

# A Comparative Study on the Occurrence of Foodborne Diseases by Noroviruses in Korea and USA: 2009-2013

Jae Eun Lee\*, Ji Young Ahn\*\*, Jeong Eun Kwak, Seol A Kwon, Yun Hee Song  
Chungbuk National University, Korea

## Abstract

Recently, noroviruses are the leading cause of acute gastroenteritis worldwide and has a serious impact on people's health. Consequently, preventive measures for foodborne disease caused by norovirus play an important role. This paper epidemiologically analyzed and compared five norovirus outbreak aspects of Korea and USA from 2009 to 2013. Five aspects are the major pathogen of foodborne disease, the peak season of outbreaks, the facility of outbreaks, the food commodity causing a disease, the genotype of norovirus. Then the food hygiene regulations and risk management policies of foodborne disease were compared. This paper expects to develop appropriate measures for damages depending on post-counteraction to fundamental domestic response system.

**Key words:** norovirus, foodborne disease, outbreaks, preventive measures

## 1. INTRODUCTION

Gastroenteritis, both epidemic and sporadic, is a common cause of morbidity and mortality among persons of all ages, accounting for over 1.8 million deaths in children under five years of age worldwide. The causes of gastroenteritis include a large variety of bacteria, parasites and viruses, yet in many settings the relative contribution of these agents is unknown[1][2]. Noroviruses (NoV), the leading cause of foodborne illness in the world, and a member of the Caliciviridae family, are considered the major cause of acute gastroenteritis worldwide.

---

\* Tel. +82-43-261-2197. Fax. +82-43-268-2197. E-mail. [jeunlee@chungbuk.ac.kr](mailto:jeunlee@chungbuk.ac.kr)

\*\* Corresponding author. Tel. +82-43-261-2301. E-mail. [jyahn@chungbuk.ac.kr](mailto:jyahn@chungbuk.ac.kr)

Submission & Publication Process

Received: Jan. 3, 2014 / Revised: Feb. 06, 2014 / Accepted: Feb. 10, 2014

In Korea, foodborne diseases(caused by norovirus) at schools broke out in a large scale in 2006. Nearly 2,000 school children received hospital treatments. As a result of this case, the norovirus problem was becoming serious. Moreover, noroviruses have rapidly changed their own genotypes, which is a consequence of effective evasion of host immunity. For this reason, norovirus outbreaks continuously have occurred. In 1968's USA, there was mass foodborne disease in an elementary school of Norwalk, Ohio in 1968. And the norovirus was first detected in the diarrheal stool of students. Since then, norovirus is a leading cause of acute gastroenteritis in USA.

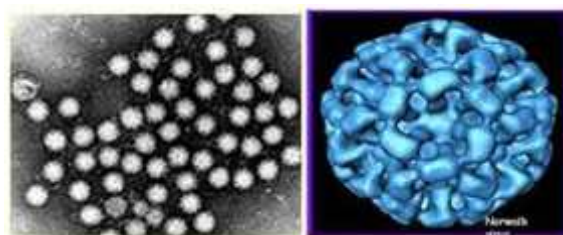
This paper epidemiologically analyzed and compared norovirus outbreak aspects of Korea and USA from 2009 to 2013. In this study, we analyzed data reported to the Center for Disease Control and Prevention(CDC) in Korea, Korea Food and Drug administration (KFDA) and journals. Based on the analysis, the purpose of this study is to investigate different characteristics of norovirus outbreaks in Korea and USA and to suggest the appropriate protective measures.

## II. THEORETICAL BACKGROUND

A 27-nm particle derived from the samples of Norwalk was first observed by immune electron. The infected people showed the serological evidence of infection. This case was first evidence that the particle was the etiological cause of gastroenteritis occurred in Norwalk[3].

There were a lot of taxonomic proposals approved by the Executive Committee of the International Committee on Taxonomy of Viruses(ICTV). They finally named Norwalk-like virus norovirus(NoV) at its meeting in Houston earlier 2002[4].

Caliciviruses have a single-stranded RNA genome and an icosahedral capsid with a diameter of 27-40 nm. The symptoms are diarrhea and vomiting[5].

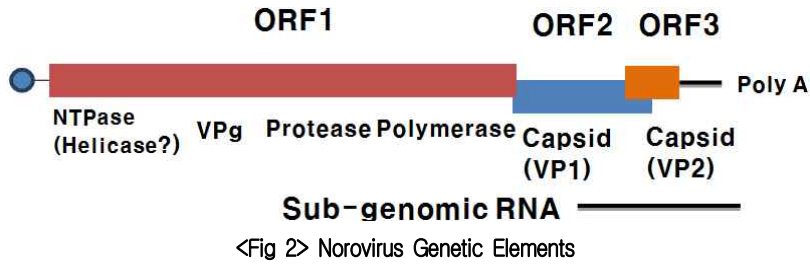


<Fig 1> The Picture of Norovirus

※ Source: [6]

The norovirus genome consists of three open reading frames(ORFs). ORF 1 encodes the nonstructural polyprotein that includes the deduced RNA-dependent RNA polymerase

(RdRp). ORF2 and ORF3 encode the structural protein, including the major (VP1) and minor (VP2) capsid proteins respectively.



※ Data: [7]

Previous outbreaks caused by Norovirus-contaminated ice and cooked shellfish have shown that these viruses have the resistance to harsh environmental conditions. Norovirus can genetically be classified into six different genogroups (G) and viruses from GI, GII, and GV are pathogenic for humans. GI has nine genotypes, GII contains 22 genotypes including GII.11, GII.18, and GII.19. Over the past 15 years, GIV genogroup has caused a small number of illnesses in human[8].

New GII.4 variants emerge every two or three years and become the main cause of acute gastroenteritis. It looks like GII.4 variants have higher epidemiological strength than that of other genotypes. Since 1995, at least five GII.4 variants have been responsible for global epidemics[9].

Norovirus illness can have the severe symptoms of vomiting and non-bloody diarrhea and after two or three days the symptom disappears. Recent studies have shown that the median period of illness can be longer if patients are affected during hospital outbreaks and children under the age of 11 are infected[10].

&lt;Table 1&gt; Generic character of Norovirus

Feature	Observation	Consequences
Low infectious dose	<math><10^2</math> viral particles	Permits droplet or person to person spread, secondary spread, or spread by foodhandlers
Prolonged asymptomatic shedding	$\leq 2$ weeks	Increased risk for secondary spread or problems with control regarding foodhandlers
Environmental stability	Survives up to 10ppm chlorine, freezing, and heating to 60°C	Difficult to eliminate from contaminated water, virus maintained in ice and steamed oysters
Substantial strain diversity	Multiple genetic and antigenic types	Requires composite diagnostics; repeat infections by multiple antigenic types; may limit sensitivity of diagnostics and thus result in underestimate of disease prevalence.
Lack of lasting immunity	Disease can occur with reinfection	Childhood infection does not protect from disease in adulthood; difficult to develop vaccine with lifelong protection

※Data: [11].

### III. EPIDEMIOLOGICAL ANALYSIS

#### 1. Major Pathogen Causing Foodborne Diseases in Korea and USA

The bacteria and virus are common causes of foodborne diseases. Since 2002, Korea Food and Drug Administration (KFDA) has formally offered outbreak statistics of foodborne diseases.

The Foodborne Disease Outbreak Surveillance System (FDOSS) is a database system on foodborne disease outbreaks offered by the center for Disease Control and Prevention (CDC). Based on this database system, we collected statistical data and selected eight major pathogen causing foodborne diseases[8].

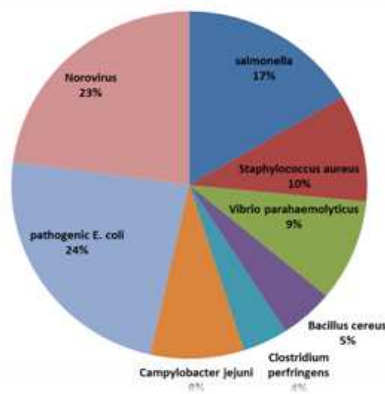
##### 1) Korea

From 2009 to 2011, a total of 808 foodborne diseases occurred in Korea. In this paper, foodborne disease outbreaks that have not been identified for causing pathogen were excluded. The outbreaks that have been identified on causing pathogen major pathogen were 411. As a result, the pathogenic E.coli(24%) and Norovirus(23%) are an overwhelming cause of foodborne diseases. The following is to describe salmonella, a major pathogen.

<Table 2>The table of Main Pathogen leading the Foodborne disease in Korea (2009–2011)

	2009	2010	2011	Total
Salmonella spp.	17	27	24	68(17%)
Staphylococcus aureus	12	19	10	41(10%)
Vibrio parahaemolyticus	12	18	9	39(9%)
Bacillus cereus	0	14	6	20(5%)
Clostridium perfringens	5	5	7	17(4%)
Campylobacter jejuni	7	15	13	35(8%)
pathogenic E. coli	37	28	32	97(24%)
Norovirus	32	31	31	94(23%)
Total	122	157	132	411

※Data: [6].



<Fig 3> The Graph of Main Pathogens leading the Foodborne disease in Korea (2009–2011)

## 2) USA

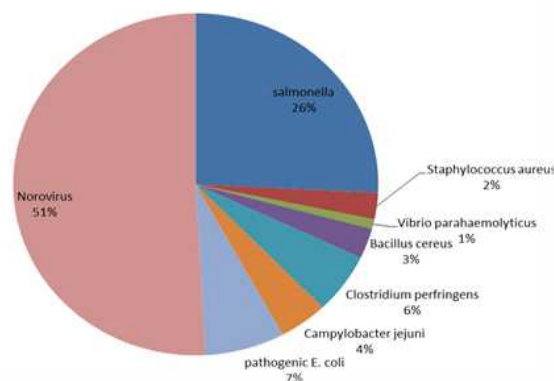
During the last three years from 2009 to 2011, a total of 2300 foodborne diseases occurred in USA. 863 of 2300 outbreaks were not identified for causing pathogen. Therefore, unknown outbreaks were excluded here, in this paper.

In USA, Norovirus accounts for over 50%. Unlike the result of Korea, pathogenic E.coli takes only 7% in the Figure 4. Norovirus is a main reason of foodborne diseases in both countries. These results of two countries give the importance on norovirus research.

<Table 3> Major Pathogens leading the Foodborne Disease in USA (2009–2011)

	2009	2010	2011	Total
Salmonella	120	134	116	370(26%)
Staphylococcus aureus	13	11	12	36(2%)
Vibrio parahaemolyticus	2	5	6	13(1%)
Bacillus cereus	14	16	11	41(3%)
Clostridium perfringens	29	33	20	82(6%)
Campylobacter jejuni	15	24	23	62(4%)
pathogenic E. coli	39	33	29	101(7%)
Norovirus	198	304	228	730(51%)
Total	430	560	445	1435

※ Data: [8].



<Fig 4> Major Pathogens leading the Foodborne Disease in USA (2009–2011)

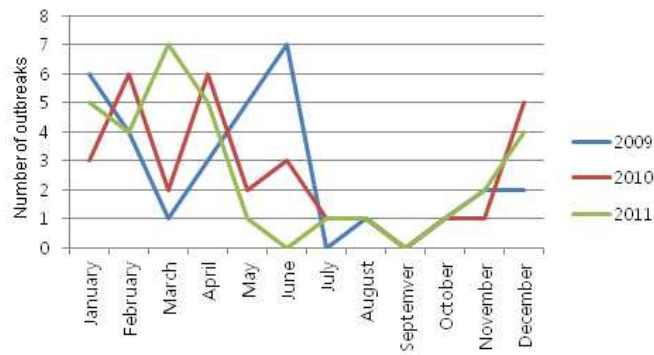
※ Data: [8].

## 2. Outbreak Seasons in Korea and USA

In order to analyze the seasonality of norovirus outbreaks in Korea and USA, we also used the food poisoning database offered by Korea Food and Drug Administration(KFDA) and the foodborne Disease Outbreak Surveillance System(FDOSS) offered by the Center for Disease Control and Prevention(CDCP).

### 1) Outbreak Seasons in Korea

Foodborne norovirus outbreaks were slightly more frequent in winter months than in the rest of the year, but occurred continuously from late fall to spring and rapidly declining in summer. However, the seasonality of norovirus varied somewhat from year to year. In 2009, norovirus outbreaks started from October and reached its peak in June. However, in 2010 and 2011, it reached its peak in February and March.



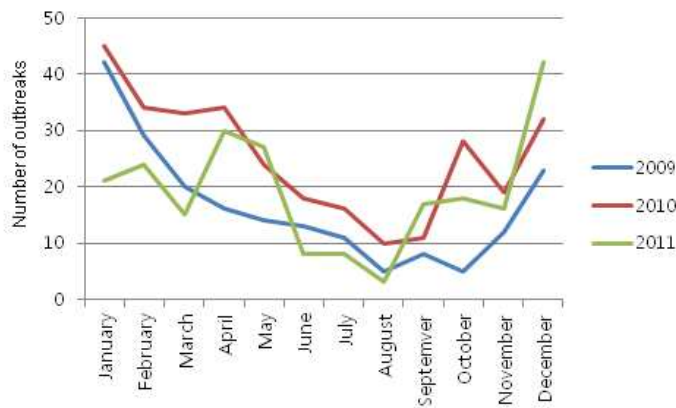
<Fig 5> The Seasonality of all Norovirus outbreaks in Korea (2009-2011)

※ Data: [6]

## 2) Outbreak Seasons in US

Foodborne norovirus outbreaks peaked in the winter season. Between January 2009 and December 2011, outbreaks began increasing in September and January was almost peak norovirus month.

Norovirus exhibited the winter time seasonality in both countries. This is why norovirus has been called as a winter vomiting bug. For norovirus, the winter climate is indirectly related to the winter seasonality. It influences transmissibility, host susceptibility, and the resistance of norovirus to environmental conditions[11].



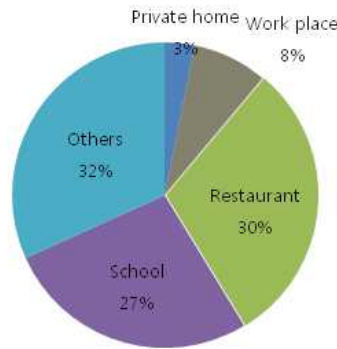
<Fig 6> The Seasonality of all Norovirus outbreaks in USA (2009-2011)

※ Data: [12].

## 3. Facilities in Korea and USA

Noroviruses are highly contagious, and mostly occur in hospitals, schools, cruises, and restaurants. They can be transmitted by person to person contact, aerosolization, and contaminated food or water.

1) Korea

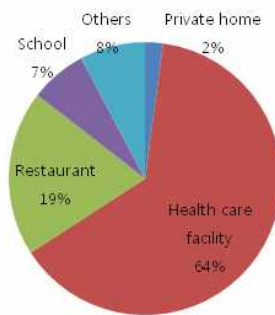


<Fig 7> Settings of Foodborne norovirus outbreaks in Korea (2009-2010)

※ Data: [6]

In Korea, 63 foodborne norovirus outbreaks were reported between 2009 and 2010. Nineteen(30%) outbreaks occurred in restaurants and 17 (27%) in schools, 5 (8%) in workplaces, and 2 (3%) in private homes. Twenty(23%) outbreaks most frequently occurred in other settings such as accommodations, banquet facilities, and unknown facilities.

2) USA



<Fig 8> Settings of Foodborne norovirus outbreaks in USA (2009-2010)

※ Data: [12].

In USA, 199 foodborne norovirus outbreaks were reported from 2009 to 2010. 932(64%) outbreaks most often occurred in health care facilities. 287(19%) outbreaks occurred in

restaurants and 114 (8%) in other setting, 98(7%) in school, and 31(2%) in private homes.

#### 4. Food Commodities

<Table 4> Top 3 Frequent Commodities implicated in reported norovirus outbreaks involving single food commodities in Korea (2011–2012) and USA (2009–2010).

	1	2	3
Korea	Shellfish (33%)	Pickled vegetable (25%)	Water (13%)
USA	Leafy Vegetables(28%)	Shellfish (23%)	Fruits/Nuts (20%)

※ Data: [6][12][13].

It is difficult to determine food sources responsible for illnesses. There are several reasons for this. First of all, the dish has many ingredients. Also, most people couldn't know and remember what they ate. Lastly, not everyone who ate the same contaminated food shows the sickness. Therefore, most of the food sources responsible for illnesses were unknown. We analyzed confirmed food sources and compared single food commodities.

##### 1) Korea

Among the 75 norovirus outbreaks with food commodity during the years of 2011 till 2012 in Korea, the most frequent single commodities is shellfish(33%), pickled vegetable(25%), and water(13%).

##### 2) USA

Among the 491 norovirus outbreaks with food commodity during the years of 2009 till 2010 in the US, the most frequent single commodities were leafy vegetables(28%), shellfish(23%), and fruits/nuts(20%).

#### 5. Genotypes of Norovirus

##### 1) Korea

To investigate the recent tendency of norovirus's genotype in Korea, we quoted some findings from "Emergence of GII4 Sydney norovirus in Korea during the winter of 2012–2013"

In the four university hospitals, 1,780 stool samples were checked into norovirus antigen

testing between November 2012 and June 2013. The 254 samples of stool sample showed positive reactions to norovirus antigen testing. January to June 2013 Among 151 norovirus positive samples, 91 samples could be genotyped[9]. The genotype results are described in (<Table 5>).

<Table 5> The Dispersion of Norovirus Genotype in Korea (January to June 2013)

GI.4	1
GI.9	1
GII.2	4
GII.3	3
GII.4	58
GII.4 Den Haag(non-Sydney)	3
GII.4 Sydney	55
GII.6	5
GII.8	1
GII.13	5
GII.13/14	4
GII.17	6
GII.21	3
Total	91

※ Data: [9].

As shown in <Table 5> the main genotype of norovirus is GII.4. Especially, GII.4 Sydney is taking part almost 94% in the GII4 genotype.

## 2) USA

Through CaliciNet, the laboratory-based outbreak surveillance of norovirus outbreaks has been conducted in USA since 2009. The Calicinet is a surveillance network of state and local public health laboratories cooperated with CDC. Using this system, data have been investigated[8].

As a result, September 2009 to August 2013, 3,960 norovirus outbreaks were reported and 122 of which 2,254 (57%) occurred and has genotyped.

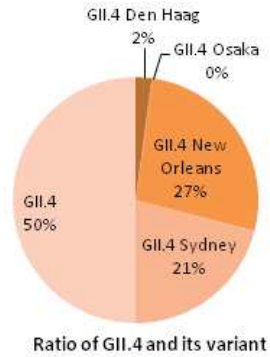
In USA, the most case genotype of norovirus is GII.4 and its variant (GII.4 New Orleans 2009, GII.4 Sydney2012, GII.4 Osaka 2007, GII.4 Den Haang 2006b). The GII.4 New Orleans 2009 is a major cause of foodborne disease in USA.

The GII.4 Sydney 2012 has been reported in many countries like Australia, New Zealand, Japan, Western Europe, Canada, and the USA[9].

<Table 6> The Number of Outbreaks with Norovirus Gastroenteritis by Genotype in 2009–2013

GI.1	2
GI.2	7
GI.3	75
GI.4	27
GI.5	21
GI.6	161
GI.7	12
GI.9	3
GII.1	159
GII.2	49
GII.3	13
GII.4 Den Haag	81
GII.4 Osaka	5
GII.4 New Orleans	1025
GII.4 Sydney	802
GII.4	1913
GII.5	9
GII.6	110
GII.7	39
GII.12	42
GII.13	19
GII.14	3
GII.15	1
GII.16	3
GII.17	4

※ Data: [8].



<Fig 9> The Percentage of Outbreaks with norovirus gastroenteritis by genotype in 2009–2013

※ Data: [8].

<Table 7> The Comparison Analysis of Norovirus Outbreaks in Korea and USA

	Korea	USA
Major pathogen of Foodborne Diseases	1. Pathogenic E. coli (24%)	1. Norovirus (51%)
	2. Norovirus (23%)	2. Salmonella (26%)
Peak Seasons	Difference in every years	January
Facilities	1. Others (32%)	1. Health care facility(64%)
	2. Restaurant (30%)	2. Restaurant(19%)
Food Commodities	1. Shellfish (33%)	1. Leafy vegetables (28%)
	2. Pickled vegetable (25%)	2. Shellfish (23%)
The Genotypes of Norovirus	1. GI.4 Sydney	1. GI.4 New Orleans
	2 GI.17	2. GI.4 Sydney

Until now, we've looked at the tendency of occurrence of foodborne disease caused by noroviruses in Korea and USA. Table 7 shows the comparison of two countries according to major pathogen, season, facilities, food, and genotype.

#### IV. THE LAWS AND POLICIES FOR FOODBORNE DISEASE CONTROL

##### 1. Food Hygiene Regulations

<Table 8> The Hygienic Regulations between Korea and USA

		Korea	USA
Food Handler	Kind of Diseases	Infectious diseases of digestive system, tuberculosis(except non infections stage), skin disease, purulent disease, hepatitis B(except inactive) HIV(employer who should take a healed exanimation about venereal disease)	Persons affected with any disease in a communicable form, or while a carrier of such disease, or while affected with boils, infected wounds, sores, acute respiratory infection, nausea, vomiting, or diarrhea which could cause food borne diseases such as staphylococcal intoxication, salmonellosis, shigellosis or hepatitis shall not work in any area of a food establishment in any capacity in which there is a likelihood of such person contaminating food or food contact surfaces with pathogenic organisms, or transmitting disease to other individuals and no person known or suspected of being affected with any such disease or condition shall be employed in any such area or capacity.

<Table 8> The Hygienic Regulations between Korea and USA(Continue)

		Korea	USA
Food Handler	Washing hands	-	The hands of all employees shall be kept clean while engaged in handling food and food contact surfaces. Employees shall thoroughly wash their hands and exposed arms with soap and warm water before starting work, and shall wash hands during work hours as often as is necessary to keep them clean, and after smoking, eating, drinking, visiting the toilet room, or handling raw food of animal origin. Approved separate hand washing facilities shall be provided at convenient locations as necessary to maintain clean hands and arms during working hours. Utensil washing sinks or vats and food preparation sinks are not acceptable as hand washing facilities for personnel.
	Cloth	Persons who work in food manufacturing process should wear clean clothes, hats, and gloves.	Employees shall keep their fingernails clean and neatly trimmed. All persons, including dishwashers, engaged in handling food or food contact surfaces shall wear clean outer garments. Employees engaged in the preparation of food and other persons who may come in contact with these operations shall use effective hair restraints to prevent the contamination of food. Service personnel shall take steps necessary to keep hair from food and food contact surfaces.
Dish & Utensil	Washing	Dishes and utensils should be washed and sterilized after use	I. Sinks shall be clean prior to use. Equipment and utensils shall be pre-flushed or pre-scraped and, when necessary, presoaked to remove gross food particles and soil. II. Equipment and utensils shall be thoroughly washed in the first compartment with a detergent solution that is kept clean and used in accordance with manufacturer's directions. III. Equipment and utensils shall be rinsed free of detergent and abrasives with clean water in the second compartment. IV. Equipment and utensils shall be sanitized in the third compartment
	Disinfection	-	I. Immersion for at least 30 seconds in clean hot water at a temperature of at least 170 degrees Fahrenheit. II. Immersion for at least one minute in a clean solution containing at least 50 parts per million of available chlorine as a hypochlorite and at a temperature of at least 75 degrees Fahrenheit III. Immersion for at least one minute in a clean solution containing at least 12.5 parts per million of available iodine and having a pH not higher than 5.0 and at a temperature of at least 75 degrees Fahrenheit;

※ Data: [14].

The foodborne diseases caused by norovirus were usually caused by mass feeding in

schools and restaurants in Korea. In general, the main cause of foodborne disease in Korea is lack of sanitary control for mass feeding. As for Korea's hygiene regulations(1997) and USA's Sanitary Code for Retail Food Establishment and Food and Beverage Vending Machines(1992), we compared the regulations on hygiene of food handler, dish and utensil which have the potential to cause foodborne diseases of mass feeding. The regulations on food hygiene are summarized above(<Table 8>).

There are no specific regulations on washing hands, washing of dish, utensil and disinfection in hygiene regulations of Korea.

Overall, USA's Sanitary Code for Retail Food Establishment and Food and Beverage Vending Machines is more specific and clear than Korea's hygiene regulations. Therefore, those vague regulations should be modified and changed so that people in food industry can easily understand and follow the regulations.

Finally, the following is the result of comparative analysis of risk management policy of foodborne diseases between Korea and USA.

<Table 9> Risk Management Policies of Foodborne Disease

	Korea	USA
Foodborne Disease Surveillance System & Early Warning System	<ul style="list-style-type: none"> <li>• An early warning system using DNA fingerprinting database of pathogens (KPulseNet) was first developed in 2006.</li> <li>• There is foodborne disease early warning system only for schools</li> </ul>	<ul style="list-style-type: none"> <li>• An early warning system using DNA fingerprinting database of pathogens (PulseNet) was first developed in 1996</li> </ul>
Response Actions for Foodborne Disease Outbreaks	<ul style="list-style-type: none"> <li>• KFDA is in full charge of managements and response actions for foodborne disease.</li> <li>• When the outbreak case is related to waterborne disease, The Ministry for Health, Welfare and Family Affairs (MOHW) and KCDC cooperate with KFDA.</li> </ul>	<ul style="list-style-type: none"> <li>• All the ministries (CDC, FDA, FSIS, EPA) assume the responsibility for foodborne and waterborne disease.</li> <li>• Once foodborne disease outbreaks occur, The foodborne Outbreak Response Coordination Group is established, cooperating with relevant ministries and finding effective measures.</li> </ul>

※ Data: [15].

## 2. Risk Management Policies of Foodborne Disease

First of all, we compared the foodborne disease surveillance system and early warning system. They both use an early warning system using DNA fingerprinting database of pathogens(PulseNet). But, there are several differences. As for USA, PulseNet has linked foodborne disease outbreaks together and detected thousands of local and multi-state

outbreaks since 1996. Korea's PulseNet was first developed in 2006. Also, there is no detailed early warning system for foodborne diseases because it comprehensively deal with all the infectious illness cases.

Compared to the differences of foodborne disease surveillance system and early warning system, the differences of response actions for foodborne disease outbreaks are more distinct. As for USA, all the ministries(CDC, FDA, FSIS, EPA) assume the responsibilities for foodborne and waterborne diseases. Also, to find effective measures, the Foodborne Outbreak Response Coordination Group is always established. But, in Korea, KFDA is in full charge of managements and response actions for foodborne disease and cooperate with other ministries in a certain situation. In addition, clear roles of relevant ministries have not been established and legal bases for dividing roles have not existed.

## V. CONCLUSION

This paper attempted to investigate the epidemiological aspects of norovirus outbreaks to compare the main different characteristics of outbreaks in Korea and USA from 2009 to 2013. Then we analyzed laws and policies for foodborne disease control.

From these results, we suggest some protective measures to control the foodborne diseases in Korea as follow;

First, Korea's food hygiene regulations are more loose and vague than those of USA. According to the epidemiological analysis, the main cause of foodborne disease in Korea is E.coli. The E.coli is an indicator of fecal contamination. Also, in Korea, the foodborne diseases were usually taken place in food service facilities like school, restaurants. The regulations in Korea should be reconstructed more strict and detailed to get the people in food industry understand and follow easily. So, it can be helpful to control the E.coli contaminations and mass foodborne diseases.

Second, when foodborne diseases outbreaks occurred on a large scale, Korea always has had a low efficiency in dealing with the problems because roles of relevant ministries have not been established and legal bases for dividing roles have not existed.

Third, there is no early warning system only for foodborne disease. Roles of supervising ministries should be, therefore, clarified and the government should establish the legal bases for dividing roles of relevant ministries. Also, KCDC should use the early warning system more positively and establish a more detailed foodborne disease early warning system for all the facilities. Especially, we have a problem getting information of tendency of genotypes. By using the foodborne disease early warning system effectively, we will be able to understand the tendency more thoroughly and construct appropriate measures for Korea.

Finally, nowadays, lots of kinds of food vegetables and food reserves have been imported from China, Thailand, Vietnam, and so on. But Korean government does not have regulations or standards of controlling the quality of food-related materials. So, it is necessary to establish regulations or rule for acquiring the standard quality.

Norovirus is a major pathogen of foodborne disease worldwide. As mentioned earlier, USA has more developed disease control systems than Korea. Meanwhile, Korea has many norovirus outbreak cases. Consequently, comparing the aspects of outbreaks and analyzing the problems of control system, we expected to develop measures for damage depending on post-counteraction to fundamental domestic response system.

## References

- [1] Bryce, J., C. Boschi-Pinto, K. Shibuya, and R. E. Black. 2005. WHO Estimates of the Causes of Death in Children. *Lancet*. 365(9465): 1147-1152.
- [2] Patel, Manish M., Aron J. Hall, Jan Vinje, Umesh, and D. Parashar. 2009. Noroviruses: A Comprehensive Review. *Journal of Clinical Virology*. 44: 1-8.
- [3] Kapikian, Albert Z., et al. 1972. Visualization by Immune Electron Microscopy of a 27-nm Particle Associated with Acute Infectious Nonbacterial Gastroenteritis. *Journal of Virology*. 10(5): 1075-81.
- [4] Mayo, M. A. 2002. A Summary of Taxonomic Changes Recently Approved by ICTV. *Archives of Virology*. 147(8):1655-1656.
- [5] Glass, R. I., et al. 2000. The Epidemiology of Enteric Caliciviruses from Humans: A Reassessment Using New iagnostics. *Journal of Infectious Diseases*. 181(Supplement 2): S254-S261.
- [6] FDA. 2013. [www.fda.gov](http://www.fda.gov)
- [7] Lee, Min Hwa., et al. 2013. Trends and Epidemiology of Norovirus Outbreaks. *Ministry of Food and Drug Safety*. 8(1) : 3-11
- [8] Vega, Everado, et al. 2013. Genotypic and Epidemiologic Trends of Norovirus Outbreaks in the United States. *Journal of Clinical Microbiology*. 52(1):147-155
- [9] Kim, Hyun Soo, Won Hyun Jeong, Han Sung Kim, Jae Seok Kim, Won Keun Song, Kyu Man Lee. 2013. Emergence of GII.4 Sydney Norovirus in South Korea during the Winter of 2012-2013. *Journal of Microbiology and Biotechnology*. 23(11):1641-1643.
- [10] Rockx, B., et al. Natural History of Human Calicivirus Infection: A Prospective Cohort Study. 2002. *Clinical Infectious Diseases*. 35(3): 246-253.

- [11] Ahmed, Sharia M., Benjamin A. Lopman. Karen Levy. 2013. A Systematic Review and Meta-Analysis of the Global Seasonality of Norovirus. *PLoS One*. 8(10): 759–781.
- [12] CDC. Foodborne Outbreak Online Database. Atlanta, Georgia: U.S. Department of Health and Human Services, Center for Disease Control and Prevention. Available from URL:<http://www.cdc.gov/foodborneoutbreaks>. Accessed 19/11/2013
- [13] CDC. <http://www.cdc.gov/foodborneburden/attribution.html>
- [14] Roh, Pyong-Ui, Sung Oh Bin. 2005. Comparison of Sanitary Codes of Retail Food Establishments of Korea, China, Japan and USA. *Journal of Food Hygiene and Safety*. 20(2): 103–113
- [15] Paik, Min Kyoung, Hyo Keun Park. 2009. Study on Risk Management of Foodborne Disease in Korea. *Hanyang Law Review* .26(1): 97–120

---

**Jae Eun Lee** is a Professor of Public Administration in the College of Social Sciences at Chungbuk National University, Cheongju, Korea, in which he has taught since 2000. He received a Ph.D. degree in Public Administration from Yonsei University, Seoul, Korea in 2000. His research interests include crisis and emergency management, policy implementation, and organizational theory(jeunlee@chungbuk.ac.kr)

**Ji Young Ahn** is a Professor of Microbiology in the College of Natural Sciences at Chungbuk National University, Cheongju, Korea, in which she has taught since 2012. She received a Ph.D. degree in Chemical Engineering from Korea University, Seoul, Korea in 2006. Her research interests include Diagnostic probe, Point of Care Testing (POCT) and Environmental Toxicology(jyahn@chungbuk.ac.kr)

**Jeong Eun Kwak** is a student of Microbiology in the College of Natural Sciences at Chungbuk National University, Cheongju, Korea(jekwak77@gmail.com)

**Seol A Kwon** is a doctoral-course student of Public Administration in the College of Social Sciences at Chungbuk National University, Cheongju, Korea(seola@chungbuk.ac.kr).

**Yun Hee Song** is a student of Microbiology in the College of Natural Sciences at Chungbuk National University, Cheongju, Korea(hardboiled23@gmail.com).