# Comparison and Analysis of Incidence Rate of Bacillary Dysentery in Selected Countries

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**Abstract.** Bacillary dysentery is a waterborne and foodborne disease, which results in substantial morbidity all over the world. However, the changes in morbidity over time and the cause of bacillary dysentery varies in countries with different level of development. The study aims to compare the characteristics and changes of bacillary dysentery incidence and proper interventions in selected countries. From 2010 to 2019, the morbidity and mortality of it in underdeveloped countries are higher, indicating that the disease burden of bacillary dysentery in a specific country is associated with the level of development. The species of Shigella also show a difference. The outbreaks of bacillary dysentery in under-developed and developing countries are mainly caused by S.flexneri, while S.sonnei account for most infections in developed countries. The risk factors in underdeveloped countries are uneven health conditions and funding, inadequate health education, and poor hygiene and sanitation. As for developing countries, the risk factors are related to regional economic conditions, meteorological conditions, health conditions, and living habits. However, for developed countries, the emerging drug resistance of the pathogenic Shigella and the transmission between the men sex with men (MSM). Individual, household and government should be carried out with cooperation in countries with varying levels of development to reduce the burden of bacillary dysentery. The pathogen of bacillary dysentery has advanced quickly in recent years, bringing much disease burden globally. All nations must address the socioeconomic causes of bacillary dysentery. Scientific interventions need to be carried out according to the actual situations and specific risk factors to meet the demand of reducing Shigella morbidity and mortality.

**Keywords:** Bacillary Dysentery, Shigellosis, Incidence Rate, Risk Factors.

## 1. Introduction

Bacillary dysentery is acute infectious enteritis. The population is generally susceptible to bacillary dysentery, and preschool children are easier to be infected, which is related to poor hygiene habits. Adult patients with reduced body resistance, exposure to many related infection opportunities, in addition to suffering from the same type of bacillary dysentery after no consolidated immunity and no cross-immunity between different bacterial groups and different serotypes of shigella dysenteries, as a result, get infected repeatedly. The typical signs of this disease are mucus and bloody stools and abdominal pain. Complications include hemolytic uremic syndrome (HUS), toxic encephalopathy, deep ulceration or perforation of the bowel, and acute stricture and obstruction of the bowel lumen. Malnutrition can also lead to weight loss due to the reduced absorption capacity of the patient's gut [1]. The disease can occur acutely or chronically. Among them, acute bacillary dysentery is divided into typical bacterial dysentery, atypical bacterial dysentery, and toxic bacterial dysentery. Toxic bacterial dysentery is seen more in children. When acute bacillary dysentery treatment is not complete, or the body resistance is poor, the disease tends to become chronic. The course of the disease is more than two months. Bacillary dysentery is distributed all year round, seen more in summer and autumn. It is excreted with the feces of patients or carriers and is transmitted through contaminated hands,

food, water, or living contact, or indirect means such as flies and cockroaches. Eventually, it is transmitted through the mouth into the digestive tract to infect susceptible people.

Studies have shown that Shigella type 1 (SD1 or Shigella) can cause epidemics. The prevalence of other common infectious bacteria has not been reported. The mechanism and reasons for this phenomenon are not fully understood. The disease epidemic exacerbates the burden of endemic bacillary dysentery in developing countries. Worldwide, there are 164.7 million cases of diarrhoea each year, of which 163.2 million are in developing countries. According to statistics, about 1.1 million people die from this disease every year [2]. The harm caused by Shigella in recent years is far greater than that reported above. At present, Shigella has developed resistance to a variety of antibiotic drugs, which makes the harm of dysentery more serious. Therefore, reducing or exempting antibodies has become the focus of attention, especially in the research and development of effective vaccines.

Many existing reviews have previously examined the incidence and prevalence of bacillary dysentery in different countries, and there were many line graphs and tables showing trends in the disease in previous years. At the same time, many contributions and achievements have been made by various countries to reduce the annual incidence of the disease, find its causes, take effective measures and reduce the annual mortality rate. However, due to changes in time and uneven development in different countries, especially in terms of the establishment of infrastructure like sewage and water treatment plants and complete health care and laboratory systems, the annual incidence of bacillary dysentery has varied considerably between countries with different levels of development in recent years, a new review is urgently needed at this time. In this study, two countries each from developed, developing, and underdeveloped countries were selected as representatives to investigate the burden of bacillary dysentery in these countries, with emphasis on different annual incidence patterns, for the period 2010 to 2019.

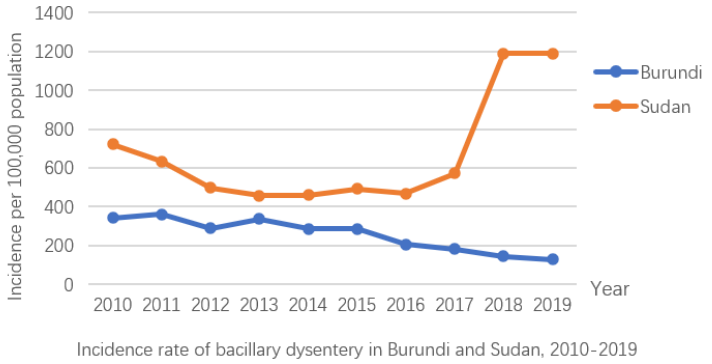
This paper will describe and compare the trends of the annual incidence of bacillary dysentery in these six countries with different levels of development by using the information and data collected at this stage. The study will demonstrate the differences in morbidity between countries during this decade, which will provide new insights into the causes and influences of morbidity, as well as preventive measures prior to and post-morbidity management in relatively underdeveloped countries.

## 2. Discussion

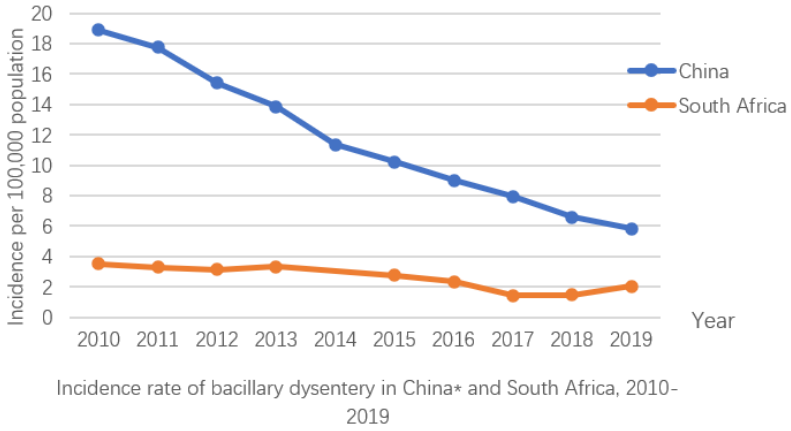
### 2.1. Data description

#### 2.1.1 Characteristics and trends of the annual incidence rate in different countries

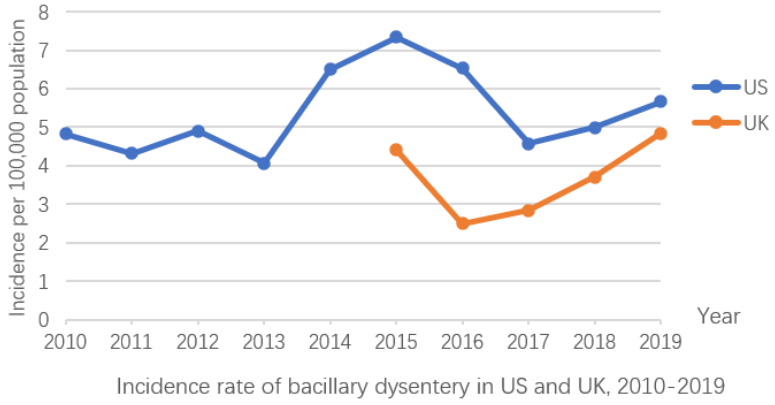
The incidence in poor countries was higher, and the morbidity in developing and developed countries did not show a significant difference. In Burundi and Sudan, the morbidity declined from 2010 to 2017. But in 2018 and 2019, the morbidity of bacillary dysentery increased sharply in Sudan. In China and South Africa, the morbidity kept decreasing from 2010 to 2019. In US and UK, the morbidity of bacillary dysentery fluctuated from 2010 to 2019 and both increased after 2017. According to the reported case number of bacillary dysentery, the burden of disease in underdeveloped countries is much higher than that of developing and developed countries, indicating that more public health interventions aiming at improving hygiene and sanitation need to be carried out in low-income regions. The annual incidence rate of each country are shown in Figure 1.




A) under-developed countries




B) developing countries




C) developed countries

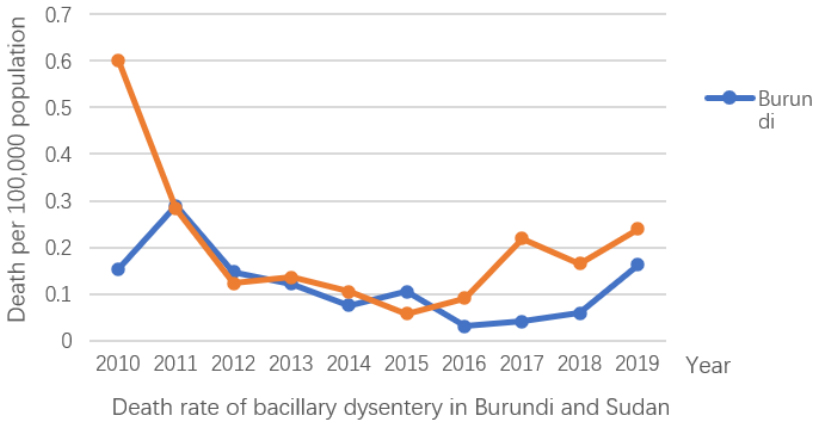
**Figure 1.** Incidence rate of bacillary dysentery in different countries

*The reported dysentery cases included bacillary and amoebic dysentery in China

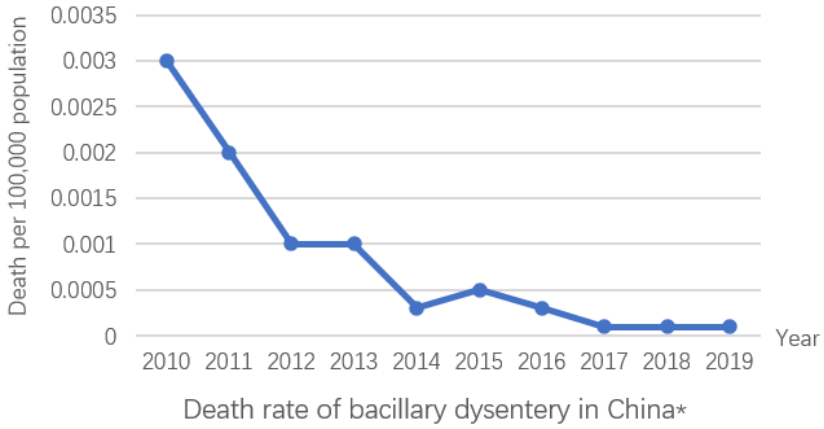
### 2.1.2 Characteristics and trends of annual mortality in different countries

According to the reported death numbers of the National Health Ministry, the mortality showed a trend of declining in Burundi, Sudan, and China, and the mortality in under-developed countries was much higher than in developing countries and developed countries. The mortality decreased broadly from 2005 to 2013 in the UK [3], and Public Health England declared that dysentery was no longer notifiable from 2010. In the United States, Shigella causes approximately 40 deaths every year and the annual mortality is about 0.01 death per 100,000 population [4]. Although children especially the ones under 5 years are at greater risk of developing symptoms of higher severity which might cause

shigellosis to relate to mortality, the association between HIV infection and shigellosis severity is suggested. Factors such as hospitalization length, adequate drug and antibiotics usage, health expenditure, and health education might lead to the disparity of mortality in countries with different levels of development [4]. The annual mortality of each country is shown in Figure 2.




A) under-developed countries




B) developing countries

**Figure 2.** Mortality of bacillary dysentery in different countries

*The reported dysentery death number included bacillary and amoebic dysentery in China

### 2.1.3 The prevalent species of Shigella in countries with different level of development

Bacillary dysentery is caused by S.flexneri, S.sonnei, S.dysenteriae, or S.boydii. The outbreaks of bacillary dysentery in under-developed countries and developing countries are mainly caused by S.flexneri, while S.sonnei with multiple antimicrobial resistance account for 80% of bacillary dysentery especially in Europe and North America, and the trend of S.sonnei infection has changed from developed countries to developing countries [5]. S.sonnei dominance in a country or region is associated with economic development due to several proposed mechanisms, correlated to the immune system of a specific population and water quality [6]. In developed countries, the cases of bacillary dysentery were not only associated with travel to endemic countries or regions and specific eating habits but also were related to sexual transmission of S.sonnei, especially between the men sex with men (MSM) [5]. In contrast, in under-developed and developing countries, outbreaks or endemic of bacillary dysentery were still mainly caused by contaminated water and food. However, the worldwide emerging drug resistance of all pathogenic Shigella species affects the efficiency of antibiotic therapy, making the treatment of bacillary dysentery challenging [7].

### 2.2. Dominant risk factors in countries with different level of development

#### 2.2.1 Risk factors in under-developed countries

According to the above graphs, the incidence and prevalence of bacillary dysentery in Burundi and Sudan were significantly higher than in the other four countries during the observed decade. Bacillary dysentery risk factors are primarily determined by comparing socio-economic status variables with and without bacillary dysentery via household risk factors and individual risk factors. In previous research studies [8], the influx of refugees into Eastern Sudan and their malnutrition led to infectious diseases, especially measles, diarrhea, and bacillary dysentery, which became the main cause of their deaths. In Burundi, two case-control studies [9] discovered that infected female persons were more likely to use a cloth rag after defecation and not wash their hands before preparing food. Food preparers who do not wash their hands with soap, a shortage of soap in the home, and the use of open toilets, shared family toilets, or open collecting buckets can all lead to bacillary dysentery. And secondary household transmission was regarded as the second cause.

Through the change of time and national control, we can see that the incidences of bacillary dysentery in two countries, Burundi and Sudan, have gradually decreased year by year. However, in 2018, there was a steep increase in the incidence of the disease in Sudan, which can be due to advances in technology that have allowed Sudan to use culture-independent methods to detect the prevalence of enteric pathogens in the population. Thus, according to Bliss et al [10], those displaced patients living in the camps were detected in large numbers.

From the perspective of the mortality rate of bacillary dysentery in Sudan and Burundi, the above graph shows that in Sudan, the mortality rate of the disease was 0.6 per 100,000 population(the highest value) in 2010 and had been hovering between 0.1 and 0.3 per 100,000 population in the remaining years; while in Burundi, the mortality rate of the disease had also been hovering between 0.1 and 0.3 per 100,000 population in this decade. In terms of the overall number of deaths, these two countries do not account for a large proportion of deaths, but the values are much higher than those of developing and developed countries. Therefore, there is some similarity in the risk factors of morbidity and mortality of bacillary dysentery in these two countries. First, due to the uneven health conditions and funding provided by the government in urban and rural areas, health disparity [11] is more severe in the more disadvantaged areas, and therefore, most of the residents in these areas do not receive treatment for diseases, and also do not receive knowledge of vaccination and miss the opportunity to reduce morbidity. Secondly, the living conditions of the residents are backward and the awareness of hygiene and epidemic prevention is insufficient. Many residents living in the camps do not have clean water, which leads to a high incidence of the disease, and at the same time, they cannot be educated about epidemic prevention [12], so the residents in the area do not have the habit of water and food hygiene, which makes the death rate of bacillary dysentery unrelieved in the long run.

#### 2.2.2 Risk factors in developing countries

In developing countries like China and South Africa, the morbidity of bacillary dysentery kept decreasing from 2010 to 2019. In China, it is high in northwest, southwest, Beijing, and Tianjin. Bacillary dysentery occurred in all age groups. Infants aged 0-4 have the highest incidence accounting for 27.77% of the total. This is followed by the 30-39 age group. Preschool children aged 10-14 years accounted for 13.58% of the total. It accounts for 12.96 percent of the total. Bacillary dysentery occurred in all occupational groups. In particular, the small age groups, such as scattered children, children in childcare, and primary and middle school students, accounted for 49.38% of the total number of bacillary dysentery, followed by farmers and migrant workers, accounting for 40.12%, other personnel accounted for 10.50% [13]. Fundamentally speaking, the rapid economic growth of developing countries has brought about earth-shaking changes in the material and cultural life of their people. Water supply systems and basic sanitation facilities in various parts of the country have been significantly improved, reducing the risk of bacillary dysentery transmission. However, bacillary dysentery is still an important intestinal infectious disease that threatens people's health in developing

countries. Outbreaks caused by bacillary dysentery occur from time to time, and its prevention and control should not be ignored.

The risk factors of bacillary dysentery in developing countries are related to regional economic conditions, meteorological conditions, health conditions, and living habits. Environmental factors can affect the reproduction and spread of dysentery pathogens. For example, in southwest China, the humidity is high and the temperature is high from May to October. Under this condition, bacteria are easy to multiply, and the virulence plasmid carried by intestinal pathogens is activated, which enhances the invasiveness and diffusion of the bacteria and easily causes transmission [14]. At the same time, with the increase of roadside stalls in summer, the consumption of aquatic products and cold food increased, and the probability of infection and incidence increased accordingly [15]. Regional economic conditions, population distribution, and living habits also affect it. In China, the incidence in Sanzhou area is higher than that in other areas of Sichuan province, and the number of reported cases in Chengdu Plain is higher than that in other areas. This distribution characteristic is related to the economic level. Chengdu Plain is an economically developed area in Sichuan Province, which pays attention to the improvement of the living environment and sanitary conditions, which can realize the supply of safe water and food, and fundamentally reduce the risk of bacillary dysentery transmission. On the other hand, the economically developed areas around Chengdu have a relatively large population base, convenient transportation, and high personnel mobility, which is conducive to the transmission of diarrhea. People in economically developed areas have a strong awareness of medical treatment, so they report more medical records. In addition, the Sanzhou area is an ethic minority autonomous prefecture with many ethic minorities and unique ethnic cultural habits, such as eating raw food, drinking raw water, special food cooking methods, etc., which have a high risk of diarrhea transmission [14].

### 2.2.3 Risk factors in developed countries

According to Figure 1, the incidence of Bacillary dysentery in affluent nations has been kept within a reasonably low incidence range when compared to impoverished countries over the last ten years, from 2010 to 2019. Since 2010, the prevalence of dysentery in the US has dramatically increased, peaking in 2015. Since then, the prevalence of Bacillary dysentery has steadily decreased, although it has recently begun to climb again. During the same period, the incidence of dysentery in the United Kingdom follows a similar pattern to that of the United States, albeit the overall yearly incidence rate is lower.

It can be seen from the changes in time and national control that the incidence in the UK and US countries has decreased year by year. Evolving medical conditions in developed countries may explain this trend. To begin with, people suffering from dysentery can receive quick treatment and are isolated in a hospital to ensure that others are not impacted. Besides, it is undeniable that the environmental conditions of developed countries are better than that of developing countries. A developing country, China, is an example. Most of China's exports still depend on factories and industries, which undertake a large number of imports. There are many heavy industrial factories, so China's environment and water sources are seriously polluted. Finally, the availability of clean drinking water is also a major cause of bacillary dysentery, which can be referred to as underdeveloped Africa. Most people use open toilets or public bathrooms, and there is no independent and hygienic space, so the incidence of bacillary dysentery will increase significantly. At the same time, patients with bacillary dysentery have no hygienic conditions for treatment, and some people are also responsible for preparing food and touching containers filled with water, which greatly increases the incidence of bacillary dysentery to a certain extent.

## 2.3. Interventions for countries with different level of development

### 2.3.1 Interventions for under-developed countries

There have been successful interventions reducing its morbidity. Giving soap to contacts of shigellosis patients, a handwashing intervention, and the education project showed their prominent

position. Other interventions like housefly control and breastfeeding played a significant role as well [16]. However, due to insufficient government funding, these underdeveloped countries do not have adequate health care and health disparity in different regions [11]. Individual and household hygiene interventions can be the best way to minimize the prevalence of bacillary dysentery.

For individuals, promoting household water management is in need. As for drinking water, boiling water before use is a practical disinfection method. As the water pipe is buried underground, the long-distance transportation and time migration, the water pipe will have a certain degree of corrosion, therefore, the water transported in this way can not be completely guaranteed by sanitation. However, high temperature is the most common and easiest way to kill microbes. The idea of boiling water was scientifically supported in China in the 1930s because it would kill most of the pathogens and help Chinese people eradicate cholera.

For household water storage, the containers and facilities need to be well settled. As for the residents who use underground water, the wells should be well managed and separated from wastewater or rainwater. And as for the residents who store surface water in tanks, the containers need to be cleaned regularly to reduce the growth of pathogens. At the same time, the water obtained from these two collection methods should be avoided to drink directly, but after precipitation and filtration, and disinfection before drinking if possible.

As for toilet management, avoiding sharing toilets with other families is recommended by WHO. This method can effectively reduce the transmission of pathogens between different people and families. But in specific regions, using public toilets is inevitable due to insufficient space and dense urban settlements. Therefore, while using shared toilets, washing hands with soap is the most effective way of avoiding infection. So, the shared toilets should be well designed and constructed with adequate hygiene facilities and be cleaned frequently.

### 2.3.2 Interventions for developing countries

The continuous decline of bacillary dysentery mortality in China cannot be separated from the implementation of effective interventions. For example, active prevention and supervention work has been carried out. Bacillary dysentery occurs in summer every year. In May, prevention and supervention work are to be prepared in advance, especially in rural areas, in order to check the health situation and drinking water standards there. The establishment of new and efficient detection methods is of great significance for disease diagnosis, emergency treatment, and control. In recent years, new molecular biological methods and immunological methods can detect Shigella sensitively and efficiently, which provides a new way of thinking for the detection of bacillary dysentery. Moreover, with the popularization of antimicrobial agents, the drug resistance rate of Shigella has been increasing in recent years, and even the phenomenon of multiple drug resistance has appeared. Therefore, it is of great significance to pay attention to the detection of clinical microbial specimens and to take corresponding measures according to the information on bacterial resistance to ensure the treatment effect and delay the progress of Shigella resistance.

The incidence of bacillary dysentery in developing countries is at a low level, and the incidence level varies greatly among regions. The prevention and control situation in regions with high incidence is still severe, and all interventions need to be strictly implemented. The state should strengthen targeted poverty alleviation policies and improve basic public health facilities in backward areas, At the same time, it is necessary to win the support of local finance for the establishment of a bacillary dysentery pathogen monitoring project, so as to understand the distribution characteristics of bacillary dysentery pathogen in the country and provide strong evidence for scientific interventions. In addition, increasing the publicity and health education on the prevention and control of intestinal infectious diseases, especially on hand hygiene and health education for people who are vulnerable to infection, improving the awareness of disease prevention among key populations in key areas, and effectively reducing the burden of disease [14].

### 2.3.3 Interventions for developed countries

In developed countries, health education and medical institutions are important means of treatment that can reduce the incidence of bacillary dysentery to a certain extent. Firstly, to maximize the impact of the intervention, WHO, UNICEF, the Red Cross, and the European Community are involved in the bacillary dysentery medical program. Each agency uses its strengths and strives to coordinate. Secondly, the research in Chicago discovered that schools had greatly boosted instructional programs aimed at preventing intestinal infectious infections [17]. Drinking boiling water, not eating half-raw food, washing hands before and after meals, and developing excellent hygiene practices are all recommended. Therefore, the treatment of patients with bacillary dysentery depends on a well-developed disease defense education system and well-trained health personnel. However, health workers may need to respond quickly to provide care to patients.

In addition, developed countries have laboratory capacity to identify bacillary dysentery and monitor the progress of the epidemic. In initial cases in an area, health personnel must plan carefully to accurately detect bacillary dysentery and confirm case samples as the epidemic continues. Furthermore, medications can help to lower the occurrence of bacillary dysentery. Antidiarrheal medications, such as loperamide, are accessible without a prescription at pharmacies. This frequently reduces the frequency of bowel motions in the early stages of bacillary dysentery. However, it should not be used in newborns or very young children since it may impair breathing. At the same time, for individuals with severe Bacillary dysentery, a short course or even a single dosage of broad-spectrum antibiotics can minimize the severity and duration of the condition. However, there is presently no optimal medicine or vaccination that provides longer-lasting protection, so further research on vaccine invention is still in need.

## 3. Conclusion

In conclusion, bacterial genetics has advanced quickly in recent years, and bacillary dysentery should be highly respected. All nations must address the socioeconomic causes of bacillary dysentery. Even though our study offers helpful data on morbidity, mortality, and treatments in each nation, it has several drawbacks. Some nations with slow economic growth struggle to maintain advanced levels of health and education. However, developing and underdeveloped nations can benefit from developed countries to minimize morbidity and mortality from bacillary dysentery, especially in Africa where mortality from these infections is so high. Additionally, it is helpful to compare reactions from different nations, and the right organizations should get involved and run campaigns or lobbying to increase patient knowledge and comprehension of bacillary dysentery.

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