衞生防護中心
Centre for Health Protection

Scientific Committee on Enteric Infections and Foodborne Diseases

Food Poisoning Associated with *Vibrio parahaemolyticus* in Hong Kong –Current Situation and Recommendations

Purpose

This paper examines the epidemiology of *Vibro parahaemolyticus* (VP) related food poisoning in Hong Kong and the current health protection measures.

The Pathogen and the Disease

The Bacterium

2. *Vibrio* spp. are Gram-negative, facultative anaerobic rod-shaped bacteria. Twelve *Vibrio* species have been isolated from human clinical specimens and eight including VP are food associated pathogen[1]. VP is a halophilic bacterium that inhabits in marine and estuarine environment worldwide. It was first described as the cause of gastroenteritis in Japan in the 1950s[2].

3. VP is normally present in many types of raw seafood, including fish, crustaceans and molluscan shellfish. Foodborne illness has been associated with the consumption of different kinds of seafood[3]. Consumption of raw or undercooked seafood and cooked food that have been contaminated can cause the infection. The infective dose is usually between 10^5 to 10^7 viable cells ingested[4,5].

4. This organism can grow at a temperature range from 5C to 43C (optimum 37C), pH range from 4.8 to 11 (optimum 7.8 to 8.6), and 0.5% to 19% (optimum 3%) saline (NaCl). Under optimum conditions the generation time can be as fast as 9 to 10 minutes[6]. Therefore foods contaminated with a small dose of VP can reach an infectious dose in only a few hours if stored at room temperature. However, in shellfish, heating to produce an internal temperature of at least 65C for several minutes appears sufficient to inactivate the bacteria[6].

5. VP can be differentiated by serotyping based on the different antigenic structures of the lipopolysaccharides groups (O groups) and capsular types (K types). 75 different combinations of O and K of VP are recognized up to date[7], and more than a dozen different serotypes (e.g. O3:K6) have been associated with outbreaks from different countries[3]. Various molecular typing techniques have been developed in recent years to facilitate the study of molecular epidemiology.

6. Not all strains of VP are pathogenic. In fact, only some strains of VP can cause illnesses in human. The major virulence factors of VP are the production of thermostable direct haemolysin (TDH) and the TDH-related haemolysin (TRH). The pathogenic strains are generally capable of producing a characteristic haemolytic reaction on Wagatsuma agar medium. Such reaction is known as Kanagawa phenomenon[8,9].

The Disease

7. VP is one of the most important bacterial pathogens throughout the world associated with seafood. It is the leading cause of food poisoning in Hong Kong. VP generally causes self-limiting acute gastroenteritis characterized by watery diarrhea and abdominal cramping in nearly all cases, and usually with nausea, vomiting, headache and fever. The incubation period is usually between 12-24 hours and most of the affected persons recover within 3 days and suffer no long-term sequelae[9,10]. The general population is susceptible to the infection though persons with underlying medical conditions like alcoholism and liver disease may have higher risk of infection and complications. Septicemia may occur occasionally but death is rare. Illness rates are usually higher during the warmer months[3,11].

Laboratory Diagnosis

8. Diagnosis of VP is confirmed by isolating VP from the patient's stool on appropriate media (typically thiosulphate citrate bile salt sucrose (TCBS) agar medium)[9]. The pathogenicity of VP can be determined by identification of the genes encoding haemolysin using molecular methods for TDH and TRH[3,9].

9. In addition, pulsed field gel electrophoresis (PFGE) could be applied to establish molecular relatedness of the pathogens isolated in outbreak investigation. PFGE is a molecular technique by which the chromosomal DNA of a pathogen is cut into large restriction fragments that are separated into specific pattern through agarose gel by constantly changing the direction of the electrical field during electrophoresis. The technique has been applied in the investigation of outbreak of foodborne pathogens such as *Salmonella* spp, *Escherichia coli* O157:H7 as well as VP[12-14]. Standardized PFGE protocol for VP has been developed and validated internationally[15-16]. It allows inter-laboratory comparison of the test results and, together with serotyping, tracking the global spread of the pathogen.

Global Situation

10. Since its identification as a pathogen of gastroenteritis in 1950s, VP has been implicated as a major cause of foodborne illness worldwide[3]. While the disease course may be mild, VP is known to result in large, explosive food poisoning outbreaks, affecting a large number of people. Sporadic cases and outbreaks had been reported in Asian countries and the United States (US)[3].

11. In Japan, about 40 to 800 VP related food poisoning outbreaks, affecting about 1,200 to 12,000 persons each year from 1991 to 2007[17]. These outbreaks usually peaked in August[3,18]. Consumption of sashimi, sushi, shellfish, and cooked fish were the most common food vehicles implicated in these cases[3]. In Taiwan, there were about 52 to 160 outbreaks of food poisoning caused by VP annually, accounting for 76.9% (664/863) of confirmed bacterial food-borne disease outbreaks during the period 1996 to 2002[19]. Seafood was the source of infection in most of the cases. Outbreaks were also more prevalent during the warmer months between April and October[20]. In the US, there were about 4,500 persons infected with VP annually[10]. In 2004, outbreak due to consumption of Alaskan oysters in the US was reported[21]. It has been postulated that the effect of global warming and rising temperatures of ocean water might have contributed to outbreak. Compared to Asia and the US, disease caused by VP is relatively uncommon in Europe[22].

12. Historically, infections caused by VP are usually associated with diverse serovars, but the O3:K6 serovar has become increasingly common since its identification in India in 1996. The O3:K6 serovar and its variants (for example O4:K68, O1:K25 and O1:KUT) has caused unprecedented multiple epidemics across the US, Africa, and Asia areas including Japan and Taiwan, China[7, 23-25]. In Taiwan, China, the proportion of VP infections caused by the O3:K6 serovar increased from 0.6% in 1995, to 50% and 84% in 1996 and 1997 respectively[24].

Local Situation

13. We examined data collected in the notifiable disease surveillance, laboratory surveillance, and food surveillance programmes to assess the local situation of VP-associated food poisoning outbreaks from 2001 to 2009.

Data from Food Poisoning Outbreak Investigation

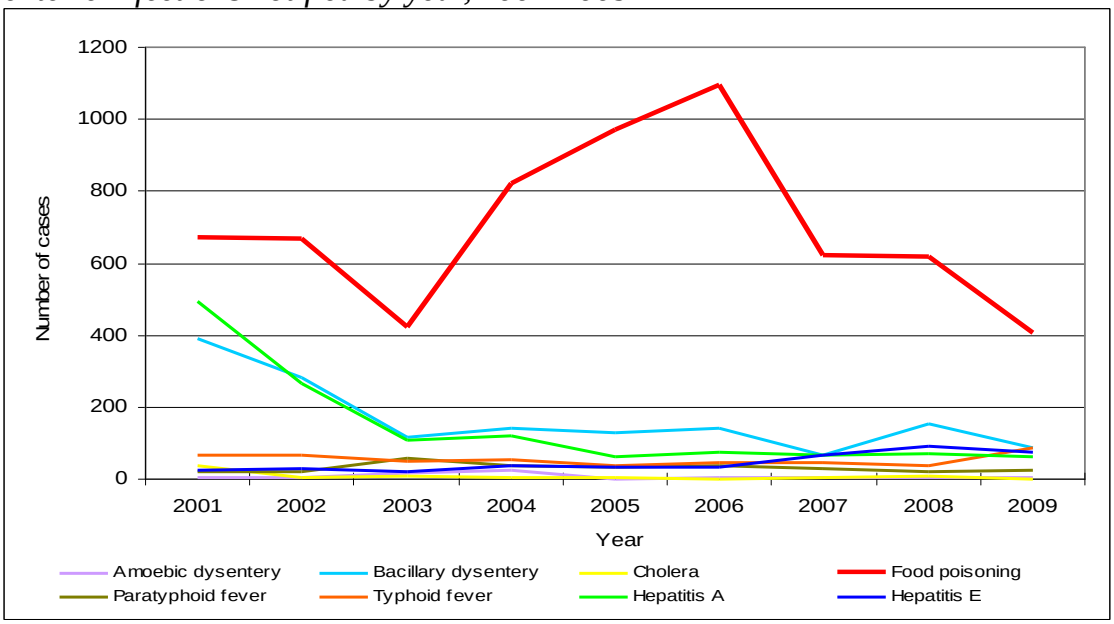
14. We examined the data collected in the statutory notification system on food poisoning outbreaks of the Department of Health (DH). Food poisoning outbreak data from 2001 to 2009 were retrieved for current analysis.

15. Food poisoning is a statutorily notifiable disease. When DH receives a report of suspected food poisoning, investigation will be carried out immediately. A suspected VP related food poisoning outbreak is defined as an incident in which two or more persons having compatible symptoms and common meal that suggests the food as the source of the illness. If further investigations identify VP as the food poisoning organism from at least one patient's clinical specimens or food remnant or sample from the same batch of food, it is classified as a confirmed outbreak. Alternatively, if a patient in an outbreak is epidemiologically linked to a confirmed case, it is also regarded as a confirmed outbreak.

Outbreak Trends and Characteristics

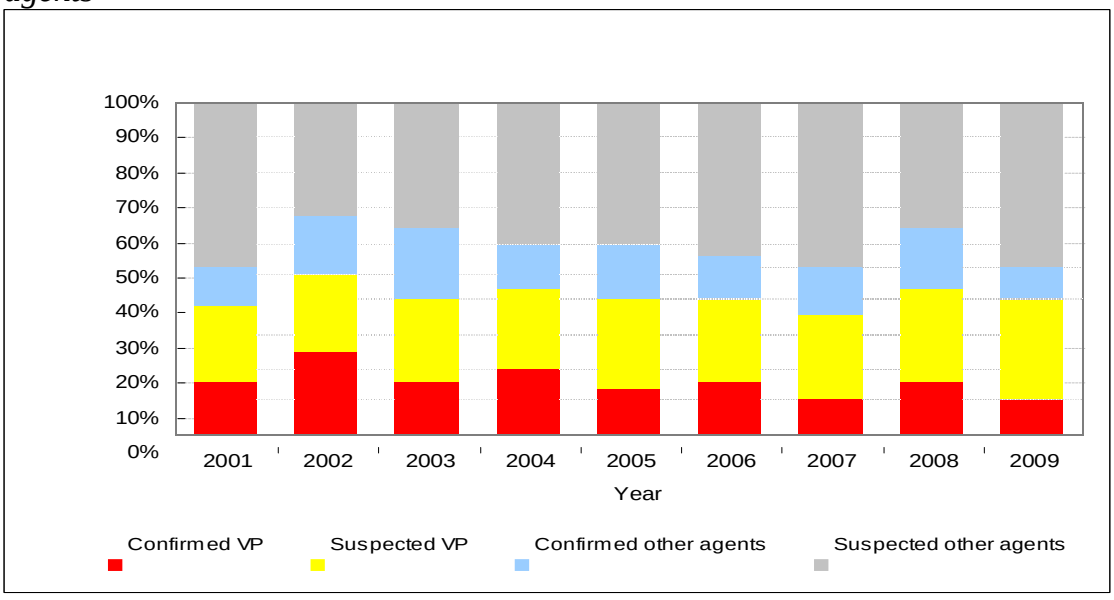
16. From 2001 to 2009, there were a total of 6,298 food poisoning outbreaks reported. The annual number of food poisoning notification was around 600 cases in 2000 – 2001. After a significant drop which might have related to SARS outbreak in 2003, the notification number climbed up gradually from 821 in 2004 to 1095 in 2006 and then decreased since 2007 to around 400 in 2009. Similar drop in notification was not observed in other statutory notifiable foodborne diseases and enteric infections (Figure 1). Among all outbreaks, 2,044 (32.5%) were classified as confirmed according to the above case definitions.

Figure 1. Number of selected statutory notifiable foodborne diseases and enteric infections notified by year, 2001-2009



17. VP remained the commonest pathogen among all causative agents. Despite the year-to-year variation of total number of food poisoning outbreaks over the period, the proportion of outbreak related to VP remained relatively stable (Figures 2). VP accounted for around 36% to 50% of all food poisoning outbreaks between 2001 and 2009. Overall, only 37.0% (983/2658) of VP-related food poisoning outbreak were confirmed.

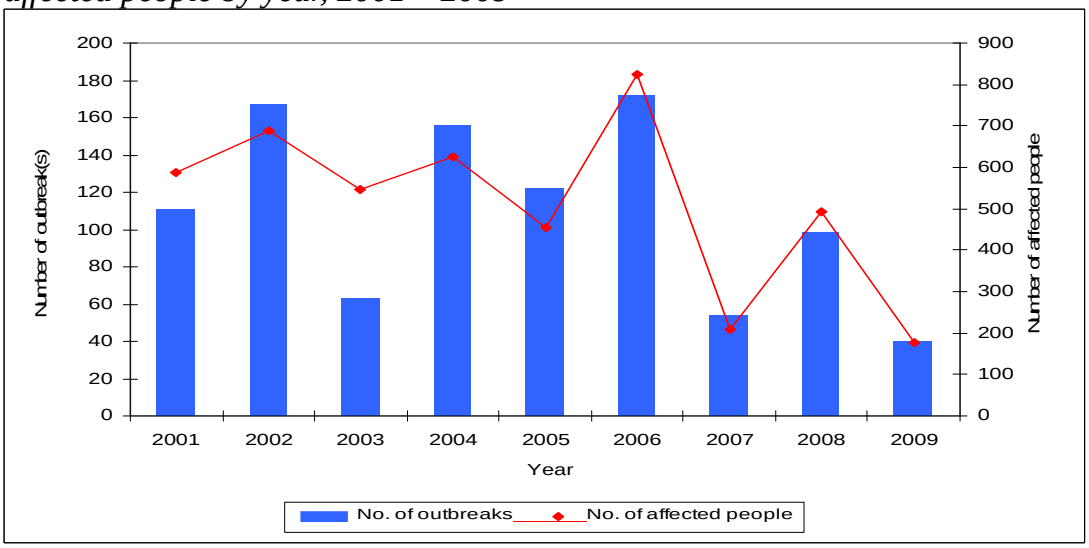
Figure 2. Proportion of food poisoning outbreak caused by VP versus other agents



18. We conducted further analysis based on the details of the 983 confirmed outbreaks. The annual number of confirmed outbreaks and people affected is shown in Figure 3. Most of the outbreaks reported in these nine

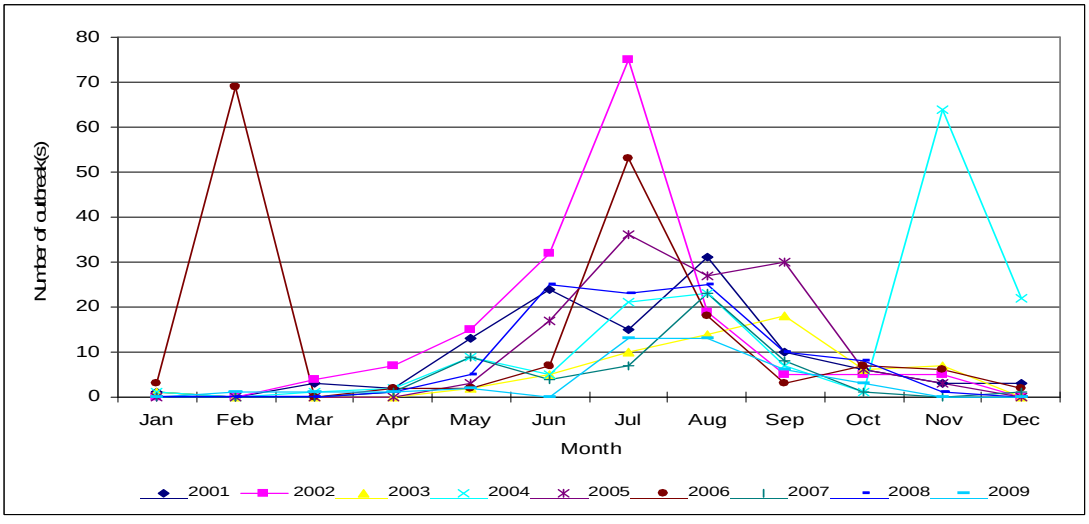
years were local cases. Less than 4% of the outbreaks were associated with food consumption outside Hong Kong, such as Mainland China and Southeast Asia.

Figure 3. Number of confirmed VP food poisoning outbreaks and number of affected people by year, 2001 – 2009



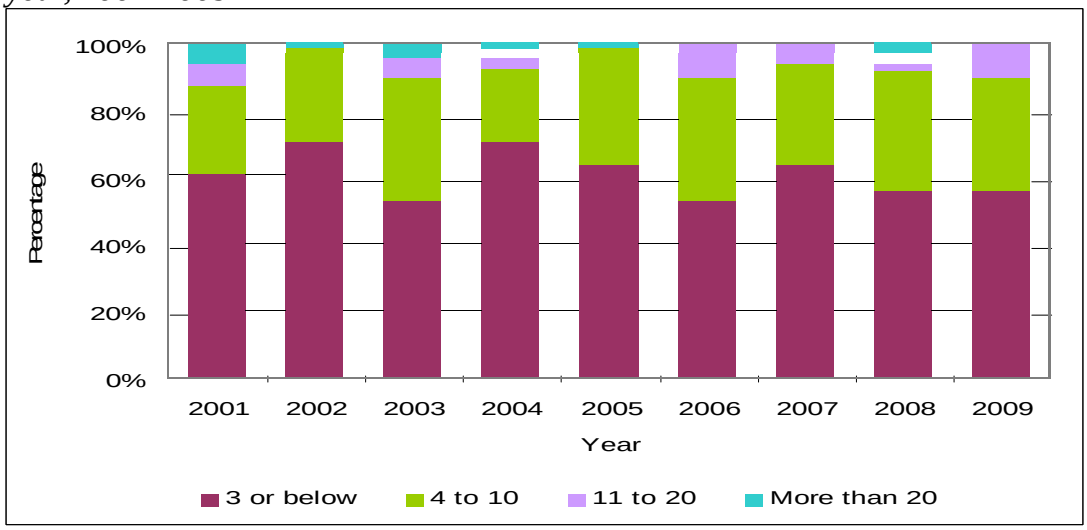
19. The occurrence of VP food poisoning outbreaks exhibited seasonal pattern with outbreaks occurring most commonly in summer (Figure 4). This is consistent with the faster multiplication time of VP under higher temperatures[6].

Figure 4. Number of confirmed VP food poisoning outbreaks reported by month, 2001 – 2009



20. Most of the outbreaks affected ten or less people (Figure 5). Overall, the median size of outbreak (i.e. the number of people affected in the outbreak) was 3 people. From 2001 to 2009, larger outbreak (affected more than 10 persons) accounted for less than 6% of confirmed VP-related outbreaks each year.

Figure 5. Size of outbreak (i.e. number of persons affected in each outbreak) by year, 2001-2009



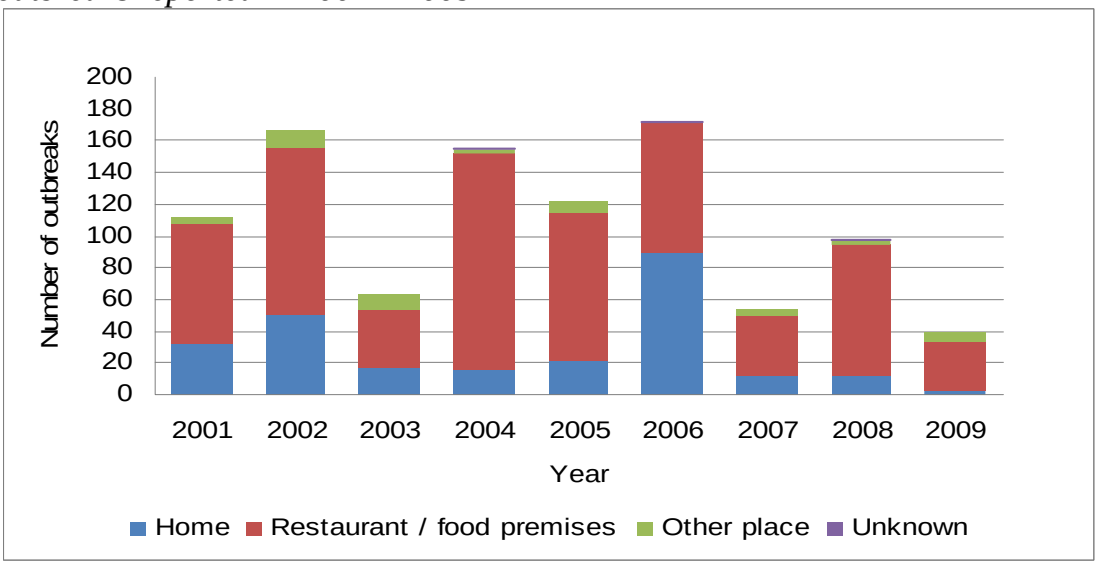
21. The male to female ratio of all persons affected by VP food poisoning was 1:1.3 (Table 1). Less than 9% of all affected persons in our notified outbreaks were below 10 years or above 65 years of age.

Table 1. Age and sex distribution of persons affected by confirmed VP food poisoning, 2001 - 2009

	Female	Male	Unknown	Total	Male : Female ratio
Under 1 year	0	0	0	0	Not applicable
1 - 9 years	103	83	0	186	1:1.24
10 - 19 years	289	314	0	603	1:0.92
20 - 64 years	2000	1470	8	3478	1:1.36
65 years & above	126	75	0	201	1:1.68
Unknown	72	51	13	136	1:1.41
Total	2590	1993	21	4604	1:1.30

22. Most of the confirmed VP-related food poisoning outbreak occurred at restaurant or food premises (Figure 6). For instance, a large cluster of VP-related food poisoning (with 78 epidemiologically linked outbreaks) associated with a food premises was reported in November 2004, where 186 persons were affected[26]. An exception was noted in 2006 when there were more domestic outbreaks than those occurred in restaurant or food premises. This was related to another large-scale food poisoning cluster related to take-away Poon Choi containing seafood. This particular cluster, consisted of 71 linked outbreaks and affected 485 persons, occurred in February 2006[27].

Figure 6. Place of food consumption for confirmed VP-related food poisoning outbreaks reported in 2001 – 2009



23. The specific food item causing the outbreak was investigated in accordance with exposure history, biological plausibility, and environmental investigation findings. Seafood such as shrimp, squid, and marine fish as well as sashimi and sushi were the most frequently implicated food item in VP food poisoning outbreaks reported in Hong Kong. Poached chicken, "Siu Mei" and "Lo Mei" are other common food items causing VP food poisoning. Unlike some Western countries such as the US, oyster is relatively less important in causing VP food poisoning outbreaks in Hong Kong. Other implicated food items included assorted dish, bean curd, vegetables, and dish with noodle or rice.

24. Overall, cross contamination (48%) and inadequate cooking (31%) were considered as the most common contributory factors for the confirmed VP-related outbreaks (Table 2). While cross contamination was mostly suspected in food such as chicken, Lo Mei, sushi and sashimi, inadequate cooking mostly referred to seafood.

Table 2. Primary contributing factors in confirmed VP food poisoning outbreaks, 2001 – 2009

	Outbreaks		No. of affected people	
Cross-contamination	468	48%	2037	44%
Inadequate cooking	304	31%	1714	37%
Contaminated raw food	117	12%	441	10%
Contamination by utensil	15	2%	69	1%
Others	79	8%	343	7%

25. In summary, VP is the commonest causative agent of food poisoning outbreak in Hong Kong. A drop in number of VP-related food poisoning outbreak was observed since 2007. The drop was also observed in food poisoning outbreaks related to other pathogens, but not in other statutory notifiable foodborne diseases or enteric infections. Nevertheless, VP still accounted for 36% to 50% of food poisoning outbreak each year. Most of the VP-related outbreak was small in size, but large-scale clusters occurred occasionally and could affect hundreds of victims. Seafoods together with siu-mei and lo-mei, which might have not cooked adequately or have been contaminated by raw food, were the most commonly encounter food items in confirmed VP-related outbreaks.

Behavioral Risk Factor Survey

26. A territory-wide telephone survey (The Behavioral Risk Factor Survey) was conducted in April 2006 to examine various behavior of the population including practice of food hygiene[28]. Only 72.7% of the respondents mentioned that they "performed cooking or reheating food thoroughly (including seafood)" all the time while 66.9% of the respondents "keep raw and cooked food separately" all the time.

Laboratory Data

27. Laboratory surveillance data came from the laboratory component of the sentinel surveillance based at Government out-patient clinics (GOPC) and general practitioners (GP) were reviewed. Criterion for specimen collection at the sentinel physicians is when a person presented with acute diarrhoeal disease. All tests were conducted by the Public Health Laboratory Services Branch (PHLSB) of CHP. In addition, information on serotyping of VP isolates conducted between 2005 and 2008 was also retrieved for analysis.

28. Among 2,010 specimens taken for culture at the sentinel physicians between 2001 and 2008, 319 were positive for bacteria. VP was the second most common bacterial agent isolated (22%), following *Salmonella* species which accounted for 23% of the positive cultures.

29. Since 2005, O3:K6 has remained the predominant serovar of all VP isolates typed by PHLSB. It accounted for 67% of all VP isolates typed by PHLSB in 2005 and for 40% to 47% between 2006 and 2008. This picture is compatible with the situation in Asia where O3:K6 was identified as the commonest serovar associated with food poisoning outbreaks.

Food Surveillance

30. The Centre for Food Safety (CFS) of Food and Environmental Hygiene Department (FEHD) maintains a food surveillance programme that monitors the occurrence of hazards including pathogens like VP in food. Under the programme, ready-to-eat food samples are collected at import, manufacture, wholesale and retail levels of the food supply chain for detection of VP. CFS, in consultation with its Expert Panel on Microbiological Safety of Food, has published the Microbiological Guidelines for Ready-to-eat Food, which considered unacceptable if the level of VP in a tested food sample is at or above 1000 cfu/g[29].

31. In 2008, among about 17,100 food samples taken for microbiological tests under the food surveillance programme, 36 were found to contain unaccepted level of pathogens but none of the samples was found to contain unacceptable level of VP[30].

Current health protection measures

Surveillance of Food-borne Diseases

32. All registered medical practitioners are required by law to report suspected or confirmed cases of food poisoning to the Department of Health. CHP monitors trends of VP-associated food poisoning through analysis of data obtained from investigation of food poisoning outbreaks and laboratory results of specimens taken during food poisoning investigations. Disease trend, causative agents and risk factors for food poisoning are reviewed and analysed on a regular basis.

Outbreak Investigation and Control

33. All reported food poisoning outbreaks are investigated by CHP. For outbreaks associated with food premises, they are jointly investigated by the CHP and FEHD. CHP is responsible for delineating the epidemiology of the outbreak (including source identification and associated contributing factors), while CFS/FEHD collects food and environmental specimens for laboratory analysis, provide specific advice on food hygiene, conduct source tracing and take actions against any irregularities identified during the course of investigation. Sale and distribution of incriminated food may be suspended

as appropriate. Closure order would be issued if food premises poses an immediate health hazard to the public.

Promotion of Health Protection Measures to Public and Trade

34. Overseas evidence has shown that food handler training can improve the knowledge and practices of food handlers while selected community-based education programs can increase public knowledge of food safety[31]. CHP and CFS both have important roles in educating the public on the prevention of foodborne diseases. CFS has produced a variety of education materials and pamphlets on the prevention of food borne infection including VP infection targeted at both members of the public and the food industry. CFS also organized various publicity activities to increase awareness of the public on food safety, and various seminars and educational campaigns targeted at food industry operators and food handlers on safe food handling practices. These activities also include education and publicity on the prevention of VP-related food poisoning.

Legislation

35. The Public Health & Municipal Services (Amendment) Ordinance has been in force since 14 February 2003. The Amendment Ordinance enables the FEHD to more effectively tackle the problems of unlicensed food establishments and licensed and unlicensed premises which pose immediate health hazard. The Director of Food and Environmental Hygiene (DFEH) is empowered to make a direct application to the court for a Closure Order to close premises where specified activities are carried out without the requisite licence or permit. DFEH is also empowered to close premises if he has reasonable cause to believe that the use of such premises poses an immediate health hazard.

Food Surveillance and Control

36. FEHD has put in place the routine food surveillance programme in order to ensure food safety and prevent health hazards associated with food. Since the establishment of CFS in 2006, a more targeted approach has been adopted to be in line with the international trend of putting more focus on target-based surveillance. Under the said programme, samples of ready-to-eat food including sushi/sashimi, rock oyster, etc. are taken for bacteriological examinations including total bacterial count, *E. Coli*, *Staphylococcus aureus*, *Vibrio parahaemolyticus* and *Salmonella* organisms. The surveillance results are announced to the public on regular and timely basis. Products with unsatisfactory result would be removed from the market immediately. Further follow-up actions, such as source tracing and legal prosecution, will be carried out as appropriate.

Recommendations

37. To enhance the preventive and control measures of food poisoning related to VP, the following strategies are proposed:

Outbreak Investigation and Control

38. VP-related food poisoning outbreaks in food premises have wide public health impact, close collaborations between CHP and CFS are essential for the investigation and control of VP related outbreaks. Moreover, typing by pulsed-field gel electrophoresis may be applied to better delineate the epidemiology of VP-related food poisoning outbreak.

Food Surveillance and Control

39. It is recommended maintaining the surveillance programme on pathogens including VP in ready to eat food. This is especially important for high risk foods such as seafood and those related to previous food poisoning and food incidents. In addition, it is supported to monitor the efficient use of resource for the surveillance programme.

Public Health Education

40. It is recommended to further enhance health education activities on prevention of VP related food poisoning, including both food industry and the general public at large. It is also crucial to ensure adequate risk communication prior to the usual seasonal peak. Specific health messages targeted in preventing VP related food poisoning can be considered. Example of such health messages can be found in the "Risk Assessment studies on Vibrio Species in Seafood" published by FEHD[32]. For instance, in buffet setting, the food industry should display seafood at 4°C or below or 60°C or above. In handling equipment and utensils, it is important to prevent cross-contamination between raw seafood and other food. For general public, it is advised to cook high risk food such as oysters in boiling water for not less than 5 minutes. In addition, evaluation of the effectiveness of health education activities is encouraged to practice evidence-based medicine.

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