

Management of a Child with Vomiting

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Abstract Vomiting is a protective reflex that results in forceful ejection of stomach contents up to and out of the mouth. It is a common complaint and may be the presenting symptom of several life-threatening conditions. It can be caused by a variety of organic and nonorganic disorders; gastrointestinal (GI) or outside of GI. Acute gastritis and gastroenteritis (AGE) are the leading cause of acute vomiting in children. Important life threatening causes in infancy include congenital intestinal obstruction, atresia, malrotation with volvulus, necrotizing enterocolitis, pyloric stenosis, intussusception, shaken baby syndrome, hydrocephalus, inborn errors of metabolism, congenital adrenal hypoplasia, obstructive uropathy, sepsis, meningitis and encephalitis, and severe gastroenteritis, and in older children appendicitis, intracranial mass lesion, diabetic ketoacidosis, Reye's syndrome, toxic ingestions, uremia, and meningitis. Initial evaluation is directed at assessment of airway, breathing and circulation, assessment of hydration status and red flag signs (bilious or bloody vomiting, altered sensorium, toxic/septic/apprehensive look, inconsolable cry or excessive irritability, severe dehydration, concern for symptomatic hypoglycemia, severe wasting, Bent-over posture). The history and physical examination guides the approach in an individual patient. The diverse nature of causes of vomiting makes a "routine" laboratory or radiologic screen impossible. Investigations (Serum electrolytes and blood gases, renal and liver functions and radiological studies) are required in any child with dehydration or red flag signs, to diagnose surgical causes. Management priorities include treatment of dehydration, stoppage of oral fluids/feeds and decompression of the stomach with nasogastric tube in patients with bilious vomiting. Antiemetic ondansetron (0.2 mg/kg oral; parenteral

0.15 mg/kg; maximum 4 mg) is indicated in children unable to take orally due to persistent vomiting, post-operative vomiting, chemotherapy induced vomiting, cyclic vomiting syndrome and acute mountain sickness.

Keywords Children · Vomiting · Antiemetic

Introduction

Vomiting is a very common complaint in infants and children who present to the emergency department (ED). A large percentage of infants and children with vomiting have a non-serious etiology for their symptoms and have a self-limiting illness. However, vomiting may be the presenting symptom in several life-threatening conditions. The ED management is primarily tailored to identify and manage those with a serious underlying cause, and provide symptomatic relief to others.

Terminology

Vomiting is a complex behavior. It is usually composed of three linked activities: nausea, retching and expulsion of stomach contents.

Nausea is a sensation of impending emesis and is frequently accompanied by autonomic changes, such as increased heart rate and salivation. Vomiting can occur without preceding nausea, for *e.g.*, projectile vomiting in individuals with increased intracranial pressure.

Retching is defined as strong, involuntary efforts to vomit but without expelling material from the mouth, which may be seen as preparatory manoeuvres to vomiting.

Vomiting is a protective reflex and is defined as forceful ejection of stomach contents up to and out of the mouth [1].

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It is caused by violent co-ordinated contraction of the diaphragm and abdominal muscles accompanied by pyloric constriction and gastroesophageal relaxation in response to stimulation of the medullary vomiting centre. This stimulation may occur from a variety of impulses -from pelvic and abdominal viscera, the heart, the peritoneum, the inner ear, and the chemoreceptor trigger zone (caused by circulating drugs, toxins, and metabolic derangements). Vomiting is complete emptying of the stomach as compared to *regurgitation*, which is nearly effortless return of short amount of food during or shortly after eating. When regurgitation occurs in a baby at or after milk feed, it is known as *possetting*.

Causes

Vomiting does not always localize the problem to the GI system. A variety of organic and non-organic disorders, gastrointestinal (GI) or outside of GI, can be associated with vomiting. Acute gastritis and gastroenteritis (AGE) are the leading causes of acute vomiting in children. Although vomiting is a fairly frequent occurrence in a younger child, it tends to be less prevalent in older children [2]. The differential diagnosis of isolated vomiting is broad and age specific (Table 1). Non-organic causes are difficult to

identify and often are viewed as diagnoses of exclusion. Examples of non-organic causes are psychogenic vomiting, cyclic vomiting syndrome, abdominal migraine, and bulimia. Mnemonic ‘VOMITINGS’ can help to remember wide ranging causes of vomiting:

- **Vestibular:** Otitis media
- **Obstruction:** Pyloric stenosis, malrotation, volvulus, intussusception, incarcerated hernia
- **Metabolic:** Diabetic ketoacidosis, inborn errors of metabolism, congenital adrenal hyperplasia, Reye’s syndrome
- **Infections:**
 - Gastrointestinal- Gastritis, gastroenteritis, necrotizing enterocolitis, appendicitis, hepatitis, pancreatitis, cholecystitis.
 - Other systems- Upper respiratory infections, pharyngitis, sinusitis, pneumonia, sepsis
- **Toxins and drugs:** Various poisons, chemotherapeutic agents, iron, organophosphates, theophylline, salicylates, alcohol, lead and other heavy metals.
- **Increased intracranial pressure** from any etiology.
- **Nephrologic disease :** Acute renal failure, chronic renal failure, pyelonephritis, renal tubular acidosis, obstructive uropathy.

Table 1 Illnesses presenting with vomiting according to the age group

	Neonate	Infant	Toddler/older child	Adolescent
Common	Reflux	Food poisoning	Gastroenteritis/Gastritis	Gastroenteritis/Gastritis
	Pyloric stenosis	Gastroenteritis	Nonspecific (Otitis, sore throat, sinusitis)	GERD
	Sepsis	GE Reflux	Post tussive	Appendicitis
	UTI	Post tussive	UTI	Ingestion (toxic, bacillus cereus)
	Malrotation	Overfeeding	Meningitis	Migraine
	Esophageal atresia	Feed intolerance	Toxic/Poisoning/Drugs	Inflammatory bowel disease
	Inborn error of metabolism (IEM)	UTI	GERD	Toxic/Poisoning/Drugs
	Hydrocephalus	Nonspecific (otitis media, pneumonia)		Obstruction
	Milk allergy			
	Uncommon	Congenital Adrenal Hyperplasia	IEM	DKA
Incarcerated hernia		Renal Tubular Acidosis	IEM	DKA
Ileus		Obstruction	Hepatitis	Peptic ulcer
Hirschprung disease		Malrotation	Migraine	Psychological
Intracranial bleed		Intussusception	Peptic ulcer	Pancreatitis
		Milk allergy	Pancreatitis	Cholelithiasis
		Renal insufficiency	Raised ICP (Brain Tumor)	Renal colic
		Raised ICP	Reye’s syndrome	Raised ICP (Brain tumor)
			Cyclic vomiting syndrome	Middle ear disease
				Cyclic vomiting

IEM Inborn error of metabolism; *DKA* Diabetic Ketoacidosis ; *GE* Gastro esophageal; *UTI* Urinary tract infection; *ICP* Intracranial pressure; *GERD* Gastroesophageal reflux diseases

- **Gastrointestinal:** Gastro -Esophageal reflux (GER), formula intolerance, peptic ulcer disease, cyclic vomiting syndrome.
- **Genital system:** Testicular torsion, epididymitis, dysmenorrhea, ovarian torsion, pelvic inflammatory disease.

Evaluation

Evaluation of a child with vomiting in ED comprises assessment of severity (*e.g.*, presence of dehydration, surgical or other life-threatening disorders) and diagnostic search for a cause. This is achieved through focussed history (including characteristics of vomiting and associated symptoms) and physical examination, and consideration of possibilities according to the age (Fig. 1).

The initial diagnostic focus is on likely acute GI or systemic infections and exclusion of surgical causes. In infancy, the life threatening causes include congenital intestinal obstruction, atresia, malrotation with volvulus, necrotizing enterocolitis, pyloric stenosis, intussusception, shaken baby syndrome, hydrocephalus, inborn errors of metabolism, congenital adrenal hyperplasia, obstructive uropathy, sepsis, meningitis and encephalitis, and severe gastroenteritis. In older children, life threatening causes that need attention are appendicitis, intracranial mass lesion, diabetic ketoacidosis, Reye's syndrome, toxic ingestions, uremia, and meningitis.

Initial Evaluation

Initial evaluation is directed at assessment of airway, breathing and circulation *i.e.*, checking the vitals (heart rate, respiratory rate, blood pressure, capillary refill time and SpO₂), assessment of hydration status and Red flag signs (Table 2). If red flag signs, seek gastroenterologist and surgical consult.

If vomiting is non-bloody and non-bilious, the important diagnostic variables in history which help in making diagnosis are described below.

Age

Causes of vomiting vary with the age of the child (Table 1). However, some overlap across the age groups can occur. For *e.g.*, congenital anomalies of the GI tract present commonly in the neonatal period; yet webs and duplications can be discovered throughout childhood. Malrotation or non-fixation of the small intestine complicated by intermittent volvulus can cause episodic vomiting at any age. Duodenal hematoma typically follows accidental trauma to the abdomen in bicycling children but can result from abuse of toddlers. [3]

Temporal Pattern of Vomiting (Table 3)

Acute vomiting episode, which is abrupt onset of vomiting in previously well child, is the most common presentation in children. Episodes separated by not more than 2 min are

Fig. 1 Algorithm for evaluation of a child with vomiting in emergency room – based on presence of other symptoms, type of vomitus, age, and physical signs

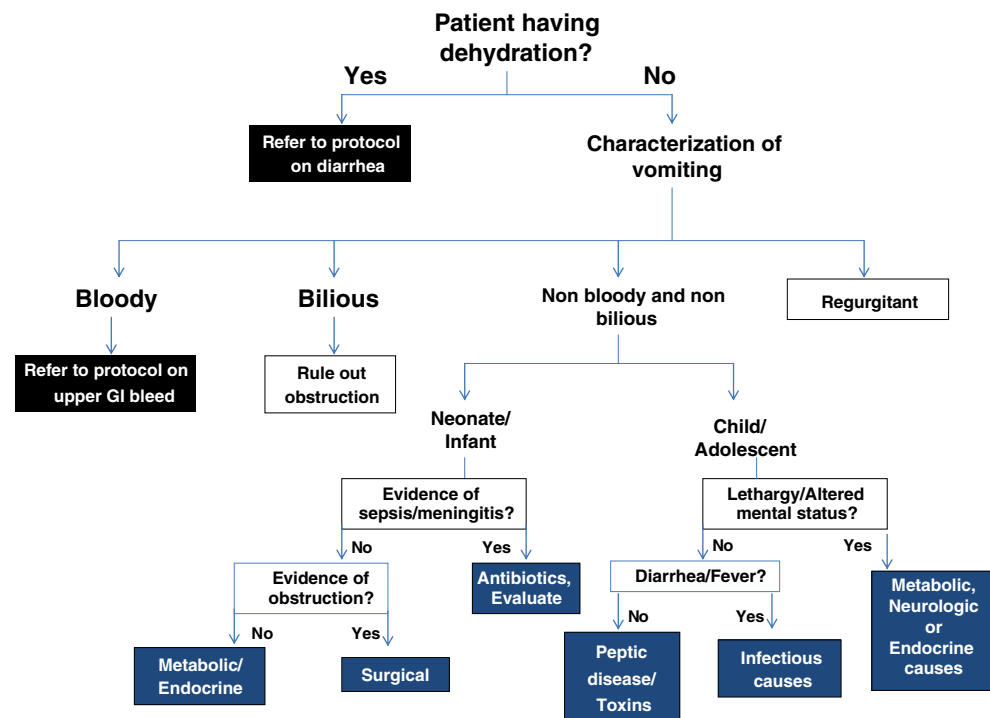


Table 2 Red flag signs in a child presenting with vomiting

- Altered sensorium (cause or effect)
- Toxic/ septic /apprehensive look
- Bilious or bloody vomiting
- Presence of inconsolable cry or excessive irritability (meningitis, intussusception)
- Signs of severe dehydration or concern for symptomatic hypoglycemia
- Visible severe wasting
- Bent-over posture (drawing of legs up to the chest), and pained avoidance of unnecessary movement typical of peritoneal irritation (peritonitis, intussusception)

counted as a single episode. *Recurrent vomiting* is defined as at least 3 episodes occurring over 3 mo period. Recurrent vomiting is further subdivided into *chronic* vomiting, which is low grade frequent (>2/wk) vomiting episodes, and *episodic* or *cyclic* vomiting, which is discrete episodes of high intensity vomiting that occur sporadically in between asymptomatic intervals. *Cyclic vomiting syndrome* is distinct clinical entity. It is important to elicit temporal pattern of vomiting because any single attack of episode or cyclic vomiting may resemble an acute vomiting attack.

Time of day vomiting occurs can give some clue to diagnosis. Vomiting consistently in early morning is common with increased intracranial pressure from various causes and cyclic vomiting syndrome.

Contents of Vomiting

Contents of vomiting gives important clue to diagnosis and sometimes helps in identifying serious illness. These are given in Table 4.

Relationship with Diet

Vomiting is aggravated by food in patients with gastritis, cholecystitis, pancreatitis, protein allergy, and hereditary

fructose intolerance. History of binge eating should be asked when behavioral cause is suspected.

Associated Symptoms

GI Symptoms

- Diarrhea: Gastroenteritis (diagnosis is made if vomiting and diarrhea both are present), bacterial colitis, inborn error of metabolism and partial intestinal obstruction.
- Abdominal pain and its location
 - Generalized : [peritonitis, abdominal migraine (recurrent)]
 - Substernal : Esophagitis
 - Epigastric: Gastritis, pancreatitis
 - Right upper quadrant : Cholelithiasis, pneumonia
 - Right lower quadrant : Appendicitis (vomiting after pain)
 - Lower abdominal or suprapubic- UTI

Extra Intestinal Symptoms

- Sore throat, ear pain: Sinusitis, otitis media
- Urinary retention, dysuria: Urinary tract infection, pyelonephritis
- Jaundice: Hepatitis, biliary disorders
- Headache: Allergy, chronic sinusitis, migraine
 - Nocturnal or early morning worsened by coughing or valsalva manoeuvre
- Vertigo: Migraine, Meniere disease
- Rash or urticaria: Food allergy, Henoch Schonlein purpura
- Back pain- Pyelonephritis

History of Toxic Ingestions: Food, iron, alcohol, organophosphates

History of Drug Intake: digoxin (vomiting is first sign of toxicity), theophylline, salicylates, chemotherapeutic drugs, acetaminophen

Table 3 Temporal patterns of vomiting

	Acute pattern	Recurrent: chronic	Recurrent: cyclic/episodic
Epidemiology	Most common	2/3 of those with recurrent vomiting	1/3 of those with recurrent vomiting
Etiology	See Table 1	Gastrointestinal (GI) more common than extra-intestinal ones (7:1) Acid peptic disease, <i>H. pylori</i>	Extra-intestinal causes outnumber GI ones (5:1) Cyclic vomiting syndrome (88 %), DKA, Addison disease, metabolic disorders, malrotation, hydronephrosis
Vomiting severity	Moderate to severe ± dehydration	Mild (1–2 emeses/h at peak). Rarely dehydrated	Moderate to severe (6 emeses/h at peak), >50 % require IV hydration
Migraine family history		Up to 14 % positive	Up to 82 % positive

History of recent head trauma, similar symptoms in family or neighbourhood (gastroenteritis, food poisoning, hepatitis)

Physical Examination

The physical examination is directed towards evaluation of degree of toxicity and dehydration and then focused according to possible clinical etiology.

Abdominal Examination

- Look for signs of obstruction such as distension, tenderness, high-pitched bowel sounds (or absent sounds in ileus), or visible peristalsis
- Look for organomegaly
- Genitalia and hernia sites for ovarian/testicular torsion, strangulated hernia
- Per rectal examination: especially when intussusception is suspected.

Clinical features of some common surgical causes of vomiting are given in Table 5.

Extra Abdominal Examination

- Look for icterus (hepatitis, biliary disease), pallor (intracranial bleed), rash or petechiae (CNS infection or bleed)
- Ear examination- Bulging red tympanic membrane (otitis media)
- Abnormal muscle tone : Cerebral palsy (GER), metabolic disorder, mitochondriopathy
- Abnormal fundoscopic exam or bulging fontanelle: Increased intracranial pressure, pseudotumor cerebri
- Neck stiffness, Kernig's and Brudzinski's sign: Meningitis [Sensitivity and specificity of vomiting is 71 % and 62 % respectively for diagnosis of meningitis in a child with clinically suspected meningitis [4]].

Infant Regurgitation is defined as vomiting occurring two or more times per day for 3 or more wk in the first 1–12 mo of

life (2–4 wk commonly) in an otherwise healthy infant [5]. Affected children may appear irritable during or after the feedings and stereotypic opisthotonic movements with extension and stiffening of arms and legs and extension of the head (Sandifer syndrome) occasionally may be observed. Infants who have the classic history of recurrent emesis but who are thriving and have normal physical examination findings do not need specific treatment; up to 95 % of them have resolution of symptoms by 12 mo (majority by 6 mo). Thickening the formula or human milk by adding cereal may help reduce vomiting in such infants, but elevating the head in the supine position has no proven beneficial effect [6].

Infants with severe GER can have recurrent microaspiration into their lungs resulting in chronic wheezing, respiratory symptoms, and even failure to thrive. This is known as GER Disease. Basic reflux precautions such as smaller, more frequent feeds and allowing the infant to remain upright for 30 min after feeds can be helpful. Reassuring the family that most children spontaneously outgrow GER by the age of 1 usually helps alleviate parental anxiety.

Minor Head Injury Minor head injury can present as vomiting in children, especially toddlers [7]. There is evidence to suggest that vomiting after a minor head injury may be related to intrinsic patient factors rather than the severity of the injury [8]. Vomiting that is persistent or latent in onset may more likely to signify head injury.

Rumination Syndrome Rumination syndrome, an under-recognised condition, is characterised by effortless, often repetitive, regurgitation of recently ingested food into the mouth. It was originally described in children and in the developmentally disabled but it is now well-recognised that the condition occurs in patients of all ages and cognitive abilities [9]. The pathophysiology is incompletely understood, but involves a rise in intra-gastric pressure, generated by a voluntary, but often unintentional, contraction of the abdominal wall musculature, at a time of low pressure in the lower oesophageal sphincter, causing retrograde movement

Table 4 Etiology and source of vomiting according to contents of vomitus

Material	Source	Examples
Undigested food	Esophageal	Esophageal stricture, achalasia
Bile: green/yellow	Post-ampullary Distal to ampulla of Vater	Small bowel obstruction (e.g., malrotation), prolonged vomiting of any cause
Digested food, milk curds	Stomach proximal to pylorus	Pyloric stenosis
Blood: red (fresh blood)/brown (old blood)	Lesion above ligament of Treitz: Stomach, esophagus	Gastritis, esophagitis, bleeding diathesis
Clear large volume	Increased gastric secretions	Peritonitis, Zollinger-Ellison syndrome
Malodorous/ feculent	Distal or Colonic obstruction	Malrotation, appendicitis, stasis syndrome
Mucus	Respiratory mucus, gastric	URI, sinusitis, eosinophilic esophagitis

Table 5 Typical clinical presentation of some surgical illnesses which may present with vomiting

Appendicitis	Pre-adolescent child with periumbilical crampy pain and anorexia followed by vomiting. Pain shifts to right lower quadrant and fever may develop. Abdominal pain preceded by vomiting can be helpful in distinguishing appendicitis from acute gastroenteritis
Intussusception	3 mo to 5 y-old (peak 6–11 mo) with intermittent colicky abdominal pain, vomiting, and bloody mucous stools (triad in 20 % to 40 % of cases, and at least two findings in 60 %), appears ill, quiet, or exhausted. Uncommonly classic tender sausage shaped mass on right side of the abdomen and occult blood or frankly bloody, foul-smelling “currant jelly” stool on rectal examination (absence of these does not rule out diagnosis).
Pyloric stenosis	3 wk-3 mo- old infant, with progressively worsening non-bilious vomiting, may appear quite well early in the illness, but often seem frustrated and hungry. As the obstruction increases, the vomiting becomes projectile.

of gastric contents into the oesophagus [9]. A typical history can be highly suggestive but oesophageal manometry may help to distinguish rumination syndrome from other belching/regurgitation disorders [9].

Laboratory Investigations

The diverse nature of causes of vomiting makes a “routine” laboratory or radiologic screen impossible. The history and physical examination must guide the approach in individual patients. Investigations are not required in following conditions and a therapeutic trial of medications should be given if required.

- Well appearing infant with typical regurgitant reflex (no diarrhea, fever, nausea and forceful abdominal contractions)
- Well child with suspected gastritis or gastroesophageal reflux.
- Brief episode of vomiting with no dehydration and clear etiology like gastroenteritis
- Chronic vomiting where acid peptic disease is suspected

Selected tests can give useful clues to diagnosis.

Urinalysis

Presence of glucose and ketones suggest diabetic ketoacidosis; red blood cells suggest a renal cause (nephritis, UTI, renal calculi or trauma); and leukocytes or nitrites suggest a urinary tract infection.

Blood Investigations

In any child with dehydration or red flag signs (Table 2), total blood counts, blood sugar, serum electrolytes, blood gases, Liver enzymes, and renal function tests should be obtained according to the clinical possibility.

- *Serum Electrolytes and Blood Gases:* Typical abnormalities occur in an infant with projectile vomiting from pyloric stenosis (hypochloremic, hypokalemic metabolic alkalosis), congenital adrenal hypoplasia (hyperkalemia and hyponatremia), increased lactate production caused by alcohols, salicylates, uremia, and metabolic defects

(acidosis with elevated anion gap), renal tubular acidosis (metabolic acidosis with a normal anion gap) and renal or prerenal failure (elevated creatinine).

Hepatic or pancreatic enzymes may be elevated in the setting of liver or pancreatic disease.

Radiographic Tests

Radiographic tests are needed to differentiate surgical causes from nonsurgical etiologies.

- *Plain Radiograph Abdomen:* Abdominal X ray (erect preferably) should be done in any child with suspected intestinal obstruction. Upright or cross-table lateral view can reveal distended bowel loops and/or air-fluid levels consistent with intestinal obstruction (in a child with bilious vomiting, abdominal pain and distension); dilated stomach in pyloric stenosis; free air under diaphragm in case of a hollow viscus perforation; abnormal calcifications like renal or biliary stones or fecoliths; and basilar infiltrates caused by lower lobe pneumonias.
- *Ultrasound:* Ultrasonography of abdomen should be obtained according to the clinical possibility. Abdominal ultrasound can be helpful in diagnosis of appendicitis, pyloric stenosis, and intussusceptions. Pelvic ultrasound is the test of choice for renal, ovarian or uterine pathology in children.
- *An Upper GI Series* best demonstrates malrotation and upper gastrointestinal tract obstructions and may sometimes be needed for diagnosis of pyloric stenosis.
- *CT Scan:* A limited CT with rectal contrast can be helpful in diagnosis of appendicitis. An abdominal CT is most useful in imaging the liver and pancreas, and for evaluating mass lesions in the abdomen.

Upper GI Endoscopy

Upper GI endoscopy is useful for defining upper GI mucosal pathology such as acute gastritis, gastric erosions, esophagitis, acute duodenitis, duodenal ulcers, stricture, varices,

mass (polyp, lymphoma), and foreign body impaction. The diagnostic yield of upper gastrointestinal endoscopy in children up to 18 y of age with vomiting in one study from Saudi Arabia was 67 %. [10]

Metabolic Work Up

In a child with episodic vomiting or suspected metabolic disorders, blood and urine screening are positive only during actual vomiting episode. Therefore, attempt should be made to obtain samples (*blood pH, ammonia, lactate, ketones, urine ketones and electrolytes, porphyrins and reducing substances*) during acute episode only.

In chronic vomiting if therapeutic drug trial fails to improve symptoms, screening laboratory tests (complete blood count, ESR, celiac screening, liver enzymes) and abdominal ultrasound can be obtained along with pediatric gastroenterology consultation.

Emergency Management

- Treat dehydration (refer to protocol for diarrhea)
- If bilious vomiting, stop oral fluids/feeds (nil per os – NPO) and decompress the stomach with nasogastric tube. Start intravenous fluids. Seek surgical consult.
- Antiemetics: Antiemetics are not routinely indicated due to concerns about side effects of earlier generation of antiemetics (promethazine, prochlorperazine, and metoclopramide) which cause somnolence, nervousness, irritability, dystonic reactions and other extrapyramidal symptoms. Newer antiemetics such as ondansetron have far fewer side effects [11]. Evidence based on a limited number of studies evaluating the role of ondansetron in the treatment of acute gastroenteritis complicated by vomiting, favour the use of ondansetron and metoclopramide to reduce the number of episodes of vomiting. However, diarrhea increases with both ondansetron and metoclopramide, which is thought to be as a result of retention of fluids and toxins that would otherwise have been eliminated through the process of vomiting [12]. A recent RCT concluded that administration of oral ondansetron in children with acute gastroenteritis with vomiting who are unable to tolerate oral intake decreases vomiting, ratio of hospitalization as well as IV fluid requirement [13].

Use of antiemetics prior to evaluation for surgical abdomen should be avoided. Following are acceptable indications for antiemetics (Ondansetron) in children with vomiting:

1. Child not able to take orally due to persistent vomiting
2. Post-operative vomiting
3. Chemotherapy induced vomiting
4. Cyclic vomiting syndrome

5. Acute motion sickness

Dose of Ondansetron Oral: 0.2 mg/kg and Parenteral 0.15 mg/kg (maximum 4 mg); range 0.13–0.26 mg/kg. Higher doses are not beneficial nor do they have more side effects [14].

While there are existing older studies evaluating domperidone, dexamethasone and promethazine, these studies have small sample sizes, low methodological quality and reveal inconsistent results and their use is not recommended, particularly in the light of increased concerns regarding the safety of these medications for children.

- Drugs for acid peptic disease: can be given empirically for 2 wk to 4 wk. H₂ receptor antagonist or proton pump inhibitor can be used.
- Cyclic vomiting syndrome is an idiopathic disorder that usually begins in early childhood and is characterised by repeated, discrete attacks of vomiting to the point of dehydration, (on average 12 episodes/d, typically lasting for 2–3 d) and intervening periods of normal health. Relatively little is known about its' pathogenesis or cause [15]. Episodes usually occur in morning hours, and may have associated prodrome of nausea, pallor and headache. Treatment is supportive, focused on fluid management in cases where dehydration and electrolyte imbalance occur. Amitriptyline and propranolol have been described as effective for prophylactic therapy (antiemetics may be of benefit during an acute episode).
- The mainstay of treatment for rumination syndrome is explanation and behavioral treatment which consists of habit reversal techniques that compete with the urge to regurgitate [9].

Conflict of Interest None.

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