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Review Article

Recurrent Diarrhoeal Disease Is a Major Cause of Childhood Malnutrition and Necessity of Contravention of the Vicious Cycle of Diarrhoea Related Malnutrition in Bangladesh

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Abstract: In children, diarrheal illness and its sequelae continue to be a leading cause of morbidity and death, particularly in impoverished nations like Bangladesh. Globally, diarrheal illnesses pose a severe threat to public health, particularly because they are the second-leading cause of mortality in children (behind respiratory illnesses). About 63% of the worldwide burden of childhood diarrhea affects children under the age of five. The etiology of many disorders must be accurately and quickly detected, but standard procedures are typically unsuccessful in doing so, in addition to being time- and labor-intensive. Up to 40% of cases of diarrhoea, on average, have an unknown etiological cause. This study highlights the promise of the metagenomics technology as a diagnostic method for enteric diseases and provides an overview of current trends in the epidemiology and management of diarrhea. Increased frequency, increased volume, and altered stoma consistency are all signs of diarrhea. Environments in the industrialized and underdeveloped worlds have different pathogens. The most significant aetiological factor associated with severe dehydrating diarrhea is rotavirus diarrhea. In order to target the right treatment, it is crucial to identify the specific microbiological cause of diarrhoea. However, the World Health Organization (WHO)'s recommendations for broader preventive measures highlight the key causes of the enormous disease burden in developing nations. Worldwide, acute diarrheal illness in children under the age of five continues to be a leading cause of morbidity and death. Children are more likely to experience severe infectious diarrhea in environments with low sanitation and hygiene, limited water supply, and a lack of resources. A complete history and physical examination, as well as assessments of the child's nutritional and hydration status as well as a thorough clinical evaluation for any complications or accompanying diseases, are all necessary for the care of a kid who presents with severe diarrhea. In Bangladesh, the use of zinc supplements, reduced-osmolarity oral rehydration solution (ORS), and

rotavirus vaccination are recent advancements in the management of severe diarrheal illness.

Keywords: Infectious Diarrhea, Dehydration, Developing Countries, Diarrheal Disease, Nutritional Status, Under-5 Children, Gastrointestinal Diseases, Gastroenteritis

1. Introduction

The major cause of mortality and morbidity in children under the age of five is diarrhea. Despite accessible basic and effective treatment, 526,000 early baby deaths occur each year, or more than 1,300 each day [1]. Recent decades have seen a decline in diarrheal mortality due to improved hygiene and water availability. Unfortunately, there are still many people who have diarrhea [2]. Bangladesh has a mortality rate for children under five of 35/1000 live births [3]. 15% of children under five were wasted, 33% were underweight, and 36.2% were stunted [4]. Young children's physical and cognitive development might be harmed by the vicious loop that exists between diarrhea and hunger [5, 6]. Malnutrition can result from vitamin deficits brought on by diarrhea. Children are more prone to diarrhea as a result of malnutrition because it weakens the immune system [7]. Malnutrition and diarrheal diseases have long been known to be adversely connected, with diarrhea being linked to lowered child growth, development, and cognitive function [8]. Chronic diarrhea can have a negative impact on weight and height increase, making malnutrition even worse [9]. The limited use of physical signs of malnutrition, such as edema or wasting, underscores the need for accurate anthropometric measures to identify at-risk children. These vulnerable refugees, who are frequently placed in designated sites or host communities, have greater health requirements as a result of the inadequate living circumstances and lack of basic amenities in camps and settlements. Access to new communities is challenging due to recent floods, a lack of resources, and logistical challenges. As a result, there are gaps in the general delivery of life-saving medical treatment to the impacted populations and surrounding towns. Malnourished children under the age of five can be identified using a variety of signs. A child's weight in relation to their age is referred to as weight-for-age (W/A). A child's "moderate or severe underweight" status is indicated by this indication. Weight-for-age is an excellent indicator of acute malnutrition if the child's age is accurate [10]. Based on a patient's weight and age, the World Health Organization's (WHO) 'WHO Anthro' software can accurately determine a patient's weight for-age z-score (WAZ). Weight changes over time, indicating severe starvation. Therefore, the purpose of this study was to evaluate the nutritional condition of children under the age of five who were being treated for diarrhea at primary health facilities in Bangladesh.

2. Diarrhea

2.1. What Diarrhea Refers to

Increased frequency, increased volume, and altered stoma consistency are all signs of diarrhea. It is important to keep in mind that the frequency of bowel movements changes with age and is higher in newborns [11]. The passage of blood and mucus in diarrheal stools is referred to as dysentery. Diarrhea that lasts longer than seven days is considered persistent, while diarrhea that lasts longer than 14 days is considered chronic [11, 12].

2.2. The Primary Causative Agents of Diarrhea

Though some cases of diarrhea are brought on by metabolic mistakes, chemical sensitivity, or organic disruption, infectious microorganisms are responsible for the great majority of cases [13]. Bacterial infections: Infants, young children, older children, and adults all have severe diarrhea brought on by enteric bacterial infections. This is especially true in tropical and poor nations like Bangladesh. E. coli, Salmonella, Shigella, Campylobacter, Yersinia, vibrios, and Clostridium difficile are only a few of the many causal bacteria [14]. Rotavirus is one of the most prevalent viral illnesses that can cause severe diarrhea. Other viruses, such as enteric adenoviruses, caliciviruses, and astroviruses, may also play a significant role in the development of diarrheal illness in humans [14].

2.2.1. Parasites

Parasites can settle in the digestive system after entering the body by food or drink. Giardia lamblia, Entamoeba histolytica, Cyclospora cayetanensis, and Cryptosporidium are a few of the parasites that can cause diarrhea.

2.2.2. Dietary Intolerances

Some people have digestive issue for a specific dietary ingredient, such as gluten or the sugar lactose present in grains like wheat and barley.

2.2.3. Some Antibiotics

Some medicines like (including clindamycin, cephalosporins, and sulfonamide), laxatives, and antacids can cause reactions.

2.2.4. Internal Illnesses

Intestinal conditions including celiac disease or inflammatory bowel illness. functional bowel diseases in which the intestines do not function regularly, including irritable bowel syndrome.

3. Transmission Routes of Diarrheal Disease

Infectious diarrhea is conveyed by fecal-oral transmission, which requires ingesting contaminated food or drink, direct contact with feces, and interpersonal interaction. Transmission patterns for water-borne diarrhea appear when indoor water storage facilities or/and water sources are contaminated (equal

to domestic domain and public domain contamination) [15, 16]. The most common place for diarrhea to spread is in a household setting.

Viruses
- Rotavirus
- Norovirus
- Enteric adenovirus
- Other: caliciviruses, astroviruses, enteroviruses

Bacteria
- *Campylobacter jejuni*
- Non-typhoid *Salmonella* sp
- Enteropathogenic *E. Coli*
- *Shigella* spp
- *Salmonella typhi*
- Shiga-toxin producing *E. Coli* (ETEC)
- *Vibrio cholera*

Protozoa
- Cryptosporidium parvum
- *Giardia lamblia*
- Entamoeba histolytica

Unidentified

Mixed infections

Figure 1. *Causative Agents for Childhood Diarrheal Disease.*

According to Curtis V [17], the main infectious agents can transfer from one human to another via the environment, from one human to another while proliferating in the environment, from one human to another via an animal to another human, and from an animal to another human via an animal. In environments where faecal contamination of the household environment is severe, the majority of cases of endemic sickness presumably arise either through human-to-human transmission or through the human-to-human transmission of pathogenic organisms that have proliferated in the environment.

4. Diarrhoeal Disorders Classification

Based on the mechanism, diarrhea may be divided into four broad categories: osmotic diarrhea, secretory diarrhea, exudative diarrhea, and motility problem diarrhea [18]. Diarrhea can be divided into four types, each reflecting a different pathogenesis, according to WHO [19], Vesikari T and Torun [20], Banerjee B, Hazra S, and Bandyopadhyay D [21], based on clinical syndromes. These types include acute watery diarrhea, dysentery, persistent or prolonged diarrhea, and chronic diarrhea.

4.1. Acute Watery Diarrhea

This phrase describes a type of diarrhea that develops suddenly and lasts for less than two weeks. The symptoms include frequent, watery, loose feces without any obvious blood. Acute watery diarrheal bouts often end 72 hours after they start. Abdominal discomfort, malaise, and flatulence might also be present. Vomiting, nausea, and fever are all possible side effects. Acute watery diarrhea is frequently brought on by bacterial, viral, and parasite illnesses.

Acute food poisoning can also be brought on by bacteria. Although their numbers varies, the bacteria that cause this diarrhea are enteric. In underdeveloped nations, these are basically the same as those seen in wealthy ones. Bacterial pathogens are often more significant in nations with poor hygiene standards. Rotavirus, Shigellae, enterotoxigenic E. coli (ETEC), Vibrio cholerae, Campylobacter jejuni, enteropathogenic E. coli (EPEC), Salmonella spp., and Cryptosporidium are the most significant causes of this diarrhea in poor nations [20].

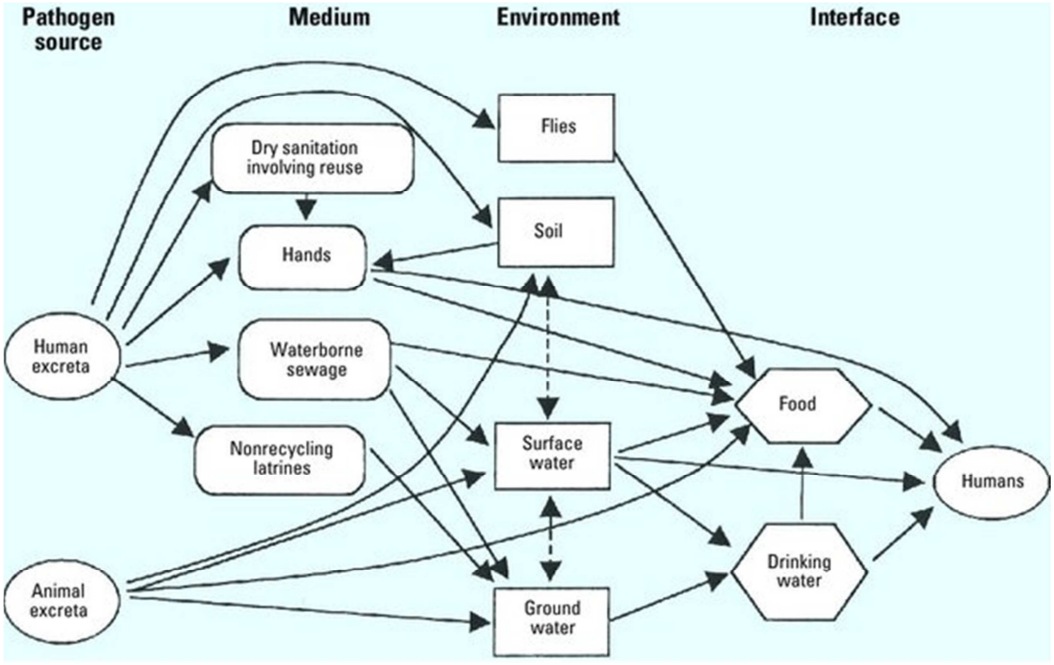

Figure 2. *Transmission Route of Diarrhea.*

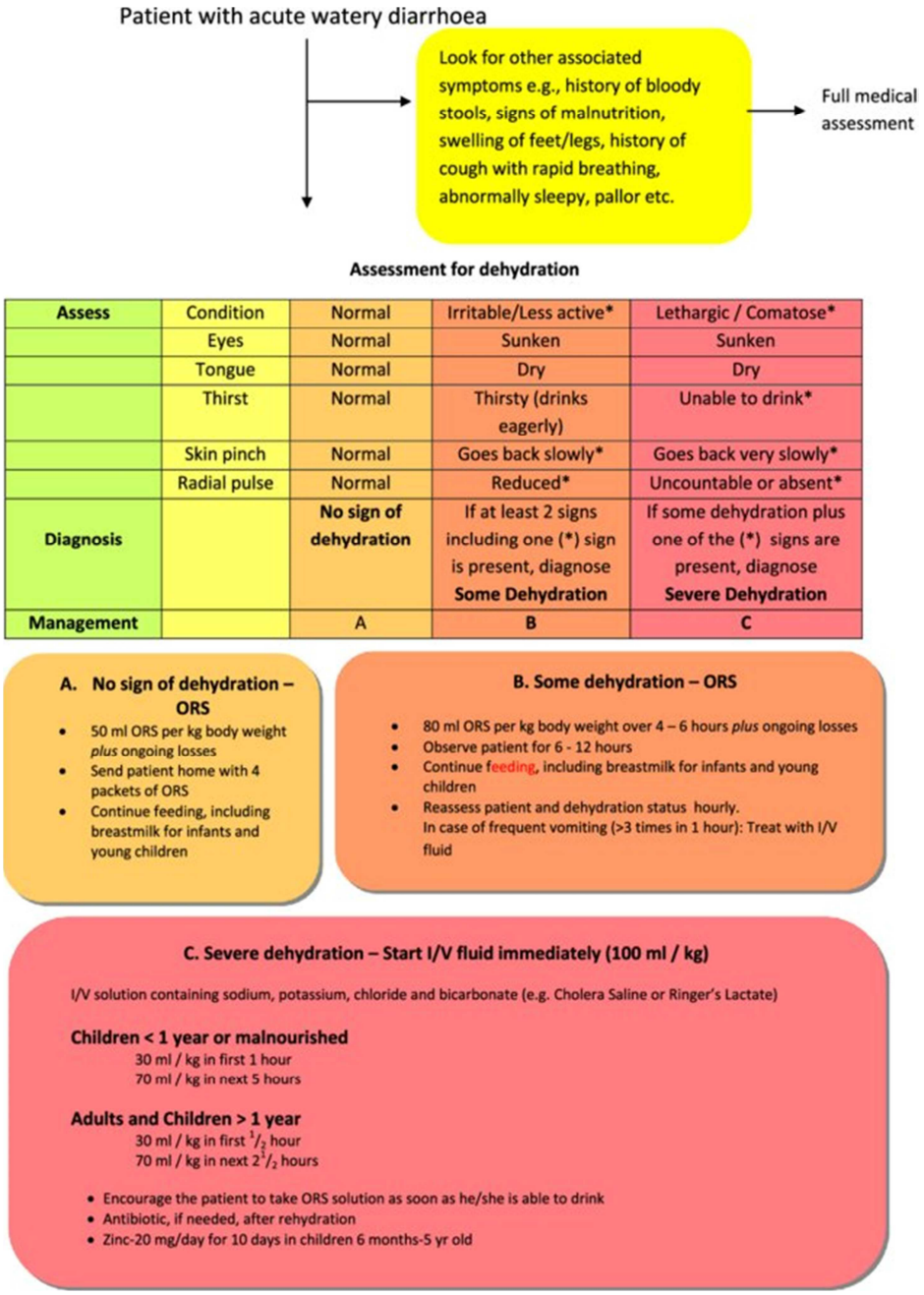

Figure 3. *Acute Diarrheal Management.*

The most dangerous adverse effect is dehydration, which occurs when the body loses excessive amounts of water and minerals (electrolytes). Your dehydration worsens if you throw up. Babies and young children are especially susceptible to dehydration because to their rapid body water cycle, high body water content, and relatively higher body surface [22]. Patients with mild dehydration may just experience thirst and dry mouth. Decreased urine production, extreme weakness, shock, renal failure, disorientation, acidosis (too much acid in the blood), and coma are all symptoms of moderate to severe dehydration. Another consequence of dehydration is orthostatic hypotension with syncope (fainting upon standing owing to a lower blood volume, which results in a drop in blood pressure upon standing).

4.2. Dysentery

Simply put, it is diarrhea with blood and mucous in the stools. Rectal soreness, fever, and stomach cramps are other symptoms of the condition. Shigella is the main factor causing bloody diarrhea. The genus Shigella contains four species of bacteria: S. dysenteriae, S. flexneri, S. boydii, and S. sonnei. S. flexneri, S. boydii, and S. dysenteriae are the leading causes of dysentery in impoverished nations, whereas S. sonnei is the main culprit in affluent nations [23]. *Shigellosis epidemics are brought on by S. dysenteriae type 1 (Sd1). Serious side effects from S. dysenteriae type 1* include haemolytic-uraemic syndrome (HUS), recta1 prolapse, septicemia (blood

poisoning), and prolonged diarrhea. HUS is a dangerous illness that affects the blood coagulation and renal systems. When compared to S. dysenteriae type 1, S. flexneri, S. boydii, and S. sonnei are often less harmful and do not spread widely [24]. Approximately 10% of diarrheal episodes in children under the age of five had blood visible in the stool, according to the evidence. About 15% of mortality in this age range related to diarrhea are caused by this 10% of episodes [25]. Infants, the elderly, and those who are undernourished are more likely to get S. dysenteriae type 1 disease. These groups also have the greatest mortality rates. The following infections also cause endemic dysentery in children:

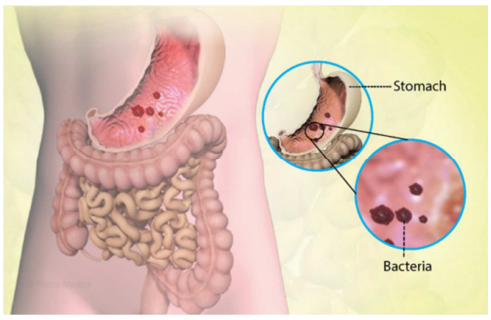

Figure 4. *Dysentery Symptoms.*

4.3. Persistent Diarrhea

It is characterized as bouts of diarrhea with a likely infectious cause that persist at least 14 days and are exceptionally protracted in duration 3, [22]. Children from impoverished nations experience chronic diarrhea in around 10% of cases, particularly notably in newborns and children under three years old. Dysentery or watery diarrhea are two acute symptoms that the episode might start with. Most individuals who get this diarrhea lose a lot of weight. One-third to fifty percent of all deaths resulting from diarrhea may be attributable to it. Since chronic diarrhea is a major cause of malnutrition in poor countries, even milder, non-fatal bouts of diarrhea contribute to the overall high mortality rates that are frequently associated with malnutrition in these countries.

The precise mechanism causing persistent diarrhea is unknown. Infections with entero aggregative E. coli (EAggEC), EPEC, and Cryptosporidium, food intolerance, delayed intestinal mucosal recovery from protein-energy malnutrition or vitamin A or zinc deficiency, immunodeficiency (aside from AIDS-related chronic diarrhea), and inappropriate antibiotic use are just a few of the many factors that cause chronic diarrhea, most likely in combination [20].

4.4. Chronic Diarrhea

This expression refers to protracted or persistent diarrhea that is mostly brought on by non-infectious causes. Numerous conditions, such as gastrointestinal problems, systemic illnesses, and even psychological concerns, can result in chronic diarrhea [18, 20]. In terms of pathophysiology, chronic diarrhea can be divided into five different types: inflammatory diarrhea (caused by conditions like regional enteritis or ulcerative colitis), osmotic or malabsorptive diarrhea (caused by conditions like lactose intolerance, tropical sprue, celiac disease, Whipple's disease, chronic pancreatitis, and bile duct obstruction), secretory diarrhea (caused by medications, bowel resection, [20, 26].

5. Determinant for Diarrheal Disease

5.1. Demographic Factors

Numerous studies have demonstrated that younger children are more likely to experience diarrhea [22, 28-32]. The prevalence is highest in infants aged six to eleven months, maintains a high level in children aged one, and declines in the third and fourth years of life [22, 27, 31, 32].

Boys have been shown to experience diarrhea at a higher incidence than girls. Other demographic characteristics, such as younger moms, less-educated mothers, more siblings, and birth order, were strongly linked to higher rates of diarrhea in young children [22-27].

Figure 5. *Causes of Diarrheal Disease.*

5.2. Socio-Economic Factors

According to several research, there is a statistically significant correlation between socioeconomic characteristics including inadequate housing, congested living circumstances, and low income with a greater risk of diarrhea. [22, 27, 29, 33].

5.3. Water-Related Factors

Due to the fact that diarrhea is spread through tainted food and water, water-related factors have a significant role in determining the likelihood of diarrhea. Increased distance from water sources [32, 34], inadequate drinking water storage [15, 16, 32, 33] (e.g., lacking a facility to store drinking water and having to delve into storage containers to collect water), use of questionable water sources [28, 30, 35-39], storage of water in widemouthed containers [16, 39], and low per capita water use [36, 37] have all been identified as risk factors for increased diarrhea incidence.

5.4. Sanitation Factors

Obviously, sanitation is important in lowering diarrhea morbidity. The risk of diarrhea in children was elevated by certain sanitation issues, such as the incorrect or careless disposal of household waste and children's feces, the lack of latrines or unsanitary toilets, sharing latrines, and homes without sewage systems. [27, 31, 32, 36-40].

5.5. Hygiene Practices

Children eating with their hands rather than spoons, eating cold leftovers 23, mothers feeding children or preparing foods without washing their hands, unhygienic domestic settings (kitchen, living room, yard), unsafe food storage34, presence of animals inside the house, and presence of flies inside the house have all been linked to an increased risk of diarrhoea, according to some studies. [31-33, 35, 38, 41, 42].

5.6. Breastfeeding

There is a wealth of information on eating habits and diarrhea risk. In general, completely weaned children have the highest morbidity of diarrhea, followed by partially breastfed children and exclusively breastfed children. Additionally, bottle-feeding has a unique risk of diarrhea. The considerable protective impact of breastfeeding has been demonstrated in several research. Following colonization with enteropathogens, the risk of diarrhea is decreased by breast milk's high content of certain antibodies, cells, and other mediators. [22, 30, 39, 43-45].

5.7. Malnutrition

The concept of a vicious loop, where starvation causes diarrhea and diarrhea causes malnutrition, is attractive since diarrhea and malnutrition are so frequently related in low-income countries. Children whose immune systems have been weakened by malnutrition are most frequently affected by diarrhea. Diarrhea, especially persistent and chronic diarrhea, lowers nutritional status because it causes malabsorption of nutrients or reduces the body's ability to absorb nutrients to maintain health. According to various research, children who are underweight have diarrhea more frequently. Additionally, it was shown that children who were stunted or had low weight-for-age tended to experience more diarrhea. [22, 33, 46, 47]

5.8. Immunodeficiency

Chronic diarrhea is the main cause of morbidity and mortality in individuals with human immunodeficiency virus (HIV) [19, 20], and immunodeficiency is both a cause of it and a risk factor for it. Patients are more susceptible to viruses that cause infectious disorders like diarrhea because of innate or acquired immunodeficiency. Up to 60% of AIDS patients report having diarrhea [48]. The dramatic drop in childhood diarrheal mortality recorded over the previous four decades may come to an end as one of the numerous effects of the HIV/AIDS epidemic. Children with HIV/AIDS have greater rates of diarrheal incidence, duration, severity, and death than typical children [19].

5.9. Seasonal Distribution

Pediatric diarrhea has been connected to two different seasonal peaks in many tropical countries, with the summer peak being associated to bacterial infections and the winter peak being linked to viruses 8. Diarrhea occurs more frequently during the rainy season than during the dry season, according to several studies [14, 49]. During the dry seasons, when rainfall and borehole water are less easily available, disinfecting drinking water from accessible surface sources may greatly reduce illness [38]. Research has shown that pollution was worse during the wet season [32, 50, 51]. According to claim A, there is a high correlation between pre-monsoon climatic parameters and the number of diarrhea patients at the first peak in April. Teshima and others [52]. The total number of patients with diarrhea peaks in the spring (April–May) and the fall (August–October), respectively, depending on the weather before the monsoon. In the spring and fall, when weather factors switch roles, the number of patients with diarrhea peaks. Additionally, a number of studies suggest that the prevalence of diarrhea increases noticeably during El Nino years [53–55].

5.10. Consumption of Food Sold By Street Vendors

This poses a serious risk as well [38]. Consuming contaminated items such fruits, vegetables, shellfish, raw meat, water, and ice cubes can cause diarrhea in tourists traveling to distant countries with warm weather and inadequate sanitation [14].

5.11. Eating Habits

Eating with the hands; eating raw foods; or drinking unboiled water, may increase the risk of diarrhea.

6. The World's Burden of Childhood Diarrheal Disease

Diarrhea is a worldwide issue, although it is more common in underdeveloped nations due to unsanitary environments, insufficient water supply, poverty, and a lack of educational opportunities 49. Around one billion cases of diarrhea are thought to occur annually, costing 99.2 million DALYs (disability adjusted life years) in lost productivity, according to the World Health Organization. It is generally known that diarrheal infections are among the most prevalent illnesses and causes of death among young children in undeveloped countries. In spite of the fact that the morbidity of diarrhea has largely stayed constant at one billion episodes, or 3.2 episodes per child-year, it still kills 2.5 million people every year, making up 21% of all diseases that cause death in children under the age of five [19, 56-58].

7. Effect of Diarrheal Disease on Children

A significant burden is the 2.5 million fatalities each year brought on by diarrhea. Furthermore, this number frequently has long-lasting negative impacts on a person's nutritional condition, development, fitness, cognition, and academic performance [19, 36, 56]. There is evidence that diarrhea affects growth, according to certain research.

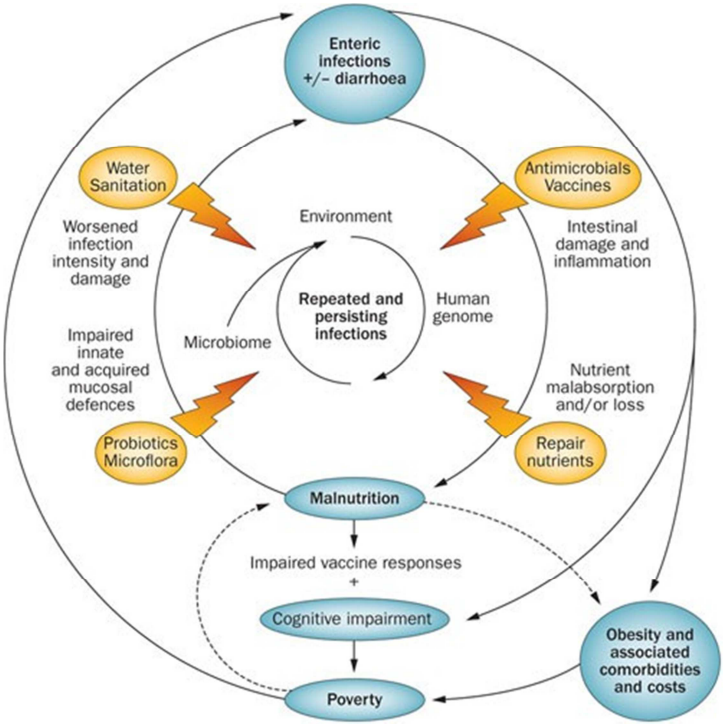

Figure 6. *Causes of Diarrhea.*

It is thought that diarrhea significantly hinders growth because it alters feeding habits, decreases appetite, and decreases nutrient absorption [56].

8. Deterrence and Contravention of the Vicious Cycle of Diarrhoea

A diarrheal episode is frequently classified according to symptoms into one of the three categories of acute watery diarrhea, dysentery or bloody diarrhea, or chronic diarrhea in order to help with best case treatment and for epidemiological tracking. The clinician is guided by certain concerns specific to each of these groups to administer suitable treatment.

8.1. Acute Watery Diarrhea

Acute watery diarrhea would be the most common type of diarrheal episode. In general, secretory microbes cause diarrheal symptoms referred to as acute watery diarrhea. Enterotoxins are frequently produced by agents that cause this non-inflammatory kind of enteric sickness, such as V. cholerae or ETEC. Alternatively, as in the case of viruses or Giardia, they may impair the enterocyte's regular absorptive or secretory functions without generating acute inflammation or mucosal damage. Despite usually being minor, this kind of disease can quickly cause dehydration. The infection in these situations may be brought on by rotavirus, ETEC, or V. cholerae [59]. There may be a nutritional cost in cases of watery diarrhea lasting seven days or more [60].

Figure 7. *Diarrheal Therapy.*

8.2. Dysentery or Bloody Diarrhea

Bloody diarrhea is the phrase used in medicine to describe faeces that may be either obviously bloody or have blood visible under a microscope. Small-volume, bloody or mucoid stools with stomach pain and tenesmus are typical symptoms of dysentery. However, both phrases are frequently used synonymously, and fever is a coexisting sign of both. Inflammatory or invasive organisms can cause dysentery or bloody diarrhea. Fecal leukocytes or lactoferrin are often present when invasive pathogens are present [61].

Dysentery or bloody diarrhea-causing pathogens can damage gut cells or infiltrate the mucosa, which can lead to inflammation or ulceration. Cytotoxin-producing noninvasive bacteria like EAEC and invasive pathogens like Shigella, Salmonella, Campylobacter, and amoeba are examples of inflammatory organisms. Fever can be caused by an enterotoxin or be a sign that an invading organism has damaged intestinal tissue [61].

8.3. Persistent Diarrhea

Only the length of the illness—more than 14 days—distinguishes persistent diarrhea from other types of diarrhea. Multiple gastrointestinal illnesses that occur one after another or an infection that has not healed are two causes of recurrent diarrhea. Even though there are several distinct enteric infections that can cause chronic diarrhea, Giardia, Cryptosporidium spp., EAEC, and EPEC are the most significant [62, 63]. The risk of mortality is ten times higher in instances of bloody diarrhea lasting more than two weeks when chronic diarrhea develops as a result, as is commonly the case [64]. When it comes to children, the chance of dying from chronic diarrhea might rise if they were underweighting before getting sick or had other systemic diseases [63].

A complete history and physical examination, as well as assessments of hydration and nutritional status, as well as a thorough clinical evaluation for any complications or related diseases, are all necessary for managing a kid who presents with acute diarrhea [11, 12]. The technique of rehydration, nutrition, and any indications for specialist studies must subsequently be decided. Pharmacologic treatment is often only used to supplement micronutrients [11, 12].

Following a history of vomiting or diarrhea, the initial examination is to identify and treat shock. The clinical characteristics and early management of shock are shown in Figure 10. These children require venous access immediately, and if shock symptoms persist following the initial fluid bolus, a second 10 ml/kg bolus should be given. These children may also need more general supportive care, such as oxygen, and they must always be under close observation [12, 65]. The additional history should cover the length and frequency of the diarrhea, the presence of blood or mucus in the stool, the presence of bile stains in the vomit, the use of home rehydration fluids, the mixing of these fluids, as well as other typical elements of the paediatric history like prior illnesses, immunization status, feeding, medications, and associated side effects.

The Integrated Management of Childhood Illness (IMCI) (Figure 8, 9) lists the conditions that warrant admitting a child with diarrhea to the hospital [65]. Dehydration is now classified as having no signs, having some signs (corresponding to the old classification of 5% dehydration), and having severe signs (corresponding to the old classification of 10% dehydration).

Dehydration may be measured in a highly objective way by comparing present weight to a weight that was previously recorded, frequently on the Road to Health Card (RTHC). According to a thorough research, skin turgor, capillary refill time, and an abnormal respiratory pattern suggestive of acidosis are the best indicators of degree of dehydration. [12, 66].

9. Management of Diarrhea

No visible dehydration	Some dehydration	Severe dehydration	Shock
Features: • alert with normal eyes • not thirsty • normal skin pinch	2 or more signs: • restless and irritable • thirsty and drinks eagerly • skin pinch returns slowly • fontanelle is sunken	2 or more signs: • lethargic or sleepy • deeply sunken eyes and fontanelle • very slow skin pinch	**Signs of:** • depressed level of consciousness or weakness • weak or absent peripheral pulses • a prolonged capillary refill time of > 3 seconds • tachycardia of > 120 bpm Usually but not always with evidence of severe extravascular dehydration
Initial fluid management • treated at home with additional fluids • Other supportive measures	• ORS orally or nasogastrically • Continue breastfeeding or formula milk within 4 hours • Replace ongoing losses with ORS	• Intravenous rehydration with ½ Darrows Dextrose • Continue breastfeeding or formula within 4 hours • Replace ongoing losses with ORS	• Rapid venous access, either an intravenous or intraosseous line • Bolus of 20 ml/kg of Ringers lactate or Normal Saline.

ORS = Oral Rehydration Solution

Figure 8. *Features and management of shock and dehydration (modified from WHO and IMCI) [11, 12].*

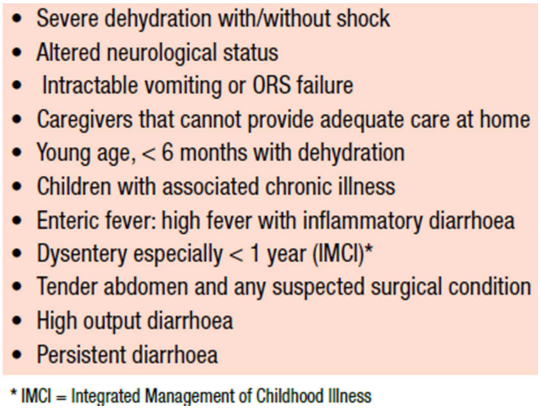

Figure 9. *Indications for hospitalization [11, 12].*

9.1. Rehydration and Fluid Management

The discovery that glucose-sodium co-transport was unaffected in cholera and the understanding that secretory and absorptive processes in the intestine are distinct led to the development of Oral Rehydration Solution (ORS), which has similar concentrations of sodium and glucose that optimize absorption along with potassium, chloride, and bicarbonate [66]. It is recognized as one of the most important medical discoveries of the contemporary age, and during the 1980s, when it was widely pushed as part of the WHO Control Diarrheal Disease (CDD) campaign, the number of diarrheal disease mortality was reduced by half during the next 20 years. [67, 68]. The development of Oral Rehydration Solution (ORS), with similar concentrations of sodium and glucose that optimize absorption along with potassium, chloride, and bicarbonate, was prompted by the observation that glucose-sodium co-transport was unaffected in cholera and the realization that secretory and absorptive processes in the intestine are separate [66]. It is regarded as one of the most significant medical advancements of the modern era, and in the 1980s, when it was actively promoted as part of the WHO Control Diarrheal Disease (CDD) program, the number of fatalities from diarrheal disease was cut in half over the next 20 years. [67, 68].

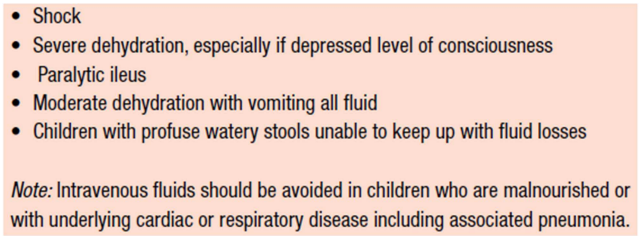

Figure 10. *Indications for intravenous fluid.*

The WHO, European Society of Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN), and American Academy of Pediatrics (AAP) all recommend quick rehydration over four hours in situations of mild to moderate (IMCI "some") dehydration. Rehydration should be delayed over 8–24 hours in infants under three months old, those with respiratory or cardiac issues, those with suspected or proven hypernatremia, and in malnourished children [70].

There has been ongoing discussion on the ideal ORS composition. The first WHO formulations had a higher salt content since they were created in areas with a high prevalence of cholera, which is exacerbated by hyponatraemia. Using an ORS with a lower osmolarity and lower salt and glucose contents (75 mmol/l vs. 90 mmol/l and 111 mmol/l, respectively) is advised by the most recent WHO recommendations.

9.2. Maintain Nutrition

Based on level 1 evidence, the WHO, ESPGHAN, and the AAP all concur that breastfeeding should continue at all times and that regular feedings should resume within four hours in cases of uncomplicated gastroenteritis. There is no place for specific formulas like soy-based or lactose-free, or for dilution or gradual reintroduction of formula. Drinks containing a lot of sugar shouldn't be consumed. In order to allow for catch-up growth after a gastroenteritis episode, one additional meal per day should be promoted for at least a week [11, 12, 70].

9.3. Investigations

Children receiving IV fluids, those with concurrent malnutrition, those in hospitals with severe dehydration or shock, and any child who seems ill relative to their degree of dehydration should all have their electrolytes evaluated [11, 12]. Infants who appear floppy or have abdominal distension should have hypokalaemia ruled out, while children who are well-nourished, have skin that feels rubbery, cry loudly, or have a history of mixing ORS wrongly should be evaluated for hypernatraemia. Sending a stool microscopy, culture, and sensitivity (MCS) test is indicated in cases of chronic diarrhea, inflammatory diarrhoea with blood and pus in the stool, high fever and systemic illness, and in hospitalized children who develop diarrhea, including for C. difficile. Routine rotavirus testing is important for epidemiology but has no bearing on the supportive strategy for treating diarrhea. Routine stool testing is not recommended, the yield from stool MCS is low, and the majority of laboratories do not test for different E. Coli strains [11, 12, 66]. Regular complete blood counts and inflammatory markers like C-reactive protein have no role in the diagnosis of uncomplicated gastroenteritis, but kids under three and those who have a high fever require a thorough septic workup [11, 12, 66].

9.4. Pharmacologic Therapy

Young children typically experience zinc insufficiency in developing nations, which is associated with lowered cellular and humoral immunity, decreased brush border enzyme activity, and poor water and electrolyte absorption. The length and intensity of acute and chronic diarrhea are reduced by taking a zinc supplement, and the risk that it will occur again during the next two to three months is decreased, according to meta-analyses. WHO and UNICEF recommend zinc

supplementation (10 mg for babies under six months and 20 mg for kids over six months) for 10 to 14 days as a general treatment [71-73]. Except in cases of underweight children, ESPGHAN advises against use as a routine treatment choice for children in Europe [11].

Probiotics may be an effective supplement for treating diarrhea, but it's critical to only suggest those that have been scientifically established to be effective. The efficacy data from Saccharomyces boulardii and Lactobacillus GG have been reported most frequently. When the probiotic is administered at a dose of 1010 CFU/day early in the course of the diarrhea, the best results have been observed in young neonates with viral gastroenteritis. However, there are concerns in the poor world about the use of probiotics in the therapy of diarrhea due to the high frequency of bacterial diarrhoea in these clinical settings, where probiotics may be less effective and safety problems associated to immunosuppression may occur [11, 74].

Indications	Antibiotic regimen
• Bacterial gastroenteritis complicated by sepsis • Neonates • Ill immunocompromised children • Associated infection e.g. urinary tract infection or pneumonia	• Usually ampicillin and gentamicin OR ceftriaxone
Dysentery • *Shigella* • *Salmonella* spp (non-typhoid) • *Campylobacter* First try to exclude ETEC due to the associated with HUS	• Nalidixic acid, fluoroquinolone or ceftriaxone • Erythromycin or one of above
Specific infections: • Amoebiasis • Giardiasis • *Vibrio cholera* if complicated by severe dehydration • *C. difficile*	• Metronidazole • Metronidazole • Doxycycline(> 6 years) or fluoroquinolone • Metronidazole or oral vancomycin

ETEC = Enterotoxigenic *E. Coli*, HUS = Haemolytic Uraemic Syndrome

Figure 11. *Indications for systemic antibiotics.*

Non-pharmacologic therapies and supportive measures are frequently used to treat diarrhea. Since loperamide and other antimotility drugs have been connected to toxic megacolon in cases of C. difficile infection, prolonged sickness in cases of Shigellosis, and haemolytic-uraemic syndrome in children with E. coli that generates Shiga toxin, they are not recommended [11, 12, 66]. Due to the potential for extrapyramidal adverse effects, older anti-emetics are therefore not recommended, even if certain more modern drugs, such ondansetron, are effective without them [11, 12]. There is no evidence to support the use of prebiotics, glutamine, folic acid, kaolin-pectin, attapulgite, activated charcoal, or bismuth. However, there could be benefits to employing smectite, an aluminum-magnesium silicate that binds intestinal mucus. Despite having minimal impact on the progression of severe diarrhea, vitamin A should be given, according to national recommendations [11]. Antibiotics are not frequently indicated in cases of viral or straightforward bacterial gastroenteritis (Figure 11).

9.5. Management of Children with Chronic Diarrhoea

A complete history, including family history, and thorough clinical examination should be performed for the child who arrives with acute diarrhea, taking into account the effects of chronic diarrhea on nutritional status [Figure 8] [74]. After an acute dehydrating diarrheal episode, it is critical to determine whether the diarrhea is persistent. A number of clinical conditions, such as small bowel bacterial overgrowth, acquired disaccharidase deficiency, deconjugation and dehydroxylation of bile salts, which cause diarrhea, and protein sensitization, may necessitate additional specialized care [75]. A complete history, including family history, and thorough clinical evaluation should be performed for the child who arrives with acute diarrhea, taking into account the effects of chronic diarrhea on nutritional status [74]. After an acute dehydrating diarrheal episode, it is critical to determine whether the diarrhea is persistent. A number of clinical conditions, such as small bowel bacterial overgrowth, acquired disaccharidase deficiency, deconjugation and dehydroxylation of bile salts, which cause diarrhea, and protein sensitization, may necessitate additional specialized care [75].

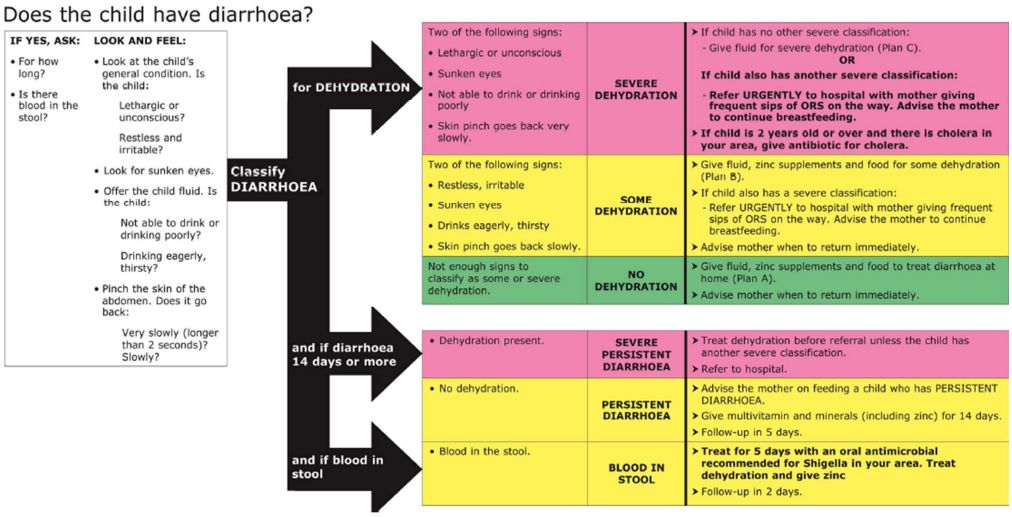

Figure 12. *Diarrheal Management by WHO.*

10. Conclusion

Bangladesh's public health is affected by malnutrition. Numerous health-related problems have an influence on the health of the Bangladeshi people when they are compelled to leave their homes and find shelter in different camps in Bangladesh. Malnutrition and diarrhea are two among them. The current study found that 41.3% of Bangladeshi children under 5 who reported having diarrhea to primary health facilities in Cox's bazar had malnutrition. Malnutrition was shown to be highly correlated with age, which emphasizes the importance of age-specific therapies. Additionally, it was shown that the caretakers of Bangladeshi children under five are unwilling to utilize ORS or are unaware of its significance when experiencing diarrhea. They do, however, frequently seek medical attention for their kids. The study recommends creating new regulations to raise ORS usage awareness among Bangladeshi caregivers. It also indicates that acute diarrhea treatments in primary health clinics incorporate early identification and fast treatment of malnutrition. That research, however, disregards weight after discharge. It is known that hydration status affects a patient's weight, thus discharge weight would have been a better way to detect malnutrition.

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