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Viral Infections as a Cause of Foodborne Illness

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Abstract

Different enteric viruses, including norovirus (NoV), rotavirus (RV), hepatitis A virus (HAV), and hepatitis E virus (HEV) may infect persons after ingestion of contaminated food and water and are shed through stool. NoV and HAV are currently established as the most common human foodborne viruses, which may lead to widespread outbreaks. The enteric viruses can cause wide range of diseases such as gastroenteritis, hepatitis, meningitis, Flaccid paralysis, fever, and respiratory diseases. The transmission of enteric foodborne viruses may be occurred during the consumption of contaminated raw, semi-cooked bivalve molluscan shellfish. In addition, poor personal hygiene during food preparation as well as surfaces used for food preparation were considered.

Keywords: Foodborne; Outbreak; Shellfish; Gastroenteritis; Hepatitis; Virus

Introduction

Foodborne pathogens cause foodborne diseases either by infectious agents or by toxic metabolites, such as bacterial and fungal toxins [1,2]. Foodborne illness can have economic burden on both developed and developing countries [3-6]. A wide variety of viruses belong to numerous different families may be foodborne transmitted (Table 1). These viruses can cause a wide range of diseases may range from mild gastroenteritis to severe neural diseases, diabetes, myocarditis, flaccid paralysis, hemorrhagic fever, hepatitis and respiratory disease. However, gastroenteritis and hepatitis are the common frequently reported foodborne syndromes. The most notable foodborne viruses are norovirus, hepatitis A virus, hepatitis E virus (HEV), and rotavirus [7,8]. Centers for Disease Control and Prevention (CDC) reported that foodborne diseases cause48millionpeople get sick in US, 128,000 are hospitalized, and kill about 3,000 American, annually.

Viruses cannot grow in food or water and they require living host cells to replicate. Enteric viruses are essentially transmitted through the fecal-oral route. Patients suffering from viral diarrhea may shed large amounts of viruses in their feces which may reach more than 1010 norovirus genome copies per gram of stool, up to 1011 HAV genome copies per gram of stool, and around 108 HAV genome copies per gram of stool which occurs during the period of virus incubation and early acute phase of infection [9-11].

A wide range of food products at all stages of production (pre-harvest or post-harvest stages) can

become contaminated with virus. Foods such as fruits and bivalve molluscan shellfish are most commonly associated with pre-harvest contamination. Post-harvest contamination are commonly occurs from poor personal hygiene during preparation of uncooked or lightly cooked food products. Surfaces used for food preparation and other types of fomites can act as vehicle spread for foodborne virus. Also, some food borne viruses such as HEV can be transmitted through consumption of products from animal infected with a zoonotic virus [12,13].

Short Description of Common Foodborne Viruses

Noroviruses: Human NoVs, belonging to the family Caliciviridae, is divided into two genera including norovirus and sapovirus that cause infections in humans. NoVs have also been detected in animals such a mice, pigs, dogs, cattle, cats, and sheep, while sapoviruses has been detected in pigs [14-24]. NoVs cause gastroenteritis in human while in animal NoVs can cause a range of different diseases including systemic disease with hemorrhagic syndromes, oral lesions, upper respiratory tract infections, and others. Moreover, one other potential genus comprising viruses has been described in rhesus macaques [25]. Till now, five norovirus genogroups (GI-GV) have been identified based on genetic diversity of the capsid protein [26,27]. Genogroups GI and GII are well known to infect humans, causing gastroenteritis [28]. GII viruses have also been identified in pigs [29]. Other genotypes GIII, GIV, GV viruses have been detected in animals. Genotype GII.4 is responsible for the most foodborne outbreaks, compared with other NoV genotypes [30-33]. However, genotypes GI.3, GI.6, GI.7, GII.3, GII.6, and GII.12 showed a high number of foodborne transmission in both USA and Europe [30,32].

Rotaviruses: Rotavirus, belonging to the family Reoviridae, is considered to be the leading cause of acute diarrhea among younger children, worldwide and can result in severe morbidity and deaths in both developing and developed countries [34]. Although the role of rotavirus infection in diarrheal outbreaks in adults has not been well documented, it has been reported as a causative agents of adult diarrheal outbreaks in nursing homes, hospitals, travelers, and isolated communities [35-38]. The oral-fecal is the most common rout of rotavirus transmission which occurs mostly either through water-borne infection or direct contact with infected persons. However, food-borne illness outbreak due to rotavirus infections involving prepared foods in restaurants and sandwiches have been documented. Also, rotavirus infection has been identified in lettuce in Costa Rican markets [39-41].

Hepatitis A virus

Another important enteric virus associated with foodborne viruses is hepatitis A virus (HAV). HAV, belonging to the family Piconoroviridae, is a small non-enveloped spherical infection agent that consists of single-stranded RNA virus. Globally, an estimated 1.5 million clinical cases caused by HAV each year [42,43]. HAV is considered the major cause of acute liver disease, worldwide [42,44]. HAV can be transmitted either by person-to-person contact or through ingestion of contaminated water or foods. Foodborne HAV outbreaks can occur via shellfish, ready-to-eat foods, and produce such as green onions, lettuce, frozen fruits, berries, strawberries and pomegranate [43,45-50].

Hepatitis E virus

HEV infects variety kinds of mammalian species, in addition to chickens and trouts [51]. HEV infection usually cause acute hepatitis that can become fulminant, especially in patients with preexisting liver disease and among pregnant women, or may even evolve to a chronic state, particularly in immunosuppressed individuals [52]. HEV has been reported to cause a range of extra-hepatic manifestations including acute thyroiditis, aplastic anaemia, glomerulonephritis, neuralgic amyotrophy, encephalitis, and neurological disorders such as Guillain-Barré syndrome [53,54].

By analysis of HEV whole genome, 7 genotypes of mammalian HEV have been identified within subgenus Orthohepevirus A [51]. The predominant genotypes in this subgenus are: HEV-1 and HEV-2 in human; HEV-3 in human, rabbit, pig, wild boar, mongoose, and deer; HEV-4 in human and pig; HEV-5 and HEV-6 in wild boar; HEV-7 in camel. In addition, Orthohepevirus B is well known to infect chickens, Orthohepevirus C infects rats and ferrets, while Orthohepevirus Dinfects bats [51].

Recently, hepatitis E was considered to be endemic in developing countries but considered rare in developed countries, essentially in returned travelers from endemic regions. Sporadic cases of hepatitis E infections have been identified through ingestion of raw or undercooked meats from animal such as wild boar, pig livers, deer meats, and sausages [55,56]. HEV is also present in porcine muscle. A large amounts of HEV issued in feces, runoffs, and animal manure land application can contaminate drinking water and irrigation, leading to contamination of shellfish or fresh produce. HEV RNA of swine origin has been detected in sewage water, swine manure, and oysters, and ingestion of contaminated shellfish has been involved in sporadic cases of hepatitis E [55,57,58].

Virus	Genome	Family	Genus	Disease
Aichi virus	Non-enveloped single-stranded RNA	Picornaviridae	Kobuvirus	Gastroenteritis
Astrovirus	Non-enveloped single-stranded RNA	Astroviridae	Mamastrovirus	Gastroenteritis
Enteric adenovirus	Non-enveloped double stranded DNA	Adenoviridae	Mastadenovirus	Gastroenteritis, respiratory disease, Fever
Hepatitis A Virus	Non-enveloped single-stranded RNA	Picornaviridae	Hepatovirus	Hepatitis
Hepatitis E Virus	Non-enveloped single-stranded RNA	Hepeviridae	Orthohepevirus	Hepatitis
Norovirus	Non-enveloped single-stranded RNA	Caliciviridae	Norovirus	Gastroenteritis
Rotavirus	Non-enveloped segmented double stranded RNA	Reoviridae	Rotavirus	Gastroenteritis
Sapovirus	Non-enveloped single-stranded RNA	Caliciviridae	Sapovirus	Gastroenteritis
parechovirus	Non-enveloped single-stranded RNA	Picornaviridae	Parechovirus	Gastroenteritis, respiratory disease, Meningitis,
Picorbirnavirus	Non-enveloped segmented double stranded RNA	Picobirnaviridae	Picobirnavirus	Gastroenteritis
Poliovirus	Non-enveloped single-stranded RNA	Picornaviridae	Enterovirus	meningitis, Flaccid paralysis, fever

Table 1: Common foodborne viruses and their characteristics

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