

Gastroenteritis

Physiology of the intestinal function :

Normally there is bidirectional flow of fluids in the wall of the intestine , there is water and electrolytes absorption in the wall of the villi Of small intestine and water and chlorid secretion at the base of the crypt of small intestine.

The fluid and electrolytes absorption in tha villi is much more power full than secretion in the crypt , so 90% of the fluid pass in the small intestine is absorbed and the remain 10% pass to the large intestine from which 90% is absorbed and 10% excreted outside the body.

Mechanisms of diarrhea :

1-Osmotic diarrhea occurs after malabsorption of an ingested substance, which “pulls” water into the bowel lumen. A classic example is the diarrhea of lactose intolerance. Osmotic diarrhea also can result from generalized maldigestion, such as that seen with pancreatic insufficiency or with intestinal injury. Certain no absorbable laxatives, such as polyethylene glycol and milk of magnesia, also cause osmotic diarrhea. Fermentation of malabsorbed substances (e.g., lactose) often occurs, resulting in gas, cramps, and acidic stools.

2-Secretory diarrhea occurs when the intestinal mucosa directly secretes fluid and electrolytes into the stool and is the result of inflammation (e.g., IBD, chemical stimulus). Secretion also is stimulated by mediators of inflammation and by various hormones, such as vasoactive intestinal peptide secreted by a neuroendocrine tumor. Cholera is a secretory diarrhea stimulated by the enterotoxin of Vibrio cholera, which causes increased levels of cyclic adenosine monophosphate (cAMP) within enterocytes and leads to secretion into the small-bowel lumen.

Biochemical and pathological change of diarrhea with or without vomiting

Diarrhea lead to loss of water, NA, K,CL, HCO₃ and calories.

Vomiting lead to loss NA ,K ,HCL ,and calories

Both of them lead to cause dehydration ,acidosis , electrolytes imbalance and malnutrition

Dehydration lead to decrease intravascular volume , hypotension , shock ,oliguria , acute renal failure (per renal) with severe dehydration cause renal vein thrombosis.

Acidosis occur due to loss of HCO₃ in stool . which lead to starvation acidosis(ketone body production) lead to impaired renal profusion and tissue hypoxia .

Electrolyte imbalance

...hypokalemia lead to impaired cardiac function , hypotonia , and paralytic ileus.

Acute Gastroenteritis in Children

Definition :

It is the increase in frequency ,liquidity , and volume of stools with passing more than three bowel motion per day or more than 10gm \kg \day of liquid stool.

Normal infant pass 5-10gm \kg\day which contain 20-25 mEq/L Of sodium and chlorid and 50-70mEq/L OF potassium

One of the leading cause of death in the word

Type of diarrhea

WHO Classification

Acute diarrhea : watery continue for less than 2 week

Chronic diarrhea : semi liquid or watery continue more than 2 weeks and non-infection in origin

Persistent diarrhea : diarrhea watery continue more than 2 weeks and infection in origin

Dysentery : diarrhea with blood

Other classification

Acute diarrhea : watery continue for less than 2 week

Chronic diarrhea : watery continue for more than 2 week

Acute diarrhea

Cause:

1-acute gastroenteritis the most common cause

2-over feeding diarrhea

3-systmeic infection (parantral diarrhea) like UTI , otitis media.....

4-Antibiotic induce diarrhea (pseudomembranous enterocolitis)

5-food poisoning

6-drug (laxative)

Etiologies of

Gastroenteritis

Viral cause

Viral Diarrhea. Symptoms of rotavirus AGE usually begin with vomiting followed by frequent passage of watery nonbloody stools, associated with fever in about half the cases.

The diarrhea lacks fecal leukocytes, but stools from 20% of cases contain mucus. Recovery with complete resolution of symptoms generally occurs within 7 days.

Although disaccharide malabsorption is found in 10–20% of episodes, it is rarely clinically significant. Other viral agents elicit similar symptoms and cannot be distinguished from rotavirus based on clinical findings.

Diarrheal illnesses caused by enteric adenovirus infections tend to be more prolonged than rotavirus (7 to 10 days), whereas astroviruses cause a shorter course (~5 days) usually without significant vomiting

Caliciviruses (including noroviruses and sapoviruses) 12-48 hr Nausea, vomiting, abdominal cramping, diarrhea, fever, myalgia, and some 1-3 days Person-to-person (fecal-oral and aerosolized vomit), and food, water, and fomites contaminated with human feces. Very contagious (chlorine and heat resistant); produces large outbreaks in No.

Etiologies of Bacterial Gastroenteritis

Although there is considerable overlap, fever >40°C, overt fecal blood, abdominal pain, no vomiting before diarrhea onset, and high stool frequency (>10 per day) are more common with bacterial pathogens

older children. 5-7 days (sometimes >10 days) usually self-limiting Swine products, occasionally person-to-person and animal-to humans, waterborne, blood borne (can multiply during refrigeration) Undercooked pork, improper food handling, unpasteurized milk, tofu, contaminated water, transfusion from a bacteremia person, cirrhosis, chelation therapy.

Etiologies of Parasitic Gastroenteritis

Cryptosporidium 1-11 days Diarrhea (usually watery), bloating, flatulence, cramps, malabsorption, weight loss, and fatigue may wax and wane. Persons with AIDS or malnutrition have more severe disease. 1-2 wk; may be remitting and relapsing over weeks to months Person-to-person (fecal-oral), Contaminated food and water (including municipal and recreational water contaminated with human feces

. Entamoeba histolytica 2-4 wk Gradual onset of cramps, watery diarrhea and often dysentery with cramps but rarely fever. Can wax and wane with weight loss. Variable; may be protracted (several weeks to several months) Fecal-oral transmission Any uncooked food or food contaminated by an ill food handler after cooking; Persons living in or traveling to LMIC, institutionalized persons, MSM.

Giardia intestinalis 1-4 wk Diarrhea, stomach cramps, gas, weight loss; symptoms may wax and wane. 2-4 wk Any uncooked food or food contaminated by an ill food handler after cooking; drinking water Hikers drinking unfiltered surface water, persons living in or traveling to LMIC, MSM, IgA deficiency.

Pathogens

Rotavirus is the most common cause of AGE among children throughout the world. Several other viruses occur less frequently. Norovirus and sap virus are the 2 genera of Caliciviruses that cause AGE. Norovirus Geno group II, genotype 4 (GII.4) has predominated globally during the past decade. Among the more than 50 serotypes of adenovirus, 40 and 41 are most often associated with diarrhea. Astroviruses are identified less often.

The major bacterial pathogens that cause AGE are nontyphoidal Salmonella (NTS), Shigella, Campylobacter , and Yersinia

Two serogroups of Vibrio cholerae (O1 and O139) produce epidemic cholera and cause nearly all sporadic cases. Clostridium difficile disease can be both nosocomial and community acquired in children. Bacterial pathogens that cause foodborne illness due to their ability to produce emetic and/or enterotoxins include Bacillus cereus , Clostridium perfringens , and Staphylococcus aureus. The significance of isolating Aeromonas and Plesiomonas in a diarrheal stool remains uncertain.

Giardia intestinalis, Cryptosporidium spp., Cyclospora cayetanensis , and Entamoeba histolytica are the most common parasites that cause diarrhea in the United States

Clinical Manifestation of Diarrhea

General Findings. Diarrhea is usually defined as the passage of 3 or more abnormally loose or liquid stools per day. associated with vomiting , abdominal cramp ,fever , malaise , abdominal distention ,with sign and symptom if dehydration and acidosis.

Frequent passage of formed stools is not diarrhea, nor is the passing of loose, pasty stools by breastfed babies.

Extrainestinal manifestation following bacterial invasion which include meningitis ,endocarditis ,septicemia , UTI ,septic arthritis...ect

Neurological manifestation include : paresthesia , hypotonia , descending weakness(Clostridium botulinum)

Immune mediator : which occur after diarrhea has resolved include :

A- Reactive arthritis : after Salmonella , shigella , campylobacter -

B- IgA nephropathy; campylobacter

C- erythema nodosum; campylobacter , salmonella , Yersinia

D- hemolytic anemia; Yersinia , campylobacter

E-Hemolytic uremic syndrome : E. coli , shigella

F- Gillian –barre syndrome: campylobacter

G- Glomerulonephritis : Yersinia , campylobacter

Types of dehydration:

Can be classify according to

A--- serum osmolality and Na level :

1-1-isotonic dehydration : normal Na level (135-145 mEq/L) can see in 70% of diarrhea

2-hypertonic dehydration : serum Na more than 145 mEq/L , can see 20% of the cases, plasma and interstitial hypernatremia lead to shift water from cell to interstitial tissue cause intracellular dehydration and collapse of brain cell , so the child become irritable, usually febrile, opisthotonus, with convulsion due to cerebral hemorrhage, with good urine output.

3-hypotonic dehydration : serum Na less than 135 mEq/L , can see 10% of cases. shifted of water from interstitial tissue to cell, causing cellular distention, extracellular dehydration

more hypotension with sever dryness of mucous membrane and sever loss of skin turgor , sunken eye lead to shock and renal shut down.

B--- according to the degree of water loss

1-mild dehydration : when the body loss 5% of the body weight .

2- moderate dehydration : when the body loss 6-9% of the body weight . the patient become pale ,lethargic , normal or rapid pulse , moderately sunken eye and fontanel , moderate dryness of mucous membrane moderate loss of skin turgor and skin perfusion , oliguria deep rapid breathing due to acidosis , so fluid deficit is 60-90 ml/kg .

3- severe dehydration : when the body loss 10-15% of the body weight .the patient become drowsy ,cold , very rapid and weak pulse , acidosis with low or un recordable blood pressure with sever loss of skin perfusion , sever dryness of mucous membrane ,sunken eye , all them lead to renal shut down , shock , coma and death

Fluid deficit (100-150 ml/kg).

In mild dehydration the patient is thirst history of diarrhea and vomiting with normal fontanel ,present of eye tear , wet mucous membrane , normal blood pressure and good urine output, body loss 5% of total body weight , so fluid deficit is 50 ml /kg .

In moderate dehydration the patient has/had history of diarrhea and vomiting for several days or repeated uncontrolled vomiting ,unable to drink , oral ulceration .

In severe dehydration :

Treated at hospital for IV fluid so

Total fluid requirement=Deficit+ Maintenance + Ongoing loss

1-Deficit:

= weight * percentage of body loss

Eg.10% dehydration in 10 kg = $10/100*1000*10=1000\text{cc or ml}$

2-maintenance fluid :

The daily requirement of fluid can be calculate according to :

A- Body surface area : 1500 ml /m²

B- Weight of the child :

1-10kg =100ml/kg/day

10-20kg=50ml/kg/day +1000ml of first 10 kg

>20kg =20ml/kg/day+1500ml of first 20 kg

So , the type of fluid should be content water ,Na, K, and glucose.

The total of collected fluid per day giving in 24hrs in isotonic and hypotonic type of dehydration , but should be giving in 36 hrs in hypertonic type.

3- ongoing loss:

Including fever ,breathing ,sweating , with vomiting and diarrhea

So the average composition of the stool in diarrhea is (55mEq/L Na ,25mEq/L K , 15mEq/L bicarbonate).

So the average composition of the gastric fluid in vomiting is (60mEq/L Na ,10mEq/L K , 90mEq/L Chloride).

Who to assess and treated of severe dehydration :

Admitted to hospital

Rapid assess the pulse , breathing , level of consciousness

Insert cannula and take sample of blood for CBC , RFT ,RBS , and serum electrolyte (Na ,K ,PH and bicarbonate)

Calculate the total fluid required for 24 hrs

First think to do is restore intravascular fluid by giving 20ml/kg of normal saline in 20minute , and assess the dehydration , this

Treatment :

According to WHO :

Treatment in this method is more applicable ,easy , money saving, can be prepared ORS , and shorting time than IVF . also can treat all type of dehydration.

Treatment classify in to 3 groups (A,B,C)

Group A: A fluid loss less than 5% of body weight , called diarrhea with no dehydration , clinically the same of mild type.

Treated by giving ORS according to age :

Less than 2 years : 50-100ml/ motion

2-10 years : 100-200 ml/ motion

More than 10 years : as much as he /she can drink of ORS .

Encourage feeding

Group B : treated in ORS center by giving 75ml/kg ORS solution orally within 4 hrs.

then check for sign of dehydration , If improved shift to group A , IF still repeat group B ,
IF deteriorate shift to group C.

in group B can used NG feeding or IVF in :

- 1- Very severe diarrhea or passing more than 15ml/kg /hr watery stool.
- 2- Persistent sever vomiting
- 3- Severe gastric or abdominal distention
- 4- Congenital glucose intolerance
- 5- Stupor or comatose
- 6- Severe stomatitis

IVF giving 75ml/kg within 4 hrs.

Group C:

Treated in hospital by IVF 100ml/kg within 6 hrs for child less than one year and 3hrs for child more than one year as follow :

Age of child	Initial replacement 30 ml/kg	Continue therapy 70ml/kg	Total 100ml/kg
Less than one year	1hour	5 hour	6 hours
More than one year	Half hour	2 and half hrs.	3 hours

For the initial rehydration therapy give 30ml/kg of normal saline within 1 hr. for patient less than one year and half hr for more than one year. Repeated if still shocked or no improved , then start continue therapy using ringer lactate at 70 ml/kg within 5 hrs for less than one year and 2 and half hour for more than one year. Assess dehydration every one hour if no improved can be repeated the method.

If IVF not available can use ORS at rate 20 ml/kg/hr for 6 hrs by NG tube .

Antibiotic indicated only in special cases according to culture and sensitivity.

Anti- diarrhea like pectin and kaolin not used.

Probiotic can be used now for treatment of acute diarrhea and antibiotic diarrhea associated due to clostridium also for traveling diarrhea.

According to classical method :

Mild dehydration : treated at home by ORS , 50ml/kg within 4 hrs , continue with 100ml/kg/day till diarrhea stops. Add 10ml/kg/motion for ongoing loss. With enhanced breast feeding.

Moderate dehydration: treated in the hospital (ORS center) , by giving the patient 100ml/kg within 4-6 hrs , then continue with 10-15ml/kg/hr till diarrhea stops. Also add 10 ml/kg/motion (ongoing loss). With enhanced breast feeding.

Severe dehydration :

Treated at hospital for IV fluid so

Total fluid requirement=Deficit+ Maintenance + Ongoing loss

1-Deficit:

$$= \text{weight} * \text{percentage of body loss}$$

$$\text{Eg.} 10\% \text{ dehydration in } 10 \text{ kg} = 10/100 * 1000 * 10 = 1000 \text{ cc or ml}$$

2-maintenance fluid :

The daily requirement of fluid can be calculated according to :

A- Body surface area : 1500 ml /m²

B- Weight of the child :

$$1-10 \text{ kg} = 100 \text{ ml/kg/day}$$

$$10-20 \text{ kg} = 50 \text{ ml/kg/day} + 1000 \text{ ml of first 10 kg}$$

$$>20 \text{ kg} = 20 \text{ ml/kg/day} + 1500 \text{ ml of first 20 kg}$$

So , the type of fluid should be isotonic water ,Na, K, and glucose.

The total of collected fluid per day giving in 24hrs in isotonic and hypotonic type of dehydration , but should be giving in 36 hrs in hypertonic type.

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Who to assess and treated of severe dehydration :

Admitted to hospital

Rapid assess the pulse , breathing , level of consciousness

Insert cannula and take sample of blood for CBC , RFT ,RBS , and serum electrolyte (Na ,K ,PH and bicarbonate)

Calculate the total fluid required for 24 hrs

First think to do is restore intravascular fluid by giving 20ml/kg of normal saline in 20minute , and assess the dehydration , this method can be repeated for 3 time until go to second stage

Then start with 1/2 dextrose saline solution , then wait the result of Na.

Add 20 mEq/L of KCL (after voiding).

To calculate the drops per minute used this method :

No. of drops = volume (ml) x infusion set drops (15 or 60)

Time hrs x 60

If serum Na 135-145 mEq/L , continue with same fluid , give $\frac{1}{2}$ of the total fluid during first 8 hrs. give the rest within 16 hrs.

If serum Na less than 130mEq/L , continue with same above , but serum Na should not increase more than 12mEq/L/day .

If serum more than 145mEq/L . the extracellular hypernatremia cause cellular shifted the fluid from the cell causing collapse of brain cell , this shifted cause slight improved intravascular volume so patient look less shocked with better renal urine output , while shrinkage of brain cell lead to rupture of bridging cerebral vessels , so the most important point in treatment is slow rehydration and slow decrease of serum Na but not more than 12mEq/L/day, so restore of intravascular volume with normal saline (not ringer lactate).

The time of the correction depend on the serum sodium level as follow :

145-157mEq/L :24hrs

158-170mEq/L :48hrs

171-183mEq/L :72hrs

184-196mEq/L : 84hrs

If the patient develop convolution during treatment give 5ml/kg (3%) normal saline intravenously.

Prevention of diarrhea :

- 1- Encourage breast feeding
- 2- Sterilization of bottle in bottle feeding
- 3- Pasturalization of milk
- 4- Sanitary water supply and sewage disposal
- 5- Good hygienic food prpration
- 6- Vaccination against diarrhea pathogen like Rota virus vaccine and oral cholera vaccine.

Complication of diarrhea :

- **Convulsion :** due to fever (febrile convulsion) , hypo or hypernatremia , hypoglycemia , hypocalcemia , hypomagnesemia , intracranial hemorrhage , or intracranial venous thrombosis and hypertensive encephalopathy after bilateral renal vein thrombosis .
- **Brain damage :** due to hypertonic dehydration or intracranial vein thrombosis.
- **Pulmonary odema :** due to rehydration fluid over load
- **Acut renal failure :** due to medullary necrosis or bilateral renal vein thrombosis.
- **Prolonge diahrria :** due to Disaccharidase or transient cow milk intolerance .