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Guarding the health of individuals: Effects of bacterial toxins in drinking water

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Abstract

Contamination of drinking water is one of the major concern's that affect the health of the community due to bacterial toxins. This research paper closely focuses on the impact of these toxins in human health, and the available ways of tracking and controlling their distribution in water resources. This paper will therefore consider a literature review that will help in the generation of epidemiological data from different studies done on bacterial toxins in drinking water.

The figures and levels of pathogenic bacteria, viruses, and protozoa in water make their presence or absence affect the lives of people all over the world. Waterborne pathogens can affect humanity through drinking water, fresh produce and raw foods, processed foods, or water for recreation. This increased chemical exposure has led to drinking water becoming a large source of chemical exposure despite drinking water treatment research mainly concentrating on microbial contaminants because of the large burden of diseases caused and high childhood mortality among the victims. Consequently, use of water polluted with heavy metals and bacterial toxins leads to high morbidity and mortality coefficient in various regions of the world.

The general objective of this paper is to focus on bacterial toxins' contamination of drinking water globally and evaluate the health risks that are likely to be occasioned by the intake of the said water. It will also focus on the link between exposure limits and the latent effects on health and the primary organs that are affected.

Keywords: Toxin; Water; Bacteria; Contamination; Human health

1. Introduction

Drinking water contains bacterial toxins that can harm the health of a person and the community in general. Such toxins may originate from untreated sewage and even from treatment and distribution of water. The above contaminants can be fatal in our water supply that can lead to numerous health conditions of various degrees of severity, including life-threatening ones (1). Types of Bacterial Toxins Bacterial toxins in drinking water can be divided into two main categories: endotoxins and exotoxins. Endotoxins are products known as lipopolysaccharides situated on the outer membrane of bacteria cells but are primarily on gram negative bacteria. These toxins are produced to environment when bacteria die or are killed. If ingested, they can lead to various diseases and conditions, for instance, respiratory conditions, Gastro illness and septicemia to mention but a few. While exotoxins are protein substances usually secreted by some bacteria to counteract other microorganisms in the environment. To humans, they are also dangerous and can lead to food poisoning, toxic shock syndrome or meningitis (2).

However, having said this it is important to stress again that not all bacteria are pathogenic; some of the bacteria produce toxins which are potent, and which can be fatal to humans. Indeed, some are useful, as they contribute to the regulation of the correct ratio of microflora in the human body (3).

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Sustaining the quality of drinking water is the paramount role in the agenda of health for public good since the contamination of chemicals and microbes present dangers to the well-being of the people. One of the most concerning problems among all noted is the waterborne bacterial toxins as their influence can be dreadful for the person (4).

One of the critical professions is toxicologists who help in determining the risks resulting from chemical contaminants in water and providing measures that can guarantee the safety of the source of water (5). Drinking water naturally contains chemicals; it is polluted and treated with various substances, all of which can cause the water to contain toxic elements (6).

Decayed and neglected population groups or communities register highest rates of chemical infiltration in their drinking water, owing to compromised exposures, limited access to chemical analysis and water purification, and inherently inferior standard health (7).

It is projected that chemical pollution in drinking water shall continue to increase in the next few decades due to factors like climate change, industrialization, and an enhanced ability to determine the concentration effects of some of these chemicals on human health (8). To address this challenge, there is a need for proper water treatment, the strengthening of water monitoring and regulation as well as various targeted strategies to support vulnerable groups of the population.

2. Sources of Bacterial Toxins in Drinking Water

Industrial effluents, pesticides, and fertilizers that are let into water bodies are causes for concern as they introduce toxins of bacterial origin into drinking water. These anthropogenic activities make it possible for a range of toxic and damaging materials such as heavy metals, Persistent Organic Pollutants and microbial toxins, to enter drinking water sources (9).

Furthermore, deterioration of organic matter in water can cause the formation of other by products that are toxic like trihalomethanes and halo acetic acids (5). Also, oxygen Conditions favoring increased algal production including blooms and water turbidity are also acknowledged to favor the growth Microorganisms and toxins associated with them may also be released (10).

Drinking water bacteria toxins may stem from such sources as sewage systems, agricultural water drainage as well as industrial water effluent. These toxins include they can find their way into water supply through; it seeps through the ground, or it gets into the water during treatment. To this end, awareness of the various types of bacterial toxins and their origin within drinking water is crucial in discouraging their impact on human health (11).

Pathogenic bacteria produce toxins which contaminate drinking water and are capable of causing a wide range of health effects, both the acute and chronic effects. If taken internally these toxins can trigger a negative reaction in the digestive region; the symptoms include loose bowels, nausea, vomiting and stomach pains. It can result to water loss and dangerous complications include life threatening situations especially in the groups of people that are most susceptible, including the young children or the elderly, and those with further compromised immune system or chronic diseases (12).

Furthermore, when consumed regularly over time, bacteria contaminants that are present in drinking water are also likely to contribute to cases of cancer, neurological diseases, renal diseases and so on. In addition, bacterial toxins can affect skin, respiratory, and even cause sepsis in humans in the case where people have direct contact with contaminated water (13).

3. Health Effects of Bacterial Toxins in Drinking Water

Bacterial toxins present in drinking water can have a wide range of health effects, depending on the type of toxin and the individual's susceptibility. Some common attacks such toxins can cause include (14):

- **Gastrointestinal Disorders:** The presence of bacterial toxins in the water causes numerous diseases that may relay with vomiting, diarrhea, and abdominal pain. These symptoms are normally not very serious, however there are instances where they may become very serious causing the patients to suffer from severe dehydration and electrolyte imbalance.

- Hepatitis: It is seen that some of the bacterial toxins like hepatitis A virus if consumed through contaminated water can lead to liver disorder such as hepatitis. This can result in fever, fatigue and jaundice and in severe manifestation liver failure can occur.
- Acute Kidney Injury: There are some bacterial toxins, which exist in drinking water that has been associated with acute kidney injury which is a condition whereby kidneys perform their functions abnormally at a given period of time. Some of the manifestations of the condition are a reduced amount of urine passed, accumulation of fluid, difficulty in breathing and discomfort in the chest. Chronic exposure to these toxins poses a threat to the kidney where some may cause renal damage and or kidney failure.
- Respiratory Conditions: Intake of water with bacterial toxins can at times be inhaled and thus leads to irritation and inflammation of the bronchial tubes. This might cause such signs as coughing, wheezing, and shortness of breath. It could also cause allergic reactions where individuals who could have been sensitive to sand would begin experiencing allergic reactions or worsen their asthma or COPD accustomed to developing during the dusty season.
- Neuro logical Disorders: There is progressive indication that bacterial toxins in drinking water cause diseases affecting the nervous system including meningitis and encephalitis. These toxins have been discovered to lead to swelling in the brain and spinal cord, and some of the symptoms include headaches, fever, seizures, and in worse cases, comas. Investigations on this connection are still being conducted, and more work is being done towards gaining more insight on the neurological effects of bacterial toxins in the national supply of drinking water.
- Gastrointestinal Disorders: Ingestion of drinking water that contains bacterial toxins affects the uncomfortable of the gastrointestinal. Such toxins cause manifestations like abdominal pain, nausea and vomiting, diarrhea and resulting dehydration. At worse, they can lead to more severe diseases such as cholera and salmonellosis.

Besides the effects these bacterial toxins have on the human body systems, there are also systemic effects which are repercussive to the communities and society at large. For example, when higher mortality rates are recorded due to waterborne diseases, healthcare facilities are stretched to provide treatment and a variety of medical services to people. Even in the worst-case scenarios where people generally fall ill at that scale the effects are social and economic (14).

4. Routes of Exposure to Bacterial Toxins in Drinking Water

Thus, people can be contaminated by bacterial toxins present in the drinking water through the gastrointestinal tract, skin, or respiratory system (5). Health effects that can be caused by toxins depend on the toxin type, concentration or toxicity level, and the time of exposure.

Drinking water contaminated with toxins is main way toxins enter the body and their effects range from, stomach problems, nerve disorders, to damage to different internal organs depending on type of toxin (5) (7). Skin contact can cause skin reactions and other effects during swimming or bathing Epidemic typhus is a rare disease that is transmitted through infected lice. Toxins suspended in aerosols and released during states of water treatment are another reason for people's health risks (15).

Among all the possibilities of primary contact between people and bacterial toxins in water, people are most likely to drink it. Drinking water that is contaminated by the above bacteria and their toxins causes illnesses and has prolonged impacts on health (16). They are usually worse off among the vulnerable people like the infants, young children, the elderly, and those with weaker immune systems.

Furthermore, bacterial toxins can penetrate the skin or the mucus membranes through activities that may include recreation or occupational practice to cause diseases like the wound infection, skin rash, and respiratory disorders. Accompanying respiratory ailments include difficulties in breathing when the lung tissues and alveoli are impacted by the water droplets contaminated with this bacterium; tediousness and chest pains are also evidenced Systemic infections embrace pneumonia, meningitis, and sepsis. (17)

Effects of the bacterial toxins on the health of a particular person depend on the quality of water which he or she drinks, and it is exercised regardless age or income level. We need to be informed of the possible health hazards, and necessity of providing unpolluted and protected sources of water for drinking. (18)

Thus, if the epidemic of bacterial toxins in drinking water continues to spread, societies can take measures to prevent these dangerous effects.

5. Regulations and Guidelines for Bacterial Toxins in Drinking Water

On intake standards of water, there are recommended by WHO and EPA in the U. S as institutions that have the general control of water quality. These governing bodies in collaboration with government agencies and other stakeholders have a mandate of developing and implementing policies that would protect the public through purification of water to eliminate dangerous microbes and their products. (19)

The act that pertains to drinking water in United States is the Save Drinking Water Act (SDWA) and it outlines by how the contaminants in the public drinking water supply shall be monitored and regulated. In the act, the EPA set Maximum Contaminant Levels (MCLs) or Microbial contaminants which includes bacteria, viruses, and parasites (20). These are the maximum concentration of a given contaminant that is acceptable to allow in drinking water. They are set following the risk assessment studies and from the health impacts stressed by human and animal subjects that are affected by the contaminant (21). Nonetheless other substances which are not covered by the MCL may also have the potential to harm the health of a person that ingests them. To ensure all sources of pollution, which are not included in the legislation, are regulated, the EPA has “monitoring of contaminants not included in the act” programs. These programs assess and track possible contaminants that are not under the MCL’s, compiling information for future usage in management (22).

The fact is that bacteria can appear in drinking water and thereby become a real threat to the population’s health. The presence of bacteria in water leads to water borne diseases with major effects on children, the aged and other susceptible members of the community (23). Hence, owing to their potential threat to public health, water sources with bacterial content must be identified and treated. This can be achieved through testing, treatment that involves disinfection among other things as well as optimum maintenance of the distribution systems. Bacterial contamination can also be avoided when appropriate maintenance practice for the distribution system is also practiced. This entails checking, washing, and in some cases replacing old structures to enhance the capability level of a system (24).

The following are the multiple measures that can be taken to minimize the exposure of bacterial toxins in drinking water; Some interventions may include promoting the best practices to be taken to prevent water related illnesses within homes and premises frequently used by the public. They need to educate people of the correct handling and storage of drinking water and the necessity of boiling the water before use in the diseased zone. Also, there is a need to explain the risks of bacterial contamination and probable diseases that would enable people within the affected communities to report early incidences (25).

6. Detection and Prevention of Bacterial Toxins in Drinking Water

Thus, identification and control of bacterial toxins in drinking water is very important to ensure minimal impact on human health. Some of the quality assessment methods include periodic testing for pathogenic bacteria, viruses as well as protozoa in order to establish the level of contamination (26).

However, the toxicological risk assessments and the formulation of standard policies can also assist in preventing contamination of the drinking water sources (4)(5). Disinfection, filtration, treatment techniques as well as the elimination of certain waterborne bacteria and their toxins are also vital in the alteration of risk levels (27).

Thus, the problem of the existence of bacterial toxins in drinking water is one of the most pressing issues of public health that cannot be solved by addressing only one of the aspects such as detection, prevention, or remediation.

International governmental and non-governmental bodies such as the World Health Organization has set limits to the quality and quantity of chemical and microbial contents in drinking water (5). Compliance with these guidelines alongside proper application of water treatment strategies can reduce the impacts of bacterial toxins as identified (28).

In total, the subject of bacterial toxins in potable water is an important issue that affects the health of population and should be addressed with the help of numerous complex interventions.

Meeting this challenge can help in a push to promote availability of clean and safe drinking water in equal measure to the poor and the rich and across the seas (29).

Efficient measures in detection and preventing of bacterial contaminated water should be taken by the individuals or the communities at large. This is in relation to water supply by ensuring checkup of water sources, water treatment, and practices relative to water consumption and sanitation(30). Besides, the acquisition of the new technologies that would

allow for the comprehensive purification of water and the provision of specific information to people about how they can identify cases of bacterial toxin ingestion can also improve on the extent to which negative health consequences are prevented in relation to contaminated drinking water (31).

While bacterial toxins in the water supply maybe potentially dangerous to individual health if taken in large quantities there are certain measures that can be taken to prevent organisms getting into the water. In conclusion, the talents of distinct people and groups, as well as local and state authorities, should come together to help protect society from potential infection by bacterial toxins in the consumed water (32). Now, it is high time to discuss the ways to eliminate the dangers of bacterial toxins in drinking water in detail. Nevertheless, one of the most significant steps is to solve the problem of bacterial contamination of our water. This can comprise figuring out and eradicating improper dumping of human and animal wastes, enhancing sanitation in the developing states, and checking wastewater treatment plants are running (33).

7. The availability and association of the toxin contaminated water environment

Thus, bacterial toxins present in drinking water pose not only an immediate threat on the health of users but also several other effects. In the case of consumed water with toxins, the impacts are not only felt on individuals, but also on other objects in the environment (34).

If toxins are dumped into water bodies, they get assimilate into the various organisms in water bodies thus polluting the food chain (4). This can lead to chain reactions on the ecosystem in as much as it affects the wildlife and the community beneficiaries of these resources in terms of food and other services (28).

Besides, toxins in water also have adverse effects on bacteria within water that can lead to precedence of more risky strains, which poses danger to lives that rely on the water supply. (35)

For instance, the funkification of industrial wastes and agricultural release of toxic compounds brings about pollution of both the surface water and groundwater sources necessary for human consumption and also for the preservation of aquatic life (36). The disruption of these natural environments can affect the ecosystems and the entire botany and animality of the region, and the people of the region who depend on the resources from the natural environment for food, income, and leisure (37). Moreover, even when toxins are in the solid phase, the emanation of volatile, some hazardous materials like volatile organic compounds contributes to air emissions and may endanger human health and the environment at large (38).

This means that to tackle the issue of bacterial toxins in the drinking water, a multi-sectoral strategy needs to be developed for a better understanding of the interrelatedness of the issues under the environmental and health care categories (39). Tap water holds a broad list of various types of toxins, which can be attributed to fairly innocuous to rather hazardous. Consequently, these contaminants influence the health of human beings in relation to the soil content and flow of water. At times, toxins can evaporate fast in the surrounding air or can be elicited by bacteria (40). While the maintenance of some toxins is more gradual and only impacts the long-term health of the soil and ground water. That is why it is crucial to emphasize first prevention and treatment of intruding contaminants to decrease disease prevalence and stabilize the state of the environment. (41) It is essential to know several methods of preventing toxic contaminants from affecting the ecosystem. To start with, the methods of waste disposal can be undertaken in a safe manner (42). This also extends to correct handling of chemicals that are used in the house such as those used in cleaning and proper disposal of medical wastes, and industrial chemicals. Also, catalyzing or controlling the levels of various pollutants in the environment also assist in avoiding various toxins that may accumulate in the water table and the ground (43). Special emphasis should be placed on trying to find out which zones are most contaminated and thus one should take measures to eliminate the threat and contain it. Measures should also be taken regarding the air quality and polluting factors should be handled without delay (44).

It is also evident that one can easily contaminate water sources with the bacterial toxins by considering the environment. Evaluating this correlation is critical for designing the appropriate measures to protect people from toxic compounds found in drinking water (45). Originally used for agriculture will always use chemical fertilizers, pesticides, and herbicides. But, if these chemicals are used in larger proportions, they pollute the neighboring surface and ground water resources. The disposal of the treated water especially for irrigation is also becoming a big issue since many places they are facing water shortages. (46) Pollution of water sources can also be attributed to industrial or commercial uses where treated water is discharged back into the environment. To illustrate, chemical works, steel processing works, or any establishments involving the processing of chemicals or heavy metals and farming practices involving animal

manure spread on fields can contaminate water bodies nearby (47). Likewise in manufacturing or mining industries the chemicals that are released to the sources of water such as ground water has an extreme danger to the people.

8. Conclusion and Recommendations

This remains a paramount danger to the human society since most of the bacterial toxins contaminate the drinking water and thus it becomes crucial for people and societies to act as barriers to such incidences. We have to be more careful about taking showers, washing our hands frequently and avoid eating or having contact with contaminated water products but with the help of the guideline, rules and regulation for water safety hygiene practices we are safe from the effects of this disease. However, it is also safer for us to investigate and report any trace of contamination or realization of an outbreak so that authorities and healthcare practitioners can contain it on time. Moreover, in an effort to encourage and advance the technology of treating waterborne threats like the one mentioned above that causes illness and even death from such toxins, efforts should be put into researching diseases that trigger the occurrence of contamination by bacteria that multiplies within the water source. Limited as this research could be, it may involve considerations of the quality of water, the condition of the environment, and standards in hygiene. It should also be understood that we can contribute to tackling the problem of bacterial contamination in our drinking water by investing in research. Additionally, awareness raising campaigns should be continued as well as enhanced as the best way to raise the public's awareness of the dangers of bacterial poisoning.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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