drugas GT. Gastric Trichobezoar: Case Report and Literature Review. *Mayo Clin Proc,* 1998;73(7):653-656
8. Deslypere JP, Praet M, Verdonk G. An unusual case of the trichobezoar: the Rapunzel syndrome. *Am J Gastroenterol,* 1982; 77:467-470.

Appendix A
Options While on a Liquid Diet

Clear Liquids

Tea, Coffee

Clear juices such as apple, cranberry, grape

Fruit-flavored drinks

Carbonated beverages

Broth or bouillon

Plain, flavored gelatins

Fruit ices, popsicles, sorbets

Clear liquid type supplements (see contact information below):
- Boost Breeze (Mead Johnson)
- Enlive (Ross)
- Resource Fruit Beverage (Novartis)

Full Liquids

All juices (nectars, fruits juices of any kind), tomato or V-8 juice

Milk, chocolate milk, buttermilk, lactaid milk

Carnation instant breakfast (or equivalent), Ovaltine, Nesquik, etc.

Milkshakes, Eggnog

Flavored coffees
- Add whole milk, cream or flavored creamers such as: hazelnut, vanilla cream, etc.
- Starbuck's Frappaccino's

Smoothies* (see recipes in Appendix C)

Soy Milks

Kefir (liquid yogurts), Yoplait Nouriche, Go-gurts, etc.

Creamy type yogurt (vanilla, lemon, key lime, etc)

Custard, puddings

Smooth ice cream (no nuts, etc)

Hot cereal (low in fiber) such as: grits, cream of wheat, cream of rice, farina

Strained creamed soups

Thinned down strained vegetables, fruits, meats (such as strained baby foods)
- Can also add to broths or cream soups to increase nutritional value

Also allowed:
- Butter, margarine, sugar, hard candy, honey, syrups

9. Wolfson PJ, Fabius RJ, Leibowitz AN. The Rapunzel syndrome: An unusual trichobezoar. *Am J Gastroenterol,* 1987;82:365-367.
10. Erenberg A, Shaw RD, Yousefzadeh D. Lactobezoar in the low-birth-weight infant. *Pediatrics,* 1979;63:642-646.
11. Duritz G, Oltorf C. Lactobezoar formation associated with high-density caloric formula. *Pediatrics,* 1979;63:647-649.
12. Dubose TM, Southgate WM, Hill JG. Lactobezoars: A patient series and literature review. *Clin Pediatr,* 2001;40:603-606.
13. Taylor JR, Streetman DS, Castle SS. Medication bezoars: A literature review and report of a case. *Ann Pharmacother,* 1998;32: 940-946.
14. Stack PE, Patel NR, Young MF, et al. Pharmacobezoars-the irony of the antidote: first case report of nifedipine XL bezoar. *J Clin Gastroenterol,* 1994;19:264-271.
15. Chung M, Reitberg DP, Gaffney M, et al. Clinical pharmacokinetics of nifedipine gastrointestinal therapeutic system. *Am J Med,* 1987;83:10-14.
16. Schneider RP. Perdiem causes esophageal impaction and bezoars. *South Med J,* 1989; 82:1449-1450.
17. Frohna WJ. Metamucil bezoar: an unusual case of small bowel obstruction. *Am J Emerg Med,* 1992;10:393-395.
18. Agha FP, Nostrant TT, Fiddian-Green RG. Giant colonic bezoar: Medication bezoar due to psyllium seed husks. *Am J Gastroenterol,* 1984;79:319-321.
19. Goldman RD, Schachter P, Katz M, et al. A bizarre bezoar: case report and review of the literature. *Pediatr Sur Int,* 1998;14:218-219.
20. Dietrich NA, Gau FC. Postgastrectomy phytobezoars: Endoscopic diagnosis and treatment. *Arch Surg,* 1985;120:432-435.
21. Bowden TA, Hooks VH, Mansberger AR. The stomach after surgery: An endoscopic perspective. *Ann Surg,* 1983;197:637-644.
22. De Backer A, Van Nooten V, Vandenplas Y. Huge gastric trichobezoar in a 10-year-old girl: Case report with emphasis on endoscopy in diagnosis and therapy. *J Pediatr Gastroenterol Nutr,* 1999;28:513-515.
23. Bouwer C, Stein DJ. Trichobezoars in trichotillomania: Case report and literature review. *Psychosom Med,* 1998;60:658-660.
24. Kim JH, Ha HK, Sohn MJ, et al. CT findings of phytobezoar associated with small bowel obstruction. *European Radiology,* 2003;13:299-304.
25. Bowden TA, Hooks VH, Mansberger AR. The stomach after surgery: An endoscopic perspective. *Ann Surg,* 1983;197:637-644.
26. Rider JA, Foresti-Lorente RF, Garrido J, et al. Gastric bezoars: Treatment and prevention. *Am J Gastroenterol,* 1984;79:357-359.
27. Walker-Renard P. Update on the medicinal management of phytobezoars. *Am J Gastroenterol,* 1993;88:1663-1666.
28. Cain GD, Moore P, Patterson M. Bezoars: A complication of the postgastrectomy state. *Am J Dig Dis,* 1968;13:801-809.
29. Cohen NN, Strika ZA. The medical treatment of bezoars. *Gastrointest Endosc,* 1968; 14:144-145.
30. Dugan FA, Lilly JO, McCaffery TD. Dissolution of a phytobezoar with short-term medical management. *South Med J,* 1972;65:313-316.
31. Holsinger JW, Fuson RL, Sealy WC. Esophageal perforation following meat impaction and papain ingestion. *JAMA,* 1968;204:188-189.
32. Zarling EJ, Moeller DD. Bezoar therapy: Complication using Adolph's meat tenderizer and alternatives from literature review. *Arch Intern Med,* 1981;141:1669-1670.
33. Lee P, Holloway WD, Nicholson GI. The medicinal dissolution of phytobezoars using cellulase. *Br J Surg,* 1977;64:403-405.

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34. Scoular RS, Lee SP. Gastric phytobezoar. *Aust N Z J Med,* 1979;9:207-210 (letter).
35. Smith BH, Mollot M, Berk JE. Use of cellulase for phytobezoar dissolution. *Am J Gastroenterol,* 1980;73:257-259.
36. Bruck HM. Gastric phytobezoar. *JAMA,* 1975;231:26 (letter).
37. Delpre G, Kadish U, Glanz I. Metoclopramide in the treatment of gastric bezoars. *Am J Gastroenterol,* 1984;79:739-740.
38. Schlang HA. Acetylcysteine in removal of bezoar. *JAMA,* 1970;214:1329.
39. Ladas SD, Triantafyllou K, Tzathas C, et al. Gastric phytobezoars may be treated by nasogastric Coca-Cola lavage. *Eur J Gastroenterol Hep,* 2002;14:801-803.
40. McCloy RF, Greenberg GR, Baron JH. Duodenal pH in health and duodenal ulcer disease: effect of meal, Coca-Cola, smoking, and cimetidine. *Gut,* 1984;25:386-392.
41. Chung SCS, Leung JWC, Li AKC. Phytobezoar masquerading as the superior mesenteric artery syndrome: successful endoscopic treatment using a colonoscope. *JR Col Surg Endinb,* 1991;36: 405-406.
42. McLoughlin JC, Love AHG, Adgey AAJ, et al. Intact removal of phytobezoar using fiberoptic endoscope in patient with gastric atony. *BMJ,* 1979;1:1466.
43. Madsen R, Skibba RM, Galvan A, et al. Gastric bezoars a technique of endoscopic removal. *Am J Dig Dis,* 1978;23:717-719.
44. Naveau S, Poynard T, Zourabichvili O, et al. Gastric phytobezoar destruction by Nd:YAG laser therapy. *Gastrointest Endosc,* 1986;32:430-431.
45. Wang YG, Seitz U, Li ZL, et al. Endoscopic management of huge bezoars. *Endoscopy,* 1998; 30:371-374.
46. Kuo JY, Mo LR, Tsai CC, et al. Endoscopic fragmentation of gastric phytobezoar by electrohydraulic lithotripsy. *Gastrointest Endosc,* 1993;39:706-708.
47. Emerson AP. Foods high in fiber and phytobezoar formation. *J Am Diet Assoc,* 1987; 87(12):1675-1677.

Appendix B
Commercial Nutritional Supplements

Ensure Ensure Plus Enlive	Ross	800/986-8502	www.ross.com
Resource Resource Plus Resource Fruit Beverage	Novartis	800/438-6153	www.walgreens.com/store/novartis
Boost Boost Plus Boost Breeze	Mead Johnson	800/831-3959	www.meadjohnson.com
Nutra Shakes	Nutra/Balance Products	800/654-3691	www.nutra-balance-products.com
NuBasics NuBasics Plus NuBasics Juices	Nestle	800/776-5446	www.nestleclinicalnutrition.com
Scandishakes	Scandipharm	800/950-8085	www.cystic-l.org/handbook/html/scandipharm_htm
Milk Shake Plus Mix Egg Nog Mix	Tad Enterprises	800/438-6153	Must order a case

**Cost based on pricing for December 2003. Prices can be variable among stores.
Note: Many larger pharmacy and food chains have their own "Ensure or Boost equivalents."
Examples: Wal-Mart = "Nutritional Supplement"
CVS Pharmacy = "Liquid nutrition"
Kroger = "Fortify" and Fortify Plus"
Giant = "Nutritional Drink"

Appendix C
Recipes for Smoothies, Fruit Blends, Shakes, Fruit Drinks

Smoothies

Basic Smoothie
½ cup vanilla
(or other creamy smooth yogurt)
1 small ripe banana

Strawberry Yogurt Frappe
1 tbsp strawberry syrup or other flavoring
½ cup vanilla yogurt
½ cup milk
¼ cup orange Juice
Dash vanilla

Peach Plus
½ Peach, canned
¼ cup vanilla yogurt
¼ cup milk
Dash vanilla
Dash nutmeg

Tropical Smoothie
½ cup creamy fruit yogurt
½ banana
1 oz. orange Juice

Fruity Yogurt Sipper
1 ripe large banana or,
2 medium peaches, peeled and pitted
1 ½ cups whole milk
1 8 oz carton vanilla yogurt
1-2 tbsp powdered sugar
½ cup ice cubes

Cut fruit into chunks. Combine all ingredients except ice in a blender until smooth. Add ice, one cube at a time. Blend until smooth.

Fruit Blends

Pear
½ cup canned pears
½ cup cottage cheese

Peach
½ cup canned peach
½ cup cottage cheese

Banana-Apple
½ small banana
½ cup cottage cheese
¼ cup apple juice

Combine these next 3 recipes in a blender until smooth. Chill until firm.

Option 1
¼ cup cottage cheese
¼ cup vanilla ice cream
½ cup prepared gelatin

Option 2
¼ cup flavored yogurt
¼ cup vanilla ice cream
½ cup prepared gelatin

Option 3
¼ cup ricotta or cottage cheese
¼ cup vanilla ice cream
½ cup blended fruit
½ cup prepared gelatin

Shakes

Super Milkshake
½ cup fortified milk
1-2 scoops high fat ice cream
1 packet Instant Breakfast

Chocolate Peanut Butter Shake
1 can chocolate Ensure or Boost (or "Plus")
2 Tablespoons smooth peanut butter
2 scoops vanilla ice cream

High-Protein Shake
1 cup fortified milk
½ cup ice cream
½ tsp vanilla extract
2 tbsp butterscotch, chocolate, or your favorite fruit syrup or sauce

*For variety, add ½ cup banana or
1 tbsp smooth peanut butter and
2 tsp sugar
Put all ingredients in a blender.
Blend at low speed for 10 seconds.

Orange Breakfast Nog
1½ cups buttermilk
2 tbsp brown sugar
1 tsp vanilla extract
2-3 large ice cubes
1/3 cup of frozen orange juice concentrate

Combine all ingredients except ice in a blender until smooth. Add ice, one cube at a time. Blend until smooth and frothy.

Appendix C (continued)
Recipes for Smoothies, Fruit Blends, Shakes, Fruit Drinks

Shakes (continued)

Sherbet Drink
½ cup milk or fortified milk (see below for recipe)
1-2 scoops sherbet or sorbet

Can substitute for ½ cup milk:
- Nutren 1.5, unflavored
- Osmolite, Osmolite HN
- Isocal, Isocal HN
- Soy milk

High-Calorie Malt
½ cup whole milk
1 tbsp malted milk powder
½ cup half and half
1 oz package instant breakfast, any flavor
2 cups ice cream, any flavor
2 tbsp Ovaltine

Mix all ingredients together in a blender. Process until smooth.

Fruit and Cream
1 cup whole milk
1 cup vanilla ice cream
1 cup canned fruit in heavy syrup (peaches, apricots, pears)
Almond or vanilla extract to taste

Blend all ingredients and chill well before serving.

Fruit Drinks

Bucky Badger Punch
1 quart cranberry juice cocktail
1 cup orange juice
1 cup grapefruit juice
2 cups 7-up or club soda

Combine the 3 juices in a pitcher. Add 7-up or club soda when ready to serve.

High Protein Fruit Drink
8 ounce Enlive, Boost Breeze, Resource or Resource Plus
½ cup sherbet
6 ounces ginger ale

Sherbet Punch
1 cup sherbet
12 oz gingerale

Slushy Punch
1 cup sugar
2 ripe medium bananas, cut up
3 cups unsweetened pineapple juice
2 tbsp lime juice
1 6 oz can frozen orange juice concentrate
1 1-liter bottle carbonated water or lemon-lime beverage, chilled

Combine carbonated water and sugar until dissolved. In a blender, combine bananas and juices. Blend until smooth. Add to sugar mixture. Pour in carbonated water.

Frozen Fruit Slush
1-6 ounce can frozen fruit juice concentrate
4 tablespoons sugar
3 cups crushed ice

- Fortify milk by adding dry milk powder—1 cup powder to 1 quart milk.
  – Soy milks can be substituted for milk in any recipe.
- Flavor extracts such as vanilla, almond, coffee, etc can be added for interest.
- Other flavorings such as dry gelatin or pudding mixes, syrups, etc. can be added for additional flavors or extra calories.