Call for society to be aware of Vibrio cholerae from aquatic animals

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Abstract

Cholera is an ancient and widespread infectious disease, mainly manifested as severe vomiting, diarrhea, water loss, and high mortality. It belongs to the group of international quarantine infectious diseases, and *Vibrio cholerae* is the pathogen of human cholera. Since 1817, there have been seven global cholera pandemics, which have caused hundreds of millions of human deaths. The cause of these cholera epidemics is highly complex; how it spreads globally and the reason for seasonal epidemic peaks in epidemic areas remains unclear. Most sporadic outbreaks of cholera are related to aquatic products or related water bodies.

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Cholera is an ancient and widespread infectious disease, mainly manifested as severe vomiting, diarrhea, water loss, and high mortality. It belongs to the group of international quarantine infectious diseases, and *Vibrio cholerae* is the pathogen of human cholera. Since 1817, there have been seven global cholera pandemics, which have caused hundreds of millions of human deaths. The cause of these cholera epidemics is highly complex; how it spreads globally and the reason for seasonal epidemic peaks in epidemic areas remains unclear. Most sporadic outbreaks of cholera are related to aquatic products or related water bodies.

V. cholerae belongs to the *Vibrio* family, which can be divided into 139 serogroups. Of these, O1 and O139 can cause a human cholera epidemic. O1 and O139 *V. cholerae* can cause cholera mainly because they carry cholera toxin, which can activate adenylate cyclase in intestinal epithelial cells, resulting in Cl^- ions' secretion and impairment of the absorption of Na^+ ions. Water enters the intestinal cavity with ions, causing severe watery diarrhea, eventually leading to human death. However, non-O1 and non-O139 *V. cholerae* may carry other virulence factors, which are widely distributed in the water environment. These can cause gastrointestinal inflammation and extraintestinal infections such as meningitis, sepsis, and wound infection.

V. cholerae widely exists in various water bodies and has been reported to infect aquatic animals. *V. cholerae* , in particular non-O1 and non-O *V. cholerae* , can infect fish, shrimp, and other aquaculture animals. However, O1 and O139 *V. cholerae* have also been reported in aquatic animals, such as the O1 group found in tilapia(Hounmanou et al., 2019) and the O139 group found in loach and shrimp(Joseph et al., 2015; Chen et al., 2016). Therefore, *V. cholerae* is an important zoonotic bacterium that can be enriched in aquatic animals, both in the non-O1 and non-O139 groups, and the O1 and O139 groups, which can cause cholera outbreaks. Although there have been no reports of cholera outbreaks in humans caused by O1 and O139 *V. cholerae* from aquatic animals, there is a possibility of a future cholera outbreak. *V. cholerae* can cause disease in aquatic animals, suggesting it can grow and reproduce in aquaculture water and aquatic animals. The aquaculture water and aquatic animals may serve as a culture medium, allowing *V. cholerae* to obtain the conditions for large-scale reproduction, forming a large population, enriching *V. cholerae* . This can lead to animal disease and pollute the water body, appearing as diffusion. Therefore, aquatic animals and the water environment are an important carrier of *V. cholerae* , making these a potential source of *V. cholerae* transmission(Malka & Ido, 2017). *V. cholerae* from aquatic animals may be transmitted

through three routes, birds, food, and environmental pollution. In China, due to the open aquaculture mode of aquatic animals, birds eat small fish and shrimp, resulting in birds carrying *V. cholerae*and causing transmission(Laviad-Shitrit, Izhaki, & Halpern, 2019). Additionally, farmers sell diseased aquatic animals at low prices, and people may eat aquatic animals with *V. cholerae* , possibly causing infection if unripe or raw aquatic products are eaten. Third, the treatment scheme of aquatic animal breeding wastewater is not perfect, and wastewater is prevalently discharged directly into nature without treatment. Water used for aquatic animal breeding and its polluted environment may be exposed to people, leading to *V. cholerae*infection.

In recent years, most of the *V. cholerae* infected by aquatic animals are of the non-O1 and non-O139 groups, which also cause great harm to humans. In fact, 42.4% of the cases are caused by eating aquatic animals(Li et al., 2020). Although Chinese researchers detect *V. cholerae* in aquatic products, there is no strict quarantine system, and there are some policy loopholes. In terms of aquaculture wastewater, although strict discharge standards have been formulated, due to extensive aquaculture, lax supervision results in inevitable environmental pollution, leading to the spread of pathogens. Current research indicates that O1 and O139 *V. cholerae* were found in fish and shrimp, a dangerous signal of a highly critical situation.

Wild animals have always been considered "natural reservoirs of pathogens", as many severe human infectious diseases, such as SARS and Ebola, are transmitted from wild animals. The New Coronavirus was also possibly derived from wild animals (Leroy, Gouilh, & Collection, 2020). The open culture mode of aquatic animals is similar to the living environment of wild animals. This is mostly uncontrollable and may become a natural reservoir of pathogens. It can spread rapidly through water sources, birds, and aquatic products, which is more dangerous than terrestrial animals. Therefore, the public health department should pay attention to the zoonosis, formulate corresponding prevention plans, improve the supervision measures of aquatic products, improve the treatment of aquaculture wastewater, and strictly implement the discharge standard of aquaculture wastewater, to avoid disaster. We hope that society will pay attention to the relationship between *V. cholerae* and humans.

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Data Availability Statement

All data generated or used during the study appear in the submitted article.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of the work described in this manuscript.

Ethical statement

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to. No ethical approval was required as human or animal subjects were not involved in this study.

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