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**GASTROENTEROLOGY**

by  
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**Diarrhea**

Diarrheal disorders in childhood account for a large proportion of childhood deaths, it is the second most common cause of child deaths worldwide. The risks are particularly higher with micronutrient malnutrition, e. g. vitamin A and Zinc deficiency.

It is defined as increased total daily stool output to be >10gm/kg/day or more than adult limit >200gm /day associated with increased water content. In practice and in many regions diarrhoea is defined as three or more loose or watery stools in a 24-hour period.

Normally, there is bidirectional flow of fluid in the wall of the intestine, there is absorption of water & electrolytes at the tip & wall of the villous of small intestine, while their secretion at the base of the crypts.

**Mechanism of Diarrhea**

<b>PRIMARY MECHANISM</b>	<b>PATHOPHYSIOLOGY</b>	<b>STOOL EXAMINATION</b>	<b>EXAMPLES</b>	<b>COMMENT</b>
<b>Secretory D.</b>	Active electrolyte and water fluxes toward the intestinal lumen, by activation of adenylate cyclase causing increasing of intracellular cAMP & cGMP or calcium in response to microbial enterotoxins	Usually massive, Watery, no stool leukocytes or RBCs	Cholera, toxigenic <i>E. coli</i> ; carcinoid, neuroblastoma,	Persists during fasting.
<b>Osmotic D.</b>	Caused by intraluminal non absorbed solutes drives water passively into the intestinal lumen.	Watery, acidic (pH less than 5.4) stool, presence of reducing substances, no stool leukocytes or RBCs	Lactase deficiency, lactulose intake. Toddler diarrhea.	Stops with fasting or stopping of ingested substance.
<b>Mucosal invasion</b>	Inflammation, decreased colonic reabsorption, increased motility	Dysentery (blood), mucus, and WBCs	<i>Salmonella</i> , <i>Shigella</i> ; amebiasis; <i>Yersinia</i> , <i>Campylobacter</i>	Unrelated to fasting

PRIMARY MECHANISM	PATHOPHYSIOLOGY	STOOL EXAMINATION	EXAMPLES	COMMENT
<b>Increased motility</b>	Decreased transit time so reduce the time for absorption.	stimulated by gastrocolic reflex	Irritable bowel syndrome, thyrotoxicosis.	Infection may also contribute to increased motility
<b>Decreased motility</b>	Stasis leading bacterial overgrowth		Pseudoobstruction, blind loop	
<b>Decreased surface area</b>	Decreased functional capacity		Short bowel syndrome, celiac disease, rotavirus enteritis, surgical resection.	
<b>Adherence to the mucosa</b>	By decreasing the absorptive area of intestine		Giardiasis, entero-adherent E. Coli.	
<b>mixed</b>				

### **Biochemical Changes of Diarrhea +/- Vomiting**

- **Diarrhea** leads to loss of water, NaCl, KCl, bicarbonate, & loss of calories.
- **Vomiting** leads to loss of water, NaCl, KCl, acid, & loss of calories.

In case of both diarrhea & vomiting lead to dehydration, electrolyte imbalance, metabolic acidosis, & malnutrition.

- **Dehydration** lead to collapse of intravascular volume, hypotension, shock, acidosis, oliguria, acute renal shutdown, & hemoconcentration & renal vein, intracranial, or other intravascular thrombosis.
- **Acidosis** occur with diarrhea due to loss of bicarbonate in the stool, starvation lactic acidosis, tissue hypoxia lactic acidosis, impaired renal perfusion.
- **Electrolyte imbalance:**
  - . Hypokalemia led to impaired cardiac function, hypotonia, & paralytic ileus.
  - . Hyponatremia, hypernatremia may lead to convulsion.

### **Types of Diarrhea**

**Acute diarrhea:** diarrhea that continues for less than 2 weeks. The majority of cases of diarrhea resolve within the 1st wk of the illness. A smaller proportion of diarrheal illnesses fail to resolve and persist for longer than 2 wk.

**Persistent diarrhea:** Gastroenteritis that began acute diarrhea, but lasts for 14 or more days. Persistent diarrhea belongs to chronic diarrhea.

**Chronic diarrhea:** diarrhea that lasts for more than 14 days.

**Dysentery:** diarrhoea with blood in the stool, with or without mucus

## ACUTE GASTROENTERITIS

Rotavirus is the most common identifiable viral cause of gastroenteritis in children, it accounts for 197,000 deaths annually or 28% of all deaths caused by diarrhea among children younger than 5 yr of age.

Transmission is by feco- oral route or direct person to person. More common in babies of less than 2 yr old & in bottle fed infants & more severe is under 6 months of age.

More common at summer because of increased multiplication at increased temperature, increased water intake, increased fruit & vegetable intake with swimming at pools & river.

Usual clinical manifestations are: Diarrhea (usually watery) may be associated with vomiting, abdominal cramps, fever, malaise, abdominal distension, & dehydration.

### **Causes**

**Bacteria:** It is considerable when fever > 38.5c & the diarrhea is severe and may be bloody. Causative bacteria are Salmonella, Shigella, E. coli, V. cholera, Staph aureus, Clostridia, Compylobacter, Yersinia, & others.

Extraintestinal infections following bacterial invasion may cause meningitis, endocarditis, UTI, vulvovaginitis, pneumonia, peritonitis, hepatitis, septic arthritis, osteomyelitis, & sepsis.

**Viruses:** Fever is usually < 38.5c & diarrhea is usually watery & not severe, the possibility is higher with preceding or associated viral respiratory tract infection, in winter season & when more than one member of the family is simultaneously affected. Causative viruses are Rota, calcivirus, norovirus, adenovirus, ... others.

**Parasites:** Giardia & E. histolytica.

Entamoeba histolytica: the diarrhea is commonly bloody & associated with tenesmus, but fever usually mild or absent. Treatment with metronidazole (30-50 mg/kg/day for 10 days) followed by diloxanide furate (cyst killer).

Giardia Lamblia infection: the diarrhea is usually watery, foul smelling, & associated with abdominal distention, no fever.

### **Stool Examination**

Stool specimens could be examined for mucus, blood, and leukocytes.

### **Treatment**

- The broad principles of management of acute gastroenteritis in children include Rehydration therapy, enteral feeding and diet selection, zinc supplementation, and additional therapies such as probiotics.
- The most important step is treatment of dehydration.
- Continue breastfeeding, foods with complex carbohydrates (rice, wheat, potatoes, bread, cereals), lean meats, yogurt, fruits, and vegetables are also recommended. Fatty foods or foods high in simple sugars (juices, carbonated sodas) should be avoided.
- Zinc therapy: Zinc supplementation in children with diarrhea in developing countries leads to reduced duration and severity of diarrhea and could potentially prevent a large proportion of cases from recurring. All children older than 6 mo of age with acute diarrhea in at-risk areas

should receive oral zinc (20 mg/day) in some form for 10-14 days during and continued after diarrhea.

- Probiotics: nonpathogenic bacteria for prevention and therapy of diarrhea has been successful in certain settings, but with questionable safety in some of them.
- Antibiotics: Although they can reduce the duration and severity of illness and prevent complications, they are indicated only in selected cases & supported by culture.
- Antimotility agents (loperamide) are contraindicated in children with dysentery and probably have no role in the management of acute watery diarrhea in otherwise healthy children.
- Antiemetic agents, such as the phenothiazines, are of little value and are associated with potentially serious side effects. Nonetheless, ondansetron is an effective and less-toxic antiemetic agent.

### **PERSISTENT DIARRHEA**

Persistent diarrhea accounts for 3-19% of all diarrheal episodes in children younger than 5 yr of age and up to 50% of all diarrhea-related deaths and it has a case fatality rate of 60%. Although few individual episodes persist beyond 14 days, frequent episodes of acute diarrhea, as well as prolonged diarrhea (lasting between 7-13 days of age), can result in nutritional compromise and can predispose these children to develop persistent diarrhea.

#### **Causes**

Shigella, Salmonella, enteroaggregative E. coli, enteropathogenic E. Coli, Cryptosporidium (especially in malnourished & immunocompromised patients), & Giardia & E. histolytica.

It causes extensive changes in the small bowel mucosa by damaging of the villi so reducing secretion of disaccharidase & enterokinase enzymes leading to malabsorption & then malnutrition, which by itself will lead to secondary immune deficiency, so persisting the infection & diarrhea. This cycle if not stopped, it will lead to death.

Risk factors for persistent diarrhea:

- Malnutrition.
- Young children: more common in less than 18 months old.
- Immunological impairment: as in measles, AIDS, or primary immune deficiency.
- Previous history of persistent diarrhea.
- Hypersensitivity to cow milk protein.
- Lactose intolerance.

#### **Investigation**

- **GSE:** macro- & microscopical examination for RBC, pus cells, cysts, trophozoite, in addition to stool pH & reducing substance.
- **Stool culture & sensitivity.**
- **WBC count & differential.**
- **Serum electrolytes.**
- **Blood urea.**
- **Specific tests** for AIDS, immunoglobulin assay, etc.... if indicated.

## **Treatment**

- Treat dehydration.
- Antibiotics according to culture & sensitivity.
- Nutritional therapy: Temporarily reduce the amount of animal milk & lactose in the diet. Although children with persistent diarrhea are not lactose intolerant, administration of a lactose load exceeding 5 g/kg/day may be associated with higher purging rates and treatment failure. Alternative strategies for reducing the lactose load while feeding malnourished children who have prolonged diarrhea include addition of milk to cereals and replacement of milk with fermented milk products such as yogurt.
- Micronutrient supplementation (zinc, vitamin A, folate) for two weeks.
- Follow-up in 5 days.
- Avoid giving foods & drinks aggravates the diarrhea.

## **CHRONIC DIARRHEA**

It is usually semi liquid or watery in consistency.

### **Causes**

- Parenteral diarrhea : UTI, otitis media, others.
- Dietary factors: over feeding, cow milk & soy protein intolerance,
- Severe malnutrition
- Carbohydrate malabsorption:
  - Congenital: congenital sucrase – isomaltase deficiency.
  - Congenital glucose- galactose malabsorption.
  - Acquired: acquired lactose intolerance.
- Irritable bowel syndrome.
- Celiac disease.
- Inflammatory bowel disease: Crohns & Ulcerative colitis
- Acrodermatitis enteropathica.
- Abetlipoproteinemia.
- GIT anomaly: e.g. short bowel syndrome.
- Congenital cause started at neonatal period ( microvillus inclusion disease, congenital chloride diarrhea, congenital sodium diarrhea,.....etc.).
- Pancreatic disorders: cystic fibrosis.
- Liver disorders: chronic cholestasis.
- Endocrinopathies: e.g. thyrotoxicosis
- Functional tumors as carcinoid tumor, neuroblastoma
- Chemotherapy or radiation.
- Drugs: e.g. iron preparation, Ab.

### **Investigation**

- Stool examination: macroscopic, microscopic, & chemical analysis ( pH, sreducing substances), with C./S.
- GUE.
- WBC count & diff..
- Intestinal biopsy.
- Sweat test.
- Serum zinc level.
- Barium meal, follow through, & enema.

- Sigmoidoscopy & colonoscopy.
- Endocrine investigation: T3, T4, TSH, ACTH, cortisol.

### **Treatment**

- Correct dehydration
- Nutritional therapy
- Specific treatment accordingly.

## **DYSENTERY**

Occupy 10 % of cases of diarrhea in children below 5 yr.

### **Causes**

Shigella, Salmonella, Campylobacter, enteroinvasive *E. coli*, enterohemorrhagic *E. coli* (especially type O157: H7), & Yersinia.

- Epidemic dysentery occur due to shigellosis until prove otherwise. 60 % of dysentery cases are due to shigellosis. More severe in children with malnutrition.
- It has harmful effect on the nutritional state because of the associated protein loss from the large bowel & anorexia due to the destruction of the endothelium of colon & distal ileum.
- Other cause for bloody D. is *E. histolytica* (mentioned above).

### **Clinical manifestations**

Frequent diarrhea with RBC & pus cells in the stool, & may be bloody stool & usually associated with tenesmus, abdominal colicky pain, rectal pain, anorexia, convulsion, & fluid loss which may lead to dehydration.

Complication may occur which include intestinal perforation, toxic megacolon, rectal prolapse, septicemia, & hemolytic uremic syndrome.

### **Diagnosis**

- GSE: frank bloody stool, with mucus, RBC, & pus cells. Fecal leukocytes indicate bacterial invasion of colonic mucosa, although some patients with shigellosis have minimal leukocytes at an early stage of infection, as do patients infected with Shigatoxin-producing *E. coli* and *E. histolytica*.

- Stool cultures is indicated in **bloody diarrhea** in whom stool microscopy indicates **fecal leukocytes**, in **outbreaks** with suspected **hemolytic-uremic syndrome**, and in **immunosuppressed** children with diarrhea.

- WBC count & differential: leukocytosis with neutophilia in bacterial dysentery & eosinophilia in amebic dysentery.
- Blood C./ S. if septicemia suspected.

### **Treatment**

- Treat dehydration
- Antibiotics for 5 day. Better give oral locally sensitive one, like: ampicillin & co-trimazole-trimethoprim, nalidixic acid, & 3<sup>rd</sup> generation cephalosporin.
- Nutrition supplement.
- Follow up especially for malnutrition or complicated dysentery.

## **PREVENTION OF GASTROENTERITIS**

- Encourage breast feeding.
- Sterilization in bottle feeding.
- Pasturalization of milk.
- Sanitary water supply & sewage disposal.
- Good hygienic food preparation.
- Vaccination against certain important & common pathogen, e.g. Rota virus & oral cholera vaccine.

### **Specific Causes of Diarrhea**

#### **Dietetic diarrhea**

It may follow recent change in the type of milk, or recent addition of new foods not suitable for the age of the infant. Detailed dietetic history is important.

#### **Drug induced diarrhea**

Most oral antibiotics especially ampicillin can cause diarrhea. Oral vitamins in big amount may also cause diarrhea.

#### **Parantral diarrhea**

It occurs secondary to infection outside the gastrointestinal tract as respiratory & urinary tract infection. The cause is hypermotility.

\*\*\*It is important to emphasize that in all noninfectious diarrhea, the diarrhea is usually mild.

#### **Postinfectious diarrhea**

In infants and very young toddlers chronic diarrhea can appear following infectious enteritis, regardless of the nature of the pathogen. The pathogenesis of the diarrhea is not always clear and may be related to secondary lactase deficiency, food protein allergy, antibiotic-associated colitis (including pseudomembranous colitis caused by *Clostridium difficile* toxin), or a combination of these.

Treatment is supportive and may include a lactose-free diet in the presence of secondary lactase deficiency; infants might require a semielemental diet. The beneficial effect of specific probiotic products should await well-controlled clinical trials.

## **DEHYDRATION**

Children, especially infants, are more susceptible than adults to dehydration because of the greater basal fluid and electrolyte requirements per kg and because they are dependent on others to meet these demands.

### **TYPES OF DEHYDRATION**

#### **- According to the degree of dehydration:**

- 1- Minimal or no dehydration (wt loss is less than 3%): normal examination, but urine output may be decreased.
- 2- Mild-moderate dehydration (wt loss is 3-9%): the child looks normal, fatigued, irritable; thirsty, eager to drink; heart rate is normal to increased; breathing is normal or fast; eyes slightly sunken; decreased tears; dry mouth and tongue; skin turgour is prolonged but less than 2 seconds; cold extremities; decreased urine output; and prolonged capillary refilling.

- 3- Severe dehydration (weight loss is >9%): Lethargic, unconscious; drinks poorly; tachycardia, with bradycardia in most severe cases; pulses are weak, thready, or impalpable; deep breathing; deeply sunken eyes; absent tears; parched tongue; skin turgor recoils in >2 sec; capillary refilling is prolonged and minimal; extremities are cold, mottled, cyanotic; minimal urine output.

**- According to the serum osmolarity & sodium level:**

- 1- Isotonic dehydration: account about 70 % of cases, normal serum sodium & osmolarity, occur when the deficit of Na & water are equal.
- 2- Hypertonic dehydration: S. Na is more than 150 mg/ dl. Occur when the loss of water is more, 20 % of cases. Plasma & interstitial hypernatraemia lead to shift of water from cells to the interstitial tissue causing intracellular dehydration & collapse of the brain cells. Children are often lethargic, but irritable when touched. Hypernatremia may cause fever, hypertonicity, and hyperreflexia; more severe neurologic symptoms may develop if cerebral bleeding occurs. The skin is doughy in nature, signs of dehydration are less severe, but the tongue is parched, shriveled & small. The condition is dangerous & may lead to permanent brain damage.
- 3- Hypotonic dehydration: about 10 %, Na level is below 130 mg/ dl with low serum osmolarity, occur when the sodium deficit is more than water deficit. Shift of water from interstitial tissue to the cells causing cellular distension, extracellular dehydration with more hypotension and more severe signs of dehydrations; severe dryness of mucous membrane, severe loss of skin turgor, sunken eyes, & more liability to shock & renal shutdown.

### **TREATMENT**

In general:

Mild dehydration: treated at home by ORS (Dextrolyte)

Moderate dehydration: treated by ORS at hospital (ORS center), I. V. fluid in certain situation.

Severe dehydration: by I. V. fluid at hospital, & completed by ORS or I. V. fluid.

### **ORS (Dextrolyte)**

**Standard ORS (WHO):** It contains 3.5 gm NaCl, 2.9 gm Na citrate, 1.5 KCl, & 20 gm glucose, after dissolution in one liter of water: 90 mEq sodium, 80 mEq Cl, 20 mEq K, 30 mEq HCo<sub>3</sub>, & 111 mmol glucose.

**The low-osmolarity World Health Organization (WHO) oral rehydration solution (ORS):** It contains 75 mEq of sodium, 64 mEq of chloride, 20 mEq of potassium, and 75 mmol of glucose per liter is now the global standard of care.

It is given by spoon every 2-3 minutes, the baby fed in sitting position, & the rest of solution is discarded after 24 hr of dissolution. Vomiting may occur during the first 2 hr of administration of ORS, but it usually does not prevent successful oral rehydration if the ORS is given in small amounts at short intervals (a teaspoon every 1 to 2 min) & the emesis usually lessens over time.

## CLASSICAL METHOD FOR REHYDRATION

### Minimal or no dehydration

**1- Deficit** (the lost fluid): no need for replacement.

**2- Ongoing loss** (The fluid will be lost by diarrhea & vomiting):

it is recommended to be replaced

- if <10 kg body weight: 60-120 mL ORS for each diarrheal stool or vomiting episode

-if >10 kg body weight: 120-240 mL ORS for each diarrheal stool or vomiting episode.

### Mild to moderate dehydration

**1- Deficit:** ORS 50-100 mL/kg body weight over 3-4 hr

**2- Ongoing loss:** same as above

- limitations of ORS are:

1- severe emesis.

2- an ileus.

3- intussusceptions.

4- shock.

5- Carbohydrate intolerance (rare).

6- High stool output (>10 mL/kg/hr).

In such conditions, I. V. fluid can be given.

### Severe dehydration

Treated by I.V. fluid as soon as possible, as the followings:

- Initially:

. Admit the patient to the emergency unite and measure the body weight, insert cannula.

. Rapid assessment of the level of consciousness, PR, BP, RR, urine output, & skin perfusion.

. Aspirate blood for urea, creatinine, and serum electrolytes.

- Start Rehydration:

. Rapid restoring intravascular volume as soon as possible by **Initial Rehydration Therapy (IRT)**:

20 ml/ kg Normal Saline or Ringer Lactate within 20 min or faster, you may need to repeat this dose

3 times until perfusion and mental status improve, hypovolemic patients generally void within 2 hr.

After volume resuscitation;

- administer 100 mL/kg body weight ORS over 4 hr or 5% dextrose normal saline IV according to the following equation and serum Na:

**Total fluid requirement = deficit + maintenance**

Deficit:

= wt (gm) \* % of body loss.

e. g. 10 % dehydration in 8 kg wt baby=  $8 \times 1000 \times 10/100=800$  ml.

#### Maintenance fluid:

The daily requirement of fluid which is physiologically lost through metabolism, urine, skin, lung, & stool. It is calculated according to the weight of the child:

1<sup>st</sup> 10 kg= 100 ml/kg/ day.

50 ml/kg /day for every kg above 10 kg

20 ml /kg /day for every kg above 20 kg body wt.

#### Result of S. Na;

- if S. Na 130- 150 mEq/l : continue the same fluid, give one half of the total fluid during the 1st 8 hr and give the rest within the next 16 hr.
- If S. Na was more than 150: there will be generation of osmoles within the brain to increase the osmolality within the cells of the brain to protect the brain cells from shrinkage. These osmoles will dissipate slowly during correction of hypernatremia. Rapid lowering of the extracellular osmolality during correction of hypernatremia will lead to rapid water movement into the cells of the brain, producing cerebral edema, which can lead to seizures, brain herniation, and death; therefore, it is important to replace the deficit slowly within more than 36 hr and monitoring of S. Na (decrease of s. Na of no more than 12 mEq/ l/ day).
- If S. Na less than 130 mEq/l: a rapid increase of S. Na will precipitate central pontine damage, s. Na must not be increased more than 12 mEq/l/day.

Continue the same regimen for isonatremic dehydration, but take your care with s. Na monitoring. Patients with neurologic symptoms (e.g. seizures) from hyponatraemia need to receive an acute infusion of hypertonic (3%) saline (5 ml/ kg) to rapidly increase the serum sodium concentration.

- This plan of rehydration is only at beginning of management and all calculations are approximated, especially the assessment of percent dehydration. It is important to monitor the patient during treatment and to modify therapy based on the clinical situation.

- If the urine didn't pass after the adequacy of the circulating blood volume, give a diuretic (furosemide 2-4 mg/kg), if there is no response with deranged renal function tests, discontinue diuretic and start management of acute renal failure.

#### Ongoing loss:

same as above; if unable to drink, administer through nasogastric tube or administer 5% dextrose in normal saline 10ml/ kg/ motion or vomiting, with 20 mEq/L potassium chloride IV

### **WHO METHOD FOR REHYDRATION**

More easy, more applicable, money saving, the patient classified into:

Group A: called Diarrhea with no dehydration.

Group B: called D. with some dehydration, mild - moderate dehydration.

Group C: called D. with severe dehydration.

#### **Group C:**

Give the initial rehydration therapy 30 ml/kg Normal saline (for less than 1 yr within 1 hr, for more than 1 yr within 1/2 hr) , then continue the therapy with Ringer lactate 70 ml/ kg (for child less than 1

yr within 5 hr, for more than 1 yr within 2.5 hr), then assess the state, if no improvement repeat the dose till improvement, if improved, shift to group B.