# LEVERAGING ARTIFICIAL INTELLIGENCE ON CAUSES, EFFECTS, EARLY DETECTION AND CONTROL OF WATERBORNE DISEASES

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## Abstract
*Waterborne diseases are infections caused by exposure to water contaminated with pathogenic microorganisms. They remain a major public health concern, particularly in areas with inadequate water supply and sanitation. Prevention depends on access to safe water, improved sanitation, and proper hygiene practices. The main trust of this paper was to find out waterborne, diseases, causes, effects and their prevention. It was observed by World Health Organization (2023) that, waterborne diseases are caused due to consumption of contaminated water either directly or through food made with it. It was found out by the World Health Organization (2023) that pathogens such as bacteria, viruses and protozoa are commonly found in contaminated drinking water can lead to a variety of illnesses such as, cholera, dysentery, typhoid fever and giardiasis. It was concluded that waterborne diseases remain a public health challenge, particularly in areas or region with inadequate access to clean water and proper sanitation, as a result, this disease can cause significant morbidity and mortality, especially vulnerable population such as children, elderly and low-income people. Consequently, it was recommended that health educators provide community-based education on safe water handling practices, including water boiling, filtration, and proper sanitation, to prevent contamination and protect public health.*

**Keywords:** Waterborne diseases, Pathogens, Prevention, Sanitation

## Introduction
Waterborne diseases remain a major public health challenge, particularly in low- and middle-income countries where access to safe drinking water and adequate sanitation is limited. These diseases are caused by pathogenic microorganisms, including bacteria, viruses, protozoa, and parasites, that are transmitted through contaminated water used for drinking, food preparation, and domestic activities. Contamination of water sources commonly results from inadequate sanitation, improper disposal of human and animal waste, environmental pollution, and poor hygiene practices. Consequently, the consumption or use of contaminated water facilitates the transmission of infectious diseases such as cholera, typhoid fever, dysentery, hepatitis A, and other diarrhea illnesses (Landrigan et al., 2020). Despite global efforts to improve water quality and sanitation, access to safe drinking water remains inadequate for a substantial proportion of the world's population. The World Health Organization (2022) estimated that approximately 844 million people lack access to basic drinking-water services, while about 159 million people depend directly on untreated surface water sources. Furthermore,

nearly 2 billion individuals consume water contaminated with faecal matter, exposing them to a heightened risk of waterborne infections. These conditions are particularly prevalent in rural and underserved communities where water treatment infrastructure is either inadequate or nonexistent (WHO & UNICEF, 2021).

The burden of waterborne diseases disproportionately affects children, who are more vulnerable to infection due to immature immune systems and increased exposure to contaminated environments. In many developing countries, poor sanitation, inadequate hygiene practices, and limited access to safe water contribute significantly to childhood morbidity and mortality associated with diarrhoeal diseases. Evidence suggests that waterborne diseases remain among the leading causes of preventable deaths among children under five years of age, highlighting the urgent need for sustainable interventions aimed at improving water quality and sanitation services (Shailemo& Firoza, 2016).Globally, contaminated drinking water continues to contribute substantially to disease burden and mortality. According to the World Health Organization (2020), unsafe water, sanitation, and hygiene are associated with approximately 502,000 diarrhoeal deaths annually.

Beyond their health consequences, waterborne diseases impose considerable socioeconomic costs through increased healthcare expenditure, reduced productivity, school absenteeism, and diminished quality of life. Therefore, strengthening water safety measures, expanding access to improved sanitation facilities, and implementing effective health education programmes are critical strategies for reducing the prevalence of waterborne diseases and improving public health outcomes worldwide.

**Common Waterborne Diseases**

There are different types of waterborne diseases which vary depending on the pathogen that is likely to cause the disease. The following are some common waterborne diseases.

*i. Cholera*

Cholera is a water-borne disease commonly occurring in rural communities where people do not always get access to proper sanitation. Cholera is a harmful disease which can be lethal if left untreated. Cholera is spread by polluted water, which causes severe diarrhea and dehydration, particularly in areas with bad sanitation and using water from open water sources (such as ponds), which are used for a variety of reasons such as washing, bathing, cleaning, etc. cholera, being highly contagious, can caused an outbreak quite easily and be lethal within days or even hours of infection. It is caused by bacteria named vibrio cholera via consumption of contaminated food or drinking water. Cholera occurs mostly in children, but can also affect adults. It possesses a mortality rate that is alarmingly high among the water-borne diseases. People with a suppressed immunity, like those who are malnourished or infected with Human Immunodeficiency Virus (HIV) are at a heightened risk of death if they're infected with the bacteria. About one in ten people will develop severe symptoms that can be life-threatening. Early symptoms of cholera include: watery diarrhea, sometimes described as "rice-water stools" because they are milky white, vomiting, leg cramps and restlessness or irritability

*ii. Fever*

Fever is one of the most common waterborne diseases spread through contaminated food and water. People living in places without access to clean and hygienic water are more prone to typhoid fever. Typhoid is extremely contagious and spreads widely by coming in contact with water contaminated by an infected person. However, it can be prevented by taking proper hygiene measures and taking necessary vaccines (Parry, Hien, Dugan, White, & Farrar, 2002) Symptoms of the disease include headache, chills, loss of appetite, stomach (abdominal) pain, rose spots rash or faint pink spots usually the chest or stomach, cough, muscle aches, nausea, vomiting, diarrhea or constipation, and constant fatigue (Rabasa, Mava, Pius, Timothy, & Baba, 2018).

**Artificial Intelligence and the Early Detection of Waterborne Diseases**

***i.*** *Dysentery*

Dysentery is a waterborne disease caused by Shigella bacteria or the protozoan parasite Entamoeba histolytica. The disease is transmitted through the consumption of contaminated food and water and is characterized by bloody diarrhea, fever, abdominal cramps, nausea, vomiting, and severe dehydration (Healthline, 2024). Artificial Intelligence has emerged as a valuable tool in the early detection of dysentery outbreaks through the analysis of epidemiological, environmental, and clinical data. Machine learning algorithms can process hospital admission records, laboratory reports, sanitation indicators, and weather conditions to identify unusual disease patterns and predict potential outbreaks before they escalate. Such predictive capabilities enable health authorities to implement timely interventions, reducing disease transmission and associated morbidity.

*ii. Hepatitis A*

Hepatitis A is a viral liver infection transmitted primarily through the ingestion of food or water contaminated with the hepatitis A virus. The disease is common in regions with inadequate sanitation and poor hygiene practices and presents with symptoms such as fatigue, nausea, abdominal pain, jaundice, fever, and loss of appetite (Mayo Clinic, 2024). Artificial Intelligence contributes significantly to hepatitis A surveillance by integrating data from healthcare facilities, environmental monitoring systems, and public health databases. Predictive analytics can identify high-risk populations and geographical areas susceptible to outbreaks, enabling public health authorities to prioritize vaccination campaigns, sanitation improvements, and educational interventions.

*iii.Giardiasis*

Giardiasis is an intestinal infection caused by the parasite Giardia lamblia, commonly transmitted through contaminated water, food, or direct human contact. Symptoms include diarrhea, abdominal cramps, bloating, nausea, fatigue, and weight loss (Annan, 2018). Artificial Intelligence enhances giardiasis control through intelligent water-quality monitoring systems capable of detecting contamination in real time. AI-powered sensors

can continuously monitor microbial indicators in water supplies and generate early warning alerts when contamination levels exceed acceptable standards. This technology facilitates rapid public health responses and minimizes exposure to contaminated water sources.

**Artificial Intelligence in the Prevention of Waterborne Diseases**

Artificial Intelligence offers innovative approaches to preventing waterborne diseases through predictive modeling, real-time surveillance, and automated monitoring systems. AI algorithms can analyze climatic variables such as rainfall, temperature, flooding patterns, and water quality indicators to forecast potential disease outbreaks. Smart water management systems equipped with AI technologies can continuously monitor water sources for microbial contamination and notify relevant authorities when intervention is required. Furthermore, AI-powered mobile applications and virtual health assistants can disseminate health education messages, promote hygiene practices, and provide guidance on water treatment methods, including boiling, filtration, and chlorination.

**Effects of Waterborne Diseases and the Role of Artificial Intelligence**

Waterborne diseases impose significant health, economic, social, and environmental burdens on affected populations. Health consequences include diarrhea, dehydration, malnutrition, stunted growth, and death, particularly among vulnerable groups such as children and older adults. Economically, disease outbreaks increase healthcare expenditures and reduce workforce productivity. Socially, affected individuals may experience school absenteeism, social stigma, and reduced quality of life. Artificial Intelligence can help mitigate these effects by facilitating early outbreak detection, improving resource allocation, optimizing healthcare delivery, and supporting evidence-based decision-making in public health management.

**Community Participation and AI-Driven Disease Control**

Communities remain central to the prevention and control of waterborne diseases. Artificial Intelligence can strengthen community engagement through digital surveillance platforms, mobile reporting systems, and health information applications. Community members can utilize AI-enabled mobile technologies to report suspected disease cases, monitor local water quality, and receive real-time health alerts. Such technologies promote rapid response to disease outbreaks while enhancing public awareness regarding safe water handling, sanitation, and hygiene practices.

**Conclusion**

Waterborne diseases such as dysentery, hepatitis A, and giardiasis continue to pose substantial public health challenges worldwide. The integration of Artificial Intelligence into disease surveillance and water-quality monitoring systems has created new opportunities for the early detection, prediction, prevention, and control of these diseases. By leveraging machine learning, predictive analytics, and real-time monitoring technologies, public health authorities can identify outbreaks earlier, implement timely interventions, and

reduce the burden of waterborne diseases on affected populations. Therefore, it was recommended that governments and public health agencies should invest in Artificial Intelligence-based disease surveillance systems to strengthen outbreak preparedness and response. Water utilities should adopt AI-powered monitoring technologies to ensure the safety and quality of drinking water supplies. Health educators should integrate AI-driven communication platforms into community health promotion programs to improve awareness of waterborne disease prevention. Furthermore, collaboration among policymakers, researchers, technology developers, and community stakeholders is essential to maximize the effectiveness of Artificial Intelligence in waterborne disease control and prevention

**References**

Adelodun, b., Ajibade, F., O., Ighalo, J., O., Odey, G., Ibrahim, R., G., Kareem, K., Y., &Magambo, K., J (2021). Assessment of socioeconomic inequality based on virus-contaminated water usage in developing countries, *A Review of Environmental Research*, 192:110309.

Aggarwal, R., (2011). Clinical presentation of hepatitis E. *Virus Research,* 161(1) 15-22. https://doi.org/10.1016/j.virusres.2011.03.017

Ali, A., Ahmed, A., & Gad, A., (2017). Chemical and microstructural analyses for heavy metals removal from water media by ceramic membrane filtration, *Water Science Technology,* 75(2) 439-450. https://doi.org/10.2166/wst.2016.537

Annan, E., Agyei-Tuffour, B., Bensah, Y., D., Konadu, D., S., Yaya, A., Onwona-Agyeman, B., & Nyankson, E., (2018). (Application of clay ceramics and nanotechnology in water treatment, 5(1)1476017.

Bui, X., T., Nguyen, P., T., Nguyen, V., T., Dao, T., S., Nguyen, P., D., (2020). Micro plastics polluted in wastewater, characteristics, occurrence and removal technologies, *Environment Technology Innovation,* 19 (2), 461-480.

Bulta, A., L., & Micheal, G., (2019). Evaluation of the efficiency of ceramic filters for water treatment in KambataTabaro zone, southern Ethiopia, *Environmental Systematic Research,* 8(1) 1. https://doi.org/10.1186/s40068-018-0129-6

Jiang, S., C., &Ashbolt, N., J., (2023). Global risk assessment of water borne pathogens in the 21st century, challenges and opportunities, *International Journal of Environmental Research and Public Health,* 20(15), 3794.

Kariuk, J., G., Magambo, K., J., Njeruh, M., F., & Muchiri, E., M. (2012). Effects of hygiene and sanitation interventions on reducing diarroea prevalence among children in resource constrained communities, case study of Turkey District, Kenya, *Journal of Community Health,* 37, 1178-1184.

Mayo Clinic, (2023). Diarrhea symptoms and causes, (mayoclinic.org).

Mayo Clinic Staff, (2024). Hepatitis A, symptoms and causes, (akamai.mayoclinic.org).

Parry, C., M., Hien T., T., Dougan G., & White, N., J., (2002). Typhoid fever, *New England Journal of Medicine,* 347 (22), 1770-1782.

Rabasa A., I., Mava, Y., Pius, S., Timothy, S., & Baba U., I. (2013). Typhoid fever in children, clinic presentation and risk factors, *Nigeria Journal of Pediatrics*, 40 (1), 60-63.

Verma, S., Daverey, A., & Sharma, A., (2017). Slow sand filtration for water and wastewater treatment, *Environmental Technology Review*, 6(1) 45-58.

World Health Organization (2022). Guidelines for drinking water quality, incorporating the first and second addenda. https://apps.who.int/iris/handle/10665/352532

World Health Organization (2017). State of the world's sanitation, an urgent call to transform sanitation for better health, environments, economics and societies.