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## The Medical Complications Associated with Purging

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### Abstract

**Objective**—Purging behaviors, including self-induced vomiting, laxative abuse, and diuretic abuse, are present across many of the eating disorders. Here we review the major medical complications of these behaviors.

**Method**—Although we identified over 100 scholarly articles describing medical complications associated with purging, most papers involved case studies or small, uncontrolled samples. Given the limited evidence base, we conducted a qualitative (rather than systematic) review to identify medical complications that have been attributed to purging behaviors.

**Results**—Medical conditions affecting the teeth, esophagus, gastrointestinal system, kidneys, skin, cardiovascular system, and musculoskeletal system were identified, with self-induced vomiting causing the most medical complications.

**Conclusions**—Purging behavior can be associated with severe medical complications across all body systems. Mental health professionals should refer patients with purging behaviors to medical providers for screening and treatment as needed. The medical work-up for individuals with eating disorders should include a comprehensive metabolic panel, complete blood count, and a full body exam including the teeth to prevent severe complications. Medical providers should screen patients for purging behaviors and associated medical complications, even in the absence of an eating disorder diagnosis, to increase the detection of eating disorders. Recognizing the link between purging and medical complications can aid in identifying potential eating disorders, particularly those that often elude detection such as purging disorder.

### Key Terms

purging; self-induced vomiting; laxative; diuretic; medical complications

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In the context of eating disorders, purging behaviors are used to prevent weight gain or promote weight loss. (1) Self-induced vomiting, laxative abuse, and diuretic abuse are the most common methods of purging used in those with disordered eating and eating disorders. (1) Purging may be present in anorexia nervosa and bulimia nervosa and is the defining

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feature of purging disorder, an eating disorder identified as part of the new diagnostic group Other Specified Feeding or Eating Disorder (OSFED). (1) Additionally, some individuals report purging in the absence of a full syndrome eating disorder. Purging behaviors are most common in young adult women, with community point prevalence estimates of any purging ranging up to 2.1% in women and up to 1% in men. (2) Lifetime estimates of purging behaviors are higher, with up to 16.5% of women and 3.3% of men endorsing purging in their lifetime. (3) Among college women, self-induced vomiting (8.8%) and laxative abuse (8.3%) are the most common purging behaviors, followed by diuretic abuse (6.6%). (4) Some women engage in multiple methods of purging, with 7% of women in a college-based setting reporting using multiple methods of purging in their lifetime. (5) The prevalence of purging behaviors in eating disorder patients has ranged from 56.6% (6) to 86.4% (7) for self-induced vomiting, 26.4% (8) to 56.3% (7) for laxative abuse, and 49.1% (7) for diuretic abuse. The use of multiple purging methods has been reported to range from 13% to 52.5% of individuals with eating disorders characterized by purging. (7,9–11) Notably, these prevalence estimates of purging behaviors in eating disorder populations may be elevated as these studies were typically conducted in normal weight populations and/or examined specific groups (e.g., bulimia nervosa, purging subtype).

Eating disorders are associated with increased risk of death, (12,13) in part due to increased medical complications attributed to purging. This underscores the need for health professionals to become aware of the medical complications associated with the major methods of purging. Thus, the current paper reviews the medical complications associated specifically with purging behaviors, focusing on self-induced vomiting, laxative abuse, and diuretic abuse. Articles were identified by searching PubMed using the terms “purging,” “self-induced vomiting,” “laxative abuse,” and “diuretic abuse,” and by searching these terms with “medical complications.” Within these articles, relevant references were identified and reviewed. Only articles where complications could be specifically linked to purging behaviors, rather than low weight, binge eating, or other eating disorder symptoms, were included in the review. We would have liked to perform a systematic review in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) style. However, most studies were case reports or had small sample sizes, thus limiting a meaningful review based on the PRISMA guidelines. Thus, the current paper reviews medical complications associated with self-induced vomiting and laxative and diuretic abuse, briefly reviews other methods of purging, and reviews the association of purging behaviors with mortality.

## Self-induced Vomiting

Vomiting often is induced by stimulation of the pharynx (back of the throat) to induce the gag reflex and can become an “automatic” or conditioned behavior after eating. Inducing the gag reflex causes the abdominal walls to contract and expel gastric content. The esophagus and mouth are then exposed to the acidic milieu of the stomach, which disturbs the typical milieu of the esophagus and mouth. Repeated vomiting is associated with dehydration and loss of electrolytes, such as potassium.

Self-induced vomiting is among the most frequent purging behaviors associated with anorexia nervosa binge/purge subtype, bulimia nervosa, and purging disorder. (7,14) When self-induced vomiting was initially identified in the medical literature, Russell's sign was noted as a common co-occurring consequence. (15) Russell's sign is the presence of lesions or scars on the hands caused by repeated scraping of the back of the hand against the upper teeth during gagging to induce vomiting. Although this has been described in a number of case reports, (15–18) this consequence may be seen much less clinically than previously estimated. (19) Subconjunctival hemorrhages, small bleeds in the eyes, are another observable consequence associated with self-induced vomiting. (20) Thus, the presence of Russell's sign or subconjunctival hemorrhages may indicate the presence of self-induced vomiting.

### Dental complications

Dental abnormalities are prevalent in patients with eating disorders. Conviser and colleagues (21) surveyed 201 individuals seeking treatment for an eating disorder and found the majority of participants had self-reported enamel erosion (63%) and sensitive teeth/gums (69%). Over a third reported tooth pain (42.9%), caries (37.1%), and gingival recession (39.1%), and 20% reported dental lesions. A study of eating disorder outpatients who received a dental exam demonstrated similar rates of dental erosion in patients who engaged in self-induced vomiting. (22) Problematically, the majority of participants (70%) in Conviser and colleagues' study had not disclosed their eating disorder to their dental professional due to embarrassment and fear. (21) Indeed, individuals with eating disorders are more fearful of dental visits than individuals without eating disorders, possibly contributing to decreased treatment seeking and the worsening of dental problems over time. (23)

While some dental complications in patients with eating disorders may be due to poor nutrition (e.g., acidic beverages) or dehydration, most dental complications appear to be primarily related to self-induced vomiting as a consequence of stomach acid washing over teeth and gums. (24–26) Indeed, a recent systematic review and meta-analysis supports that self-induced vomiting is particularly linked with increased risk of tooth erosion. (27) These dental erosions are most common on the occlusal surfaces (the “biting” surface of molars) and palatal surfaces of the front teeth (i.e., facing the palate). (22) The likelihood of dental erosions is positively associated with duration of self-induced vomiting. (25) Longer duration of self-induced vomiting (i.e., greater than 10 years) is associated with a different distribution of dental erosion, specifically more buccal (side of tooth adjacent to cheeks) and palatal lesions in the lateral segments of the mouth. (22) Longer duration of self-induced vomiting also is associated with more severe dental damage, specifically lesions of the dentin, the hard, calcareous tissue that lies beneath the enamel. (22)

The extant literature has identified individual differences in dental complications associated with self-induced vomiting. More dental erosion is observed in those who eat more sweetened and acidic foods (25) and those with higher salivary viscosity. (28) Consuming water before vomiting may be protective against the development of dental erosion. (25) In contrast, tooth brushing immediately after vomiting is associated with dental erosion, (25)

which is concerning as approximately one-third of individuals with eating disorders report brushing their teeth after vomiting. (21) However, the deleterious effect of tooth brushing has not been found in all studies. (26) Some have hypothesized that salivary pH and salivary production (22) play roles in dental erosion due to vomiting. In line with this hypothesis, one study found that individuals with bulimia nervosa reported xerostomia (dry mouth) more frequently and had lower unstimulated whole saliva flow rates than healthy controls. (29) However, studies generally have not found differences in pH and salivary production between eating disorder groups with binge eating and vomiting behavior and healthy controls (30) or between individuals with eating disorders who engage in self-induced vomiting compared to individuals with eating disorders who do not. (28,29)

The cessation of self-induced vomiting is a major treatment goal because vomiting is associated with a number of negative consequences. Consistent with the psychoeducation component of cognitive-behavioral therapy, (31) highlighting the medical complications caused by self-induced vomiting might help promote abstinence and recovery in patients while decreasing possible complications. (31–33) Patients who find it difficult to stop vomiting immediately should be advised the following in order to reduce damage to the dental system: 1) avoid tooth brushing after vomiting; (25) 2) rinse the mouth with water or fluoride solution after episodes; (34–36) 3) regularly brush teeth with fluoride toothpaste (outside of vomiting episodes) and floss teeth daily; (37) and 4) have regular dentist visits for regular dental care. (37)

### Parotid Glands

A case-control study found that patients with eating disorders are more likely than matched controls to have parotid gland (salivary gland located near mouth and ear) swelling, also called parotid sialadenosis. (24) A review of case studies suggests that parotid gland swelling is a consequence of self-induced vomiting specifically. (38–41) Parotid gland swelling tends to appear in the days following the *cessation* of self-induced vomiting (40) and can be painful. Serum amylase elevation has been documented with parotid gland enlargement (38) and is correlated with self-induced vomiting frequency in some patients. (42) However, comparisons of individuals who purge with and without binge eating suggest serum amylase elevation may be due to binge eating, as serum amylase was not elevated in those with purging disorder and was not associated with frequency of self-induced vomiting. (43) Enlargement of the minor salivary glands (e.g., submandibular salivary gland) in eating disorder patients has also been reported. (41,44) In most cases the glands will normalize with treatment of the eating disorder and cessation of vomiting. Although quite controversial and considered contraindicated by some, (45) parotidectomy has been reported in the literature for severe cases. (46) In lieu of a parotidectomy, using tart candy to stimulate saliva production can be helpful in minor cases. In more severe cases, pilocarpine may be prescribed to increase saliva in the mouth and reduce discomfort from the parotid swelling. (47)

### Oral Bleeding

A less frequent presentation indirectly associated with self-induced vomiting is bleeding in the oral cavity from using an instrument (e.g., spoon) to induce vomiting. (48) Repeated

mechanical stress and/or the acid present in vomit may contribute to necrotizing sialometaplasia, which is a palatal ulcer caused by the death of minor salivary gland tissue from trauma. (49,50) Self-induced vomiting is a hypothesized causal factor in some cases of tonsillitis. (51) Additionally, facial petechial hemorrhages (small spots on the skin caused by broken capillaries), (52) perioral erythema (reddening around the mouth), (17) and temporary facial purpura (“mask phenomenon” or a rash of purple spots on the skin) (17,53) have been attributed to self-induced vomiting.

### Esophagus and Stomach

The repeated exposure of the esophagus to stomach acid causes irritation and/or damage to the mucosal wall lining. In a study of patients with bulimia nervosa, a quarter of the patients had mild esophagitis and symptoms of gastroesophageal reflux, frequent retrosternal burning (heartburn) and acid regurgitation. (54) Another 16% of those patients had superficial mucosal erythema in the stomach or duodenum (red and irritated lining). The presence of these symptoms was not associated with the duration or severity of purging behavior. It may be that intraindividual sensitivity to esophagus damage, rather than the presence of more frequent purging behaviors, is associated with the presence and severity of esophagus damage. Laryngopharyngeal reflux (stomach acid reaching the throat) has been reported in singers with bulimia nervosa who engage in self-induced vomiting, laxative abuse, and/or diuretic abuse. (55) This was associated with hoarseness, “burning throat,” heartburn, thick mucous over the larynx, enlargement of tissue joining the vocal folds, and dilated capillaries (telangiectasia). Hoarseness can be a general sign of self-induced vomiting given that stomach acid in vomit may irritate the vocal chords and surrounding tissue. (56)

Another problem that may be associated with self-induced vomiting is disordered esophageal motor activity, including complications such as achalasia (muscles of lower esophagus do not relax) and esophageal spasm (irregular contractions). (57) Notably, these symptoms were not related to the frequency or duration of self-induced vomiting. (57) Additionally, one study did not find evidence of abnormal esophageal motility in eating disorder patients, although esophageal symptoms such as dysphagia (inability to swallow oral contents normally) and odynophagia (painful swallowing) were more common in eating disorder patients than in matched controls. (58) Thus, although it is not certain that vomiting causes esophageal abnormalities, it is prudent to assess for these symptoms in individuals with purging behaviors.

Taken together, although esophageal disorders appear to be elevated in eating disorder populations, the cause of this association remains unknown. We are not aware of any research on specific interventions that would benefit the throat and esophagus after self-induced vomiting. Generally beneficial interventions include sipping small amounts of water or sucking on ice chips in order to reduce the acidic milieu as well as replenish fluids. (59) In the case of severe dehydration, oral rehydration powders, dissolved in water, can be used under medical supervision. (60) In clinical practice, proton-pump inhibitors are used to ease symptoms of indigestion associated with eating disorders. This type of medication may be of some benefit to individuals who self-induce vomit, as it has been used to treat indigestion in non-ulcer dyspepsia. (61,62) Notably, the discontinuation of these

medications may induce a dyspepsia syndrome (e.g., nausea, heartburn) due to acid rebound hypersecretion. (63)

Finally, disagreement exists around the relationship between self-induced vomiting and esophageal cancer. Gastroesophageal reflux (GERD) is associated with Barrett's Esophagus, a condition where the normal squamous cell mucosa is replaced by metaplastic columnar mucosa (i.e., change in cells resulting in abnormal tissue), due to the irritation by stomach acid. (64) It is hypothesized that recurrent self-induced vomiting irritates the esophageal mucosa, increasing cancer risk. One case study of a 31-year-old woman attributed squamous cell carcinoma (cancer) to a history of self-induced vomiting. (65) A study of the Transkei population in South Africa, a group that has high rates of esophageal cancer, drew similar conclusions. (66) The authors found that self-induced vomiting was associated with increases in risk factors for esophageal cancer, perhaps due to associations with gastroesophageal reflux. (66) A linked records study examined risk of esophageal cancer among individuals who were previously hospitalized for an eating disorder. (67) Patients who had previously received eating disorder treatment had an elevated standardized incidence ratio of esophageal cancer, specifically squamous cell carcinoma. However, the authors concluded that the elevated incidence of esophageal cancer was likely due to comorbid problematic behaviors (i.e., tobacco and alcohol use), rather than self-induced vomiting. (67) Notably, because eating disorder cases were chosen from records due to their history of eating disorder treatment and specific eating disorder behaviors were not coded, the authors were not able to examine whether history of self-induced vomiting was linked to esophageal cancer.

### Gastrointestinal Tract

Rectal prolapse (wall of rectum slips out of place) at an atypically young age of onset has been documented in seven women with bulimia nervosa, of whom six used self-induced vomiting and one employed an unknown method of purging. (68) All women had rectal bleeding, and five of the seven had lax sphincter tone. The authors hypothesized that constipation or intra-abdominal pressure from vomiting could be the mechanism of association. Case studies suggest that the pressure and force of self-induced vomiting can cause the rupture of the posterior gastric artery, (69) tears of the gastrosplenic ligament, which connects the stomach and spleen, and tears of the greater omentum, which is a membrane attached to the stomach. (70) As both of these case studies were reported in men, it is unknown if relatively higher musculature or muscle strength may contribute to more forceful vomiting and greater likelihood of tearing.

A seemingly rare but potentially high impact problem comes from the forceful contraction of the stomach during vomiting. This may cause gastroesophageal intussusception, a condition in which the stomach slides up and becomes enfolded within the esophagus. Gastroesophageal intussusception can cause obstruction and is a precursor to Mallory-Weiss tears, or tears at the membrane where the esophagus and upper part of the stomach meet. (71) Both vomiting and binge-eating/overeating were identified as risk factors for gastroesophageal intussusception in one retrospective study of 43 patients. (71) A case study



suggested that self-induced vomiting may cause hiatal hernia, but this is a rare complication. (72)

A study of eating disorder patients found that irritable bowel syndrome had a prevalence of 68.8% and was associated with presence of self-induced vomiting. (73) As there is no clear link between the two conditions, the mechanism of this association is unknown. In contrast, another study found that irritable bowel syndrome was associated with laxative use; (74) however, the cross-sectional nature of the study leaves temporal precedence unknown.

### **Other complications**

There are additional rare complications of self-induced vomiting. A few case reports described hyoid bone fracture (52,75) or subcutaneous emphysema (air trapped in the tissue below the skin) on the soft tissues of the neck and anterior chest wall in individuals who engaged in self-induced vomiting. (76) Indirectly associated with self-induced vomiting are accidental ingestions of instruments used to induce vomiting, including both metal and plastic silverware and toothbrushes. (48,77–81) This increases the risk for perforations in the gastrointestinal tract, abscesses, or dysphagia. Case reports indicate that ipecac abuse to induce vomiting can be associated with muscle weakness (82–85) and skeletal muscle abnormalities. (83,86)

### **Cardiovascular Complications**

Cardiovascular complications are extreme, rare adverse events that have been reported as a result of the use of agents to induce vomiting. Cardiac complications appear to be due to hypokalemia as a consequence of self-induced vomiting, leading to prolonged QT intervals, which are markers for arrhythmias, due to potassium deficits. (87) Abuse of ipecac to induce vomiting has been associated with a number of cardiac complications including damage to the heart muscles, (82,85,86,88) congestive heart failure, (84) tachycardia (accelerated heart rate), (83,86,89) hypotension, (86,89) and death. (86,89) Indeed, the complications associated with ipecac abuse led to the discontinuation of this product on the American market.

### **Laxative and Diuretic Abuse**

Laxatives are a class of medication that includes a variety of drugs with different mechanisms of action. These range from bulking agents to stool softeners and drugs that stimulate the intestinal wall, increase fluid (osmotic laxatives) in the intestine, or reduce absorption (lubricant laxatives) of food in order to speed up the emptying of the intestine. Stool softeners such as docusate increase water absorption by the stool and stimulate contraction of the intestine. They can cause bloating and cramping. Osmotic or hyperosmolar laxatives, such as polyethylene glycol, increase the amount of water in the intestine to soften the stool and decrease constipation and straining. Prolonged abuse can cause electrolyte imbalances. Both stool softeners and osmotic laxatives have a gradual onset of action and are often used to help individuals with eating disorders when they are in treatment. Notably, they should only be used on a short-term basis. Stimulant laxatives, such as bisacodyl or senna glycosides, are taken orally or via rectal suppository and stimulate the

contraction of the intestinal muscles. Stimulant laxatives are typically fast-acting and are particularly prone to abuse. A severe long-term problem associated with stimulant laxative use is the so-called “cathartic colon,” wherein the colon’s motility is impaired (90) and can no longer function normally. The existence of this condition is controversial. The majority of reports of this condition date to the 1960s. This condition may have been caused by podophyllin-containing laxatives, a type of laxative that is no longer sold. (91) Stimulant laxatives do cause brown discoloration of the colon (“melanosis coli”), but this may have no functional importance. It is uncertain whether chronic use of the stimulant laxatives available on the market today cause structural abnormalities or true biological tolerance. (92) Finally, mineral oils are fast-acting laxatives also prone to abuse. If aspirated (i.e., inadvertently enter the lungs while swallowing), mineral oils can cause the serious condition of lipoid pneumonitis (inflammation of the lungs).

Diuretics act on the kidneys to increase urination and reduce body water. Although diuretics typically are used to reduce high blood pressure, individuals with eating disorders may abuse them because they lower body weight by reducing water weight. In order to increase water excretion, diuretics reduce reabsorption of electrolytes such as sodium, chloride or potassium in the kidneys. Thus, these medications can cause severe electrolyte alterations.

## Kidney

Renal inflammation has been associated with the use of laxatives, (93) and longer duration of laxative abuse is negatively associated with poorer creatinine clearance (a measure of kidney functioning) in individuals with anorexia nervosa. (94) Individuals with analgesic nephropathy (kidney damage due to use of analgesic medications like aspirin) are more likely to have a history of laxative abuse, suggesting that laxative abuse may increase vulnerability to other medical conditions. (95)

Concerning diuretic abuse, tubulointerstitial nephritis (swelling of the kidney tubules) has been associated with abuse of the diuretic furosemide. (96) Furosemide abuse is thought to cause changes in the granules of juxtaglomerular cells (cells that produce the enzyme renin) in the kidneys; these changes begin to reverse with the cessation of furosemide use. (97) Finally, renal failure has been attributed to diuretic and laxative use, both in individuals with eating disorders (98,99) and those without eating disorders. (100–102) Renal failure is likely mediated by hypokalemia (low potassium in the blood) in these cases. (98,102)

Calcium and other kidney deposits have been reported in patients with eating disorders. In a sample of 18 adults who abused furosemide, rates of medullary nephrocalcinosis (calcium deposits in the kidneys) were considerably high (83%), and the presence of nephrocalcinosis was more common in those who took larger doses of furosemide. (103) Higher doses also were associated with a greater likelihood of the diffuse type than the rim type of nephrocalcinosis. (103) Laxative abuse was identified as a cause of a specific type of kidney stone, ammonium urate renal calculi, in a sample of nine women who abused laxatives. (104) One case study reported kidney stones in a woman with underlying idiopathic hypercalciuria (excess calcium excretion) who abused laxatives; (105) however, a review of the literature by these authors suggested that individuals with eating disorders may be protected from calcium oxalate kidney stone formation. (105) Thus, laxative and diuretic



abuse contribute to specific renal complications, such as nephrocalcinosis, but may be associated with lower rates of other renal complications, such as calcium oxalate kidney stones.

In summary, the kidneys may be severely affected by purging behavior. It is imperative to have medical professionals who treat patients with an eating disorder cover these aspects of disease and intervene when necessary. Staging of a potential kidney disease is necessary, including assessment of glomerular filtration rate, whether there is proteinuria (protein in the urine), whether there is blood in the urine (hematuria) or whether there are white blood cells. The referral to a nephrologist is advisable if kidney damage is likely, especially because the typical laboratory values (e.g., glomerular filtration rate using creatinine clearance) can be confounded by low muscle mass. (106)

### **Gastrointestinal Tract**

One study of 185 eating disorder inpatients found that self-reported laxative use over the past three months was associated with pelvic floor dysfunction, bowel dysfunction, and abdominal discomfort, (107) suggesting that laxative abuse may contribute to these conditions. However, another study found no association with changes in purging behaviors and the presence of functional gastrointestinal disorders over a 12-month period in a sample of 73 eating disorder inpatients. (108) Thus, temporal and causal associations between purging and functional gastrointestinal disorders remain unclear.

Colorectal cancer has been hypothesized to be related to laxative abuse, but the literature is not conclusive. Anthranoid containing laxatives (e.g., aloe, cascara, etc.) have been associated with increased risk of colorectal cancer. (109) Although one epidemiological study suggests that more frequent laxative use may be associated with a modest increase in colorectal cancer risk, (110) numerous other studies have not found an association between laxative use and colorectal cancer. (111–113) Taken together, laxative use does not have a strong association with cancer risk.

### **Cardiovascular Complications**

Use of laxatives and diuretics has been associated with cardiac arrest and seizures. (114) Additionally, laxative abuse has been associated with a specific type of tachycardia - torsades de pointes - secondary to hypokalemia. (115) Cardiac failure was documented in response to laxative withdrawal in a 60-year old woman, (116) and the change of diuretics was associated with hypokalemic cardiac arrest in another case. (117) Hypokalemia appears to mediate these cardiac complications. With these potential complications in mind, the medical work-up of patients with eating disorders should incorporate labs including electrolytes and EKG.

### **Muscular-Skeletal Complications**

Rhabdomyolysis (break down of muscle tissue) was reported as a consequence of hypokalemia and dehydration following diuretic and laxative abuse. (98) The clinical symptoms of rhabdomyolysis include muscle weakness, tender muscles, and dark, tea colored urine. This is a medical emergency that is typically treated with hydration. Dialysis

also may be used in the case of severe kidney damage. Hypokalemic paralysis as a result of diuretic abuse also has been reported. (118) Finally, abuse of the laxative phenolphthalein has been associated with osteomalacia (softening of the bones). (119) Osteomalacia is a condition of abnormal bone formation associated with aching pain at night or when weight is put on the bone. The disorder increases likelihood of fractures and can be diagnosed with careful clinical exam, laboratory tests for serum calcium and phosphorus, X-ray and, if needed, bone biopsy. Signs for rhabdomyolysis and osteomalacia should become apparent during the medical work in the context of eating disorders.

### Other Complications

There are various organ systems that are particularly affected by laxative and diuretic abuse. Laxative abuse has been associated with chronic or nocturnal diarrhea, (93,120–124) constipation, (93) laxative dependence, (125) bloody stool, (124) bleeding, (126) and abdominal tenderness, (121,124) in addition to melanosis coli (darkening of the colon) (123,124,127,128) and gastric melanosis (darkening of the stomach). (129) In addition to colon problems, one case study documented hyperplasia (cell proliferation) in pancreatic islet cells. (130) A larger study of treatment-seeking patients suggested that laxatives may damage the pancreas, interfering with insulin secretion. (131) Both laxative abuse and diuretic abuse are associated with finger clubbing (enlargement of soft tissue beneath finger nails). (121,124,127,133–135) Finally, the abuse of senna has been associated with acute hepatic failure. (132) In summary, laxative and diuretic abuse are associated with severe medical complications that affect multiple organ systems. Due to these complications, every effort should be made to stop abuse of these substances.

### Other Purging Behaviors

Although not covered in this review, clinicians and medical professional should be aware that medicines may be abused to induce vomiting (e.g., ipecac) or may be abused to manage weight. For example, thyroid medications are sometimes abused in eating disorders. Increasing thyroid action increases metabolism, which may lead to weight loss. Common side effects of thyroid medication misuse include nervousness, insomnia, and anxiety, whereas severe side effects include hypertension, cardiac arrhythmias, and heart failure. (136) Similarly, although not covered in this review, individuals with diabetes may purge by omitting insulin in order to avoid weight gain or to induce weight loss. By omitting insulin, the blood glucose is prevented from entering cells to provide energy and is prevented from being stored as fat. Instead, glucose is excreted by frequent urination. Insulin omission increases blood sugar, potentially causing life-threatening hyperglycemia or damage to kidneys and eyes by injury to small blood vessels. (137,138) Adolescents are particularly prone to non-compliance with the insulin regimen. (139) Finally, professionals should be aware some individuals abuse illicit substances, such as cocaine, to manage weight.

### Mortality

Mortality is elevated in eating disorders, (13) although the connection between eating disorders and early death is unclear in some cases. One cause of early mortality is suicide, with one review identifying that approximately 20% of deaths in anorexia nervosa are due to

suicide. (13) One study found null results when examining purging behaviors as a distal prospective risk factor for death. (140) Importantly, difficulties identifying the cause of death using death certificates limit the ability to examine purging as a proximal cause of death. (141) For example, in some cases, the eating disorder is listed at the cause of death, which does not indicate which feature of the eating disorder (i.e., purging, low weight, the combination of the two, etc.) contributed to death. It seems likely that cardiac complications, such as those associated with hypokalemia (142) or the use of ipecac syrup, (86,89,143) may be one route through which purging behaviors are a proximal cause of death in eating disorders. However, the proportion of deaths accounted for by purging is unknown. Of note, alcohol use problems are both distally and proximally related to mortality in eating disorders, (140,144) suggesting those treating eating disorders should also monitor patient's alcohol use. Purging and alcohol use problems may share similar etiology in elevated impulsivity. (145,146)

## Discussion

This qualitative review revealed that self-induced vomiting, laxative abuse, and diuretic abuse are associated with a number of health complications, ranging from issues affecting the teeth (e.g., dental erosion), to the heart (e.g., cardiac arrest), to the gastrointestinal system (e.g., rectal prolapse), to the kidneys (e.g., renal failure). These complications can be found in any eating disorder characterized by purging, including anorexia nervosa, bulimia nervosa, and purging disorder and reinforce the clinical significance of all syndromes in which purging recurs. The range of complications highlights the importance of regular medical check-ups in individuals with eating disorders. The medical work-up for individuals with eating disorders should include a comprehensive metabolic panel, complete blood count to exclude occult bleeding and neutropenia (low count of neutrophils, a type of white blood cell), and a full body exam including the teeth to prevent severe complications.

Although very little work has examined medical complications linked to purging in purging disorder specifically, a five-year follow-up study of patients with purging disorder found a crude mortality rate of 5%, which was significantly greater than that found for patients with bulimia nervosa purging subtype (1.1%). (12) The cause of death was documented in seven of the eleven patients with purging disorder, and of these, three were likely related to purging behaviors (i.e., renal failure, multi-organ failure, circulatory collapse). (147) Two deaths were not directly attributable to purging behavior (suicide, breast cancer) while two other deaths may have been exacerbated by purging (pulmonary embolism, cardiac failure due to hypoglycemia).

Methodologically, much of the available literature about the medical complications of purging comes from case studies, and thus causality cannot necessarily be inferred. While groups of case studies provide stronger evidence for hypotheses regarding the effects of purging, the absence of control groups constrains conclusions. Additionally, many of these studies are confounded by the presence of multiple problematic behaviors (e.g., binge eating and self-induced vomiting in an underweight individual), possible preexisting conditions (e.g., gastrointestinal disorders) and by the possibility that individuals may not be disclosing all relevant behaviors (e.g., use of laxative tea).

More thorough epidemiological studies of health consequences associated with purging would be useful in estimating the likelihood of specific complications in relation to specific purging methods and contribute to better screening procedures. An understanding that certain medical problems may signal the presence of purging will help general practitioners and specialists outside the field of eating disorders identify possible eating disorder cases and refer these individuals for appropriate treatment. Additionally, clinicians who specialize in the treatment of eating disorders may use this information to ensure their patients are screened for possible complications that may require medical attention. Identification of mechanisms that worsen complications (e.g., brushing teeth after vomiting) can be helpful with informing providers and patients how to minimize the development and/or worsening of complications while treatment is underway. In summary, given the increased risk of death observed in eating disorder patients, (12,13) it is imperative to include medical professionals in diagnosis and treatment of eating disorders in addition to mental health professionals. Furthermore, while purging behaviors typically have been associated with bulimia nervosa and to a lesser degree with anorexia nervosa, it is important to educate health professionals that purging disorder also is a severe eating disorder. Health providers need to be aware of medical complications associated with purging behaviors in order to minimize bodily damage and prevent potentially fatal outcomes.

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