DIARRHEA

DEFINITION:

The excessive loose of fluid and electrolyte in the stool manifested clinically by increase in the number (≥ 3 / day), volume and water content of the stool. Normally, a young infant has about 5 gm / Kg of stool out put per day, the volume increase to 200 gm / day in an adult. The small intestine of an adult may absorb 10-11 L / day of a combination of ingested and secreted fluid, where is the colon absorbing about ½ L. Disorders that interfere with absorption in the small intestine tend to produce voluminous diarrhea, where is disorders compromising colonic absorption produce lower volume diarrhea. Dysentery, (i.e. small volume, frequent bloody stool with mucus, Tensmus and urgency) is the predominant symptoms of colitis.

EPIDEMIOLOGY:

1. Each year;
   - There are approximately 3.3 million deaths due to diarrhea, 80% in children under 2 years of age.
   - Over 1 billion episodes of diarrhea, most in the developing world with an average of 2-6 diarrhea episodes per child.
   - 5-10 million travelers affected by diarrhea.
2. It is a major factor in childhood malnutrition.
3. Diarrheal pathogens are generally spread by fecal oral transmission through:
   - Contamination of food e.g. V. cholera, C. jejuni, non typhoid salmonella and enterohemorrhagic E coli.
   - Fecal contamination of drinking water e.g. V. Cholerae & Giardia lamblia.
   - Direct person to person spread e.g. Shigella, Rota virus, and Entamoeba histolytica.
4. Risk factors for diarrhea:
   - Failure to breast feed.
   - Impaired immunity.
   - Malnutrition.
   - Lack of food hygiene.
   - Poor weaning practice.
   - Lack of sufficient clean water.
   - Inadequate sanitation.
   - Poor personal and domestic hygiene.

PATHOPHYSIOLOGY:

Diarrhea reflects either increased secretion by the intestine and / or decrease absorption by the intestine. Mechanisms of acute infectious diarrhea can be divided into 3 basic types:

- ***Secretary diarrhea***: excessive secretion of fluid and electrolyte is caused by an enterotoxin and the pathogen does not invade enterocytes e.g. cholera and ETEC.
- ***Invasive diarrhea***: reduced absorption is caused by the pathogen invading and damaging enterocytes and colonocytes. It could be
    a. Inflammatory: as in shigellosis causing bloody diarrhea.
    b. Non inflammatory: as in Rota virus causing watery diarrhea.
- ***Osmotic diarrhea***: reduced absorption is caused by osmotically active non absorbed substances (e.g. lactose) in the bowel lumen. This type is watery.

CLINICAL TYPES OF INFECTIOUS DIARRHEA:

1. ***Acute watery diarrhea***: loose or eatery stools without visible blood of less than 14 days duration. Most episodes last< 5 – 7 days.
2. ***Acute bloody diarrhea***: loose or watery stools with visible red blood of less than 14 days duration.
3. ***Persistent diarrhea***: loose or watery stools with or without visible blood. Duration 14 days or more.

PREVENSION AND CONTROL:

Interventions for the prevention and control of diarrhea include:

1. **Maternal and child health**: through
    - Promotion of breast feeding
    - Improvement of weaning practice
      - *Food hygiene*: Hands washing boiled water use clean cup and spoon and the use of refrigerator of saving food.
      - *Nutrition*: through introduction of complementary food between 4 – 6 months, giving food of high energy and nutrient and completing weaning gradually not abruptly.
    - Vitamin A supplementation: prophylaxis vitamin A will reduces diarrhea mortality in young children by 30%.
2. **Immunization**: vaccines that reduce diarrhea morbidity and mortality are targeted at
    - Rota virus (oral vaccine is under development).
    - Cholera (2 types of oral killed whole cell vaccine).
    - Measles (is part of EPI).
3. **Interrupting transmission**:

- Water supply should be clean for drinking and for personal and domestic hygiene.
- Improved sanitation reduces diarrheal incidence and mortality by permitting hygienic disposal of feces.
- Personal and domestic hygiene e.g. hand washing, sanitary disposal of feces, and maintaining drinking water free from fecal contamination.

4. **Case management**: by
   - Treatment of dehydration e.g. by ORT.
   - Appropriate nutritional management.
   - Rational use of antibiotics and other drugs. Antibiotics are indicated only for specific enteric infections but anti diarrheal drugs should never be given to a child with diarrhea.
   - Treatment of associated infections or complication.

CLINICAL ASSESSMENT OF DIARRHEAL DISEASE:

The two main objectives of assessment in diarrheal disease are to:

1. Diagnose clinical ***type of diarrhea***, this is important because the different type require different treatment :
   - Acute watery diarrhea: majority needs fluid therapy only.
   - Acute bloody diarrhea (dysentery): needs antibiotic treatment.
   - Persistent diarrhea needs careful dietary management.
2. Determination of the ***degree of dehydration***:
   - No sign of dehydration
   - Some dehydration
   - Sever dehydration

These replace the 4 categories of dehydration that were previously used which are:

- No dehydration
- Mild dehydration
- Moderate dehydration
- Sever dehydration

Mild and moderate dehydration now broadly combined into some dehydration.

There are also other objectives which are:

3. Determination of the ***nutritional status*** and evaluate feeding practice. Look for signs of sever malnutrition (Marasmus, kwashiorkor, Marasmus kwashiorkor) and of vitamin and mineral deficiency like vitamin A deficiency and anemia.
4. Diagnosis of any ***concurrent illness***

5. Determine the ***immunization status*** especially measles (because it is preventable, often accompanied by diarrhea, a risk factor for subsequent sever and persistent diarrhea and is a major cause of death and disability in its own right).

STAGES IN CLINICAL ASSESSEMENT

1. ***Clinical history and examination of the stool.***
2. ***Physical examination.***
3. ***Diagnostic investigation*** (of limited value).

LOOK AT	• Condition	Well, alert	**Restless, irritable**	**Lethargic, unconscious, floppy**
	• Eyes	Normal	Sunken	Very sunken & dry
	• Tears	Present	Absent	Absent
	• Mouth and tongue	Moist	Dry	Very dry
	• Thirst	Normal, not thirsty	**Thirsty , drink eagerly**	**Drinks poorly or cannot drink**
FEEL: SKIN PINCH		Return quickly	Return slowly	Return very slowly
DECIDE		No sign of dehydration	If 2 or more signs, including one sign: some dehydration	If 2 or more signs, including one sign: sever dehydration
TREATMENT		Plan A	If weigh possible, then plan B	Weigh the patient , than plan C urgently

The degree of dehydration is assessed by physical examination using a standardized WHO chart (above). Careful assessment must be made of the patients:

1. ***General condition and behavior***: is the child well and alert? , restless or irritable, floppy, listless, lethargic or unconscious? .The mother can be asked if she feel the child lethargic rather than sleepy.
2. ***Eyes***: Is the child's eyes look normal, sunken or very sunken and dry (the mother can be asked if she think the child's eyes are normally sunken or more sunken than usual).
3. ***Tears***: when the child cries vigoursly, are tears produced?
4. ***Mouth and tongue***: are wet, dry or very dry. Factors other than dehydration may affect this. For example, has the child recently been drinking or vomiting (wet mouth), or breathing through the mouth (dry mouth).
5. ***Thirst***: offer the child some water or ORS solution. Does the child
   - Drink normally without particular interest or refuse to drink?
   - Drink eagerly, grasping the cup or spoon and crying if it is withdrawn?
   - Appear unable to drink, or drinking poorly because of lethargy or reduced consciousness?
6. ***Skin turger***: the skin of the abdomen is pinched, gently pulled and released. Does the skin pinch flatten and go back:
   - Immediately, like a rubber band springing back.
   - Slowly in 0.5 – 1 second?
   - Very slowly taking > 2 second.

   Skin pinch test is unreliable in children with sever malnutrition.
7. ***Additional useful signs*** of dehydration that are not part of the standard WHO chart include:
   - ***Pulse rate***: in sever dehydration, radial pulse become weak and may not be felt but femoral pulse can usually be felt. Blood pressure may be too low to record.
   - ***Anterior fontanels*** in infants more sunken than usual in a child with some dehydration and very sunken in a child with sever dehydration.
   - ***Urine output***: will be decrease in sever dehydration.
   - ***Breathing rate and depth***: a child with sever dehydration often shows acidotic breathing (Kussmeaul's respiration) which is typically deep and without chest indrawing. In contrast,

breathing in pneumonia typically shallow, rapid and accompanied by a cough.

- ***Peripheral perfusion***:

	Normal hydration	**Sever dehydration**
Skin of lower arm and legs	Warm and dry	Cool and moist
Finger nail beds	Pink	Blue (cyanosis)
Nail beds refilling time	< 1 second	> 2 second

Generally no sign of dehydration represent < 5% loss in body weight and < 50 ml / Kg estimated fluid deficit (plan A home therapy to prevent dehydration and malnutrition) while some dehydration represent 5 -10% loss in body weight and 50 – 100 ml / Kg fluid deficit (plan B oral Rehydration therapy with ORS solution). However, sever dehydration represent > 10% loss in body weight and > 100 ml / Kg fluid deficit (urgent I.V rehydration).

For every 100 children with diarrhea seen in hospital outpatient, 5 – 10 will have some dehydration and only one will have sever dehydration.

MANAGEMENT PLAN

PLAN A:

This plan is designed for those with no signs of dehydration. Mothers should be taught 3 basic rules for managing these children at home.

1. ***Rule one***: give the child more fluid than usual to prevent dehydration. Several home fluid should be given at least one of which should usually contain salt (because Na facilitate absorption of water, glucose and amino acid) e.g. salted yogurt drink, salted vegetable or chicken soup and ORS solution.
    - Young infant(< 4 months): 50 – 100 ml / stool
    - Older infants : 100 – 200 ml / stool
    - Children : as much as wanted
2. ***Rule two***: continue to feed the child, to prevent malnutrition. So young infants must continue breast feeding and older infants and children should feed salt food which should be little and often (this

will lead to significant amount of nutrition absorbed, intestinal function recover rapidly and the impact on nutritional status is reduced) but should be increased afterwards. The food should never be withheld or diluted (common wrong practice, to rest the bowel??). The child should be given as much as nutritious food as he or she will accept.

3. ***Rule three***: take the child to a doctor if signs of dehydration or complications appear. The mother must take her child to doctor if he or she:
    - Has repeated vomiting.
    - Start to pass many watery stools.
    - Becomes very thirsty.
    - Does not pass urine.
    - Is eating or drinking poorly.
    - Has blood in the stool.
    - Still have diarrhea after 3 more days.

ORAL REHYDRATION SALT SOLUTION

Is a solution of glucose and electrolytes in defined amount (require 30 years of clinical trials to develop the solution).

Composition:

In g / L: Nacl: 3.5, Trisodcitrate: 2.9, Kcl: 1.5, glucose: 20

In mmol: Na: 90, K: 20, CL: 80, citrate: 10, glucose: 111

Mechanism:

- Coupled uptake of Na and glucose by the small bowel favor the uptake of water and other electrolyte.
- The Na, K, CL in ORS solution replaces losses of these electrolytes in stool.
- The citrate helps correct acidosis.

Limitations:

A major limitation of standard ORS is that it does not reduce the stool volume, decrease stool frequency and reduce duration of diarrhea. This is probably because high concentration of salt and glucose in standard ORS solution acts as an osmotic load in the bowel lumen. This can limit absorption of water and electrolytes to some extent. This limitation make ORS is not acceptable by mothers who want to see the diarrhea getting better. Two modifications in the standard solution partly overcome these problems:

- Reduced osmolarity glucose based ORS solution.
- Cereal based ORS solution.

PLAN B:

Oral Rehydration Therapy (ORT) to correct some dehydration.

ORS solution requires:

- A source of clean water suitable for drinking , but not necessarily boiled
- A clean container to measure 1 litter.
- A prepacked sachet of ORS

Volume to be given:

Calculated amount during the 1st 4 hours

Age	**Weight (Kg)**	**Volume to give in 1st 4 hours (ml)**
< 4 months	< 5	200 – 400
4 – 11 months	5 – 7.9	400 – 600
12 – 23 months	8 – 10.9	600 – 800
2 – 4 years	11 – 15.9	800 - 1200
5 – 14 years	16 – 29.9	1200 – 2200
> 15 years	> 30	2200 - 4000

How to give ORS solution:

It should be given in frequent small amount with a teaspoon every 1 – 2 minutes to children under 2 years (feeding bottle should not be used) and as frequent sips from a cup for older children and adults. It requires patience and perseverance on the part of the carer.

Problems:

1. Refuses to take fluid? Because he or she
   - Does not like the unfamiliar taste of the fluid. Patience and perseverance are needed.
   - Is irritable for some other reasons e.g. infection else where.
   - Is rehydrated and no longer thirst.
2. Vomiting: is common if ORS is drunk too quickly, especially early during Rehydration. The carer should:

- Wait 5 -10 minutes.
- Start given ORS solution again but more slowly.
- Not give antiemetic drugs which cause drowsiness.

3. becomes sleepy , drowsy or unconscious:

Condition of the child	Action to take
• Sleeping • dehydrated • well hydrated	• Gentle wake up for more ORT • Allow to sleep
Drowsy and weak	Consider Rehydration by NGT
unconscious	Look for other causes like meningitis

Monitoring the progress of ORT:

After 4 hours of ORT,

- if the child has no sign of dehydration: switch to plan A
- if the child has some dehydration : repeat plan B
- if the child has sever dehydration : switch to plan C

In monitoring the child, we should:

- Ensure that the ORS sol is being taken.
- Check for signs of dehydration. At any time the child becomes severely dehydrated, treatment plan C should be started immediately.

Feeding during ORT:

- Feeding of children above 6 months should be started after 4 -6 hours of ORT except where sever dehydration develop.
- Supplying normal fluid needs during ORT, the child needs to have its normal fluid requirement. Infants on breast feeding should continue breast feeding during ORT while non breast fed infants should be given 100 – 200 ml of clean drinking water during ORT.
- Older children and adults should be allowed drinking as much clean water as they want during ORT.

PLAN C:

This plan is used for children with sever dehydration or with shock or circulatory collapse(rapid weak or absent radial pulse, un recordable blood pressure, reduced consciousness or lethargy, cool and moist hands or feet and slow capillary refilling of nail beds > 2 seconds). Those children are at immediate risk of death and needs urgent I.V Rehydration. Intravenous Rehydration also should be considered in a child:

- Who has not improved after 2 – 4 hours of adequate ORT (poor uptake, sever diarrhea like cholera and sever vomiting).
- In whom ORT greatly increases stool volume (impaired absorption of glucose due to monosaccharide intolerance. So it will worse dehydration due to increase stool volume (due to unabsorbed glucose in stool).
- With abdominal distension (in diarrhea is due to anti motility drug e.g. codeine & loperamide and due to intestinal obstruction).

Intravenous solutions:

Preferred:

A. Ringer lactate (in mmol/L Na = 130, K = 4, Ca = 2, CL = 109, Lactate = 28, glucose = 0): also called Hartmann's solution for injection. It is one of the 2 preferred solutions for rapid dehydration, contain adequate Na & K to correct deficit of these electrolyte and it contain lactate which metabolized to bicarbonate to correct acidosis.
B. Ringer lactate with 5% dextrose (same constitute except adding glucose 278): is preferred over Ringer lactate without dextrose. It contains glucose to help prevent hypoglycemia.

Acceptable:

Normal saline (Na = 154, CL = 154): it can be used if ringer is not available. It contains enough Na but neither K nor base and it can be supplemented with added K and lactate or bicarbonate.

Not acceptable:

5% glucose (dextrose): contain only glucose 278, should not be used because it will not effectively correct circulatory volume.

Volume of fluid to be given:

Intravenous Rehydration must be started immediately and a total of 100 ml / Kg given over 6 hours in infants and 3 hours in older children and adults.

- Under 12 months: 30 ml / Kg over 1 hours followed by 70 ml / Kg over 5 hours.
- Over 12 months: 30 ml / Kg over 30 minutes followed by 70 ml / Kg over 2.5 hours.

More rapid infusion may be necessary in patients with sever Cholera and it can be repeated once if a strong radial pulse is not detected. Patients should be given some ORS solution (5 ml / Kg/ hour) by mouth when they can take it. This will provide base (to correct acidosis) and K.

Monitoring:

During Rehydration the patient pulse should be checked (initially every 15 – 30 minutes until a pulse is detected and then after every hour) and the rate of infusion adjusted accordingly. After 100 ml / Kg fluid has been given the degree of dehydration should be assessed fully and acted on as shown in the chart:

- If no sign of dehydration: switch to plan A
- If some dehydration: switch to plan B
- If sever dehydration: repeat plan C

For sever dehydration I.V Rehydration is the treatment of choice. Fluid is given through I.V line (back of hand, side of scalp in infants, front of elbow in older children and adults). When the I.V access is difficult because of circulatory collapse we use venous cut down or intraosseous infusion (a special needle into the medulla of a long bone e.g. the medial tibia. Care not to injure the growing bone plate near the knee.

If the access to this method is lacking, start nasogastric Rehydration with ORS solution and re assess every 1 – 2 hours or if the patient can drink, start ORT with ORS solution and reassess every 1 – 2 hours.

NOTES:

1. Nutritional management is a central part of the management of diarrhea. Diet is important during and after diarrhea is ended. During diarrhea breast feeding should be continued and complementary foods should be restarted 4 – 6 hours of start ORT. Breast feeding will help to reduce stool volume, volume of ORS solution needed for Rehydration, duration of diarrhea and the risk of diarrhea worsening the child's nutritional status.
2. Lactose free formula is rarely necessary except in persistent diarrhea (use yogurt which contains less lactose than animal or formula milk).
3. The vast majority of children with acute diarrhea can be given undiluted non breast milk after 4 – 6 hours of ORT.
4. Early feeding with complementary foods should be restarted after 4 – 6 hours of ORT. These foods should be culturally acceptable, readily available, is high in energy content, provide adequate essential micronutrient in mashed or ground (easier to swallow) and should contain added vegetable oil (to increase energy).
5. An extra meal a day should be given for at least 2 weeks after an episode of acute or persistent diarrhea.

DRUGS IN TREATEMENT OF DIARRHEA:

1. ***Antimicrobial***: specific indications, are either antibacterial or anti parasitic agents. It should not be routinely given. Only enteric

infections require antibiotics are: Shigellosis, Cholera, Amoebic dysentery and persistent diarrhea due to Giardiasis.

2. ***Anti diarrheal drugs***: generally not recommended in children.
    - Anti motility drugs e.g. loperamide and diphenoxylate atropine: cause no significant improvement in symptoms and has serious adverse effects in some cases. It should never be given to a child under 4 years of age.
    - Adsorbents e.g. kaolin: cause no significant improvement in stool out put and duration of diarrhea but cause minor improvement in stool consistency.

TYPES OF DEHYDRATION

The majority (70 – 80%) of cases of diarrhea results in isotonic dehydration. 10 – 15 % hyponatremic dehydration and 10 – 20 % hypernatremic dehydration. All the talk previously in this lecture is on isonatremic dehydration for which case management of WHO is appropriate. The hypo and hypernatremic dehydration require especial treatment plan regarding fluid therapy and dealing with complication that might arise.

Hyponatremic dehydration:

The pathogenesis is due to combination of Na and water loss and water retention to compensate for the volume depletion. Diarrheal fluid has an average sodium concentration of 50 mEq / L. hyponatremic dehydration occurs in:

- Replacement of diarrheal fluid (50 mEq / L Na) with water or low Na containing formula which has almost no sodium.
- Furthermore, volume depletion stimulates ADH resulting in reduced renal water excretion (body mechanism to prevent hyponatremia).
- Risk of hyponatremic dehydration increase if the volume depletion is due to loss of fluid with a higher sodium concentration e.g. Cholera.

Hyponatremic dehydration produces more substantial intravascular volume depletion due to the shift of water from extra cellular into intracellular space. In addition, some patients develop symptoms predominantly neurological, from the hyponatremia.

The initial goal in treating hyponatremia is correction of intravascular volume depletion with isotonic fluid (normal saline or ringer lactate). Hyponatremic dehydration requires replacement of Na and water losses. The following formula can be used to calculate a patient's Na deficit

Sodium deficit = 0.6 X B.W (Kg) X ($Na_d - Na_a$)

In general it is not necessary to increase the Na beyond 135 mEq / L (Na_d). Over correction is associated with an increase risk of central pontine

myelinolysis (CPM). The risk of CPM also increased with rapid correction of serum Na concentration. So it is important to avoid increasing Na by > 12 mEq / L / day. D5 ½ NS with 20 mEq / L Kcl is usually effective. Half calculated fluid given over the first 8 hours. Potassium delivery is adjusted based on initial serum K and the patient renal function (only after the patient void).

Patients with neurological symptoms e.g. seizures from hyponatremia need to receive an acute infusion of hypertonic (3%) saline to rapidly increase the serum sodium concentration.

Hypernatremic dehydration:

Hypernatremia can cause serious neurological damage including hemorrhage and thrombosis. This appear to be secondary to movement of water from the brain cells into the hypertonic extracellular fluid , causing brain cell shrinkage and tearing blood vessels within the brain.

This movement of fluid from ICS to ECS will protect the intravascular volume. So the patients with hypernatremic dehydration appear less ill than other children with same degree of dehydration, urine out put may preserve longer, vital signs preserve longer and they often missed or not brought to medical care because of mild symptomatology. The risk factors for developing hypernatremic dehydration in diarrhea include

- Presence of persistent fever
- Decrease fluid intake
- Improper mixed Rehydration solution

Children with hypernatremic dehydration are often lethargic but irritable when touched. Hypernatremia may cause fever, hyper tonicity and hyper reflexia. More sever neurological symptoms may develop if cerebral bleeding occurs.

The treatment of hypernatremic dehydration cause significant morbidity and mortality, especially if rapid reduction of serum Na by infusion of large amount of hypotonic fluid, leading to cerebral edema with a symptoms ranging from seizures to brain herniation and death. To minimize the risk of cerebral edema, the serum Na concentration should not decrease > 12 mEq / L every 12 hours. Sever hypernatremic dehydration may need to be corrected over 2 – 4 days. To avoid cerebral edema when correcting hypernatremic dehydration, the fluid deficit is corrected slowly.

- Neonates: D5 ¼ N.S
- 3 years old: D5 ½ N.S

Seizures are the most common manifestation of cerebral edema and results from an overly rapid decrease serum Na concentration during

correction of hypernatremic dehydration. Actually, increasing the serum concentration via an infusion of 3% NaCl can reverse the cerebral edema. Each ml / Kg of 3% NaCl increase the serum Na concentration by approximately 1 mEq / L. An infusion of 4 – 6 ml / Kg often results in resolution of the symptoms.

In patients with hypernatremic dehydration, oral fluid like infant formula must be used cautiously. Because of its low Na concentration, it has very high water content, and especially if added to I.V therapy, may contribute to a rapid decrease in serum Na concentration. Less hypotonic fluid such as ORS may be more appropriate initially.