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Review Article

Overview of Foodborne viruses: Important viruses, outbreaks, health concerns, food Handling and fresh produce

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Abstract

Foodborne viruses can transmit through food in lots of ways including consuming items of animal origin containing zoonotic viruses, consuming contaminated food handled by infected food workers, and consuming contaminated food produced by humans. Viral foodborne illnesses are now a major contributor to all foodborne illness reports in recent years and are seen as a rising issue to the public health of humans and animals. Noroviruses and hepatitis A viruses were shown to be predominantly linked to the food-handler transmission and sewage-contaminated foods, according to microbiological research. In order to facilitate source attribution and identify risk preventive measures, routine, standard surveillance of viral outbreaks, and surveillance of virus occurrence in food products, combined with systematic strain typing, food and clinical microbiologists, would be advocated.

Abbreviation

QVRA: Quantitative Viral Risk Assessment; NoV: Noroviruses; HEV: Hepatitis E Viruses; HAV: Hepatitis A Virus; hEV: human Enteroviruses; RV: Rotaviruses; AstV: Astroviruses; LMICs: Low- and Middle-Income Countries; AdV: Adenovirus; IPCC: Intergovernmental Panel on Climate Change

Introduction

In the environment, water can act as a source for the spread of viruses that can infect people and cause illnesses ranging from gastroenteritis to more serious conditions like meningitis and hepatitis. Adenoviridae, Caliciviridae, Hepeviridae, Picornaviridae, and Reoviridae are some of the virus families that cause this illness. The virus that transmits through an enteric system is called enteric viruses and they are responsible for both water and food infections such viruses as noroviruses, adenoviruses, sap viruses, hepatitis A, hepatitis E, and astroviruses. Bacteria and parasites could cause symptoms similar to that viruses cause. The most causative agent of foodborne diseases in Europe are Norovirus and Hepatitis A because of the large number of infected people and the large number of outbreaks caused [1].

Viruses that are present in the soil, sewage, water, air, and fomites are all studied under the title of environmental virology and food [2]. The main role of the transmission is the fecal-oral route. Nonenveloped viruses are the main mode of transmission through fecal-oral and are resistant to environmental conditions [3] including viruses that have zoonosis transmission. The traditional method is noneffective in the removal and inactivation of this virus [4,5]. Agriculture water is considered also a manner of transmission of this virus, bathers, or by defecation of free-range or wild animals onto soil or surface waters. Viruses can reintroduce to humans and animals through cause health risks to all populations through food or drink [6]. Noroviruses in very low numbers are able to

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cause infection and disease [7,8]. Children, pregnant women, and immune comprised persons are more susceptible to infection which may result in severe conditions. Also, rotavirus is another example of this virus which causes severe disease in children in both developed and developing countries [9].

The major enteric virus families include one or several types and variants of the virus; the different groups may differ in concerns persistence, pathogenicity, and infectivity. Some of these viruses, such as Hepatitis E Virus (HEV) (the sole member of the *Hepeviridae*), are thought to be zoonotic pathogens. New human pathogenic viruses that may also be transmitted via the environment emerge frequently [10]. Vomiting is one route of viral transmission which may contain a low number of viral particles as 10^6gramme of faces or a large number of virus particles as 10^{10}. Due to the massive numbers shed and the low infectivity dose of 100 or fewer cells, foodborne viruses can cause significant epidemics in a short period Food and food environments are a major source of viral transmission to humans [11]. Outbreaks resulting from eating contaminated food with the virus were reported [12-14].

The viruses transmitted by food are NoV and HAV, RV, hEV, HEV and AstV, Aichivirus, Coronavirus, Sapovirus, Parvovirus, Torovirus for NoV and HAV, individual to individual transmission the main and common method of virus spread. The second main method of virus spread is through food which results in many outbreaks of NOV and HAV [15]. Through the last decades outbreaks resulting from foodborne viruses has been increased considerably perhaps due to the quick globalization of the food shop, the growth in individual transportable and nutrition transportation, and the deep variations in nutrition eating behaviors [16]. Eat products can be polluted at several points through the food supply chain. Due to, poor preparation in the main production and/or mismanagement of ordinary and ecological resources [17], e.g., the irrigation of vegetables with polluted water – as well as pollution through roots because of crop irrigation with contaminated water [18] contact with human faces or faecally soiled ingredients and poor sanitation exercise by food trainers through the harvest of fresh produce. Furthermore, improper procedures used during manufacturing or at the point of sale or consumption may result in contamination [19]. Additionally, contaminated surfaces or tools that have already been contaminated by infected food handlers or tainted food products could cause cross-contamination [19,20].

Additionally, human excreta may be directly or indirectly contaminating seafood, fresh produce, or ready-to-eat meals, and viral food-borne outbreaks may also result from zoonotic viruses that are naturally present in ingested food. HEV in raw meat and liver from wild boar and deer has been shown to do this [21,22].

Food and fresh produce

Foods generally implicated in outbreaks are those that are slightly handled, such as shellfish and fresh produce, although ready-to-eat foods that have been contaminated by an infected food handler are also involved. Conventionally, bivalve mollusc shellfish such as oysters, mussels, clams, and cockles have been considered a principal source of food-borne viruses that might afterward be distributed [23]. Shellfish feed through filter concentrate viruses in their filter which may lead to transmission of viruses Filter-feeding shellfish can concentrate viruses from polluted water: the filtration process may lead to a concentration of viruses in shellfish more than surrounded water up to 100 to 100 times [24]. Although there is the observation that there is specific binding on the NOV surface to the epithelia of shellfish, this may impede the release of the virus thru shellfish depuration [25,26].

Fresh produce can be eaten fresh and without peeling, both of which may remove external contaminants. Fresh produce has a high water content that absorbs from groundwater during growing. Once harvested, viruses can continue to exist on their surface and can continue to be contagious for a number of days or weeks, even while being stored in homes and businesses for up to five weeks [27]. However, any food that has been handled by food handlers but is non (not appropriately) preserved and/or cooked afterward is prone to serve as a vehicle for the spread of enteric viruses. Various factors can have an impact on virus survival in meals. Kott and Fishelson [29] found that Due to microbial activity in these effluents, some viruses such as polioviruses can survive on the surface of vegetables (tomato and lettuce in pbs than in the oxidation pool outlet of waste. Furthermore, natural irradiation combined with naturally occurring antiviral components typically found in fruit may significantly lower virus infectivity [29]. However, natural or added food ingredients like fat, salt, and sucrose may protect against the inactivation of viruses by high hydrostatic pressure or heating [30]. On the other hand, some ingredients, such as acids and other fruit juice constituents, may speed up the process of viral inactivation [30]. Instead of industrially prepared foods, the majority of known outbreaks of foodborne viruses can be linked to foods that were physically handled by a food handler who was infected. From farm to fork, food can get contaminated with viruses at any point in the process. However, the majority of foodborne viral infections can be linked to infected people handling food that has not been cooked or otherwise treated after handling. Therefore, while preparing, the focus should be placed on maintaining strict personal hygiene.

Norovirus

One of the nonenveloped viruses which have + sense single-strand RNA viruses belongs to the Caliciviridae family, although the main known human pathogen responsible for many outbreaks and sporadic cases undergo several classifications to distinct groups according to serological tests, serotypes take their name from the site of discovery [31]. Morphologically classified as icosahedral and size about 27-30 nm virus particle. After ingestion of contaminated water or food, NOV replicates in the small intestine part of the digested system and damages the mucosa, and causes histopathology. Air is also considered one of several routes of transmission that emerged from an infected person during vomiting or through the use of contaminated equipment [32].

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Symptoms appear from two days to three days for all populations, with very low infection doses that occur from only 10 virus particles, a disease characterized by sickness, heaving, looseness, myalgias, and belly pain. Viruses can be shed from an infected person for a long time up to two months after infection may moreover rise in symptomless people and immunosuppressed persons. Headache and occasional-grade fever might also occur and there is anecdotal proof that there may be other diseases caused by Norovirus including infant necrotizing enterocolitis [33] The primary path of transmission is person-to-person transmission thru the fecal-oral and vomit-oral routes and circuitously via meals (geared up to eat such as leafy veggies and herbs, berries and foods treated after cooking), water and environment. In Europe, outbreaks in healthcare centers are most commonplace. Food is implicated in up to 24% of global outbreaks. Crustaceans, shellfish, molluscs, and their products and veggies and juices are the meals most customarily implicated in [34].

Rotavirus

Rotaviruses belong to the Reoviridae family and were classified into distinct groups, including 8 species A to H. Globally, Rotavirus A is considered endemic causing about eighty percent of gastroenteritis in humans. Rotavirus sized about 70nm, segmented double strand RNA have icosahedral symmetry [35]. Rotaviruses infect stomach enterocytes, with initial actions after infection being facilitated by virus-epithelial cell relations. Rotaviruses infect cells contrarily reliant on whether or not sialic acid is vital for initial binding, and infection modifies epithelial cell roles.

Rotavirus also called intestinal flu or stomach flu is a self-limited disease, slight to severe disease, vomiting, diarrhea, and low-grade fever the most common characteristic of rotavirus infection. Signs frequently start one to two days after infection with vomiting followed by three to seven days of diarrhea beginning with an infective dose thought to be 10-100 infectious viral particles; a symptomless person excretes rotavirus through 30 days after first signs of infection [35]. If the infected person is not subjected to hospitalization for treatment may lead to severe dehydration and death in specifically young children (6 to 48 months of age), old people, and the immunocompromised. Many outbreaks are caused by a different group of rotaviruses such as rotavirus B which cause outbreaks in adults and old persons, rotavirus C is also reported to cause Outbreaks in sporadic cases worldwide in children. There are two effective vaccines in the market against rotavirus [35].

Hepatitis A

The Picornaviridae family of enteroviruses includes the Hepatitis A Virus (HAV), which has six different types (A, B, C, D, E, and G). HAV was initially discovered in 1973. HAV has a buoyant density of 1.33 g/ml in Cs Cl and one RNA molecule enclosed in a 27 – 32 nm protein capsid. Foods can become infected with the virus by coming into touch with raw sewage, as is the case with mussels, or by coming into contact with contaminated water. The virus is typically transmitted orally through faces. Infected individuals excrete HAV in their bile and shed the virus in their faces. HAV only multiplies in liver cells.

With 942 cases recorded in England and Wales in 2017, hepatitis A is less frequent in developed nations. While reported cases have typically been declining since 2007, an epidemic in 2017 caused a 112.2% spike in reported cases.

Hepatitis A is a liver infection that typically manifests as a mild sickness with flu-like symptoms such as a quick onset of fever, malaise, nausea, joint pain, dark urine, pale stools, anorexia, and abdominal discomfort. Jaundice appears a few days later, and full recovery usually takes two months. When a person is sick, their symptoms typically become more severe as they age, with infected children under 6 years old showing no symptoms at all [36].

Although the minimal infectious dose for HAV infection in humans is unclear, it is likely 10100 virus particles, with the length of the incubation period depending on how many particles are consumed (fewer particles means a longer incubation period). Hepatitis A's incubation period ranges from 10 to 50 days (on average 28 days), with a lengthy period of communicability from the beginning of the incubation phase to about a week after the onset of jaundice. HAV infections frequently have no symptoms, especially in young infants. Sometimes the symptoms are worse, especially in persons who already have liver issues, and recovery might take up to three months. During their convalescence, patients experience persistent fatigue and are unable to work. Death is uncommon and mostly affects the elderly. Once exposed to the virus, a person gains permanent immunity [36,37]. It is not advised to routinely immunize all food handlers because their line of work does not put them at an increased risk for illness.

Hepatitis E

Although this virus is uncommon within the EU, it is acknowledged to be more important as an emerging pathogen. 11 HEV is a non-enveloped, positive-stranded virus with a diameter of 27 – 34 nm and a 7.5 kb spherical, likely icosahedral form. The virion has a buoyant density of 1.29 g/cm3 in potassium tartrate/glycerol gradients and is fully made up of viral protein and RNA [38].

Hepatitis E shares characteristics with other faecally transmitted viruses, such as HAV and norovirus, such as the icosahedral shape of the capsid, the absence of an outer lipid envelope, and the size of the genome. However, the virus has some distinctive physicochemical and genetic characteristics that have led to the assignment of the genus (Hepevirus) and family to it (Hepeviridae). At least five genotypes [human, swine (1-4), and avian] and one serotype exist [39].

The virus travels from the digestive system to the liver by an unidentified pathway and mechanism. Although it has been observed in the small intestine, lymph nodes, colon, and salivary glands, HEV appears to reproduce largely in liver and gallbladder cells. Following exposure, the incubation period might last anywhere between 3 and 8 weeks, with a mean of

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6 weeks. The disease often affects people between the ages of 15 and 40 and can affect youngsters asymptomatically. It is minor, asymptomatic, and self-resolves after 2 weeks. Jaundice, lethargy, anorexia, an enlarged, tender liver, stomach discomfort, arthralgia, hepatomegaly, vomiting, and fever are among the symptoms [38].

Patients with ongoing HIV infections and organ transplant recipients have both been documented to have chronic hepatitis. When present, extended fecal shedding lasts for around two weeks after jaundice starts to appear. Particularly in pregnant women, whose mortality rates increase from less than 1% to 25%, fulminant hepatic failure has been noted. Hepatitis E can persist in immunocompromised patients and is linked to higher mortality and morbidity in those with advanced liver disease [38].

Adenoviruses

The icosahedral nonenveloped adenovirus (AdV) has a dsDNA genome that is 28 – 45 kb in length. They are categorized as belonging to the 20 known species of Mastadenovirus, which belongs to the Adenoviridae family and contains three bovine, five humans, and three porcine species. Human AdV (hAdV) comprises 51 serotypes divided into six subgroups (A-F) [40]. The most common causes of gastroenteritis in young children are hAdV serotypes 40/41, which are part of Group F and are easily transmitted via the fecal-oral route. Compared to other enteric viruses, they are more resistant to the effects of UV radiation despite being sensitive to chemical treatment [41]. There have been a few suspected hAdV water-borne epidemics recorded, especially in connection with conjunctivitis and swimming pools [42]. Failures in chlorination are frequently identified as a key cause of outbreaks.

Enteroviruses

In the Picornaviridae family, the genus Enterovirus (EV) includes spherical nonenveloped viruses with an ssRNA (+) genome of 7.2–8.5 kb. There are four distinct species—A, B, C, and D—within which the serotypes are identified by their conventional names: Some coxsackievirus A strains are present in human EV (hEV) A, coxsackievirus A9, coxsackievirus B1-6, and the majority of echoviruses are present in hEV B, and polioviruses 1-3 and some coxsackievirus A strains are present in hEV C. The more recent hEVs have been categorized into all four species and given unique numbers starting with EV68 [43].

These viruses can spread through aerosols, the respiratory route, and the fecal-oral route, and may multiply in the gut and respiratory tract. Fewer than one infection out of 100 may cause clinical illness, and many infections are asymptomatic. Classical poliomyelitis, aseptic meningitis, heart disease, hand, foot, and mouth disease, conjunctivitis, and rashes are only a few of the numerous illnesses. Self-limiting fever, malaise, muscle aches, and headache are typical clinical features; vomiting and diarrhea are only seen in connection with more widespread, systemic illnesses. All age groups are affected, and antibody to one serotype does not shield against infection with other serotypes during the summer months in temperate climates [44]. The molecular drift within serotypes causes the serotypes of echoviruses and coxsackieviruses to circulate and dominate within populations to shift over time [45]. All aquatic matrices contain hEVs, indicating that they are widely present in populations [46]. However, because there are so many asymptomatic infections and close human contact is such a common method of transmission, it has been challenging to confirm the transmission of hEV infection through an aquatic route.

Climate change, health challenges and related to food-borne viruses

Climate change is impacting our global food system in a variety of direct and indirect ways and presenting new challenges to food safety and human health. Changes in temperature and precipitation can affect the distribution and survivability of pathogens that cause foodborne illnesses [47]. Changes in climate can cause severe droughts or flooding. These events can in turn affect pathogens and introduce toxins to crops. Ingestion of food contaminated with pathogens can result in foodborne illnesses, such as norovirus infection or salmonellosis. Climate change is also projected to affect the quality of food. The increase in atmospheric carbon dioxide associated with climate change can affect the nutritional value of staple crops and exacerbate malnutrition by reducing protein content and essential minerals [48,49].

There are three significant subcategories of infectious diseases that are susceptible to climate change: (i) water-borne diseases; (ii) food-borne diseases; and (iii) vector-borne diseases. Contact with tainted drinking water, recreational water, or food exposes people to water-borne illnesses. While vector-borne diseases are connected to infections spread by arthropods like mosquitoes, water- and food-borne diseases are associated with ingesting pathogens via contaminated water or food. Therefore, the prevalence of infectious diseases that are sensitive to the environment, notably water- and food-borne infections, will shift as a result of climate change and climate variability. There are concerns that the health hazards linked to inadequate access to water, sanitation, and hygiene will likely become worse in many parts of the world due to trends in climate change [50]. Food- and water-borne illnesses can be impacted by climate change in the following ways [51]. Fecal-oral pathogens present in the environment can cause water to become contaminated during extreme events like floods and sea level rise. Indirect impacts can also occur due to climatic factors (like temperature and humidity) that affect the processes of pathogen survival and multiplication, as well as other problems (e.g., agriculture, water resource management, conflicts, displacements, etc.).

One of the biggest threats to public health today is thought to be the effects of climate change on health [52]. Numerous studies demonstrate how climate change will affect the prevalence of food-borne diseases, water-borne diseases, and diarrheal diseases in particular on a worldwide scale [53,54]. Food-borne illnesses cause 91 million illness episodes and 137,000 fatalities per year throughout the continent of Africa [55]. 70% of the burden of these food-borne illnesses was

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caused by diarrheal disorders. According to a report, extreme weather conditions such as high temperatures and precipitation will have an effect on enteric pathogens, especially those that affect the environment's fecal-oral pathogens, raising the risk of gastrointestinal and diarrheal disorders [54]. According to the World Health Organization, by 2030, there will be an additional 48,000 deaths among children under the age of 15 that are primarily caused by diarrheal illnesses, and by 2050, there will be 33,000 deaths [55]. In Asia and Africa, the effects of climate change on diarrheal disease are anticipated to be greater. Sub-Saharan Africa is anticipated to bear the brunt of the mortality effects associated with climate change in 2030, whereas Southeast Asia is likely to take that role in 2050.

Foodborne outbreaks

Due to underreporting, a lack of surveillance systems, often high levels of person-to-person infection, and the inability of current systems to determine the proportion of disease that is transmitted by foodborne routes relative to other common routes, it is going to be difficult to estimate the proportion of foodborne disease caused by viruses. Viral foodborne disease is on the rise and spreading due to factors including rising population, lack of access to clean water, dietary changes such as eating rawer food, and globalization of the supply chain.

Norovirus outbreaks

- In Denmark, two outbreaks linked to imported frozen raspberries were detected in May 2005.
- In 1987, contaminated commercial ice was blamed for a number of outbreaks in Wilmington, Delaware.
- In 2005, imported frozen raspberries were blamed for a disease outbreak in France.
- An outbreak of norovirus GII/4-related food poisoning affecting 18 children and 5 adults in Tochigi Prefecture, Japan in December 2007 may have been brought on by salad
- In January 2009, 36 cases of norovirus were reported at a military base in Germany.
- In Tennessee, USA, 13 individuals were harmed by cake in January 2010.
- In February 2012, in Missouri, USA, 139 cases were reported from a banquet's fruit salad.
- In 2017, a norovirus epidemic at a US restaurant chain sickened over 130 individuals.
- In 2018, raw oysters from British Columbia, Canada, were linked to a norovirus outbreak in the US and Canada.
- 188 occurrences in England from January to August of 2018 that were lab-confirmed 12.

The rotavirus outbreak in 1982 in China was caused by raw sewage contamination of the water.

- In April 2000, there were 108 self-reported cases and 19 confirmed cases in the District of Columbia, which may have been caused by line cooks.
- In December 2000, 2722 children were treated at Tirane Hospital as a result of an outbreak that was blamed on tainted water sources in Tirane, Albania.
- 9907 patients in Malatya City, Turkey, in 2005 as a result of potential water well poisoning that may have affected two of the city's major drinking water supply districts.

From January through August of 2018, there were 4375 outbreaks in England with laboratory confirmation.

Outbreaks caused by HAV

- A clam outbreak in Shanghai in 1988 affected 280,000 individuals due to contamination and subpar preparation.
- The vehicle was believed to be a bread truck in South Cambridges Hire, England, where more than 50 people resided in 1991.

In 1997, 213 incidents in Maine, United States, were attributed to frozen strawberries.

In France, 111 incidents related to oyster consumption were recorded in November 2005.

- It's believed that seven persons in the UK contracted HAV in 2011 after eating sun-dried tomatoes.
- Pomegranate arils were blamed for a multistate US outbreak that infected 165 people in 2013.
- In the United States in 2016, an outbreak was linked to frozen strawberries.

In 2018, six EU countries reported confirmed cases that may have been connected to a specific food item.

Detection methods used for human enteric as a model for food-borne viruses

Human enteric viruses can be detected in concentrated samples using a variety of methods. They range from the direct observation of cytopathic effects in certain cell lines to the identification of indirect diagnostic signs utilizing immunological or molecular techniques, as well as direct observation by electron microscopy. Direct observation using electron microscopy is a difficult, tedious, and time-consuming operation with limited sensitivity. It is also subjective [56]. There are several commercially accessible immunological tests for the major enteric viruses, including enzymatic immunoassays, radioimmunoassays, and enzyme-linked immunosorbent assays (ELISA). Their analytical sensitivity is still too low, nevertheless, to examine environmental materials in an efficient manner. Real-time quantitative PCR (q-PCR), the preferred technology for the identification of enteric

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viruses, is now frequently utilized in viral laboratories to get over these different drawbacks and limitations. Numerous scientific investigations utilizing molecular techniques for the q-PCR is a molecular technique that allows the quantification of the amount of the target template (i.e., specific virus) initially present in a sample [51]. Other major advantages of this technique include the closed-tube format that reduces the risk of carry-over contamination, the wide dynamic range of quantification, and the possibilities for automation [16]. However, there are certain drawbacks to q-PCR as well. Only concentration techniques that can deliver a very small volume of the resulting nucleic acid solution (i.e., in the microliter range) from a realistic food or environmental sample can be employed because the volume needed in the amplification reaction is very small. The analytical sensitivity of the assay is also significantly influenced by the quality of the nucleic acids, and a variety of substances found in samples can impede the amplification response. Finally, to ensure successful implementation in real-life analytical contexts, definite international standardization initiatives are needed. A molecular technique is used with cell culture or immunological techniques as additional detection alternatives. It is possible to detect viruses that proliferate without generating cytopathic effects by combining a cell culture stage with a molecular detection step like RT-PCR or nucleic acid sequence-based amplification (NASBA), which shortens incubation times.

Instead of assessing the antibody response in blood, gastroenteritis virus infection is typically diagnosed by finding the pathogen in stool samples from sick persons. In the past, viruses were identified using an electron microscope (EM) to examine a stool solution [56]. Even though it is labor-intensive and fairly insensitive, this test is still the gold standard for diagnosing viruses.

Challenges in the evaluation of viruses in food and environment

The availability of a "gold standard" method for detection is one of the key distinctions between the study of the presence and enumeration of bacteria and that of viruses in food and in the environment. For the identification of bacteria, traditional culture-based methods are regarded as the gold standard; however, there is no widely accepted standard approach for the detection of viruses. The adaption of Quantitative Viral Risk Assessment (QVRA) models for food and food environments is hampered and delayed by the absence of a defined and widely accepted standard method for the detection and quantification of viruses. As a result, the development and use of a standard, verified method for viral identification would significantly aid in the efficient harmonization of QVRA investigations. Plaque-forming units or TCID50 are two cell culture techniques that typically result in lower virus numbers than when combined with PCR, therefore this method might be regarded as a de facto standard [57].

In order to reduce the risk of foodborne viruses we recommend:

1. Using potable water for processing and irrigation.
2. consuming seafood from authorized waters
3. monitoring sites where shellfish are produced actively for pollutants
4. Shellfish must be well cooked before eating (85°C – 90 °C for 4 minutes or steamed for 90 seconds).
5. Excluding personnel with gastroenteritis from work for 48 hours following the end of symptoms and for 1.5 weeks following the beginning of jaundice.
6. Exclude symptomatic food handlers from the whole location where food is produced.
7. Food handlers with Hepatitis A need to take seven days off of work after having jaundice or other symptoms.
8. Helpful advice in personal hygiene, including tips on how to wash your hands properly and guidance on when to seek medical help.
9. Use powerful disinfectant in cleaning and handling the environment after any vomiting incident.
10. After someone becomes ill in or close to a food handling area, destroy any food that may have been contaminated by aerosols, and thoroughly clean and disinfect the surrounding area.
11. Easy access to hand washing and sanitary facilities for all employees.
12. Keep kids away from areas where food is cooked, handled, or processed.

Conclusion

1. Enhance awareness around the existence and spread of these viruses by food handlers;
2. Adjust and regulate approaches for the discovery of foodborne viruses
3. advanced laboratory-based research techniques to quickly identify large-scale common-source outbreaks
4. Be sure to take viruses into account while building up quality control and management systems for food safety.
5. Future efforts to manage infectious diseases should take into account the requirement for adaptation to deal with the effects of climate change.

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